

# DWARKA NAGAR PALIKA

**(Technical Specifications for Pumping Machinery)**

## **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 APFC panel, transformer 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 three years 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  $\leq 2.0$  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 APFC Panel, transformer 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 three 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 NAGAR PALIKA, DWARKA.

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**~~

4.0 **THIRD PARTY INSPECTION**

Inspection and testing of the major electro - mechanical equipments such as VT / SCF / HSCF / End Suction (Back Pull Out) pumping machineries (except vacuum pump, drain / dewatering, dredging / de silting and diesel driven pumps), Induction Motors, Transformer, MCC / MVDB with APFC Panel, Flow Meter, Valves and EOT 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, motorised 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 two pole structure with accessories, cable, GI - MS pipes with specials, pressure gauge etc. internal test / quality / calibration certificates shall have to be furnished for review / acceptance.

- 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 SPECIFICAITONS FOR SUPPLY OF EQUIPMENTS**

### **1.0 GENERAL**

This part covers conditions pursuant to the contractor 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 confirm 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 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, commutates 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 exciters 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 owing to him by the contractor, under in respect of or by reasons 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 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, pre-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 MANagements**

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 provided 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 pacifications.

#### **12.0 COOPERATION WITH OTHER CONSTRUCTIONS & FOR GWSSB**

The contractor shall agree to cooperative 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. They also design requirement 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 still 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 if 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 labor 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 it's 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)

<b>Sr. No.</b>	<b>Description</b>	<b>To be submitted with the Tender</b>	<b>To be submitted after the award of the Contract</b>
<b>Outline Dimensional Drawing</b>			
.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		*
<b>Cross Sectional Drawing with Materials of Construction</b>			
.1	Pump	*	*
.2	Motor for above	*	*
.3	Pump Performance curves at rated RPM : Q Vs H, P, $\eta$ & NPSH	*	

Sr. No.	Description	To be submitted with the Tender	To be submitted after the award of the Contract
.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 Soft Copy 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 recognised 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 Electrotechnical 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 minimize 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 121<sup>0</sup> 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 unauthorized 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 nameplate 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 corners 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/cm<sup>2</sup>. 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 motive 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. Galvanizing shall be carried out after all 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 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**

### **Horizontal Split Casing Centrifugal Pump Motor Set:**

#### **1.0 Scope**

This specification covers the design, construction features, manufacture, testing performance and delivery of horizontal split casing centrifugal pumps. The pump shall be directly coupled with electric motors. A common M S base plate (fabricated) shall be provided for the pump motor with all accessories such as coupling, coupling guard, foundations bolts etc. complete.

#### **2.0 Standards & Codes**

The horizontal split casing centrifugal pumps as specified herein shall comply with the requirements of all applicable latest codes, regulation and safety codes in the locality where the pump sets will be installed. The latest editions of the following standards shall be followed.

- a) IS: 5120 Technical requirements for roto dynamic special purpose pumps
- b) IS: 6595 / 2002 (Part I) Horizontal Centrifugal Pump for clear, cold and fresh water
- c) IS: 11346 / 2002 Tests for agricultural & rural water supply pumps: code of acceptance

#### **3.0 Specific Requirements**

- 3.1 The contractor shall make his own assessment of the friction losses (based on C -100) under all conditions of operation and suitable head shall be selected. Data given in the data sheets is indicative.
- 3.2 Details of pump and motors such as discharge, efficiency head, BHP, RPM etc. shall be worked out and filled up by the contractor in the enclosed data sheets.
- 3.3 Pumps shall have a continuous rising head characteristic from the operating point towards shut off without any zone of instability. Pump with dropping curves are not acceptable. The contractor shall submit system resistance curve for the pumping station.  
  
The head capacity curve shall be continuously rising towards shut off with the highest at shut off head shall be minimum 115 % of the duty point head.
- 3.4 Pumps of each category shall be identical in all respect and shall be suitable for parallel operation and from the same manufacturer.
- 3.5 The minimum percentage of margin over the input power required at pump design should be provided as mentioned here under in table I. Motor BkW shall be suitable to cover complete operating range.

**Table I**

<b>MOTOR BKW</b>	<b>% OF PUMPING DESIGN POINT BKW</b>
<b>1.5 to 3.7 BKW</b>	<b>140 %</b>
<b>3.7 to 7.5 BKW</b>	<b>130 %</b>
<b>7.5 to 15 BKW</b>	<b>120 %</b>
<b>15 to 75 BKW</b>	<b>115 %</b>
<b>Above 75 BKW</b>	<b>110 %</b>

The power rating of motor thus selected should be higher than the power consumption on any point on the characteristic curve.

- 3.6 Materials of construction of pumps shall be as per data sheet enclosed.
- 3.7 Pump set along with its drive shall run smooth without undue noise, vibration & temperature rise.
- 3.8 All rotating parts shall be statically and dynamically balanced.
- 3.9 Pumps of approved makes shall be accepted as specified in appended vendor list.
- 3.10 Before placing the order for pumps to the pump manufacturer, approval of QAP is to be obtained from concerned Executive Engineer.
- 3.11 The motor drive shall be totally enclosed fan cooled squirrel cage induction and shall conform to IS: 325.

#### **4.0 General Requirements**

- 4.1 The calculation for system resistance is to be furnished along with offer. The HQ characteristic of individual pump is to be super imposed on system resistance curve to locate operating point and is to be enclosed with bid. The operating point should be matching with best efficiency point of the pump. The pump model shall be the one from the existing regular production range of the manufacturer.
- 4.2 At least 10 units of the pump model shall be in operation at different job sites.
- 4.3 The pump sets are to be accommodated in the prescribed size of pump house. There will not be any change in the size of pump house. The layout of the pump sets shall suit to that shown in the respective pump house drawing.

#### **4.4 Features of Construction**

Construction features shall be generally as specified here under.

##### **4.4.1 Casing**

Split horizontally along the central axis, lower half contains suction and delivery branches to facilitate dismantling, inspection and repairs.

**4.4.2 Impeller**

The impellers should facilitate single / double entry to eliminate thrusts and it shall be dynamically balanced to ensure freedom from vibrations. The determinant factor for single / double suction shall be specific speed so as to achieve maximum efficiency. It shall be positively locked on shaft and shall not loosen under reverse rotation.

**4.4.3 Shaft**

A single piece shaft shall be designed for 0.05 mm maximum deflection at stuffing box face under worst condition of shut off head. Renewable shaft sleeves shall be provided with suitable packing to prevent leakages. shaft shall be properly balanced so as not to cause any vibration during operation.

**4.4.4 Coupling**

A flexible coupling of adequate size shall be provided for direct coupled drives. It should be preferably be pin & rubber bushing type. Spacer type / Tyre type / Lovejoy are also acceptable alternatives

**4.4.5 Base Plate**

The base plate shall be of rigid construction and fabricated out of standard steel section conforming to IS: 2062. The minimum height of section shall conform to the following table:

**Table II**

<b>Pump with drive rating up to</b>	<b>Minimum section height</b>
<b>Up to 30 kW</b>	<b>100 mm</b>
<b>37 kW to 55 kW</b>	<b>125 mm</b>
<b>75 kW</b>	<b>150 mm</b>
<b>90 kW and above</b>	<b>200 mm</b>

The base plate grouting holes shall be accessible without removing the pump and drive shall permit filling of the entire cavity the base plate without trapping air pockets. Base plate shall compulsorily be manufactured / fabricated by the pump manufacturers' only.

**Tests & Inspection:****Inspection & Testing at Manufacturer's Works**

Inspection and testing at manufacture's works shall be carried out as specified below. All instruments and equipments required for such tests shall be provided by the vendor and the instruments shall be calibrated and certified by an approved independent testing authority. All the tests shall be carried out as per the relevant IS code. Brief description of the tests to be carried out is as follows.

### **5.1 Hydrostatic Test**

- 5.1.1 All the pressure containing parts shall be tested with water at 1.5 times the maximum discharge pressure on the head characteristic curve or twice the rated pressure whichever is higher.
- 5.1.2 Unless otherwise stated in data sheet the hydrostatic test shall be conducted for a minimum duration of 30 minutes.
- 5.1.3 Factory test certificate of hydrostatic test carried out is to be furnished at the time of joint i. e. third party inspection agency & the department @ the time of factory inspection.

### **5.2 Mechanical Balancing**

#### **5.2.1 Static Balancing**

Major rotating components of the pump like impeller (s), shaft etc. shall be individually statically balanced.

#### **5.2.2 Dynamic Balancing**

In addition to static balancing impeller and pump rotating assembly shall be dynamically balanced at the rated speed of rotation as per relevant IS.

### **5.3 Performance Testing**

Each pump be shall tested for its full operating range in accordance with the relevant IS standards. Site conditions shall be simulated as near as possible. They shall be carried out with minimum NPSH as available at site for its rated discharge and maximum discharge. Each pump shall be tested at its rated speed with its entire working range. Test shall be conducted with actual drive capacity motor as defined in the data sheet. No relaxation in this regard shall be permitted. During pump testing reading to the extent possible shall be taken to correspond to the net effective range specified in the data sheet and over its full working range from its closed valve condition to full valve open condition. Head flow and overall efficiency characteristic curves shall be drawn. The curve produced shall determine the capability of pump set to meet the guaranteed performance at site.

- 5.4 Pumps shall be offered for visual inspection to the purchaser before dispatch. Components of pump shall not be painted before carrying out the factory inspection.

### **5.5 Material (s) Test Certificates(s)**

Material test certificates for the various pump components shall be furnished @ time of factory inspection jointly by TPI & department.

### **6.0 Spare Parts**

- 6.1 The contractor shall supply list of spares required for commissioning & for maintenance work.

**7.0 Tools & Tackles**

- 7.1 A complete set of necessary special tools and test equipments shall be recommended by the contractor for erection, dismantling or for maintenance work to be carried out on any part of the pump set during the life of pump set. It shall be stated in the schedule of spare parts and tools and tackles.
- 7.2 The tools shall include clamps, wrenches and any other special tools, gauges testing jigs, or extractors or bearing pullers, which may be required during the life of pumps.

**8.0 Protection Packing for Transportation**

- 8.1 Prior to dispatch from manufacturer's works all equipments shall be adequately protected by painting or by other approved means for whole period of transit, storage and erection, against corrosion and incidental damage, including the effect of vermin, sunlight, rain, high temperature and humid atmosphere. The equipment shall be packed to withstand rough handling in transit and the package shall be suitable for storage including possible delay in transit.

**9.0 Tender Drawing(s) / Data**

- 9.1 The following drawing data shall be submitted along with their bids. HSCF pump data sheet shall be duly filled in by the contractor & preferably be ratified / certified by the pump manufacturer.
- 9.2 Preliminary outline dimensional drawing showing the details of pump and motor and general arrangement drawing including base plate detail.
- 9.3 Performance curves viz. capacity v/s total head, efficiency, NPSH and kW requirement duly marked at duty point from shut off duty point and maximum permissible duly certified by the pump manufacturer.
- 9.4 Typical cross section drawing catalogue showing type of construction.

**10.0 Drawing(s) to be submitted by the successful bidder**

- 10.1 Foundation drawings for pump motor set.
- 10.2 General arrangement drawing and cross sectional drawings showing parts list and materials of construction.

**11.0 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.

**12.0 Details & Requirements (DATA SHEET)****1.0 HSCF PUMP DETAILS:**

- |     |                                  |                               |
|-----|----------------------------------|-------------------------------|
| 1.1 | Pump type                        | Horizontal Split Casing C. F. |
| 1.2 | Number of pumps                  | As per Price bid              |
| 1.3 | Number of normally working pumps | As per Price bid              |

1.4	Design Capacity	As per Price bid
1.5	Total head at design capacity	As per Price bid
1.6	Suction pressure at rated capacity	Positive Suction (*In case of Negative Suction, details of available NPSH & NPSH required shall be compulsorily provided)
1.7	Total duration of operation	22 hours continuous
1.8	Speed	1450
1.9	Location	indoor

**2.0 FEATURES OF CONSTRUCTION:**

2.1	Casing	HSCF type
2.2	Impeller	Closed
2.3	Shaft	Coupled
2.4	Drive Transmission	Direct
2.5	Seal	Gland Packing
2.6	Mounting	Common Base Frame Mounting
2.7	No. of Stage (s)	Single / Two Stage (s)
2.8	Suction	Single / Double
2.9	Nozzle orientation	A. Suction Side suction B. Discharge Side discharge
2.10	Flange Drilling	IS 1538
2.11	Direction of rotation	as per manufacturer's standard

**3.0 LIQUID DATA:**

3.1	Liquid handled	Clear water
3.2	Specific gravity	1.0
3.3	Temperature	Ambient

**4.0 MATERIAL(S) OF CONSTRUCTION:**

4.1	Base Plate	M S Fabricated (to be fabricated by the pump manufacturer only)
4.2	Pump Casing	CI IS: 210 FG Grade 260
4.3	Impeller	Bronze as per IS: 318 LTB II
4.4	Shaft	SS AISI 410 or Equivalent
4.5	Shaft Sleeve	Bronze as per IS: 318 LTB / SS 410
4.6	Wearing Ring	Bronze as per IS: 318 LTB II
4.7	Painting	Epoxy
4.8	Hardware in contact with water	Hot deep Galvanized

4.9 Companion Flange MS

**5.0 ACCESSORIES AND SERVICES REQUIRED:**

5.1	Base Plate	Yes
5.2	Foundation bolts	Yes
5.3	Companion flanges	Yes
5.4	Spare parts recommended	Yes (List is to be provided)
5.5	Maintenance tools	Yes (List is to be provided)
5.6	Start up / essential spares	Yes
5.7	Painting	Yes

**6.0 TESTING:**

6.1	Hydrostatic test	Test certificate (s) required
6.2	Performance test	Required @ manufacturer's works
6.3	Static and dynamic balancing test	Test certificate (s) required
6.4	Visual inspection check	Yes
6.5	Parallel operation site	Required
7.0	Prime Mover by the contractor	Required

**Minimum Efficiency of Pump as HIS shall be achieved**

**Submerged Centrifugal Pump**

**5.0 SUBMERGED CENTRIFUGAL PUMP-MOTOR SETS (SCF PUMPS)  
TECHNICAL SPECIFICATIONS**

- a) The pump set shall be of compact unitary construction. The pump casing shall be of high efficiency, volute casing or bowl type with the impeller mounted directly onto the extended solid motor shaft (without any couplings). The pump design shall be suitable for water sump de-watering purpose. Pump shall be suitable to handle Mud, debris etc. Pump shall be of Non-clog design. Maximum solids handling capacity of the pump shall be provided accordingly.
- b) The pump is to be mounted directly in submerged condition in to the water storage area. It may suck up silt, clay, pebbles etc. Hence it should be of appropriate reliable and robust design.

**INSTALLATION**

- c) The pumps shall be suitable for portable installation either horizontal or vertical and shall be interchangeable between these modes throughout their working life time. The pump will be discharging water through vertical column pipes.
- d) The pump shall be offered with vertical column discharge with or without any bottom

supporting arrangement. Bottom anchoring with auto coupling type or horizontal axis pump suitable to the requirement may be provided.

- e) The scope of works shall be inclusive of the Pump-motor sets with Discharge / Column Pipes necessary supporting arrangements at the top floor.
- f) To "fish out" a Vertically Installed Submerged pump-set (even if a chain has not been attached to the lifting hook prior to the pump-set 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.

### PUMP DESIGN

- g) Speed: Speed is required to be decided on achievable efficiency of pump.
- h) 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 shall be suitable for parallel operation.
- i) 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. The Impeller shall be of high efficiency Multi Channel Enclosed type (except for Specific Speeds  $\geq 90$  where Semi Open Impellers shall be allowable).
- j) Suction Strainer: Provision of a suction strainer shall be dependent on the material to be lifted by the pump.
- k) 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.
- l) Fully filled up and Stamped Data Sheets as per attached format shall be submitted along with the Technical Bid.
- m) Pump shall be horizontal or vertical single shaft machine having a common shaft for pump motor
- n) A filter/screen arrangement is to be provided at the inlet of the incoming water, i.e. at the source of water to enter in to the water storage area. However, the Pump shall be suitably designed to handle the silt / mud / s / debris / grass / any other foreign material, which is likely to come along with the water.
- o) Pump-motor unit shall be provided with suitable lowering lifting arrangements
- p) The Pump-motor unit shall be supplied with a suitable sufficiently long copper cable for a direct connection with the electric power / control panel without any joints when the pump-



motor unit is installed inside the water.

- q) The Characteristic curves of the Pump Head, Efficiency, BKW the NPSHR against the Discharge Flow Rate shall be furnished by Pump-motor Vendor.
- r) The Pump-motor unit shall be of water proof design suitable for total submergence in the water compatible to operate normally against the minimum, maximum normal water levels in the water storage area and for continuous operation.
- s) The Pump-motor unit shall be provided with a suitable moisture sensing arrangement so that the pump-motor unit shall be electrically tripped when moisture is sensed.
- t) There shall be a suitable provision like: Thermistor Relay / any other for tripping of the unit against pump over load / motor overheating.
- u) The Pump-motor unit shall be provided with the necessary supporting arrangement at the top of the well the flanged discharge bend at the outlet for further connecting with the expansion elbows etc. Apart from this, the pump vendor shall provide any other auxiliary / accessories that are required for his design of pumps for smooth, safe efficient operation it will be included in their offer of the pump-set.

### MOTORDESIGN:

#### (I) TYPE OF MOTOR

- a) The motor shall be of Squirrel Cage, Induction type, Air Filled, yet suitable for the actual, maximum water immersion in to the water and also suitable for S1 duty. It may be rated for LT - 415 Volt ( $\pm 10\%$ ), 3 phase, 50 Hz ( $\pm 5\%$ ) or HT AC electric supply as suitable. Its winding should be of Class "F" insulation \* (withstanding winding hot spot temperature of up to  $185^{\circ}\text{C}$ ) while the nominal temp rise of winding hotspot should not exceed that of class "B".
- b) It should be wound using Dual Coated, Super Enameled; Copper wire with high temperature index as per IS: 4800 Part-13. PVC / Poly Propylene / Poly Ethylene insulation for winding wires shall not be allowed. Motor's Insulation should be Vacuum Varnish Impregnated and Oven Baked to ensure Moisture Impervious and Mechanically Robust insulation. Dip or Pour type Air Dry Varnishing shall not be allowed.

#### (II) MOTOR RATING

The Motor Rating should be higher of the following two criteria:

- a) 50% margin on Maximum Power consumption throughout the range of performance at 50 Hz OR
- b) 15% more Brake Kilowatt Power (BKW) consumed at duty point at 50Hz.

(III) ROTOR OF MOTOR

The Motors Rotor shall be of Dual Cage Copper Bar Brazed type to assure following:

- a) Long Corrosion free Service life (in presence of high moisture inevitable in submerged motors. Aluminum corrodes much faster than Copper)
- b) Ease of Onsite Repairing and beneficial Fly Wheel type Inertial effect (as compared to aluminum rotor, copper rotor is heavy) which reduces detrimental effects of water hammer
- c) Better Motor Efficiency and Cooler Operating Temperature

(IV) MOTOR COOLING:

To restrict the Dead Water Level (in case of Vertical Installation) in the Sump to 1m, Medium sized, Vertical pumps ( $\geq 55\text{kW}$ ) should have a Cooling Jacket – i.e. motor cooling is accomplished by circulation of pumped water between the motor casing and the jacket shell - this jacket shell is fed by cold water from the pump casing and 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.

(V) MOTOR PROTECTION:

- Thermal Overload Protectors (Bi Metallic Over Load Relays) should be embedded in each phase of the stator winding to detect overheating and trip the motor from the control panel in the event of the temperature exceeding the safe operating limit (above  $130^{\circ}\text{C}$ ).
- To detect primary Mechanical Seals Leakage a Moisture Sensor shall be provided in intermediately Oil Chamber (and not in the Motor casing or elsewhere) – this shall detect water mixing in oil by mode of increased leakage current from the moisture sensor.

(VI) CABLES:

- a) A watertight Cable Junction Box sealed from the motor shall be provided for the motor power signaling cables.
- b) The cable shall be brought directly out of the submerged motor without joints, shall be of sufficient length, minimum 10 m to be terminated in an IP 67 junction box (in the scope of electrical contractor) outside adjacent to the wet well and above the HFL. They shall be sized in accordance with the electricity utility regulations BS7671.
- c) It should have Power as well as Control Cables of Dual Sheathed EPRS / PVC Armored

type with Copper Core of required size as per detail engineering. However the Cross Section of the cable shall be ample enough to ensure a Voltage Drop of not more than 2% at actual site conditions.

(VII) SHAFT and BEARINGS:

- a) The Solid Shaft shall be supported by heavy duty Ball or Roller bearings with a minimum L10life of 75,000 hours in accordance with BS 5512. The bearings should be Permanently Greased with Premium Quality, High Temperature, Long Life Grease thereby obviating the need of re-lubrication for up to L10life of the bearings. The bearing should be of Metric Series and not Imperial ones.
- b) Oil Lubricated bearings shall not be allowed.
- c) In case the motor is to be driven via a VFD, at least one of the bearings (DE or NDE) should be Current Insulated to prevent “electric fluting damage” caused by Harmonics.

(VIII) STUFFING BOX / OILCHAMBER:

- a) The pressurized entry of water into the motor (from the pump’s volute/Bowl casing) should be prevented by Two separate mechanical seals in mounted in a Tem mode within an oil chamber.
- b) The Primary (Inboard) seal should always be of Silicon Carbide or Tungsten Carbide faces to widths erosive wear due to any silt particles.
- c) The Secondary (Outboard) seal should be of Carbon v/s Cast Chrome Molybdenum Steel or Silicon Carbide or Tungsten Carbide – i.e. Thermally Unstable materials like Alumina/ Aluminum Oxide shall not be allowed.

(IX) TESTING:

- a) The pump sets shall be tested in accordance with ISO 9906, IS 10981, IS 5120 (Tolerance Class 2); with or without VFD as per the provision in the Tender specifications.
- b) The Flow shall be measured by full Bore Electro-Magnetic or Ultrasonic Flow Meters (of 0.5% or less accuracy class.)
- c) The Testing shall include the following:
  - (A) Motor Routine Tests at Pump manufacture place:
    - 1. IR
    - 2. HV

3. No Load Amperes, Vibration, Noise Levels, etc.

Note: Job pump shall be test with job motor.

(B) Pump Performance Test:

In accordance with IS 5120 / IS ISO 9906, Grade 2 -5% / ISO 2548-5% shall include measurements of Head, Discharge, Motor Input at least 6 different points to plot the Actual Performance Curves

- (C) All the Extra Charges for such Testing shall be borne by the Contractor. It is clarified that, in case of Field Testing Failure; Engineer-In-Charge / TPI 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 Re-Testing. No extra charges shall be allowed by owner to the contractor.

Pump testing should be carried out preferably with VFD or without VFD as per the provision of the tender. 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)

### **Mono Submersible Pump Set / Drain Pump set**

Horizontal mono submersible pump set shall be as per IS: 14220 / 1994 with latest amendments. The stated specifies the technical requirement for three phase mono submersible pump sets commonly used in sump for haling clear cold water for application in water supply etc. The duty point of the set should be located at the optimum efficiency point of the pump rating curves there should not be steep fall in efficiency in the operating range. The pump with single stage RPM of shall be 2900operatingon415±10%volts,3phase and 50Hz frequency.

Minimum motor horse power rating, cable size, starting system delivery size shall be as specified in the data sheet.

Features of construction shall be as follows.

### **Pump:**

The pump casing should be free from blow holes, sludge inclusion other detrimental defects. Casing should be provided with renewable wearing rings exception radial flow pump set. Casing should be provided with wearing rings. Casing should be hydraulically tested up to 1.5 times shut off pressure. Shut off head shall be at least105 % of maximum head range.

**Impeller:**

Impeller should be of closed type, ensuring required performance free of capitations. The material of impeller will be as per moc shown in data sheet.

**Shaft:**

The pump and motor shall be unbuilt on common shaft. Below the impeller shaft assembly, shaft protection sleeve shall be provided. It shall have surface finishing of 0.75 Microns. The material of shaft shall be as per Annexure - III.

**Motor:**

The submersible motor shall confirm to IS: 9283 / 1994 with latest revision. It should be totally enclosed squirrel cage induction type water cooled water lubricated sealed against entry from outside water.

The windings shall be of wet type. The thrust bearing should be of wet type water lubricated designed to take all untoward load at most unfavorable running conditions. Front rear bearing housing thrust bearing housing should preferably be fixed separate replaceable bolts / studs (not threaded connections) to the starter to facilitate easy dismantling. Full proof sealing arrangement by s guard shall be preferred in the motor inlet body to prevent open well water impurities like s, silt from entering the motor bearing stator motor should be impregnated with a superior varnish class B thermal insulation properties by vacuum pressure or epoxy paints on stator cold rolled stamping used rotor shall be painted with Polyurethane paint and backed properly under controlled temperature condition not by manual or gravity flow to remove air pocket so that these are thoroughly filled up by varnish. Motor rotor should be preferably lead shot blasted. Subsequently rotor body should be baked repeatedly under controlled conditions to ensure long life of paint hard finish to the surface to avoid corrosion before power coating.

The material of construction of rotor shaft shall be as specified in data sheet provided with sleeves having materials as per detailed material of construction in the bearing portion. The windings should be accessible to facilitate checking locating any faults without disturbing all the coils also to enable replacement of any defective coils. It should be possible to rewind the Stator with readymade protested coils in order to save time during the repair. Kelvin Bridge / digital resistance meter shall be treated preferable for measurement of hot cold resistance of winding for evaluated temperature rise. Full proof arrangement should be made for stopping the rotating of shifting of stampings inside the stator body due to operation of pump sets. Earth leakage current should not be more than 50 Milli amperes at rated voltage.

The HP rating of motor shall be decided on minimum power margin over above the power required on duty point shall be 25 % bidder has to supply motor of minimum HP rating considering 25 % reserve power margin.

Starting method shall be direct on line.

**Cable:**

Motor shall be provided with three core flat PVC water proof flexible copper submersible cable in single length (approx. 15 meters) of suitable size as per actual requirement. The cross sectional areas should be sufficient so as not to cause voltage drop of more than % of nominal voltage i.e. 10 volts at 400 volts throughout the length of the cable size of the Following points shall be applicable for the manufacture of the pump set:

- (1) Casing individually tested to hydraulic test pressure 1.5 times of shut off pressure.
- (2) All rotating parts should be individually balanced on machine for rated RPM according to the relevant IS ( vibrations of the assembly during the testing shall not exceed to 80 micron peak to peak). Impeller closed type
- (3) Motor Wet type
- (4) Brass / Carbon steel drain plug provided.
- (5) Compensating device provided
- (6) Stator varnished by vacuum pressure method or EPOXY painted (if cold rolled stamping used).
- (7) Rotor varnished by vacuum pressure method or Epoxy Paint methane paint duty properly backed.
- (8) Rotor painted baked under controlled condition or powder coated.
- (9) Winding easily assembled.
- (10) Winding subjected to 1.5 KV for 30 seconds
- (11) Matching grooves for stopping from rotation shifting
- (12) SS / Brass suction strainer preferred.
- (13) Stud nut shall be of alloy steel nut shall be Nyloc Nut.
- (14) Stator end ring shall be of bronze metal or MS.
- (15) Stator is rewind able with readymade protested coils in each type of motor offered
- (16) Cable confirming to IS:694.**

**Testing performance As per IS: 14220 with latest revision:**

Pump shall be tested as per IS: 14220 motor shall be tested as per IS: 9283 at manufacturers works. Bidder shall have to give internal test report.

**Materials of Construction**

Sr. No.	Description	Material (s)
1	Shaft sleeve when used	Grade X04 Cr. 12, X12 Cr 12 or X 20 Cr 13 Conforming to IS: 1570 (part-5) 1985
2	Motor bearing housing base	Grade FG 200 of IS: 210/1993
3	Pump and Motor Shaft (Common)	Grade X04 Cr 12, X12 Cr 12 or X20 Cr 13 Conforming to IS: 1570 (Part-5) 1985 or Grade 40C8 or 45C8 Conforming to IS: 1570 (Part-2/ Sec.1) 1979
4	Bearing Bush	Leaded tin bronze Grade LTB3, LTB4 or LTB5 of IS: 318 / 1981 or resin bonded carbon or PTFE bonded carbon
5	Rotor	Electrical sheet steel electro grade copper rods conforming to IS: 613 / 1984 or Aluminum dia cast rotor conforming to IS: 617 / 1984
6	Stator Core	Electrical sheet steel PVC insulated winding wire/polymer insulated winding wires or with any suitable plastic covered wires conforming to IS: 8783 /1978
7	Winding Wire	) For motors other than water filled motor: Enameled copper conductor conforming to IS: 4800 Part-7) 1970 ) For water filled motors: Enameled copper conductor to IS: 4800 (Part-7 /1970or PVC insulated winding wire conforming to IS :8783 / 1978or With polymer insulated such that the test on insulated resistance satisfied
8	Breather diaphragm	Nitrile rubber
9	Cable	PVC insulated PVC sheathed 3 core flat type conforming to IS: 694/1990 or PVC insulated polymer sheathed 3 core flat type (approx. 15 meters)
10	Cable GI	Nitrile rubber

Sr. No.	Description	Material (s)
11	Thrust Bearing face combinations	Bronze- ferrobestos, Brass - Ferro tests, Carbon-Stainless steel, Bronze suitable elastomer or any other suitable combinations
12	Water drain plug	Bronze / Brass / Stainless steel / Suitable Plastic
13	Impeller	High tensile brass conforming to IS: 304 /1981 or leaded tin Bronze LTB 2 of IS: 31 8/ 1981
14	Casing	Cast iron Grade FG 200 of IS: 210 / 1993, Allow steel casing conforming to IS: 3444/1987
15	S Guard	Bronze Or S.S.

#### **4.1 Horizontal Multi-stage Pump set (If Applicable):**

Pump should be suitable for hling Raw/ Clear water. The speed of the pump shall not be more than 1500 and number of stages shall be limited to six. The complete pump rotor shall be balanced statically and dynamically to provide vibration free operation. All the pumps will also be tested hydraulically at two times the working head pressure or 1.5 times shut off head pressure whichever is higher.

The materials of construction of these pumps shall be as below: -

Casing/bowl	Cast Steel ASTM A276 Grade 316
Shaft	ASTM A276 Gr 410
Impellers	ASTM A743 Gr CF8M
Sleeves	ASTM A276 Gr 410
Neck rings and Neck bushes	Cast Steel ASTM A276 Grade 316
Packing	GI Packing
Bush bearing	Oil Lubricated

#### **1.1 Design Construction Requirements**

1.1.1 Design construction features of the pump shall be as per relevant standards.

1.1.2 Pumps shall be of indoor installed, horizontal multi stage centrifugal type, all identical pumps shall be inter changeable.

1.1.3 Design data suchas Capacity, Total Head, duty, type of pump construction, suction



condition type of coupling shall be as specified in 'Procurement Datasheet'.

1.1.4 NPSHA>NPSHR by at least 0.5m

**21 Pump casing:-**

2.1.1 Pump casing shall be provided with adequate number of vents priming connections with valves unless the pump is made self-venting priming.

2.1.2 Casing shall be robust construction.

**3.1 Impeller:-**

3.1.1 The rotor assembly shall be dynamically balanced designed with critical speed substantially above the operating speed. The impellers should be double entry to eliminate thrusts it shall be statically dynamically balanced as per grade per ISO 1940 Gr. 6.3 to ensure vibration free operation. It shall be positively locked on shaft shall not loosen under reverse rotation.

**3.2 Shaft:-**

4.1.1 Shaft size shall be selected considering that the critical speed shall be away from the operating speed as recommended in applicable code/standard. The critical speed shall also be at least 10% away from run way speed.

**3.3 Shaft sleeves:-**

5.1.1 Renewable type fine finished shaft sleeves shall be provided at the stuffing boxes.

5.1.2 Shaft sleeves shall be properly fastened to the shaft to prevent any leakage or loosening.

**6.1 Bearings:-**

5.1.3 Bearings shall be easily accessible without disturbing the pump assembly. A drain plug shall be provided at the bottom of each bearing housing.

5.1.4 Bush bearing with oil lubrication to be provided to take care of high radial load to provide better flexibility for misalignment resulting in longer service life for journal bearing.

Thrust balancing device with balance valve and seating bush designed to take care of all axial thrust should be provided in pump design.

6.1.1 Bearings hydraulic devices (if provided for balancing axial thrust) shall be of adequate design for taking the entire pump load arising from all probable conditions of continuous operation. Life of the bearings shall be guided by the design standard of

the pump. Thrust bearing shall be capable of running continuously at maximum load.

- 6.1.2 The bearings shall be oil lubricated. Suitable lubricating arrangement for the bearings shall be furnished with the pump complete all accessories like pump, filters, piping's, fittings, valves, interlocking supervising instruments etc., as necessary. The design shall be such that the bearing lubricant does not contaminate the liquid being pumped.

**7.1 Stuffing boxes:-**

- 7.1.1 Stuffing box design shall permit replacement of packing without removing any part other than the gl.
- 7.1.2 Stuffing boxes shall be sealed/cooled by the fluid being pumped/external clear water. All necessary pumps, piping, fittings, valves, etc., as required for safe trouble free operation of the pumps shall be included in the scope of supply.

Note:

- a) Impeller shall be of fully enclosed type of suitable shape shall be statically and dynamically balanced for smooth running.
- b) The impeller shall be of single entry type with all inlet eye/suction in the same direction.
- c) The motor shall be directly coupled to pump through well-designed pin bush type couplings alternatively any other suitable flexible/hydraulic coupling of adequate rating.
- d) The motor pump set along with coupling shall be supplied mounted on a common base plate of adequate strength.
- e) Technical supervision by the firm should be provided at the site for installation of the pump.

**8.1 Operating Conditions**

- a. Pump shall be designed to have the best efficiency at the specified duty point. Further, the pump(s) shall be suitable for continuous operation at any point within its specified "range of operation".
- b. The pumps shall be designed to operate under discharge valve fully open condition.
- c. The pump shall operate satisfactorily in isolation in parallel with all other working

pumps without cavitation, any deleterious effects, undue vibrations, noise leaking at all water levels, from minimum to maximum.

**d. DRIVE UNIT**

The horizontal solid shaft squirrel cage induction motors coupled to the pump sets shall be suitable for available power supply. The motors shall be energy efficient (IE3) generally conforming to latest revision of IS 12615 / 325 4722/ IEC 60034 with latest national and international code of practices.

The pump shall be directly driven by a constant speed, air cooled motor. A heavy duty coupling along with coupling guard shall be provided between the pump drive unit.

Motors shall be capable of giving rated output without reduction in the expected life span when operated continuously under the following supply conditions:

Variation in supply Voltage	+10%
Variation in supply frequency	+5%
Combined voltage frequency variation	10%

- Drive motors shall be suitable for DOL/ star- delta starter panel as the case may be. Motors shall be suitable of starting accelerating the load with the applicable method of starting, without exceeding acceptable winding temperatures, when the Supply voltage is 85% of the rated motor voltage.
- Drive motors shall be suitable for DOL/ star- delta starter panel as the case may be. The locked rotor current of the motor shall not exceed 600% of full load current (subject to tolerance as per the applicable standard).
- Motors shall be designed to withstand 120% of rated speed for two minutes without any mechanical damage, in either direction of rotation.
- Stator leads shall be brought to the terminal box as insulated cable through a suitable barrier terminated in clamp type terminals.
- The Power rating of the motor shall be the larger of the following:
  1. 115% of the power input to the pump at duty point at a speed corresponding to the frequency of 48.5 Hz.
- Maximum power input while operating solo or in parallel within maximum minimum

system resistances corresponding to the speed at 50Hz.

### **10.1 Insulation**

Any joints in the motor insulation such as at coil connections or between slot winding sections, shall have strength equivalent to that of slot sections of the coil. The insulation shall be given tropical fungicidal treatment for successful operation of the motor in hot, humid tropical climate. The motors shall be provided with class F insulation with temperature rise limited to that of class B insulation.

### **11.1 Constructional Features**

The motor construction shall be suitable for easy disassembly reassembly. The enclosure shall be sturdy shall permit easy removal of any part of the motor for inspection repair.

Motors weighing more than 25 kg shall be provided with eyebolts, lugs or other means to facilitate safe lifting.

The rotor bars shall not be insulated in the slot portion between the iron core laminations for squirrel cage motors.

### **12.1 Terminal Box**

Terminal boxes shall be of weather proof construction designed for outdoor service. To eliminate entry to dust water, gaskets of neoprene or approved equivalent shall be provided at cover joints between box motor frames. It shall be suitable for bottom entry of cables. It shall be capable of being turned through 360 degrees in steps of 90 degrees.

The terminals shall be of the stud type with necessary plain washers, spring washer's check-nuts. They shall be designed for the current carrying capacity shall ensure ample phase to phase to ground clearances. Suitable cable gls cable lugs shall be supplied to match specified cables.

### **13.1 Paint Finish**

All motor parts exposed directly to atmosphere shall be finished painted to produce a neat durable surface which would prevent rusting corrosion. The equipment shall be thoroughly degreased, all rust, sharp edges scale removed treated with one coat of primer finished with two coats of grey enamel paint.

#### **14.1 Heating during Idle Periods**

Motors rated above 30 kW shall have space heaters suitable for 240V, single phase, 50 Hz, AC supply. Space heaters shall have adequate capacity to maintain motor internal temperature above dew point to prevent moisture condensation during idle period. The space heaters shall be placed in easily accessible positions in the lowest part of the motor frame.

#### **15.1 Accessories**

Two independent earthing points shall be provided on opposite sides of the motor, for bolted connections. These earthing points shall be in addition to earthing stud provided in the terminal box.

Motor shall have Resistance Temperature Detectors embedded in stator windings, DE/NDE bearings (2 nos. per winding and 1 no. per bearing) to detect overheating and trip the motor from control panel in the event of the temperature exceeding safe operating limit. A Temperature Scanner, having minimum 12 channels with necessary relay outputs, for each motor shall be provided.

Note: Bidders has to enclose confirmation as regards to motor efficiency quoted, from original manufacturing along with tender documents.

#### **16.1 NAME PLATE**

Each pump shall be provided with a stainless steel name plate indicating the following details.

Model

Manufacturer's special number

Rated capacity in LPS /M<sup>3</sup>/HR

Total head in MWC

Speed in RPM

Weight of equipment

- Material of impeller

#### **17.1 Drawings and Documents Required**

The Following drawings/ documents shall be submitted by Manufacturer/ Bidder.

- a. Motor Technical Datasheet
- b. Motor General Arrangement and Dimension Drawing

- c. Terminal Box Drawing
- d. Performance Curves
- e. Quality Assurance Plan

#### 18.1 Vibration and Noise Level

The vibration limit measured at motor end for the pumps shall not exceed the limit specified in Hydraulic Institute Standards or specified in Owner's Technical Specification whichever is stringent. The noise level shall not exceed 85 dBA measured at 1m from the outline of pump set as defined in Technical Specification.

#### 19.1 Tests

Motor shall be subjected to all the routine tests as per applicable standard in the presence of the PURCHASERS representative. Copies of test certificates of type routine tests (as per IS 325, IS12065, IS 12075 and IEC 60034) shall be furnished for the PURCHASERS approval. The VENDOR shall ensure to use calibrated test equipment/ instruments having valid calibration test certificates from standard laboratories traceable to national/ international standards.

If type tests have not been carried out on similar Motors, or if the type test reports submitted are not found in order, then VENDOR shall carry out these tests without any extra cost to the Purchaser.

All the type, routine acceptance tests of motors shall be carried out as per applicable standard in the presence of the Purchaser/Purchaser's representative.

#### **20.1 Routine Tests:**

The following routine tests shall be carried out on 100% quantity of motors.

- a. Insulation Resistance Test
- b. High Voltage Test
- c. No load running of the motor and measurement of current voltage on all three phases
- d. Locked rotor test at suitable voltage
- e. Testing of accessories / auxiliaries for correct functioning
- f. Vibration test
- g. Noise level test

### **21.1 Type Tests:**

The following type test shall be carried out on 1 no. Of each type and rating of motor.

- a. Measurement of stator resistance
- b. No load running of motor reading of voltage, current, power speed
- c. Reduced voltage running up test at no load to check the ability of motor run up to full speed on no load in each direction of rotation with  $1/\sqrt{3}$  of the line voltage applied to the motor
- d. Locked rotor reading of voltage, current, power input torque value of the motor
- e. Full load readings of voltage, current, power input slip
- f. Temperature rise test
- g. Momentary overload test
- h. Insulation resistance test before after high voltage test
- i. High voltage test

Type test reports to be submitted shall not be older than five (5) years. In case type tests have not been carried out on similar Motors, or if the type test reports submitted are not found in order, then VENDOR shall carry out these tests at accredited test house like CPRI/ ERDA etc. without any extra cost to the PURCHASER.

### **22.1 Pump Inspection:**

Department engineer shall witness following tests at the manufacturer's test laboratory.

Performance Testing	IS 9137/ISO 9906 Gr 2
Hydro Test Pressure Testing	1.5 times of Shut off Head or 2 times of Duty point head whichever is higher

Pump manufacturer shall submit material test certificates (Physical and Chemical Testing) of Pump Casing, Impeller, Shaft, Shaft Sleeve, Impeller, Casing wear ring and Impeller Wear ring at the time of performance inspection of the pump for necessary review purpose.

Pump manufacturer shall submit dynamic balancing report of Impeller as per ISO 1940 Gr. 6.3 at the time of performance inspection of the pump for necessary review purpose.

Vibration and Noise levels of the pump set shall be recorded during performance testing should be within acceptable limit as per HIS.

Pump set shall be offered for performance test with tested and inspected job motor only. Lab motor testing is not acceptable.

## **4.2 Submersible Pump Set:**

SITC of board approved make complete set of submersible pump and wet type electrically operated motor with all standard accessories, fittings, mountings etc. including cable of suitable size. Pump conforming to I.S. 8034 motor conforms to IS-9283 (Or its latest revision and amendment) working at 3 phase 415V, 50 C/S, A.C. Supply and 2900 R.P.M. including suitable diameter delivery pipe.

The Submersible pump set should be of sturdy construction to facilitate manual loading unloading requirements. It should be repaired in workshop with ease at minimum cost shall have fast wearing parts of replaceable. Feature easy rewind-ability of electric motors of economy in repairs are overriding consideration after meeting the basic. Hydraulic, electric mechanical requirements needed.

The duty point of the pump set shall be located at the optimum efficiency point of the pump rating curves there should not be steep fall in efficiency in the operating range. The verification of the pump sets performance will be as per relevant latest IS at rated voltage.

The Company shall offer the Efficiency within (-) 5 digit at Pump Operating Head Range at

+10% to -25% (i.e. if the company offers 50% Efficiency at Duty Point, in that case 45% Efficiency is maintained at Pump Head Operating Range +10% to -25%).

Minimum Motor Horse Power Rating, Cable Size, Starting System, Minimum Overall Efficiency Delivery Size shall be as per relevant standard.

### **PUMP:**

### **BOWL:**

The pump shall conform to IS: 8034. Bowls should be free from Blow Holes, Stages inclusion other detrimental defects.



Bowls shall be provided with renewable wearing rings except in radial flow pump set. Bowls should be provided with renewable wearing rings should be suitable for lubricating by water shall be of superior quality. The fitment of wearing rings with interface fir OR locking compounds is to be done. Stage casing/ Stage Bowl shall be hydraulically tested upto 1.5 times Shut-Off Pressure or maximum upto 25 kg/cm<sup>2</sup> whichever is higher.

### **IMPELLERS:**

Impellers should be of closed type (Not Fabricated) ensuring required performance free of cavitation.

### **Shaft**

The pump shaft will be guided by bush bearings provided in each bowl wherever required. Shaft protection sleeve is to be provided below impeller shaft assembly. The material of shaft and shaft protection sleeve should be Stainless steel - AISI - 410 shaft shall have 0.75 Microns surface finish.

### **Suction casing with strainer**

Opening of the Suction casing should be of proper size shape to minimize, eddy current. In order to check entry of foreign materials strainer/Screen shall be of minimum thickness for SS-0.5 mm.

The pump-motor 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.).

Entrance velocity of water in the pump should not be more than 3.6 m/sec.

### **Bearing Bush**

The materials of bearing sleeve shall be conforming to IS: 318/ 1962 or as per latest revision.

### **INSTALLATION**

The pump is to be coupled with motor lowered into the bore well required column pipes. So.

The pumps shall be suitable for vertical, portable installation and be interchangeable between these modes throughout their working life time. The pump will be of suspended type design by column pipes.

The pump shall be offered with vertical, suspended by column /discharge without any bottom

## **INDUCTION MOTOR**

### **2.1 Design Requirements**

The motors shall generally conform to following IS and / or relevant equivalent internationally approved standards. Additionally the specific requirements mentioned in the following clauses shall also be met.

IS 325 (1996) Three phase induction motors

IS 900 (1992) Code of practice for installation & maintenance of induction motors

IS 1231 (1974) Dimensions of three phase foot mounted AC induction motors

IS 4029 (1967) Guide for testing three phase induction motors

IS 4691 (1985) Degree of protection provided by enclosures for rotating electrical machinery

IS 4889 (1968) Methods of determination of efficiency of rotating electrical machines

IS 6362 (1971) Designation of methods of cooling for rotating electrical machines

IS 7538 (1975) Three phase squirrel cage induction motors for centrifugal pumps for agricultural applications

IS 7816 (1975) Guide for testing insulation resistance of rotating machines

IS 8789 (1978) Value of performance characteristics for three phase induction motors.

IS 12065 (1987) Permissible limits of noise levels for rotating electrical machines

IS 12075 (1986) Mechanical vibration of rotating electrical machines, measurement, evaluation & limits of vibration severity

### **2.2 Performance and Characteristics**

2.2.1 Motors shall be capable of giving rated output without reduction in the expected life span when operated continuously under the following supply conditions:

a) Variation in supply voltage  $\pm 10\%$

b) Variation in supply frequency  $\pm 5\%$

c) Combined voltage and frequency variation  $\pm 10\%$

- 2.2.2 Motors shall be suitable to pump in terms of dressing & the capacity with suitable starting method as specified.
- 2.2.3 The Power rating of the motor shall be the larger of the following:
- a) Reserve power margin as tabulated in table I (clause 3.5) 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 as well efficiency at full working load of the motor shall not be less than prescribed rating in data sheet.
- 2.2.4 The type test of required rating (s) of motor (s) carried out by NABL approved lab / CPRI / ERDA are to be produced with QAP and / or at the time of inspection without fail.

### **2.3 Insulation**

- 2.3.1 Any joints in the motor insulation such as at coil connections or between slot and winding sections, shall have strength equivalent to that of slot sections of the coil. The insulation shall be given tropical and fungicidal treatment for successful operation of the motor in hot, humid and tropical climate. The motors shall be provided with class F insulation with temperature rise limited to that of class B insulation.
- 2.3.2 Motors shall be given power house treatment. This comprises an additional treatment to the winding over and above the normal specified treatment. After the coils are placed in slots and all connections have been made, the entire motor assembly shall be impregnated by completely submerging in suitable insulating compound or varnish followed by proper baking. At least three such submersions and baking shall be applied to the assembly.

### **2.4 Constructional Features**

- 2.4.1 The motor construction shall be suitable for easy disassembly and reassembly. The enclosure shall be sturdy and shall permit easy removal of any part of the motor for inspection and repair.
- 2.4.2 Motors weighing more than 25 kg shall be provided with eyebolts, lugs or other means to facilitate safe lifting.
- 2.4.3 The rotor bars shall not be insulated in the slot portion between the iron core laminations for squirrel cage motors.

- 2.4.4 In case of prime mover of HSCF pump horizontally foot mounted design shall be required.

### **2.5 Terminal Box**

- 2.5.1 Terminal boxes shall be of weather proof construction designed for outdoor service. To eliminate entry to dust and water, gaskets of neoprene or approved equivalent shall be provided at cover joints and between box and motor frame. It shall be suitable for bottom entry of cables. It shall be capable of being turned through 360 degrees in steps of 90 degrees. The terminals shall be of the stud type with necessary plain washers, spring washers and check nuts. They shall be designed for the current carrying capacity and shall ensure ample phase to phase and phase to ground clearances. Suitable cable glands and cable lugs shall be supplied to match specified cables.

### **2.6 Accessories**

- 2.6.1 Two independent earthing points shall be provided on opposite sides of the motor, for bolted connections. These earthing points shall be in addition to earthing stud provided in the terminal box.

### **2.7 Winding Design Criteria**

- 2.7.1. Motors shall be suitable of starting and accelerating the load with the applicable method of starting, without exceeding acceptable winding temperatures, when the supply voltage is 85 % of the rated motor voltage.
- 2.7.2. The locked rotor current of the motor shall not exceed 600 % of full load current (subject to tolerance as per the applicable standard).
- 2.7.3. Motors shall be designed to withstand 120 % of rated speed for two minutes without any mechanical damage, in either direction of rotation.
- 2.7.4 Stator leads shall be brought to the terminal box as insulated cable through a suitable barrier and terminated in clamp type terminals.

## 2.8 Data sheet of Induction Motors

Sr. No.	Description	Unit	Particulars
(a)	Application		Pump Motor
(b)	Number of Units	Nos.	
(c)	Type of motors		Squirrel Cage
(d)	Supply System fault level	MVA	20
(e)	Supply Neutral		Resistance earthed
(f)	Rated Voltage	V	415
(g)	No. of Phases and frequency		3 Phase, 50 Hz
(h)	Type of duty / designation		Continuous / S1
(i)	Method of Starting		DOL / Star Delta / ATS / Soft Starter (*Depending on the capacity)
(j)	Class of insulation		F
(k)	Ambient reference temperature	deg. C	45 <sup>0</sup>
(l)	Temperature rise by		
	(i) Thermometer	deg. C	70 <sup>0</sup>
	(ii) Winding resistance	deg. C	80 <sup>0</sup>
(m)	Type of Cooling (IS:6362)		<b>TEFC</b>
(n)	Degree of Protection		IP 54
(o)	Terminations		
	(i) Separate terminal box for line & neutral side		Phase segregated terminal box for Line side and neutral side
(p)	Nominal speed	rpm	1450
(q)	Minimum rating & full working efficiency	kW	<ul style="list-style-type: none"> <li>To be given by the department depending on minimum achievable efficiency of pump as per HIS 2010 with prescribed reserve power margin.</li> <li>Minimum acceptable efficiency at full working load shall be given by the department.</li> </ul>

## **VALVES**

### **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  $\pm 3$  mm
- 2) CD of flange  $\pm 3$  mm
- 3) Bolt circle diameter  $\pm 2$  mm
- 4) Thickness of flange  $\pm 2$  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 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:**

<b>1</b>	<b>General</b>	
1.1	Type	Both end flanged hand wheel / Gear operated / Actuator Operated
1.2	Rating of valves	PN 1.0 / 1.6/2.0
1.3	Manufacturing Standard	IS 13095 / BS 5155
1.4	Sizes, Rating and quantity	As per price bid
<b>2</b>	<b>Materials of construction</b>	

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

### **1.3 Sluice Valves**

- 1.3.1 Sluice valve shall conform to IS 14846 - 2000 relevant internationally recognised standards. Ends shall be flanged & drilled as per IS 1538.
- 1.3.2 They shall be of non rising spindle type. The valve shall be furnished with a bushing arrangement for replacement of packing without leakage. They shall also have renewable channel and shoe linings. The gap between the shoe and channel shall be limited to 1.5 mm.
- 1.3.3 The gate face rings shall be securely pegged over the full circumference.
- 1.3.4 Valve of 450 mm and above shall be provided with thrust bearing arrangement for ease of operation. Valve of diameter 400 mm and above shall be provided with enclosed gear arrangement for ease of operation. The operation gear of all valves 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.
- 1.3.5 All valves, spindles and hand wheels shall be positioned to give good access for operational personnel.
- 1.3.6 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 Sluice valve:**

<b>1</b>	<b>General</b>	
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 14846 - 2000
1.4	Sizes, Rating and quantity	As per price bid



<b>2</b>	<b>Materials of construction</b>	
2.1	Non rising Stem	High tensile brass as per IS or high tensile steel AISI - 410
2.2	Body / Bonnet / Wedge / Hand Wheel	CI - IS 210 FG 260
2.3	Stem Nut / Renewable body seat / wedge face ring	Bronze Grade IS: 318 LTB - 2
2.4	Stem packing (renewable valve open on stem)	Jute & Hemp as per IS : 5414
2.5	Bonnet Nuts	Carbon steel as per IS - 1367 CL 4.0
2.6	Bonnet Bolts	Carbon steel as per IS - 1363 CL 4.6
2.7	Bonnet Gasket	Rubber IS : 638 Type - B
2.8	Hydrostatic Test Pressure	
	Body	As per IS 14846
	Seat	As per IS 14846

## **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:**

<b>Sr. No.</b>	<b>General</b>	
1.1	Type	Both end flanged
1.2	Rating of valves	PN 1.0 / 1.6/2.0
1.3	Manufacturing Standard	API 594 / 598
1.4	Sizes, Rating 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
<b>2</b>	<b>Materials of construction</b>	
(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

**1.5 Electric Actuator** (If required)

- 1.5.1 All local controls shall be protected by a lockable cover.
- 1.5.2. Each actuator shall be adequately sized to suit the application and be continuously rated to suit the modulating control required. The gearbox shall be oil or grease filled, and capable of installation in any position. All operating spindles, gears and head stocks shall be provided with adequate points for lubrication.

- 1.5.3. The valve actuator shall be capable of producing not less than 1½ times the required valve torque and shall be suitable for at least 15 minutes continuous operation.
- 1.5.4. The actuator starters shall be integrally housed with the actuator in robustly constructed and totally enclosed weatherproof housing. The motor starter shall be capable of starting the motor under the most severe conditions.
- 1.5.5. The starter housing shall be fitted with contacts and terminals for power supply, remote control and remote positional indication, and shall also be fitted with internal heaters so as to provide protection against damage due to condensation. Heaters shall be suitable for single phase operation. The heaters shall be switched “ON” when the starters are “OFF” and shall be switched “OFF” when the starters are “ON”.
- 1.5.6. Each starter shall be equipped as follows:
- (a) AC electric motor
  - (b) Reduction gear unit (with thrust bearing if required)
  - (c) Torque switch mechanism
  - (d) Limit switch mechanism
  - (e) Hand wheel, for manual operation
  - (f) Valve position indicator
  - (g) Hand Auto lever with suitable locking arrangement
  - (h) Valve position transmitter
  - (i) Reversing contactor starter complete with overload relays of suitable range and adequately rated control fuses
  - (j) Actuator with integral starter shall have selection between local/remote operations
  - (k) Local control switch / push buttons
  - (l) 415 V / 240 V AC control transformer (CT)
  - (m) A white lamp for supervision of main supply to be provided locally
  - (n) A potential free contact shall be provided to annunciate over load trip / main supply failure on remote panel.
- 1.5.7 The following shall be included as standard feature for valve actuators
- (a) Two (2) DC interposing relays for matching the low voltage of remote commands with the control voltage.

- (b) The motor shall be specially designed for valve operation, combining low inertia with a high torque and with linear characteristics.
- (c) Each electric-motor operator shall be provided with a hand-wheel with handle for manual operation. The hand-wheel shall be automatically declutched when the electric motor is operating, but shall be capable of being engaged at other times by positioning the clutch lever. The electric operation shall override the manual operation.
- (d) All motor operators shall be provided with visible local valve position indicators mounted on the operator assembly itself.
- (e) The torque switch shall function to stop the motor on closing or opening of the valve, or upon actuation by the torque when the valve disc is restricted in its attempt to open or close. A minimum of two (2) torque switches, one for closing direction and one for opening direction shall be provided.
- (f) The non adjustable limit switches shall stop the motor and give indication when the disc has attained the fully open or close position.
- (g) All wiring connections from the various switches shall be brought out on to separate terminal box mounted on the valve, having liberal space for wiring and making connections.
- (h) The terminal box shall be suitable for outdoor use and shall be weather proof and dust tight.

### 1.5.8 Reversing Contactor starters for valve Actuators

- (a) The reversing starters shall comprise forward and reverse contactors, electrically interlocked with each other.
- (b) The terminal overload relays provided with the reversing starters shall be three element, positive acting, ambient temperature compensated, time lagged thermal overload relay with adjustable settings. The setting range shall be properly selected in accordance with the rating of the motor.
- (c) Thermal overload relays shall be hardest type.
- (d) 'STOP' push button of the starter and hand reset device shall be separate from each other.

- (e) Overload relay reset push button shall be brought out to the front and made easily accessible.
- (f) Overload relay shall be provided with at least one 'NO' and one 'NC' or one change over contact.
- (g) The minimum continuous current rating of the contractors shall be 16 Amps for all actuator valve motors up to 6 kW.

1	<b>Actuator</b>	
1.1	Make	
1.2	Type	
1.3	Motor rating	
1.4	Design Torque	
1.5	Time for Full open to full close	

### **1.5 Tamper proof Air Valve–**

SITC of C.I. Temper Proof Air Valve with SS304 float, gun metal nozzle of approved make and quality of following class and diameter with Manually Hand Wheel Operated CI D/F Sluice Valves with Body, Dome, Cover - CI, Seat & Face - Bronze, Spindle - SS410, Spinle Nut - Bronze, etc., including all taxes, insurance, transportation, freight charges, octroi, inspection charges, loading, unloading, conveyance to departmental stores, stacking, etc. complete.

Tamper proof double acting Kinetic Air Valves are to be supplied which shall be designed as per AWWA C512-92 standards.

#### **1.0 GENERAL**

The double air valves shall have two ball chambers, having one outlet of large capacity for admission and release of bulk volume of air during emptying and filling of the main and another having small outlet for escape of smaller quantities of entrapped air. This type of air valves shall be of flanged type with full conformation with IS:1538.

The ball sealed orifice always remains open while air is exhausting and is immediately closed when water rises in the chamber, lift the ball and seals the orifice. It shall also ensure that there are no recesses or pockets, sheltering, escaping air for the large orifice (low pressure) valve to drop into when the valve is open. Turbulent air at the time of filling of pipe shall not circulate in such cavities and cause the ball to blown into when the valve is open. Turbulent air at the time of filling of pipe shall not circulate in such cavities and cause the ball blown into the discharging air streams, blowing the valve shut prematurely.

The cone angle of the lower pressure chamber shall be such that even at the critical velocity of air escape at 300 m/sec. The total impact force on the ebonite covered ball is less than the suction force on the angular area between the ball and the cone. The design of the valve should be such as to allow maximum free air discharge at various pressure differentials. The tenderer shall submit with the tender full set of curves showing discharge of free set of curves showing discharge of free air valves pressure differential for all sizes of valves offered by him.

Under no circumstances shall be large orifice ball blow shut prematurely.

The low pressure cover shall be massive and designed to withstand full operating thrust in working conditions.

Air valve shall be design to prevent premature closure prior to all air having been discharge from the line. The orifice shall be positively sealed in the close position but float ( Ball) shall only be raised by the liquid and not by mixer of air and liquid. The sealing shall be design to prevent the floats sticking after long period in the close position. All branched outlets including outlets for Air valves will be with compensation pads (Dia of

Main / For branch Dia ratio greater than 3). Diameter of compensation pad will not be less than 1.75 times the O.D. of the branched outlet. Plate thickness for pads will be same that of the main. For outlets with above ratio less than three, then the joints will be of plate reinforcement type.

All branched outlets including air valve tee's will be provided with one ½" BSP coupling duly plugged for measurement of pressure in due course. The closing plug will be in Stainless Steel (AISI 304 or equivalent) with Hex. Head and will be provided with copper washer for sealing.

The neoprene seat ring shall be held securely in place under the low pressure cover by a joint support ring to prevent it from sagging when the ball is not sealing the orifice.

The valve body, the orifice cover, cowl of the air valves shall be made of cast iron of grade 2 of IS:210.

Where tenderer considers necessary a suitable drain plug shall be provided.

## **2.0 HIGH PRESSURE ORIFICE**

The high pressure orifice and the high pressure chamber shall be so designed that the orifice is effectively sealed in working conditions by "EPDM" coated float.

The material of the orifice shall be gunmetal. The orifice shall be of size not less than 3 mm and tapering to 100 mm suitable to release accumulated air within the pipe. The profile of the orifice shall be carefully chosen to avoid damage to the float surface. The orifice shall be protected by a suitable plug of stainless steel.

## **3.0 VALVE FLANGES**

All valves flanges shall be designed to withstand the stresses to which they would be subjected under hydraulic tests. Flanges shall be machined flat. The flanges shall be drilled in accordance with IS:1538 (part – I to XXII) – 1976 (specifications for C. I. Fittings for pressure pipes for water etc.)

## **4.0 COATING**

The casting shall be such that it shall not impart any taste or smell to water. The coating shall be smooth, glossy and tenacious, sufficiently hard so as not to flow when posed to a temperature of

770 C and not so brittle at a temperature of 150 C as to chip off when scratched lightly with the point of penknife.

Alternatively, two coats of black Japan conforming to type 8 of IS 341-1971 (Or latest edition) or paint conforming to type – 2 of IS 158-1969 (OR latest edition) shall be applied.

## **5.0 TAMPER PROOF AIR RELEASE VALVES**

The bidder has to supply tamper proof Air Release Valves.

The valves shall be

- (i) 100% tamper proof
- (ii) Zero water leakage
- (iii) Unaffected by strong air flow
- (iv) Maintenance free

The tamper proof air release valve shall have following :

- (i) Double orifice & double float.
- (ii) Stainless steel large & small float.
- (iii) Stainless steel guiding stem for large float shall give 100% perfect closing.
- (iv) Aerodynamic bucket design for maximum airflow & which should restrict entry of foreign material.
- (v) Integral vent welded to inverted cap made of MS should restrict tampering of Air

- Release Valve large orifice.
- (vi) Small orifice automatic valve vertically assembled should discharge small quantity of dissolved air / air pockets automatically.
  - (vii) Design shall be as per AWWA C512-92 standards.
  - (viii) Air Release Tamper Proof Valves shall be tested as per IS 14845 – 2000.

## 6.0 MATERIAL OF CONSTRUCTION OF KINETIC AIR VALVES

Sr. No.	Kinetic Air Valves	Material Description PN 10, PN 16 / PN 25
1	Body	Cast Iron : IS 210 Gr. FG 200
2	Float (Large)	Stainless Steel : ISI – 304 / 316 / 316L
3	Nozzle	Gun Metal : IS 318 LB2 / GM + Neoprene Rubber
4	Gasket	Rubber : Neoprene
5	Cover	Carbon Steel : Plate
6	Fasteners	Carbon Steel : IS 1363

## 7.0 TESTING

The air valves shall be tested as per IS 14845 – 2000. The air valves shall withstand 1.5 times the working pressure. The joints and air valve shall be water tight. During test if the joints of air valve are found leaking or the air valve is found not functioning properly then the same shall be got rectified or replaced by the contractor to the satisfaction of Engineer-in-charge.

## EXPANSION BELLOWS

The metallic single expansion bellows with all parts shall be manufactured as per EJMA standards. The rating of metallic expansion bellows is PN 1.0 / 1.6 as specified in data sheet & price bid. The bellow shall have both flanged ends of suitable thickness. Material of construction for bellow elements and all other parts are tabulated below. Bellow shall have minimum axial extension of 5 mm & minimum axial compression shall be 15 mm. It shall have adequate capacity to compress and expand within the limit mentioned in its entire life cycle of minimum 7000 cycles which shall be retained for the entire design period. The period shall have to be specifically mentioned by the bidders. Bellows shall have to be subjected to hydrostatic test at required pressure depending on pressure nomenclature for hold time of minimum 30 minutes.

### Materials of Construction:

Sr. No.	Component	Material
(a)	Bellows / Collar / Internal sleeve	SS 240 GR 304
(b)	Limit Rods	CS IS :1367, CL-4.6
(c)	Nut & lock nut	CS IS :1367, CL-4.0
(d)	Lugs / Flanges / Weldend	IS: 2062 Gr. B

## **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.

## **Electromagnetic Flow Meter:**

### **Scope**

The objective of the specification given in this section is not to specify all the details pertaining to the design, drawing and selection of equipment or product. The equipment or product supplied shall be of high standard of quality and shall comply with all currently applicable standards, regulations and safety codes. In case of differing constructional features than specified here in equal importance shall be given to adherences & fulfillment of technical parameters & accuracy. In case of difference in material (s) of construction, higher / better / superior grade of material (s) shall also be accepted after due diligence & evaluation by the Engineer in charge.

### **General**

Full bore electromagnetic flow meters should be designed, manufactured and calibrated according to ISO standard. The flow meter shall be capable of measuring bi directional flow. The Electromagnetic flow meters shall withstand maximum working temperature of about 60<sup>0</sup> C and working pressure of minimum 10 kg/cm<sup>2</sup> (1.0 Mpa) unless otherwise specified in the price bid and / or data sheet.

### **General Requirements**

1. Flow measuring system shall consist of flow sensor / transducers, flow computer & flow transmitter, digital flow indicator & integrator and any other item required to complete the system.
2. Flow sensors / transducers shall be rugged in construction and shall be suitable for continuous operation. The electromagnetic flow meters shall be suitable for installation on underground / above ground pipelines in pumping station / RCC chambers / open pits or buried for indication of flow rate and total consumption of water in a transmission or distribution pipe network of water supply system. Flow transducers shall have water proof construction.

3. To avoid the effects of disturbances in the velocity profile, a straight and uninterrupted run, upstream as well as downstream from the location of the flow sensor shall be provided, as required by the flow meter manufacturer.
4. The exact location of flow transducers shall be finalised in consultation with Engineer's representative. However electromagnetic full bore type shall be provided on common discharge header of the pumping station.
5. The flow transmitter shall be suitable for field mounting and shall accept input from the flow transducer. It shall process the input signal and provide 4 - 20 mA DC output proportional to flow rate. Flow transmitters shall have LCD display to indicate instantaneous flow rate. The flow range shall be adjustable. The flow meter shall be suitable for measuring flow at velocities of water from 0 to 4 m/sec.
6. Flow measurement shall not be affected by physical properties of water viz. temperature, pressure, viscosity, density etc. within given limits. Bidder shall provide compensating electronic circuits if required.
7. Bidder shall construct a suitable concrete chamber (if and as required) for enclosing flow transducer to be mounted on over / under ground pipe line. A concrete cabin shall be constructed above the chamber for housing the flow transmitter. A concrete cabin shall be constructed for housing the flow transducer and the flow transmitter to be mounted on surface pipelines.
8. The flow transmitter shall be microprocessor based and shall have self diagnosis facility.
9. Measurement of outlet flow at pumping system will be by full bore type electromagnetic type flow meter.

### Technical Requirements

Electromagnetic flow meter shall be a velocity sensing electromagnetic type, micro processor based signal converter, sealed housing, welded flanged tube meter for minimum 1.0 Mpa working pressure unless otherwise specified. The meter shall be manufactured to highest standard available for mag meters. The meter shall be equipped with minimum six digit digital totalizers, reading in units of kiloliters and shall be accurate within 0.5% of true flow. The accuracy should be inclusive of linearity, hysteresis, repeatability and pressure effect. The meter assembly shall operate within a range of 0.3 m/sec to 4 m/sec and be constructed as follows:

**Meter tube (Sensor)** shall be fabricated from stainless steel tube and use class PN 10 / 16 flat face carbon steel flanges as specified in data sheet in accordance with IS: 1538. The internal and external of the meter tube shall be blasted to near white and lined with neoprene or polyurethane. Meter tube shall have a constant nominal inside diameter offering no obstruction to the flow.

**Coil Housing** shall be fabricated from stainless steel and / or cast steel with anti corrosive epoxy painting for corrosion resistance and welded to the tube providing a completely sealed environment for all coils, electrode connections and wiring harness capable of submerged or buried operation.

**Signal Converter** shall be pulsed DC coil excitation type with auto zeroing. The signal converter shall be remotely mounted away from the meter. The converter shall indicate direction of flow and provide a flow rate indication and a total of flow volume for both forward and reverse directions.

The converter shall provide an isolated 4-20 mA output into minimum 500 ohm load and a frequency output of a maximum of 0-10 KHZ and a scaled pulse output. The microprocessor based signal converter shall have a self diagnostic test mode and a backlit display that continuously displays 'Rate of Flow' and 'Total Volume'.

The converter shall be compatible with Microsoft Windows and other software programs with built in terminal communication capabilities of RS 485, HART or other protocols for interface. The converter shall be remotely mounted up to 200 m from the sensor, and shall be supplied with all calibration complete for desired requirements.

Converter shall be supplied with a programmable low flow drop out and empty pipe zero return. The signal converter housing should be die-cast aluminum with glass window. The converter cum transmitter should be fully programmable from the front fascia. The programming should be user friendly, self-prompting menu driven.

### **Signal Cable**

The cable should be capable of transmitting low signal voltage U (milli volts, pico watts) via a double shielded cable from the primary head to the signal converter. The cable should be resistance to interference from external magnetic fields. The cable should be suitable for laying in underground and under water installation.

### **Meter size & Overall length**

Meter size is designated by the nominal diameter (DN) of the flange. For each meter size designation, there is a corresponding fixed overall length and tolerance both as specified in Table 1. The length includes lining if it covers the flange face but excludes accessories such as gaskets, grounding and protection rings. Standard length of different reputed manufacturers' from among the vendor list is also acceptable. The length shown here is only for reference. Manufacturers' standards are to be followed in this regard.

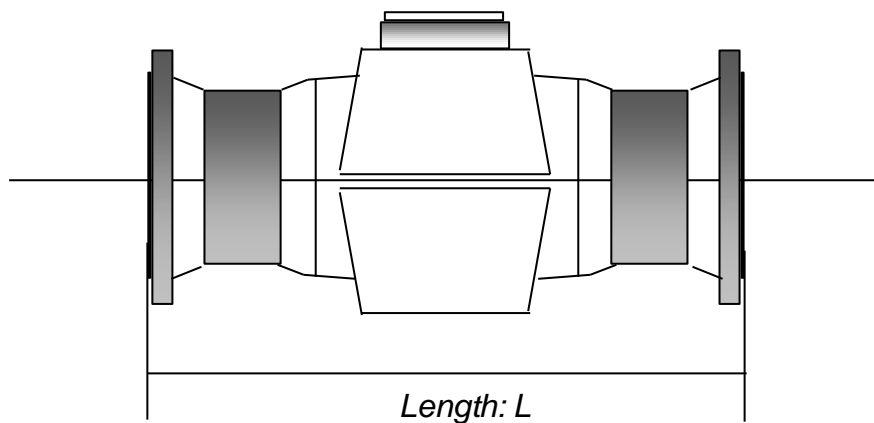


Table-1 : Overall length (only as a reference)		
Meter Size in	Meter Overall Length	
DN (mm)	L in mm	Tolerance mm
50	200	-3
80	200	-3
100	250	-3
125	250	-3
150	300	-3
200	350	-3
250	450	-6
300	500	-6
350	550	-6
400	600	-6
450	600	-6
500	600	-6
600	600	-6

### Connections

The flow meter shall be provided with flanges at both ends, the internal diameter of which shall be equal to the nominal size of the meter. The dimensions and drillings of the flanges shall be in accordance with IS: 1538.

### **Rubber Gasket**

The flat rubber gasket shall be 3/6 mm dual thickness of SBR material and shall be suitable for making flange joints. The quality of flat rubber gasket shall be as per IS: 5382 and drilling of holes shall be as per IS: 1538.

### **Nuts and bolts**

Nuts and bolts shall be of best quality carbon steel, machined on the shank and under the head and nut. Nuts and bolts shall be electro-galvanized. Nuts and bolts shall conform to IS: 1363 and IS: 1367.

### **Material Supply**

All the flanged meters shall be supplied with one rubber gasket per flange and the required number of nuts and bolts as per the meter size. Matching pair of grounding rings shall be supplied with all the meter tube.

### **Testing & Inspection**

**Volumetric testing** of all meters must be performed and approved prior to shipment. The complete meter assembly and signal converter must be wet accuracy tested and calibrated as a unit near minimum, intermediate, and maximum specified flow ranges of the meter (full range of flow). The volume of water used to conduct the test must be shown on a shipping tag attached to the meter.

To calibrate these meters, only direct volume comparison calibration method should be used. The overall accuracy of the calibration rig should be at least three times better than the accuracy of the full bore electromagnetic flow meter. The competent authority must certify the test facility. All the meters shall be calibrated for a minimum of 5 point.

The manufacturer should have an ISO 9001 certification. The magnetic flow meter should perform within the required accuracy of measured value without being affected by change in pressure due to demand fluctuation. The length of the sensor should be strictly as per ISO up to DN 600 mm and for other sizes it should be as per the manufacturer's standard. To avoid ingress of water in the sensor housing, sensor has to be of fully welded construction.

The maximum separation level (distance) between flow sensor and the signal converter / transmitter should at least 200 meters without signal boosters.

Supplier should have in house calibration facility and should give calibration certificate for all the flow meters. The flow meter should have grounding rings only. Calibration of each meter shall be tested at in house facility of manufacturer for the sizes for which manufacturer has this facility. The test bench of such manufacturer should be certified by a reputed company. In case the bulk water meters are to be imported by the bidder than ISO or EEC certification for such calibration is required. If manufacturer has no in house facility for calibration than each meter shall be tested from FCRI.

Supplier must have test facilities, spare parts, and personnel to maintain, instruct, train or whatever is necessary to assure that meters shall be maintained throughout the guarantee/maintenance contract period.

### **Quality control tests**

All water meters of the same size and class manufactured by the same firm under similar condition of production from the material of the same batch, components from the same source, shall be considered as a lot for quality control inspection. However, minimum 1 number of each size & class shall be tested. The sampling procedure and scale of sampling for visual inspection and other test shall be as per Table-4 given in IS: 779.

### **Acceptance Tests**

The flow meter having satisfied for quality control requirements shall be tested for lot acceptance. The following acceptance tests shall be conducted in accordance with IS: 779 and IS: 2373.

- Pressure tightness (Hydrostatic test).
- Metering accuracy.

In addition, to above tests manufacturer shall furnished a material (s) certificate (s) for meter tube, coil housing, connection flange and electrode, If desired, the calibration and other test shall be witnessed by the Purchaser or their authorized representatives.

### **Packing**

All the flow meters shall be packed in polyethylene bags. Smaller size meters shall be packed in cardboard boxes. The larger size bulk flow meter shall be packed in separate wooden crate, according to the size. Rubber gasket and nuts, bolts etc. shall be supplied in separate jute bags.

### **Battery backup system**

The battery backup shall be used to operate electromagnetic flow meters during power failure. The technical specification shall be as follows:

Make	:	Reputed make
Type	:	Online or line interactive
Capacity	:	800 VA
Input voltage	:	180 - 280 volts
Batteries	:	Internal
Control panel	:	Voltage correction, overload indicator alarm

**Installation and Maintenance of flow meters****General**

This section covers the technical requirements for installation of electromagnetic flow meters and their operation and maintenance. The installation of these meters shall be done in the existing / new water supply system. A proper care should be taken at the time of installation to minimize the disturbance in the supply. From O & M point of view a proper protection and easy access to the meters should be ensured at the time of installation of these meters.

**Installation philosophy**

The installation of EMF meters shall be preferably done in line, except in those cases where, due to site condition, in line installation is not feasible, the meters shall be installed on by pass line. All the installation above 150 mm size should be done with dismantling joint.

To ensure, during measurement the meters must remain completely filled with water, care should be taken to avoid locations where chances of partial flow are high, such as pipes laid on slopes. The meter should not be installed close to the strong electromagnetic fields such as close to power transformer.

The electrode axis of the meter should be in horizontal plane for horizontal pipe runs. Care should be taken to avoid installations of meters on the downstream of the control valves, 90° or 45° elbows or partially opened valves etc. to avoid cavitations / partial flow conditions.

A minimum of 5 x D, straight pipe up stream and a run of 3 x D pipe diameter downstream or as per the recommendations of the manufacture, whichever is on the higher side must be ensured for all the installation site to avoid turbulent flow profile at the meter location. The flow direction of the water should correspond to the direction shown by the arrow on the sensor.

**Specials and fittings**

It is proposed to install the meters on the existing / new common discharge header of pipe material such as Mild steel (MS) etc. All the meters shall be installed using MS fittings only.

It is desirable and advantageous to prepare the assembly of meter and pipe fittings in advance which shall be inserted at pre selected location in the system to minimize disturbance of water supply and also to ensure high degree of workmanship and fast installation.

All the flange fittings shall be installed with a proper rubber gasket for water tight joints.

**Electrical Installation**

The signal converter shall be installed remotely and mounted on the panel board / wall of the pumping stations or any other suitable location directed by the engineer in charge. 5 ampere single phase AC connection shall be made available, for power supply to the signal converter and the sensor. All other necessary fixers including wiring with proper cable conduit, safety fuses and other items necessary for the installation of EMF shall be provided by the bidder to the satisfaction of the engineer in charge and no extra payment shall be made on this account. GI pipes shall be used as a conduit for connecting cables between signal converter and the sensor. First few feet of the conduit must be run in flexible conduit near sensor terminal box and at the signal converter. The signal converter shall be fitted with face sealing cable glands. Only ½” NPT glands and double compression adapters may be used.

Only the specified signal cable recommended by the manufactures shall be fitted. The conduit entry shall be sealed to prevent moisture entering the terminal box via the conduit.

Proper grounding of flow meter with the help of grounding rings shall be ensured for proper electrical contact between flowing liquid and the ground.

**Protection of Meter**

The flow meters if buried underground shall be with proper protection of terminal box and signal cable. The bidder shall ensure protection of meter from damages due to overburden by providing pre cast cover slabs. The space between vertical walls shall be filled with coarse sand prior to placing the cover slab.

There is a possibility that at some site, installations shall be protected by constructing RCC chamber around the meter with pre cast cover slab and locking arrangement. In case, where meter can be installed inside pump house extra protection viz. RCC chamber shall not be required.

**Laying of meter assembly**

Cutting of pipes shall be necessary for laying and fixing of meter assembly if it is to be installed on the existing underground buried pipes, if any. For this purpose, a trench of sufficient width, depth and length shall be excavated for the underground pipelines. The existing pipe shall be cut and dismantled as per the requirement without damaging the extra length of the pipes. In case the extra length of pipe has been damaged by the bidder the cost of same shall be recovered from the bidder, equivalent to rates of current SOR.

Prior to lowering the meter assembly in the trench, the bottom of the trench shall be rammed and a sand bedding of 150 mm shall be prepared. The meter assembly shall fully rest on the



firm and flat bed. After the installation, the trench shall be filled with excavated soil in layer with proper compaction to the entire satisfaction of the engineer in charge. The laying of extra pipe and fixing of meter assembly shall be done as per the relevant code of practice for laying and fixing of joints for respective pipe material.

### **Testing and Commissioning**

On completion of the installation of the meter, bidder should field test (field verification) the EMF using validation tool for the following minimum verification routine to demonstrate the health of meter:

- Auto logging of instrument data and setting (Diameter, field power and converter outputs)
- Measurement of power / frequency
- Check on impedance of coil
- Check on converter linearity by simulation
- Check on current outputs

The field tested meters shall be commissioned at the earliest without the loss of time. The bidder should submit a field validation certificate after completing the field testing stated above and duly signed by the engineer in charge to the concerned authority for asset transfer. The date of receipt of validation cum commissioning certificate shall be treated for commencement of warranty period.

## **PRESSURE GAUGES**

Pressure gauges shall be provided on discharge of each pump and on common discharge header of each pump. Pressure gauge shall be bourdon type with a dial size of 150 mm in diameter and calibrated for the required range of duty heads of pumping machinery to be installed as per range available in the market unless specified otherwise in the price bid. The gauge shall be supplied complete with impulse tubing, two valve manifold with drain cock / calibration valve, fittings etc. The pressure gauges shall have an accuracy of  $\pm 1\%$  full scale and weather protection class IP 65. All wetted parts material shall be SS 316.

Pressure gauge shall comply with IS 3624 / BS 1780. Pressure gauge shall have siphon & cock arrangement. Glycerine filled dial shall be provided as the gauge is subjected to pressure pulsation and / or vibrations. The internal parts of pressure gauge shall be stainless steel.

The minimum diameter for round pressure gauge shall be 150 mm unless specified otherwise in data sheet.

The zero and span of pressure gauge shall not change by more than  $\pm 0.1$  % of the span per  $^{\circ}\text{C}$  changes in ambient temperature.

The pressure gauge shall have to be fitted on individual delivery of pump as well as on the common discharge header.

### **DRAIN PUMP SET (Diesel Driven)**

Portable type diesel engine driven self priming pump set having engine consisting single cylinder air cooled 1000 / 1500 RPM with suitable HP (minimum 5 HP) capacity & having pump consisting suction nozzle and delivery nozzle of 50 mm diameter size. Maximum suction head of 6 meters and total head 12 meters And having minimum discharge of 700 LPM with internal arrangement of fuel tank capacity of 4.5 litres etc. complete. Above all components shall be common base frame having provided arm for lifting the pump set.

Material(s) of construction of the components shall be as per ISO 9001: 2000 certified manufacturer's standard models.

## **Material Handling System**

### **(A) Hydraulic Operated Overhead Travelling Crane**

- 1 Design: The crane shall be electrically operated with all accessories including crane rails and fixtures and shall conform to IS: 15560 or relevant internationally approved standards. The crane is to be designed in accordance with IS: 807, IS: 3177 / 1965 code of practice for design manufacturing erection & testing of structural portion of the crane & IS: 3177 code of practice for design of over travelling crane. In the design of components adequate factor of safety as per relevant code is allowed. Impact, fatigue, wear, stress concentration factors etc. have to be considered whenever applicable. All accessory and auxiliary electrical equipment including drive motors, electrically operated brakes, controllers, resistors, conductors, insulators, current collectors, pendant push button station, protective devices, operating devices, cables, conduits etc. necessary for the safe and satisfactory operation of the crane shall be provided.
- 2 Steel: Steel conforming to IS: 2062 or equivalent is to be used in the manufacturing of the main load bearings members.
- 3 Brakes: Electromagnetic, hydraulic thruster type brakes are to be provided in the all motions ie: hoisting, L.T. & C. T. Motion. The brakes shall be automatically released when the motor circuit

- is ON & shall be applied when the motor circuit is OFF. This feature has to work to ensure safety in case of power failure.
- 4 Bearings: All moving parts of the crane are to be supported on anti friction type ball / roller bearings of required size & reputed make.
  - 5 Coupling: Flexible / Universal / Geared couplings are to be provided between all gear boxes & motors.
  - 6 Operation: The crane is floor operated.
  - 7 Pendant Push Button: Push button station is to be suspended from the one end of bridge at suitable height from the floor level with stepped down voltage of 110 volts.
  - 8 Power: The crane is suitable for operation of  $415\text{ V} \pm 6\%$ , 3 phase 50 cycles A C supply.
  - 9 Crab: The frame work shall be from all welded construction fabricated from rolled steel FRAME section and plates. The hoist & cross travel mechanism is to be mounted on this frame.
  - 10 Hoist: Hoist mechanism shall consist of motor brake, gear box, rope drum & bottom block.
  - 11 Rope Drum: The rope drum shall be made from mild steel fabricated construction having right & left hand spiral grooves properly machined to suit the hoisting ropes. The drum shall be such that there is not more than one layer when rope is fully wound, and length of the drum shall be such that each lead OD drum when hook is at its lowest position & one spare groove for each rope lead when the hook is at its highest position.
  - 12 Wire Rope: Wire rope shall be made from best quality & grade plough steel fiber core normally in 6x37 construction having Tensile strength of 160 / 175 Kg / sq mm. The wire rope shall have minimum factor of safety in accordance with IS 3177 depending on the class of the duty of the crane. Make of wire rope will be as per relevant IS & of reputed make.
  - 13 Bottom Block: The hook shall be of single plain shank type conforming to IS: 3815 and made of forged steel or equivalent supported on thrust bearings.
  - 14 Rope Sheaves: They are made from C.I. running on drum with provision of adequate guards to prevent the rope from leaving the sheaves.
  - 15 Limit Switches: Two number shunts / Roller type reputed make is to be provided to prevent the over lowering and over hoisting
  - 16 Cross Travel Machinery: Cross travel machinery shall consist of suitably rated motor as per relevant IS and totally enclosed dust proof gear box, break etc.
  - 17 Wheels: The wheel of the trolley and the end carriages shall be made from forged steel & shall be double flanged straight thread type fitted with antifriction bearings
  - 18 Bridge Girders: The girders shall be plate welded box / ISMB type construction designed to sustain all stresses arising due to vertical and lateral forces.
  - 19 Trolley Track: Suitable square steel section tracks are to be provided for travel of the trolley. These shall be welded on the girders.

- 20 End Stoppers For Cross Travel Trolley: Steel end stoppers are to be provided on either side of the bridge to limit the motion of the trolley.
- 21 Platform: M S chequered plate / anti skid plate platform shall be provided for full length on one side of the bridge girder.
- 22 End Carriages: End carriages shall be fabricated from rolled steel section / plates with adequate diaphragms and stiffeners to give a rigid construction. The girders with gusset plates are to be set on the end carriages and jointed with bolts in rimmed holes. Rubber buffers shall also be provided on either side of the end carriage.
- 23 Long Travel Mechanism: The driving machinery for the long travel motion can be either single motor drive or twin motor drive depending on manufacturers' standards.
- 24 Paintings: The structural parts of the crane shall be thoroughly cleaned and shall be applied with one coat of red oxide and followed by two coats of enamel paints before dispatch. Exposed machinery parts such as wheels, bright bars, etc. are also to be coated with rust protective paints.

**Technical Data Sheet For Electrically Operated Travelling**

Sr. No.	Particulars	Description
1	Item	HOT Crane
2	Location	Indoor in pumping station
3	Number required	One
4	Type	Single / Double Girder as specified
5	Class of hoist	Class – II, as per IS: 3177 / 77
6	Capacity	As per Price Bid or as per site requirement
7	Lift	As per Price Bid or as per site requirement
8	Span	As per Price Bid or As per site requirement
9	No. Of Falls	02
10	Travel Speed	As per relevant IS / Manufacturers' Standards
	Longitudinal	As per relevant IS / Manufacturers' Standards
	Cross Travel	As per relevant IS / Manufacturers' Standards
	Hoisting Speed	As per relevant IS / Manufacturers' Standards
	Creep Speed	As per relevant IS / Manufacturers' Standards
11	Fixed Girder	To be provided Minimum 250 x 125 mm ISMB
12	Type of Suspension	Wheel suspension
13	Track	Manufacturers' Standards
14	Brakes	Manufacturers' Standards

15	Method of Operation	Pendent Push Button
16	Drum & Sheaves	Mild steel, drum grooving construction as per IS: 3938
17	Hook	Forged steel, confirming to BS: 2903 / BS: 3033 / IS: 3815 with thrust bearing / latch & antilock arrangement
18	Shaft	High tensile steel
19	Wire rope	Construction 6 x 36 FMC as per IS & reputed make
20	Gear	Manganese Chromium Alloy Steel
21	Trolley	MS frame, Wheel EN – 9
22	Rail Size	Manufacturers' Standards
23	Bay Length	Manufacturers' Standards
24	Type of motor	Induction Motor of Hoist duty
25	Supply Neutral	Effectively earthed
26	Rated Voltage	415 V
27	Supply Condition	415 v $\pm$ 5 % voltage variation, 50 Hz $\pm$ 5 % Frequency Variation
28	Motor HP	
	Hoisting	Manufacturers' Standards
	C T	Manufacturers' Standards
	L T	Manufacturers' Standards
29	No of phase & frequency	3 phase & 50 Hz
30	Synchronized Speed in rpm	Maximum 1500
31	Motor Standard	As per IS 325
32	Method of Starting	Direct On Line
33	Class of Insulation & Temperature Rise by Thermometer Resistance	Class – B, 65 <sup>0</sup> c, 75 <sup>0</sup> c
34	Hazardous area division	NA
35	Atmosphere	Dusty and Humid at times
36	Type of cooling	Fan Cooled
37	Degree of Protection	IP – 55
38	Starter Panel	As per requirement
39	Cable from Crane / Hoist Motor to Starter Panel	As per requirement

**(B) Motorised Chain Pulley Block with Travelling Trolley**

**1 Scope**

Electrically operated chain pulley block unit with geared (manual / motorised) travelling trolley, accessories is to be designed for continuous duty operation & manufactured as per relevant mechanical (IS: 3832) & applicable electrical standards.

**2 General Requirement & Construction**

Chain pulley block of spur gear with mono rail traveling trolley as per IS 3832 / 1986 with all latest amendments with load chain, hand chain, suspension hook, suitable braking mechanism etc. complete unit with suitable induction motor of as per relevant IS of adequate HP. Range of lift shall be minimum 06 meters or as per actual site requirement. Chain Pulley Block (manually operated) shall be tested at 1.5 times load as per IS: 3832. While motorised CPB shall be tested at 1.25 times the normal capacity. Proof load shall be 3.75 MT for CPB while the same shall be 4.5 MT for traveling trolley in case of 03 MT MCPB unit. Hoisting speed shall be minimum 1 meter per minute & shall not be more than 3.5 meters per minute. Load chain shall have 1falls for 1 MT & the same shall be 02 falls for MCPB of more than 1 MT capacity.

Mono rail travelling trolley shall be designed to move the load along the I beam axis. It shall be robust & rigid in construction but shall also facilitate easy to assemble and dissemble. Trolley wheels shall be accurately machined & shall run on roller bearings to minimise frictional load. Load shall be evenly distributed on all wheels. It shall be adjustable in width to suit I beam flange width requirements. It shall be monorail push pull travelling trolley / geared travelling trolley /monorail electrical travelling trolley as specified in data sheet & price bid.

The capacity (safe working load) of chain pulley block shall as specified in price bid.

MS girder (I Section) of minimum thickness as per relevant IS of minimum 200 mm X 100 mm size in suitable length across the complete span of pumping house shall be supplied. The actual length of girder shall depend on the size of pump house. Required supports shall also be provided.

Hooks shall be manufactured from stainless steel to with stand shock loads free to swivel under load and confirming to IS: 15560. Load chain of 8 / 12 mm & shall be of grade 80 & shall be as per IS 6216 (1982) made from alloy steel. Hand chain shall be as per IS 3832 while the grade of hand chain shall be 30. Load chain wheel shall be made from SG iron casting & shall be accurately pocketed.

All gears are cut and machined from special alloy steel and case hardened having full depth of addendum confirming to AGMA standard. Alloy steel material, precise machined, gear hob bed

& case hardened duly annealed gears are to be provided. Gears shall be lubricated with semi liquid grease instead of oil, which is less likely to leak, eliminates oil level checks and clings to the gears even after long idle periods.

Brake shall be disc type & self actuating at any load position & shall be shoe and friction disc type.

Motor shall be foot mounted operating on 415 Volts, 3 Phase, 50 Hz AC Supply of class F, 1450 RPM with suitable & adequate rating.

Control panel unit shall be totally enclosed and giving output at 24 Volts to the operational control station (push button station).

Operational control station shall be suspended from hoist with a cable & supporting wire rope with two push buttons extendable to four / six push button station operated with 24 Volts.

For combined pump house having cluster of head works at single location, MS girder (I-section) of above size of suitable length spanning over entire pump house is to be supplied.

For motorised CPB suitable size 3 ½ core PVC insulated copper conductor cable in required length with required cable accessories is to be supplied & erected in PVC conduit pipe of required size.

## 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: 1180 (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:

<b>Sr. No.</b>	<b>Area</b>	<b>Illumination Level (Lux)</b>
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 50<sup>0</sup> C and ambient temperature as 45<sup>0</sup>C.
- 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 (Vs) and the touch potential (Vt) 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.

## **11 KV SWITCHYARD**

### **1.0 Two Pole Structure:**

The scope of work included fabrication, supply, erection, painting as per the drawing and IS and getting the double pole structure approved from I. M. & E. department. D. P. structure comprises following items:

- 1.1 All MS elements of RS joint, channels, angles, flats shall be hot dip galvanised and latter painted with two coats of Aluminium paint. All nut and bolts, washers etc. used shall be also hot dip galvanized.
- 1.2 Rolled joints of minimum ISMB -175 (175 mm x 90 mm size) of approximately 9.0 / 10.0 meters length as indicated in the BOQ with 400 x 400 x 8 mm size base plate welding to one end of both the joints.
- 1.4 Cross member of minimum ISMC - 100 (100 mm x 50 mm) size channels approximately 3.5 meters long.
- 1.5 Cross bracing angle of minimum ISA - 50 (50 mm x 50 mm) size of 4.5 meters long, Side clamps, stay clamps, cleats, patties etc fabricated from minimum 50 mm x 6 mm size M. S. flats as per actual requirement.
- 1.6 All nuts, bolts, washers etc shall be minimum 15 mm size.

- 1.7 Erection of RSJ poles and fixing of all structural members as per approved drawing and instruction of site Engineer. The structure shall be erected in plumb, line level, properly facing the incoming and outgoing lines. Cross member shall be firmly tightened.
- 1.8 All members shall be fabricated to suit the mounting / fixing of GOD, LA, DOF, Disc / Pin / Post insulators, cable end termination kit / box etc. as per the drawing.
- 1.9 All necessary hardware, nut bolts, extra members, sundry items are included in the scope of work.
- 1.10 All MS parts shall be galvanized and applied with aluminium paint.
- 1.11 Earthing terminal shall be provided by welding 12 mm size bolt / clear of 50 x 6 mm size MS flat shall be fixed to each joist with a hole of 15 mm size and cadmium coated nuts, bolts, washers shall be provided as earthing terminals. Fixing or jointing of any members is allowed by nut and bolt only. Welding is strictly not allowed.
- 1.12 Suitable MS flat support and cleats shall be fixed to R.S.J. poles for supporting / fixing the earthing protection pipes in the approved by the client.
- 1.13 All drawing shall be prepared and submitted to GWSSB for onward submission to Industry, Mines & Energy Department (GOG) for obtaining required approval & NOC.
- 1.14 Vitreous enamelled caution boards of any other requirements shall be provided.
- 1.15 CTPT mounting channels, clamps, bracing angles, nut bolts, hardware etc. shall be supplied and erected.

### **2.0 Drop Out Fuse:**

The D. O. fuse assembly should be suitable for 11 KV supply and in accordance with IS 9385 / 1985 and provided with certificates.

The assembly shall be mounted on double pole structure complete with 3 fuse elements of required ampere rating. The fuse link shall consist of iron channel base, stack insulator per phase, fuse carrier Bakelite tube, non ferrous metal parts and souing loaded phosphor bronze contents. The insulator shall comply with impulse voltage test in accordance with IS-3106

### **3.0 Lightning Arrestor:**

#### **3.1 Type and Rating:**

Lightning arrestor shall be station class, heavy duty, non linear resistance type with rating as 11 KV.

The arrestor shall have adequate thermal discharge capacity for severe switching surges, long duration surges and multiple strokes.

#### **3.2 Constructional Features:**

The arrestor shall be single pole and hermetically sealed off. It shall be of robust construction with excellent electrical and mechanical characteristics.



Insulators must be non hygroscopic and shall be wet process porcelain, brown glazed and free from imperfection. All metal parts and hardware shall be hot dip galvanized.

Creepage distance shall correspond to heavily polluted atmosphere. Grading ring if required shall be provided to maintain gradient within permissible limit.

The arrestor shall be provided with pressure relied device if applicable to prevent shattering of approach in case excessive gas pressure build up.

### **3.3 Accessories:**

Lightning arrestor shall be furnished complete with insulating base, surge counter and anchoring hardware for mounting on steel structure.

A surge counter shall be at a convenient height for reading counter. Terminals shall be such as to permit connections with minimum bends. A leakage current detector shall be furnished with the counter as an integrate part. This is for monitoring the leakage to indicate any possible break down.

A suitable sized bypass shunt along with necessary terminal shall be furnished for by passing the discharge counter if required.

### **3.4 Terminals:**

All connection terminals shall be of corrosion resistant material and shall be provided with complete connection hardware. High voltage line terminal connector suitable for ACSR conductor shall be provided.

### **4.1 Platform**

. for mounting the transformers shall be constructed as per manufacturer's instructions & drawing. However minimum size of platform shall be 2 m x 2 m and foundation shall be provided minimum at 1 m below GL The contractor shall have to provide foundation at deeper level if required as per instruction of Consultant / Owner. Top of platform shall be kept minimum at 1.5 m above GL The foundation of platform shall be cast in C.C. of grade M10 (1:3:6) to thickness of 20 cm. Size of this concrete shall be 2.3 m x 2.3 m. The platform shall be constructed in B.B. masonry or rubble masonry in C.M. 1:6. At top of the platform 20 cm thick CC M15 (1:2:4) shall be provided. Outside of the platform from 30 cm below GL shall be rendered with 15 mm thick cement plaster in CM 1:3. Contractor shall have to do necessary curing etc. as per relevant IS. Contractor shall also carry out necessary excavation and refilling.

### **4.2 Chain Link Fencing and Gravel Packing**

The work of erecting chain link fencing includes excavation, brick wall construction, erection of angle / channel supports, providing chain link mesh on angle / pipe frame barbed wire fencing at the top, concreting of support members, painting the complete structure and white washing the walls. All materials, hard wares, labours etc. are in the scope of contractor.

### **4.3 Excavation and Wall Construction**

The boundaries of fencing shall be marked by the contractor using white lime powder, pegs, ropes etc. as per instructions of Engineer in charge and get the marking approved. The earth shall be excavated up to a depth of 0.6 meter compacted by ramming and a layer of 10 cms of brickbat concreting shall be laid / and levelled. 35 cm brick wall using standard size bricks shall be constructed up to ground level and from ground level up to 40 cm height 23 cm wide wall shall be constructed. The wall shall be plastered using cement mortar, cured with water and white washed as per standard practice.

#### **4.4 MS Supports**

The support for chain link shall be fabricated from 75 x 40 x 6 CM MS channels of 3.75 meter lengths. Cleats shall be welded for fixing chain link frames. The top portion shall be fabricated for providing barbed wire fencing of 5 horizontal wires and 2 cross wires. 150 x 150 x 6 mm base plate shall be welded to each support. The supports shall be painted completely with red oxide and black bituminous paints at the bottom portion being embedded in concreting. Pits of 80 cm depth for grouting supports shall be prepared. Supports shall be erected at regular intervals and concreting shall be done with cement using 1:3:6 up to top of wall with curing as per standard practice.

#### **4.5 Frame and Chain Link**

MS angle frame using 40 x 40 x 6 mm size angle and 32 x 3 x mm MS flat for chain link gripping shall be fabricated. Cleats for fixing frame with support members shall be welded. 50 x 50 mm size square pattern chain link of 8 SWG GI wire shall be fixed with the frame using nut bolts arrangements. All frames shall be similar and inter changeable folding type in design. All frames shall be erected with necessary hard wares, nuts, bolts, washers etc. in plumb and line level.

#### **4.6 Barbed Wire Fencing**

At the top of chain link, barbed wire fencing with 5 numbers of horizontal rows and 2 numbers of cross rows of barbed wires shall be provided for a height of 0.60 meter. All hard wares, nut, bolts, tools, etc. shall be supplied by contractor.

#### **4.7 Gate**

Gate for entry in the fenced compound shall be fabricated from pipes of heavy class (minimum 50 mm diameter for less than 1 meter). Design of gate shall be got approved from the engineer in charge before starting the fabrication work. All necessary hard wares, fittings, stoppers, locking arrangements with brass pad locks of 100 mm size are in the scope of gate works. Gates shall be self supporting type. The main supporting structure shall be of minimum ISWB -150 (150 x100 mm) RSJ section. The RSJ shall be provided with 300 x 300 x 10 mm base plate. Hinges shall be sturdy and give easy and free movement of gates. The support shall be concreted with 1:2:4 cement concrete for full depth. Gate structure shall be painted with one coat of red oxide and

two coats of silver paints or any other shade of Asian / Nerolac / British / Shalimar brand as approved by engineer in charge. Gate and chain links shall be earthed suitably.

## **POWER TRANSFORMER**

### **1.0 SCOPE:**

- 1.1 The scope of work shall cover the supply of transformer suitable for outdoor installation meeting the requirements specified in the equipment data sheet. Associated minor building works required for the erection of the transformer are also included in the scope of this contract.

### **2.0 STANDARDS AND COMPLIANCE:**

The transformers shall comply with latest applicable standards listed below. In case of conflict between standards and this specifications shall govern.

IS : 1180/BS:171/IEC : 76	Power transformer
IS : 3639	Fitting and accessories
IS : 1180	Auxiliary transformer
IS : 6600/BS:CP 1010/IEC:354	Loading of oil immersed transformer
IS : 335/BS:18/IEC:296	Oil
IS : 2099/BS:223/IEC:137	Bushing for > 1000 V AC
IS : 7421	Bushing for > 1000 V AC
IS : 13917 (part-I) /IEC:947-1	Degree of protection
IS : 3637	Buchholz relay
IS : 1271/BS:2/57/IEC:85	Electrical insulation classified by thermal stability
BS : CP 1014	Climate proofing.

### **3.0 CONSTRUCTION:**

- 3.1 Transformer core shall be built up of low loss, non ageing grain oriented silicon steel laminations. Adequate cooling ducts shall be provided. Transformer tanks shall be of robust construction fabricated out of MS plate. All welded joints and valves shall be tested after fabrication of the tank to withstand up pressure of 1.0 kg / cm in excess of the static head of oil. Bolted joints shall carry non deteriorating gaskets. All MS parts shall be painted as specified in chapter for painting.
- 3.2 The transformer tank shall be made from high grade plate steel suitable reinforced by means of stiffeners made of structural steel sections. All seams, flanges, lifting lugs, braces and other part attached to the tank should be welded. The interior of tank shall be cleaned by shot blasting and painted with two coats of heat resistance and oil insoluble paint. Adequately sized of manhole shall be provided for easy inspection and maintenance. All joints may have to be opened

from time to time in the course of the operation shall be of a design to permit them to be made easily oil tight in reassembly. Steel bolts and nuts exposed to atmosphere shall be galvanized. The tank cover shall be suitable sloped such that it does not retain rain water.

- 3.3 All normal fittings required under section 14 of IS: 1180 Part I shall be provided. Additional fittings / accessories shall also be provided as stipulated in the specification of schedule.
- 3.4 The transformer shall be supplied under oil conforming to IS: 335. The transformer shall be delivered after drying out and ready to put into commissioning without further drying out at site. Should however the pre commissioning tests required drying, necessary drying with a stream line filter shall be carried out free of cost. Any other filter process is not acceptable.
- 3.5 High voltage end winding shall be suitable braced to withstand short circuit stresses set up by surges.
- 3.6 The core and oil assembly shall be dried out and impregnated under vacuum.

### **4.0 TAPS AND TAP CHANGE GEAR:**

#### **4.1 OFF CIRCUIT CHANGE GEAR**

The tap changer shall be off circuit type mechanically rugged and arranged to provide for convenient inspection and maintenance without necessity of un tanking. The position indicators shall be positive and there shall not be ambiguity resulting into incomplete tap change with respect to the mechanical tap position indication. The operating handle of tap exchanger shall be brought out of the tank at the side at an accessible height for ground level.

Tap changer operating switch mounted on the top of the transformer tanks will not be acceptable. Provision of padlocking the tap changers without interfering with visual tap position indicator shall be provided. The tap changers shall be provided with micro switch arrangement to issue trip command to the breaker connecting the transformer to the source of power in the event of an inadvertent attempt to change the taps when transformer is on load. The tap changing handle shall have locking arrangement with suitable size.

### **5.0 Bushings**

- (a) All porcelain used in bushings shall be homogeneous, non porous, uniformly glazed to brown colour and free from blisters, burns and other defects.
- (b) Stresses due to expansion and contraction in any part of the bushing shall not lead to deterioration.
- (c) Bushings shall be designed and tested to comply with the applicable standards specified.
- (d) Liquid / oil filled bushings 36 KV and above shall be equipped with liquid level indicators and means for sampling and draining the liquid. The angle of inclination to vertical shall not exceed 30 degrees.

- (e) Oil in oil filled bushings shall meet the requirements of the transformer oil standards specified.
- (f) Bushings rated 72.5 kV and above shall be of the oil filled condenser type with a central tube and draw in conductor which shall be connected to the connector housed in the helmet of the bushings. The pull through lead shall be fitted with a gas bubble deflector.
  - i) Provision for power factor testing without disconnecting main leads.
  - ii) Tress rings and lower end shields.
  - iii) Current transformers shall be provided, if specified and the bushing shall be so arranged that it can be removed without disturbing the current transformers and secondary terminals.
  - iv) Bushing turrets shall be provided with vent pipes which shall be connected to route any gas collection through the Buchholz relay.
- (g) Bushings for 36 kV (except for neutral bushings) and above shall be provided with adjustable rod gap. For bushings rated lower than 36 kV, the gap shall be of double series type to minimize interference from birds.
- (h) Bushings rated for 400 amperes and above shall have nonferrous flanges and hardware.
- (i) Fittings made of steel or malleable iron shall be galvanized.
- (j) Bushings shall be so located on the transformers that full flashover strength will be utilized and minimum clearances as required for the BIL shall be realised between live parts and live parts to earthed structures.
- (k) The connector / clamp shall be rated to carry the bushing rated current without exceeding a temperature rise of  $45^{\circ}\text{C}$  in an ambient of  $40^{\circ}\text{C}$ . The connector / lamp shall be designed to be corona free at the maximum rated line to ground voltage.

## **6.0 Cable Boxes and Disconnecting Chambers**

- (a) When connection is by cable, disconnecting chamber shall be provided for disconnecting and moving away the transformer without unsealing the cables or draining oil from the main tank, leaving the cable box or chamber.
- (b) Cable boxes and sealing ends shall be complete with jointing materials, compound and all other accessories including wiping glands, armour and earthing clamps.
- (c) The cable box shall have all standard facilities including fitting and drain plugs, relief vent, level glass and body earth terminal.
- (d) Cable boxes shall be designed to accommodate all cable joint fittings or sealing ends as required, including stress / cones or other approved means for grading voltage stress on

the terminal insulation of cables operating at voltages of 22 kV and above. The disconnecting chamber shall preferably be air insulated. If oil insulated, the oil shall be segregated from transformer tank oil or cable box oil. Bushings, oil filling and drain plugs, relief vent, level glass, removable links and removable covers shall be provided for the disconnecting chamber.

- (e) Phase to phase and phase to ground clearances within the chamber shall be such as to enable either the transformer or each cable to be subjected separately to H. V. tests when filled with transformer oil.

## **7.0 Fittings and Accessories**

The following fittings and accessories shall be provided.

- (a) Inspection manhole(s) with cover(s) on the top cover of the transformer (for transformers of 500 KVA and above)
- (b) Lifting lugs or eyes for lifting of fully assembled transformer by crane.
- (c) Jacking pads, at least four in number, at suitable height, for lifting the complete transformer filled with oil (for transformers rated 1000 KVA) and above)
- (d) Lifting arrangements for (a) complete transformer filled with oil, (b) for the assembly of core and coils and (c) for lifting the tank of large transformers whenever specified.
- (e) Hauling eyes on each face of the transformer (for transformer rated 10000 KVA and above)
- (f) Skids at the base of the transformer when specified.
- (g) Earthing pads: Two earthing pads of copper or other non corrodible material shall be welded at the bottom corners of the transformer tank and supplied with clamp type terminal conductors. Suitable earthing terminals on cable boxes and separately mounted radiator banks shall also be provided.
- (h) Neutral earthing bar of copper of specified section installed from the neutral bushing to ground level suitably supported along its run on porcelain insulators, together with clamping arrangements at neutral bushing and for two earth conductors. The supporting insulators shall be tank mounted.
- (i) Terminal marking and rating plates shall be as per the specified standard.
- (j) The conservator shall be of sufficient volume to maintain the oil seal from the minimum ambient temperature of  $-5^{\circ}\text{C}$  up to an oil temperature of  $100^{\circ}\text{C}$  with oil level varying within the minimum and maximum visible levels. The conservator shall be provided with the following accessories:
  - i) Filling plug, sump and drain valve of 15 mm size for conservator of size 650 mm and 25 mm size for conservator above 650 mm diameter.

- ii) 150 mm diameter magnetic type oil level gauge with low oil level alarm contacts or a prismatic oil sight gauge, both as specified and provided with markings for minimum oil level and oil level at rated temperature rise.
- iii) A bolted cover at one end for cleaning.
- iv) Valve for shutting off oil to the transformer.
- v) Weather-proof dehydrating breather with silica gel and oil seal to eliminate constant contact with the atmosphere, mounted at a level of about 1400 mm above ground level.
- (k) Marshalling Box.
- (l) Valves shall be supplied on the transformer tank, radiators and coolers as specified in Clause 9.0
- (l) Pressure relief device as specified.
- (m) Gas and Oil Actuated Relay (Buchholz Relay)

A double float type Buchholz relay as per specified standard shall be provided whenever called for. All gas evolved in the transformer shall collect in this relay. The relay shall be provided with a test cock suitable for a flexible pipe connection for checking its operation. A 5 mm copper pipe shall be connected from the relay test cock to a valve located about 1.25 M above ground level to facilitate sampling with the transformer in service. The device shall be provided with two electrically independent ungrounded contacts, one for alarm on gas accumulation and the other for tripping on sudden rise of pressure. These contacts shall be wired up to the transformer marshalling box. The relay shall be provided with shut off valves on the conservator side as well as the tank side.
- (n) Temperature Indicators
  - i) Dial Type Thermometer

All transformers shall be provided with a 150 mm dial type thermometer for top oil temperature indication. The thermometer shall have adjustable, electrically independent ungrounded alarm and trip contacts, maximum reading pointer and resetting device. The contacts shall be rated minimum 0.5 A making and 0.2 A breaking at 220 V DC.
  - ii) Winding Temperature Indicator

A device for measuring the hot spot temperature of the winding shall be provided when called for. It shall comprise of the following:

    - i) Temperature sensing element.
    - ii) Image coil

- iii) Current transformer
  - iv) 150 mm dia. local indicating instrument with four adjustable electrically independent ungrounded contacts, two for control of cooling equipment and two for winding temperature alarm and trip.
  - v) A pointer to register the highest temperature reached and capable of being reset without tools.
  - vi) Calibration device.
  - vii) Automatic ambient temperature compensation.
  - viii) In addition to the above, the following remote indication equipment shall be provided when called for.
    - (b) Top oil resistor temperature detector in each winding of the transformer to be connected to the multipoint temperature recorder for H V and L V winding temperature indication.
    - (c) Remote winding temperature indicating, flush mounted instrument for mounting on the panel.
- iii) All contacts shall be rated minimum 0.5A making and 0.2A breaking at 220V DC, adjustable on a scale and accessible on removal of cover. Connections shall be brought from the device to terminals placed inside the marshalling box.

## **8.0 Losses**

Losses as measured on the transformer after manufacture be found in excess of the quoted values of the guaranteed losses with plus tolerance, the bidder shall pay to the GWSSB, penalty charges based on the charges indicated.

## **9.0 Rejection**

The GWSSB may reject any transformer if during tests or service any of the following conditions arise:

- (a) No load loss exceeds the guaranteed value as per IS 1180.
- (b) Load loss exceeds the guaranteed value as per IS 1180.
- (c) Impedance value exceeds the guaranteed value as per IS 1180 without positive tolerance.
- (d) The difference in impedance values of any two phases during single phase short circuit impedance test exceeds 2 percent of the average value guaranteed by the bidder.  
Oil or winding temperature rise exceeds the specified value by 5<sup>0</sup> C.  
Transformer fails on impulse test.  
Transformer fails on power frequency voltage withstand test.



- (h) Transformer is proved to have been manufactured not in accordance with agreed specifications.
- (i) The GWSSB reserves the right to retain the rejected transformer and take it into service until the bidder replace, at no extra cost, the defective transformer by a new transformer.
- (j) Alternatively, the bidder shall repair or the replace the transformer within a reasonable period to the GWSSB satisfaction at no extra cost.
- (k) Following Drawings / Documents to be submitted for approval:
  - 2.1 GA drawing of transformer.
  - 2.2 Guaranteed technical specifications of transformer.
  - 2.3 GA of HV / LV cable box.

**Special instruction for operation of power transformer under no / part load condition:**

When pumping station is idle and power transformer is required to be kept energised under no load / part (miniscule) load condition, the necessary L T fixed capacitor bank shall be provided in MCC / PCC panel and shall be manually switched on to maintain power factor more than 0.95 but less than 0.999 (near unity). This is a complete responsibility of the contractor to maintain the power factor under idle condition of pumping station. Any power factor adjustment charges levied by power utility i. e. PGVCL/ MGVL etc. shall be recovered from the contractor along with 5 % lump sum administrative charge by GWSSB.

**DATA SHEET FOR DISTRIBUTION TRANSFORMER**

<b>Sr. No.</b>	<b>Description</b>	<b>Particulars</b>
<b>2.0</b>	<b>GENERAL DATA</b>	
2.1	Installation	Outdoor
2.2	Service	Continuous
2.3	Climate	Humid
2.4	Type of cooling	ONAN
2.5	Ambient temperature	Max. 45 <sup>0</sup> C Avg. 30 <sup>0</sup> C
2.6	Allowable temperature rise	Oil: 50 <sup>0</sup> C Winding: 55 <sup>0</sup> C
2.7	Painting	Epoxy Shade No. 631 as per IS - 5
2.8	Oil type	Mineral Oil
2.9	Position	Ground level (on pedestal)
<b>3.0</b>	<b>ELECTRICAL DATA</b>	
3.1	Earthing: L V side	Solid
3.2	No. of windings / Material of conductor	Two / Copper
3.3	Phase & frequency	3 & 50 Hz
3.4	Voltage ratio	11 KV / 0.433
3.5	phase connection	Delta – Star
3.6	Vector group	Dyn 11
3.7	% impedance	Within maximum permissible limit as per IS without positive tolerance
3.8	Rating in KVA	_____ KVA
3.9	Winding insulation class	Class A
3.10	Termination I) H V side II) L V side	Cable Box Size : Suitable size for ACSR conductor LV Neutral bushing required 3 core aluminum LT XLPE double cable suitable size
4.0	Tap Changer	
4.1	Tapping	H V
4.2	Tap Changer	Off Circuit

4.3	Tapping range	$\pm 10 \%$
4.4	No. Of Steps	8 steps in the range of 2.5 %
5.0	<b>Accessories</b>	
	▪ Sampling Valve	
	▪ Plain oil level gauge	
	▪ Conservation & conservation drain valve	
	▪ Explosion vent with diaphragm	
	▪ Silica gel breather	
	▪ Air release plug	
	▪ Marshalling Box	
	▪ Separate neutral bushing	
	▪ Top oil filter valve	
	▪ Lifting lug.	
	▪ H.V. & L.V. gland plate (if applicable)	
	▪ Thermometer pocket for O.T.I.	
Accessories shown above & in price bid (description of the item) are indicative. All the accessories & fittings required as per relevant IS have to be compulsorily supplied with the unit as a whole by the bidder.		

## **Medium Voltage Motor Control Centre (MCC) Panels**

### **1. Scope**

- 1.1 This specification covers the requirement for Medium Voltage (MV) Switchboard or Main LT Panel or Power Control Centre (PCC), Motor Control Centre (MCC), Automatic Power Factor Correction (APFC) Panel or the combination of both of these (PMCC) and Power Distribution Board required to distribute power in the plant / building at medium (low) voltage.
- 1.2 The specifications cover the requirements of relay and control panel, cubicles and desks associated equipment (s) mounted and internal wiring therein. All or part of control panel, metering, protections and other necessary equipment specifications in the following clauses of the specifications shall be provided as and when called for in the accompanied specifications / data sheets or drawings.
- 1.3 The enclosed drawings and / or data sheets if any form part of the specifications.
- 1.4 The drawings and specifications complement each other and what is shown or called for in one shall be interpreted as being called for in both. Material (s), if any, which may have been inadvertently omitted but fairly implied as required to make a complete assembly of the switchgear as shown in the drawing(s) and the specification (s) to make the unit properly operational shall be construed as required and covered in the bidder's scope.

### **2. Codes and Standards**

- 2.1 The design, manufacture and performance of the equipment shall comply with all Indian Standards, I. E. rules, statutory regulations and safety codes currently applicable in the locality where the equipment will be installed.
- 2.2 Unless otherwise specified, the equipment shall conform to the latest applicable Indian Standards and in particular the following:

Sr. No.	Details of IS	Description
1	IS:13947	Low voltage switchgear and control gear (Part 1 to 5)
2	IS:9224	Low voltage fuses
3	IS:2705	Current transformers
4	IS:3156	Voltage transformers
5	IS:3231	Specification for electrical relays for power system

		protection
6	IS:4237	General requirements for switchgear and control gear for voltages not exceeding 1000V AC
7	IS:1248	Direct acting electrical indicating instruments
8	IS:5578	Guide for marking of insulated conductors
9	IS:11353	Guide for uniform system of marking and identification of conductors and apparatus terminals
10	IS:8623	Specifications for factory built assemblies of switchgear and control gear (up to 1000 Volts AC)
11	IS: 5124	Code of practice for installation & maintenance of motor starters
12	IEC: 947.4.2 / EN 50081-1, 50082-2 & 60204	Microprocessor Soft Starter

### **3. General Requirement**

3.1 All identical equipment and parts shall be interchangeable.

For better equipment and human safety and performance, the enclosure should follow either form 3 A, 4 or 4 B standards as specified in data sheet.

3.2 The switchgear shall consist of indoor, floor mounted, metal enclosed, compartmentalised (if not indicated specifically in data sheet), modular type and totally front side operated vertical sections.

3.3 It shall be dust and vermin proof and shall be easily extensible on both sides.

3.4 All doors and removable covers shall be gasketed all around with neoprene gaskets.

3.5 Each vertical section shall comprise the following:

3.5.1 Metal enclosed bus bar compartment, running horizontally throughout the length of the switchgear.

3.5.2 Individual feeder modules in multi tier formation.

3.5.3 Shrouded main and vertical bus bars and individual feeder connection.

3.5.4 Vertical cable alley and bus bar alley with doors or covers covering the entire height of the feeder module panel.

3.5.5 Horizontal wire way for control wiring.

3.5.6 Space heater with thermostat and MCB in bus bar chamber.

- 3.5.7 Sheet steel barrier between two adjacent vertical sections except for horizontal bus bar compartments.
- 3.5.8 Separate door for each feeder module.
- 3.5.9 10 % additional space in the panel (in terms of vacant feeder compartments of various sizes), to accommodate the future requirement if any.
- 3.5.10 Totally front side operated panel i. e. cable and bus bar alleys of suitable sizes (minimum 350 mm width) shall be on the panel front side only.
- 3.5.11 Each vertical panel should be divided into the distinct zones for bus bars, feeders, power cabling, control cabling and power & control terminals.
  
- 3.6 The switchgear unit shall consist of rigid structural frame enclosed by 2 mm thick cold rolled (CRCA) sheet steel. Doors and covers shall be of 2 mm thick cold rolled (CRCA) sheet steel. Structural framework with foundation bolts etc. at the bottom shall be provided to mount the switchgear directly on concrete / steel channel base.
- 3.7 The switchgear shall be provided with removable cable gland plate (of minimum 3 mm thickness), with brass cable glands and crimping type cable lugs, as indicated in the data sheet.
- 3.8 Separate metal labels shall be provided for switchgear modules, relays, instruments, & switches etc. Approval for the type of label shall be taken from the GWSSB.
- 3.9 Control switches, push buttons, indicating lamps, meters and relays shall be mounted on the front door. Current Transformers (CTs) and Voltage Transformers (VTs) shall be mounted on the fixed portion.
- 3.10 Painting shall be done by surface coating comprising pre treatment, electrostatic powder spraying and curing. The surfaces to be coated shall be chemically de rusted and degreased at a temperature of 70<sup>0</sup> to 80<sup>0</sup>C, zinc phosphatised and then passivated at about 60<sup>0</sup>C and, after proper drying, subjected to spraying of powder charged at about 90 KV through electrostatic guns. Curing shall be done in stoving oven at 180<sup>0</sup> to 200<sup>0</sup> C for 12 to 15 minutes ensuring a uniform and continuous coating. The colour of the shade shall be 631 of IS 5.
- 3.11 Feeder control and motor control equipment not incorporating circuit breaker shall be of fixed type execution, as specified in the drawing / data sheet.
  - 3.11.1 In the case of fully draw out type withdraw able ACB chassis, all electrical power and control connections shall be of plug in type.
  - 3.11.2 In the case of semi draw out type withdrawable chassis, all electrical power connections shall be of plug in type. All control connections shall be of screwing in type.
- 3.12 200 mm clearance shall be provided between the finished floor and the bottom of the lower most feeder compartment.

- Min 300 mm clearance up to 100 kW feeder and 450 mm clearance above 100 kW feeder should be provided (both incoming and outgoing) for proper termination.
- 3.12 Panel lifting lugs shall be of removable type and are to be fixed with panel using bolts and nuts.
- 3.13 Cubicle Lighting: Each ATS / soft starter cubicle shall be provided with interior lighting, by means of a minimum 10 W CFL fixture. A lighting fixture "ON OFF" switch shall be provided. The lighting fixture shall be suitable for operation from a 240 V, 1 phase 50 Hz AC supply. Suitable AC single phase plug point shall be provided in the interior of each cubicle.
- 3.14 MCC panel shall have extra feeders for auxiliaries like general area & premises lighting, EOT / motorised chain pulley block, vacuum pump, drain pump, filter plant (if any) etc. as per requirement with MCBs of required amperage (e.g. 32 / 63 / 100) & quantity with wiring etc. complete.
- 3.16 In case of pumping stations with HT power & transformer, fixed capacitors bank of required KVAR along with MCB & wiring etc. shall be provided suitably in MCC panel to compensate for low power factor during transformer no / miniscule load condition.
- 3.17 In case where APFC panel is also to be supplied, combined (consolidated) compartmentalised enclosure for MCC & APFC panel can be supplied if so specified in the data sheet.
- 3.18 Separate annunciation window at incomer feeder with required cabling, fault indication for each pump viz. (a) pump trip (red) - through starter (b) high & low levels in sump (c) high & low discharge pressure shall be provided if specified so in the price bid.
- 3.19 Calculation for enclosure for soft starter shall be given as per governing standards.

#### **4 Main Bus Bar**

- 4.1 Main bus bars shall be of uniform cross section in Aluminium as specified in the drawing / data sheet. Feeder to bus or cable alley entry of bus bar shall be effectively sealed by electrical and thermal insulation barriers so that products of flashover do not travel from one cubicle to other cubicle creating multiple faults. Bus bar shall be calculated on 50<sup>0</sup> C ambient temperature and 85<sup>0</sup> C for continuous and short time rating.
- 4.2 Wherever Aluminium to copper connections is required, suitable bimetallic connections /clamps shall be provided.
- 4.3 Maximum temperature of the bus bars and the bus connections shall not exceed 85<sup>0</sup> C.
- 4.4 The bus bars shall be provided with heat shrinkable sleeves fully insulated encapsulation in epoxy resin with moulded caps protecting all joints or heat shrinkable PVC sleeves and tapes and colour coded for identification.

- 4.5 Separate supports shall be provided for each bus bar. If common support is provided for all bus bars, anti tracking barriers shall be incorporated.
- 4.6 In order to avoid any accidental hazards, bus bar compartments shall be protected with 3 mm thick Hylem / Bakelite sheets.
- 4.7 The neutral bus bar shall be half size that of phase bus bars in the case of all panels.
- 4.8 Calculation of cross sectional area, current carrying capacity for rightly rated bus bar shall be provided along with calculation of temperature rise. De rating factors shall be considered as per governing standards & requirement of the system.
- 4.9 Bus bar material i. e. aluminium shall be electrolyte grade aluminium with test certificate (s) of the lot. It shall be of reputed make i. e. Hindalco/ Nalco/ Balco/ Banco.

### 5 Circuit Breakers

#### 5.1 Air Circuit Breaker (Above 630 Amperes)

- 5.1.1 These shall be air break, fully draw out type, and shall consist of the following:
- 5.1.2 Shunt and / or series trip as specified in drawing / data sheet. Coordination shall be ensured between successive breakers.
- 5.1.3 Mechanical OPEN / CLOSE position indicator, visible with door closed.
- 5.1.4 Emergency trip push button.
- 5.1.5 'Red', 'Green' and 'Amber' indicating lamps for Breaker ON, Breaker OFF and Breaker trip on fault.
- 5.1.6 There shall be 'Service', 'Test' and 'fully withdrawn' positions for the breakers along with their indications on the breaker front fascia.
- 5.1.7 Mechanical anti pumping feature should be provided.
- 5.1.8 It shall be possible to withdraw the breaker only in open position.
- 5.1.9 Compartment door of the breaker shall not open unless the breaker is in open position.
- 5.1.10 Automatic safety shutters shall be provided to cover live contacts when carriage is withdrawn
- 5.1.11 Relays shall have potential free contacts.
- 5.1.12 Facility shall be provided for blocking under voltage releases if any
- 5.1.13 Electrical operating mechanism shall be of spring charged stored energy type or spring assisted type, independent of the speed at which the handle is operated.
- 5.1.14 Power operated mechanism shall be of motor wound spring charging stored energy type. Emergency manual charging facility shall also be provided.
- 5.1.15 Indicators shall be provided to show 'charged' and 'discharged' conditions of the spring.
- 5.1.16 The operating mechanism shall be trip free.
- 5.1.17 The breaker shall be provided with the microprocessor based release.



5.1.18 The micro processor release should have over current, short circuit and earth fault protections along with their indications due to which the breaker has tripped.

## **5.2 Moulded Case Circuit Breaker (Above 80 amperes & Up to 630 Amperes)**

5.2.1 The moulded case circuit breaker (MCCB) shall be air break type and having quick make quick break with trip free operating mechanism.

5.2.2 Housing of the MCCB shall be of heat resistant and flame retardant insulating material.

5.2.3 Rotary type operating handle of MCCB shall be provided in front and should clearly indicate ON / OFF / TRIP positions and should have padlocking facility.

5.2.4 The electrical contact of the MCCB shall be of high conducting non deteriorating silver alloy contacts.

5.2.5 The MCCB should have earth leakage / fault release with adjustable current setting facility and mechanical interlock facility (if with two incomers).

5.2.6 The MCCB should be provided with microprocessor based adjustable type over load release with time delay and adjustable type short circuit with time delay protection device.

5.2.7 The MCCB rating should be selected as per type II coordination (IEC 60947-4-1) chart as per manufacturer (s) standards or as per value of the table specified herein whichever is higher.

## **6 Motor Starters**

The motor starter shall comprise of contactors, relays, timers, SPP etc. having as per actual technical requirements of the system & following specifications. Different type of starters for various HP range are tabulated below.

Sr. No.	Rating	Type
1	Up to 7.5 HP	Direct On Line
2	8 to 20 HP	Star Delta
3	21 to 99 HP	Auto Transformer Starter
4	100 HP and Above	Microprocessor based soft starter

### **6.1 Contactors / Relays**

Selected rating of all contactors should be minimum as per Type II coordination as per manufacturer (s) standard or higher than the values tabulated herein. Back up protection up to 80 amperes shall be MPCB while the same shall be MCCB for above 81 amperes.

- 6.1.1 Contactors shall be air break, double break, single throw, electromagnetic type. The insulation class of coil should be B or higher. Mechanical and electrical life should be as under

Rating	No of mechanical operation in million
Up to 32 A	15
33 to 80 A	10
81 to 400 A	05

Rating	No of electrical operation in million
Up to 70 A	01
75 to 400 A	0.5

- 6.1.2 Main contacts shall be of silver faced copper.
- 6.1.3 Minimum one 'NO' or one 'NC' auxiliary contacts shall be provided for each power contactor. However, additional nos. of auxiliary contactors should be added in the control scheme as per the requirement.

## **6.2 Direct on line (DOL) starters**

- 6.2.1 DOL starters shall be suitable for AC3 utilization category as per IS: 13947 (Part 4).
- 6.2.2 Ratings of MPCB, overload relay & contactor for DOL starter panels are tabulated below.

Sr. No.	Type of Panel	MPCB rating	Overload relay Rating	Contactor Rating
1	DOL Up to 3 HP	4 – 6.3	3 – 5	16
2	DOL above 3 HP to 5 HP	9 – 14	6 – 10	16
3	DOL above 5 HP to 7.5 HP	13 – 18	10 – 16	22 / 25

## **6.3 Automatic star delta starters**

- 6.3.1 These starters shall comprise three sets of contactors and a timer relay. Star Delta timer should have feature to avoid transition peak.
- 6.3.2 Starters shall be suitable for AC3 utilisation category as per IS: 13947 (Part 4 /Sec 1).
- 6.3.3 Ratings of MPCB, overload relay & contactor for star delta starter panels are tabulated below.

Sr. No.	Type of Panel	MPCB rating Line (A)	Overload relay rating Phase	Contactor Rating		
				Main	Delta	Star
1	SD 8 to 10 HP	13 – 18	6 – 10	16	16	16
2	SD 11 to 15 HP	20 – 25	10 – 16	22 / 25	22 / 25	22 / 25
3	SD 16 to 20 HP	24 – 32	13 – 21	30 / 32	30 / 32	30 / 32

#### 6.4 Auto transformer starters

- 6.4.1 Auto transformer shall be air cooled type having 3 tapings of 60%, 70% and 80%. The same should be wound with copper wire. The size of the wire should be determined as per the HP of the motor. Stampings of reputed make and winding wire with E class insulation should be used. This should also be suitable for 6 starts per hour. Maximum temperature rise should not be more than 115<sup>0</sup> C as per IS. ATS shall be provided with thermal overload protector in each coil of transformer from overheating. Thermal overload protector rating shall be 90<sup>0</sup> C with 10% tolerance i. e. 100<sup>0</sup> C  $\pm$  10%, Acrylic / Hylem sheet over the transformer shall be provided. To absorb humming rubber sheet shall be provided below auto transformer.
- 6.4.2 Ratings of MPCB, overload relay & contactor for auto transformer starter panels up to 50 HP are tabulated below.

Sr. No.	Type of Panel	MPCB rating Line A	Overload relay rating Line	Contactor rating		
				Main	Step	Star
1	ATS 21 to 30 HP	37 – 50	30 – 50	63 / 70	32	22 / 25
2	ATS 31 to 35 HP	48 – 65	45 – 70	70	38 / 40	32
3	ATS 36 to 45 HP	56 – 80	55 – 90	80 / 110	38 / 40	32
4	ATS 46 to 50 HP	60 – 100	60 – 110	95 / 110	63 / 70	38 / 40

- 6.4.2 Ratings of MCCB, overload relay & contactor for auto transformer starter panels above 50 HP are tabulated below.

Sr.	Type of Panel	MCCB	Overload	Contactor rating
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No.		rating A	relay rating Line	Main	Step	Star
1	ATS 51 to 60 HP	120	60 – 100	120	63 / 70	38 / 40
2	ATS 61 to 70 HP	160	80 – 120	160 / 200	63 / 70	38 / 40
3	ATS 71 to 80 HP	160	90 – 150	160 / 200	100	50
4	ATS 81 to 90 HP	200	135 – 225	200	100	50
5	ATS 91 to 100 HP	200	135 – 225	200	125	50

## **6.5 Motor Protection Circuit Breaker (Up to 80 amperes)**

6.5.1 Up 80 amperes line current only motor protection circuit starters (MPCB) is to be used as back up protection. While for line currents above 80 amperes moulded case circuit breakers (MCCB) is to be used as back up protection.

6.5.2 MPCB shall be of Auto / hand reset type.

6.5.3 Motor protection should be provided by the thermal magnetic protection elements incorporated in the motor circuit breaker. The magnetic elements (short circuit protection) should have a nonadjustable tripping threshold, which is equal to 13 times the maximum setting current of the thermal trips.

The thermal elements (overload protection) include automatic compensation for ambient temperature variations.

The rated operational current of the motor is displayed by means of a graduated knob contact from the front panel.

The addition of an under voltage trip allows the circuit breaker to be de energised in the event of an under voltage condition. The user is therefore protected against sudden starting of the machine when normal voltage is restored, since the start button “I” has to be pressed to restart the motor. With the addition of a shunt trip, de energisation of the unit can be remotely controlled.

The operators on both open mounted and enclosed motor circuit breakers can be locked in the Stop position “O” by up to 4 padlocks.

It should be suitable for isolation, these circuit breakers, in the open position, provide an adequate isolation distance and indicate the actual position of the moving contacts by the position of the operators.

## **6.6 Micro processor based soft starter**

### **6.6.1 Scope**

This specification covers the requirement for design, manufacture, installation, testing and commissioning of step less reduced voltage / solid state torque controlled soft starter for motors in MCC panel to provide linear ramp starting and stopping of AC induction motors.

### 6.6.2. **Applicable Standards**

The Soft starter shall conform to the latest applicable standards specified below.

Microprocessor Soft Starter IEC: 947.4.2 / EN 50081-1, 50082-2 & 60204-1

In case of conflict between standards and this specification, this specification shall govern.

### 6.6.3 **Torque / Ramp**

The two acceleration start ramp timers shall have individual adjustments from 1 to 60 seconds. The two acceleration stop ramp timers shall have individual adjustments from 2 to 60 seconds. The initial torque setting shall be adjustable from 0 to 200 % of motor torque. The end torque setting shall be adjustable from 50 to 200 % of motor torque. Current limit starting shall be adjustable from 150 % to 500 % of the motor's full load current.

### 6.6.4 **Protection and Diagnostics**

Overload protection shall be as follows:

Meet applicable standards as a motor thermal protection device.

Shaft Power measurement without the use of external electro mechanical sensors.

Electronic thermal memory shall be provided for enhanced motor protection.

Shaft overload and under load protection shall be available through the controller, even in a by pass configuration.

Protections should be available in bypass mode.

When fault conditions are detected, the controller shall inhibit starting or shut down SCR pulse firing.

### 6.6.5 **Pump Control (standard feature)**

The standard feature pump control shall be implemented to provide closed loop control of a motor to match the specific torque requirements of centrifugal pumps for both starting and stopping. This shall aid in eliminating the phenomenon commonly referred to as "water hammer". Methods utilising soft start with soft stop shall not be independent of each other. Pump stop shall be initiated without the need for a dedicated pump stop input. A coast to rest stop shall still be possible with stop input. The pump stop times shall be user adjustable from 0 to 60 seconds for small capacity at valve actuator & need not higher.

1) Bypass contactor may have physical isolation / in built in soft starter. .

2) Soft starter should have inbuilt RS 485 communication port compatible with MODBUS type open communication port.

### 6.6.6 **Environmental Ratings**

a) Temperature Ratings

The controller shall be operable in relative humidity of 5 to 95 %, non condensing. The

Controller shall deliver its rated current in ambient temperature ranging from 0°C to + 50°C.

**6.6.7 Controller's Features and Modes**

- A)** Following **starting modes** require for controller:  
Linear Torque control for pump current limit start  
i) Voltage ramp Start  
ii) Voltage ramp with current limit Start
- B)** Following **stopping modes** require for controller:  
Linear torque control for stop  
Quadratic torque control for stop
- C)** Following **additional features** also require for controller:  
a) Analogue output  
c) Built in Display (LCD /LED)
- D)** Following **operation features** require for controller:  
Keyboard  
Remote
- E)** Following **protection features** require for controller:  
Motor Thermal Overload – selectable for starting class 10 A, 15 A, 25 A  
Under load protection (to avoid dry run)  
Soft Start thermal overload  
PTC input  
Phase imbalance  
Phase reversal  
Over voltage  
Under voltage  
Locked rotor  
Excessive starts per hour  
Phase loss input / output
- F)** Following **viewing functions** require for controller:  
Motor Current  
Three Phase Voltage  
Shaft Power in kW / HP (selectable)  
Motor thermal capacity  
Motor Energy consumption (kWh)  
Power factor  
Run time in hours
- G)** Following **fault indication functions** require for controller:  
Line failure

Phase imbalance

Over temperature – motor

Over temperature – soft starter

Shorted thyristor

Open thyristor (optional)

Locked rotor

Motor output loss

Overload – shaft torque

Under load – shaft torque

Phase imbalance

Over voltage (optional)

Under voltage (optional)

Excessive starts

Phase reversal

Event list of 10 latest fault indications /occurrence

#### **6.6.8 Ratings of MCCB (up to 270 HP) & ACB (above 271 HP)**

Ratings of MCCB for soft starter panels for and above 100 HP are tabulated below.

Sr. No.	Type of Panel	MCCB ACB rating A	By pass contactor rating of AC 1 duty (if not built in i. e. external)
1	100 HP	200	200
2	120 HP	250	250
3	150 HP	300	300
4	175 HP	400	400
5	200 HP	400	400
6	215 HP	500	500
7	250 HP	500	500
8	270 HP	600	600
9	335 HP	800	800
10	425 HP	1000	800

#### **6.7 Thermal Overload Relays**

6.7.1 Starters shall be complete with three elements, ambient temperature compensated, time lagged thermal overload relays with adjustable settings and single phasing preventive mechanism.

6.7.2 Thermal overload relays shall be of auto / hand reset type with 1 No + 1 NC potential free contact. A hand reset push button, separate from the stop push button, shall be brought out on the front of the compartment door.

## **6.8 Single Phasing Preventer**

Single phasing preventer with auto switch should be operating on negative phase sequence components principal and voltage sensing type. It should operate satisfactory from 320 / 480 V. Timing range of delay start 0 - 45 seconds. Toggle switch for Auto SPP by pass should be provided on front of unit. There must be an indication when 3 phases are balanced. When one phase is not available indication light should go off.

## **7 Earth Leakage Relay**

For the protection against the rise of damaging / dangerous and possible lethal electric shocks, automatic disconnection of supply device i. e. ELR should be incorporated in MCC panel suitably designed as per relevant IS / BSS in accordance with Indian electricity rules 1985 & statutory requirements of power utility i. e. PGVCL / MGVL etc. Separate earth leakage breaker also shall be provided in the starters. The relay shall be voltage / current operated. The Minimum range should be 320 to 480 volts with suitable time delay. ELR should be of adjustable from minimum 0.5 to 2.5 amperes with CBCT with time delay.

## **8 Instrument Transformers**

- 8.1 CTs and VTs shall conform to the requirement of IS: 2705 and IS: 3156 respectively. The ratings specified are indicative only and it shall be vendor's responsibility to ensure that the ratings offered are adequate for the relays / meters provided considering lead resistance, etc.
- 8.2 CTs and VTs shall be of dry air insulated type.
- 8.3 Facility shall be provided in the terminal blocks for shorting and earthing the CTs.
- 8.4 VTs shall be provided with adequately rated primary and secondary fuses.

## **9 Instruments**

- 9.1 Indicating instruments shall be of digital type, minimum 96 x 96 square mm size, suitable for flush mounting.
- 9.2 At main incomer multi function meter shall be provided having kW, kWh, PF, KVarh, KVAh, A, V, Hz and with RS 485 communication facility.
- 9.3 Ammeter with selector switch in outgoing shall be of digital type. The accuracy class shall be 1.0 as per IS: 248. The range shall be indicated in the drawings. These shall be provided on individual outgoing feeders.
- 9.4 Digital type time totaliser with 5 digits display shall be provided on individual outgoing feeder.

## **10 Compartment for instrumentation (flow meter etc.)**



Separate instrument's compartment for indicator of flow meter (s), energy meter / pressure controller (if any) shall be provided as per actual requirement of suitable size.

## **11 Pump Selector Switch**

It requires in the usually in the pattern of (1+1) pumps (unless otherwise specified) i. e. one pump working & one standby i. e. at any given time only one pump can be selected for operation out of total 02 installed pumps. Suitable capacity reputed make pump selector switch shall be incorporated between two pump feeders. The selector switch shall be confirming to relevant IS. Pump selector switch shall be provided in configuration (e. g. 1 W + 1 SB, 2 W + 1 SB) as per the requirement of the pumping system.

## **12 Internal Wiring**

- 12.1 All wiring inside the switchgear shall be carried out with 650 V grade FRLS PVC insulated flexible stranded copper wires. Minimum size of conductor for control wiring shall be 1.5 sq mm Copper for potential circuit and 2.5 sq mm for control circuit.
- 12.2 Ferrules shall be provided on each wire for ease of maintenance. Ferruling should be done with cross reference of equipment (s) connected.
- 12.3 All wiring shall be terminated on terminal blocks with crimping type Copper cable lugs.
- 12.4 Power connections above 100 A shall be carried out with PVC insulated copper links.
- 12.5 Vertical / horizontal Aluminum wire ways shall be provided to run the control wires within the same vertical panel and / or between different vertical panels.

## **13 Terminal Blocks**

- 13.1 All terminal blocks (minimum 4 sq mm for control circuit) for power and control circuits shall be of 650V grade stud type and shall be properly separate from each other.
- 13.2 Terminal blocks of different voltage groups shall be segregated and suitably labeled.
- 13.3 Terminals shall be numbered as per wiring diagrams.
- 13.4 20 % spare terminals shall be provided.
- 13.5 Shorting links shall be provided for all C.T. terminals.

## **14 Earthing**

- 14.1 An earth bus extending throughout the length of the Switch board / PCC / MCC/ PMCC / DBs / APFCR panel shall be provided.
- 14.2 The earth bus shall be of sufficient cross section to carry safely momentary short circuit current for 1 second.
- 14.3 All non current carrying metal parts shall be effectively bonded to the earth bus.

- 14.4 Material should be Aluminum & size should be 25 mm x 3 mm up to 250 amperes & 50 mm x 6 mm above 250 amperes.

## **15 Miscellaneous Accessories**

- 15.1 Breaker control switch in case of ACB shall be:  
Spring return to neutral type with pistol grip handle and lockable in neutral position.
- 15.2 Indicating lamps shall be multiple LED type made from FR type polycarbonate material with low voltage glow protection (up to 50V) and translucent lamp covers. Lamps shall be replaceable from front. The power consumption of each indicating lamp should not exceed 0.5 Watts.
- 15.3 Push buttons shall be momentary contact type rated for 10 A at 500 V AC. The colour of push buttons shall be as follows:
- |  |   |       |
|--|---|-------|
| Start                                    | - | Green |
| Stop (stay put, mushroom, lockable type) | - | Red   |
| All others                               | - | Black |
- All push buttons are required to have functional labels.
- 15.4 In case of submerged centrifugal pumps winding protection (thermal overload) relay and moisture controller relay in each outgoing feeder shall be provided along with required control wiring. Type, designation shall be suitable for pumping system.

## **16 Power factor improvement (Capacitor Banks)**

### **16.1 Scope**

This specification covers design, manufacture, supply, installation, testing and commissioning of capacitor banks suitable for continuous duty. Capacitors shall be as per relevant governing standards & test certificates.

Provision of required capacity of fixed / dynamic APP type capacitor banks is to be made in MCC panels. Each capacitor shall be provided with capacitor duty (AC 26 B) contactor and MCB (only D Curve) of required amperage. The fixed capacitor bank type panels should be suitable to improve power factor from 0.85 lag to 0.95 considering total working load at the pumping station. While automatic (dynamic) power factor correction panels suitable to improve power factor from 0.85 lag to 0.98 lag considering total working load at any pumping station shall be provided for all MCC panels with working load above minimum 75 kW with HT power. In case APFC panel, fixed capacitors in individual outgoing motor feeders of MCC panel are not separately required. While in case of MCC panels with fixed capacitor banks it is mandatory to install fixed & adequately rated capacitors in all outgoing motor feeders.

### **16.2 Construction**

Capacitor banks shall comprise of identical delta connected three phase units. The individual capacitor unit shall be manufactured out of APP design comprising of hazy and thick polypropylene film between two electrodes of thick aluminium foil. Each individual element of the capacitor unit shall be provided with silver fuse wire. The capacitor unit shall consist of many such elements in series / parallel combinations for getting the desired KVAR output. The capacitor shall be vacuum impregnated with liquid dielectric having high thermal stability. The dielectric losses of the capacitor shall be restricted to 1.5 watts per KVAR. The phase terminal connections of the capacitor unit shall be brought out at the top through metal insulators which should be soldered to the fabricated top cover. The capacitor shall be provided with suitably rated discharge resistors. The capacitor shall be designed to withstand the electro dynamic and thermal stresses caused by transient over current during switching.

### 16.3 **Rating**

Rating in KVAR of capacitors for fixed capacitor type banks for different HP rating panels along with MCB / MCCB rating along with contactor is tabulated below.

Sr. No.	Rating of panel in HP	KVAR rating (Power factor improvement up to 0.95 for fixed capacitor banks)	MCB rating (with time delay timer)	Contactor rating
1	7.5	3	6	8 – 10
2	10	3	6	8 – 10
3	15	4	10	10
4	20	5	10	10
5	30	7	16	16
6	35	8	16	16
7	45	10	25	20
8	50	11	25	20
9	60	13	32	20
0	70	15	40	25
11	80	18	40	25
12	90	20	50	30
13	100	22	50	30

### 17 **Automatic (Dynamic) Power Factor Correction (APFC) Panel**

Automatic power factor correction panel shall be supplied as per provision of price bid. Details & standards specified above for MCC panel also holds true for this panel. It shall have intelligent microprocessor based relay of required steps (minimum 8 steps) based on the

requirement. The relay shall have auto / manual selection feature and shall adapt the direction of CT besides, it shall possess following salient features:

- 17.1 Auto self adjustment to any capacitor step value.
- 17.2 Multiple LCD data indication of power factor at each phase (lead / lag), kW, KVA, KVAR, voltage, load current at each phase, capacitor current at each phase, injected KVAR to reach target power factor, frequency etc. inclusive of all preset parameters & specified installation data.
- 17.4 Three phase sensing suitable for three phase balanced loads.
- 17.5 Operation time delay facility for 10 - 240 seconds.
- 17.6 Memory back up to save the data in the event of power failure.
- 17.7 Alarm output for capacitor or contact failure, abnormal values of voltage, current, KVAR, power factor, temperature, frequency etc.
- 17.8 No volt relay features to immediately disconnect all capacitors in the event of power failure.
- 17.9 Various protections i. e. over temperature, overload etc.
- 17.10 Remote fault alarm indicator.
- 17.11 Power factor correction fault.
- 17.13 RS 485 serial port.

## **18 Testing & Inspection**

- 18.1 Vendor shall test the switchgear to conform to IS: 4237 with all components assembled and fully wired.
- 18.2 The following routine tests shall be carried out on all the components and the assembled switchgear as per relevant & applicable standards.
  - a) Mechanical and electrical operation tests by simulating operating conditions as at site.
  - b) High voltage test (2.5 KV for one minute).
  - c) Insulation resistance test.
  - e) Temperature rise test of auto transformer of each rating.
- 18.3 Inspection including witnessing routine tests will be carried out by the designated third party inspection agency jointly with authorised representative of GWSSB.

## **19 Guarantee**

Vendor shall guarantee the design, materials, workmanship and performance of all goods to be supplied under the order for a period of twelve months (12) from the date of initial operation or eighteen (18) months after delivery at job site, whichever earlier.

## 20 Drawings & Instruction Manuals

20.1 Vendor shall submit two sets of G. A. drawings, bill of quantities, make of materials, standard product catalogues etc. along with the initial offer and four (4) sets of the following drawings for approval after award of contract:

20.1.1 Complete assembly drawing of the switchgear, showing plan, elevation and typical sections with dimensions and location of terminals for external connections.

20.1.2 Switch gear elevation and layout plan with floor openings and floor fixing arrangements.

20.1.3 Schematic diagrams with terminal and ferrule numbers for each module / switchboard panel.

20.1.4 Wiring diagram for each module indicating terminal blocks and various apparatus.

20.1.5 Final list of apparatus for each module.

20.1.6 Manufacturer's descriptive literature on various components used in the switch gear.

20.2 One print of each drawing will be returned to vendor with comments and required clarifications if any. Vendor shall incorporate these and send within five working days, seven prints of each drawing marked "Certified for record and use".

### Check List For DOL / Star Delta/ ATS / Soft Starter MCC Panels:

Sr. No.	Description	DOL Starter Panel	Star / Delta Starter Panel	Auto Transformer Starter Panel	Soft Starter Panel
1	Incomer MPCB / MCCB / ACB	1	1	1	1
2	Indicating lamps at incomer (RYB)	3	3	3	3
3	Multifunction meter at incomer	1	1	1	1
4	<b>Outgoing Feeders</b>				
4.1	MPCB / MCCB / ACB	1	1	1	1
4.2	DOL / Star Delta / ATS / Soft Starter	1	1	1	1
4.3	Start / stop push buttons	2 + 2	2 + 2	3 + 2 (timer	2 + 2 (timer

		(timer by pass)	(timer by pass)	by pass)	by pass)
4.4	Indicating lamps for starter feeder (On, Off, Run (ATS), Trip, SPP, ELR)	5	5	5 + 1	5
4.5	Ammeter with selector switch & CTs	1	1	1	1
4.6	Single phasing preventer	1	1	1	1
4.7	ELR with CBCT	1	1	1	1
4.8	MCB / MCCB for capacitors	1	1	1	1
4.9	Set of capacitor duty contactor & electronics timer for capacitor switching	1	1	1	1
4.10	Set of capacitors of required KVAR (APP) only in case of fixed capacitor banks (Not applicable for APFC panel)	1	1	1	1
4.11	Winding protection relay unit for each outgoing feeder (in case of panel for submerged centrifugal pump)	1	1	1	1
4.12	Moisture controller relay unit for each outgoing feeder (in case of panel for submerged centrifugal pump)	1	1	1	1

**Note:** All other standard accessories etc. shall be provided as per governing standards & requirement of the system as per detailed technical specifications invariably.

#### Technical Particulars & Requirements For Medium Voltage MCC Panel

Sr. No.	Description	Particulars
<b>1.0</b>	<b>Site Conditions</b>	
1.1	Maximum ambient temperature	50° C
1.2	Minimum ambient temperature	06° C

<b>2.0</b>	<b>Operating Conditions</b>	
2.1	Voltage	415
2.2	Frequency	50 ± 3 %
2.3	No. of phase	Three
2.4	System fault level	25 Ka up to 500 KVA and 35 Ka above 500 KVA at 415 V for 1 second
2.5	System earthing	Solidly earthed
2.6	Control supply for:	
	ACB Closing and Tripping Coils	220 V AC
	Protective Relays	220 V AC
	Indicating lamps	220 V AC
	Alarm / Hooter	220 V AC
	Panel illumination lamp	220 V AC
	Thermostat	220 V AC
	Contactor coils	220 / 415 V AC
<b>3.0</b>	<b>Electrical Data</b>	
3.1	1 sec short circuit withstand capacity	As per SLD / data sheet
3.2	Bus bar current rating inside panel at	As indicated in the drawings / data sheet specified ambient temperature
3.3	Bus bar material	Electrolyte grade Aluminium with test certificate o(of the lot), PVC sleeved (heat shrinkable) & colour coded
3.4	Bus bar current density	1 sq mm = 0.8 Amp
3.5	Bus bar location	at top / bottom section of the panel
3.6	Cable entry (Incoming & Outgoing)	As per site requirement
3.7	Earth bus size and material	For MCC panel 25 x 3 mm Alluminium and for MVDB panel : 50 x 6 sq mm

		Aluminium
3.8	Bus bars alley	On front side of the panel
3.9	Cable sizes	As indicated in the drawings / data sheet
3.10	Colour shade	Powder coating – shade shall be 631 of IS 5
3.11	Feeder arrangement	Single front type front operated
3.12	Floor fixing	Integral base frame
3.13	Degree of protection	IP 42 (For indoor application) IP 52 (For outdoor application)
3.14	Maximum operating height	1800 mm
3.15	Maximum Panel height	2300 mm

## 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

## **2 Features of Construction**

### **a) 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.

### **b) 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.

### **c) 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.
- b) Cable racks / trays shall be fabricated from standard structural steel members as indicated in drawing.
- c) All cable trays, vertical raceways, cable racks and cable tray supporting structures shall be hot dip galvanized.

### **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.

## **EARTHING AND LIGHTNING PROTECTION SYSTEM**

### **1 Scope**

- a) The scope includes collection of data, design of the system as per relevant National/International Standards preparation of layout drawing supply of earthing conductors, earth electrode, installation and approval to the satisfaction of electrical inspector under this tender specification.
- b) Earthing system shall be provided to ensure equipment safety, personnel safety and facilitate designed operation of protective switching during earth fault conditions in the associated system.

**2 Applicable Standards**

The earthing and lightning protection system shall conform to the Indian Electricity rules, and the latest applicable standards indicated below:

Sr. No.	Description	Standards
1	Code of Practice for Earthing	IS: 3043
2	Code of Practice for the protection of building and allied structure against lightening	IS: 2309
3	Hot dip galvanizing	IS: 2629, 2633, 4759
4	Structural steel	IS: 2062 & 808
5	Welding	IS: 816

**3 Earthing system**

The design basis for designing earthing conductor is indicated under design criteria for electrical system. Earthing system shall be provided in plant as per the latest edition including all official amendments and revisions of IS 3043 and Indian Electricity Rules, 1956. All materials and fittings used in the earthing installation shall conform to the relevant Indian Standards or shall be approved by the Engineer's representative.

The material of earthing conductor shall be as follows:

- i. Conductor above ground shall be galvanized steel to prevent atmospheric corrosion.
- ii. Conductor buried in ground or embedded in concrete shall be mild steel.

**4 Lightning Protection**

Lighting protection shall be provided in plant as per the latest edition including all official amendment and revisions of IS 2309.

**5 Earthing and Lightning Protection Installation**

Earthing and lightning protection system installation shall be in strict accordance with the latest editions of Indian Electricity Rules, relevant Indian Standards and code of practices and regulations existing in the locality where the system is installed.

Metallic frame of all electrical equipment shall be earthed by two separate and distinct connections with earthing system.

The scope of installation of earth connection leads to equipment and risers on steel structures / walls shall include laying the conductors welding / cleating at specified intervals. Welding to the main earth grids, risers, bolting at equipment terminals and coating welded / brazed joints shall be applied by bituminous paint after completion. Galvanized conductors shall be touched up with zinc rich paint where holes are drilled at site for bolting to equipment / structure.

Suitable earth risers approved by the Engineer shall be provided above finished floor / ground level, if the equipment is not available at the time of laying of the main earth conductor. The minimum length of such risers inside the building shall be 200 mm and outdoor shall be 500 mm above ground level.

Dissimilar metals shall not be used in soil due to the possibility of accelerated corrosion resulting from galvanic coupling between two dissimilar metals.

Contact surface of copper conductors in bolted joints with other metals or in contact with steel should be tinned to prevent electrolytic action.

When material of the main grid conductor buried in soil or concrete differ from the material of the exposed earth lead, the buried conductor shall be brought out for making the joint at a minimum distance of 150 mm above ground level. The joint shall be suitably protected from corrosion by bituminous paint to exclude moisture.

**6 Earthing Connections**

All connections in the main earth conductors buried in earth/ concrete shall be welded type connection between earthing conductor and earth leads shall be of the welded type.

Connection between earth leads and equipments shall be of bolted type, unless specified otherwise or shown in the drawings.

Welding operations and fluxes/alloys shall be of approved standards.

All connections shall be of low resistance & with minimum contact resistance.

All bimetallic connections shall be treated with suitable compound to prevent moisture ingress.

Metallic conduits and pipes shall be connected to the earthing system unless specified otherwise.

- 7 Contractor shall ensure to use calibrated test equipment having valid calibration test certificates from standard laboratories traceable to National Standards.

8 **Drawings**

The bidder should prepare layout drawings, after award of contract and before commencement of work for purchaser's approval, showing the location of earthing grid, electrodes, interconnection grids and earthing leads to various equipment, down comers, isolating links etc. should be accompanied by design calculation, relevant governing standards & in the correct quantities as prescribed in price schedule.

9 **Pipe in pipe earthing**

Electrical grounding system i. e. earthing system shall have excellent electrical conductivity, low earth resistance & impedance, conductors capable of withstanding high fault currents, robust mechanical connections, high corrosion resistance & equipotential bonding.

In place of conventional earthing pipe in pipe type earthing shall be carried out if specified in the price bid. It is also acceptable as an alternative of conventional earthing i. e. GI pipe electrode earthing.

Two mild steel pipes one inside the other, hot dip galvanized, filled up with high conductive and corrosion resistance crystalline mixture and back fill compound around the electrode are to be used. Sizes of the pipes are as specified in the price bid.

Back fill compound is to be used as fill material instead of charcoal & salt. Back fill material shall not be water soluble & shall retain moisture & enhance conduction around electrode.

Back fill compound shall be low resistance & non corrosive earth enhancement compound

Ohmic value shall be within safe limits & it shall be stable & not fluctuating.

It shall provide safe discharge path to fault current & lightening current.

The bidder shall provide whether electrode is zinc / copper coated, copper pipe / rod, the length of inner strip, outer pipe, coating in microns & details of back fill compound (whether powder / gel form) prior to carrying out earthing work at site.

The bidder shall submit installation drawing for approval prior to execution.

## **LIGHTING SYSTEM**

1 **Scope**

This scope covers supply and installation of all equipment necessary for a complete lighting and receptacle system. The type of lighting fixtures and receptacles, illumination level and approximate quantity required shall be generally as per design criteria.

It shall be the responsibility of the bidder on award of contract to work out complete detailed requirement of lighting and receptacle system for the whole plant and staff quarters including area lighting as per specification and accordingly procure and install them.

## **2 General Requirements**

The Lighting system includes the following items.

- a) Lighting fixtures complete with Lamps and accessories
- b) Lighting system equipment
  - i) Light control switches, receptacle units with control switch units, lighting wires, conduits and other similar items necessary to complete lighting system
  - ii) Lighting fixture supports, street lighting poles and flood light towers
  - iii) Lighting main distribution board, lighting panels for A.C.
  - iv) Multi core cables for switchyard, transformer & pump house.

## **3 Lighting Layout**

It shall be the responsibility of the bidder to work out a detailed layout for the complete plant in order to provide the levels of illumination as indicated in the design criteria. The type of fixtures to be used in various areas is also indicated in the above mentioned drawing. The bidder shall be responsible for measuring the levels of illumination after installation and establish compliance with the specification.

## **4 Applicable Standards**

The design, manufacture and performance of equipment shall conform to the latest standards specified below. In case of conflict between the standards and this specification, this specification shall govern.

## **5 Lighting Fixtures & Accessories**

Sr. No.	Description	Standards
1	Electrical lighting fittings general and safety requirements	IS: 1913 / BS: 4533
2	Code of practice for industrial lighting	IS: 6665
3	Calculation of coefficient of utilisation	IS: 3646 (Part - III)
4	Industrial lighting fittings with metal reflectors	IS: 1777
5	Decorative lighting outfits	IS: 5077

6	Dust proof electric lighting fittings	IS: 4012
7	Dust tight electric lighting fittings	IS: 4013
8	Luminaries for street lighting	IS: 10322 Part 5
9	Water tight electric lighting fittings	IS: 3553 / BS: 4533, 5225(I)
10	Bayonet lamp holders	IS: 1258 / BSEN 61184 / IEC: 61
11	Edison screw lamp holders	IS: 10276 / BSEN 60238
12	Ballast for HP mercury vapour lamp	IS: 6616
13	Capacitors for use in fluorescent, HPMV LP sodium vapour discharge circuits	IS: 1569 / BSEN 61048 & 61049 / IEC: 586
14	Vitreous enamel reflector for tungsten filament lamp	IS: 8017
15	High pressure mercury vapour lamps	IS: 9900 / BS: 3677/IEC: 188
16	Tungsten filament general electric lamps	IS: 418 / IEC: 432
17	Cast acrylic sheets for use in Luminaries	IS: 7569
18	Screw less terminal and electrical connections for lighting fittings	IS: 10322
19	High pressure sodium vapour lamps	IS: 9974
20	Emergency lighting units	IS: 9583
21	Ignition proof enclosures, dust tight for electrical equipment	IS: 11005
22	Luminaries	IS: 10322 (Part I to V)

## 6 Lighting System Equipments

Sr. No.	Description	Standards
1	Arrangement for bus bars, main connections and auxiliary wiring and marking	IS: 5578 / 11353 / BS: 159
2	Enclosed distribution fuse boards and cut outs for voltages not exceeding 1000 V	IS: 2675/ BSEN 60439



3	General requirements for switchgear and control gear for voltages not exceeding 1000 V	IS: 13947
4	Code of practice - installation and maintenance of switchgear	IS: 10118 / BS: 6423 BS 6626, BS 6867
5	Factory built assemblies of switchgear and control gear for voltages up to and including 1000 V AC and 1200 V DC	IS: 8623 / BS- 5486 / IEC: 439
6	Miniature air break circuit breakers for AC circuits	IS: 8828 / BSEN 60898
7	HRC cartridge fuse links up to 650 V	IS: 9224 / BS: 88 / IEC: 269
8	'D' Type fuses	IS: 8187
9	Current transformers	IS: 2705 / BS: 7626 / IEC: 185
10	Voltage transformers	IS: 3156 / BS: 7625 / IEC: 186
11	Direct acting electrical indicating instruments	IS: 1248/ BS: 89 / IEC: 51
12	AC electricity meters	IS: 722 / BS 5685
13	Electrical relays for power system protection	IS: 3231 / BS: 142 / IEC: 255
14	Switches for domestic and similar Purposes	IS: 3854 / BS: 3676
15	Three pin plugs and socket outlets	IS: 1293 / BS: 546
16	Boxes for enclosure of electrical Accessories	IS: 5133(1)
17	Rigid steel conduits for electrical wiring	IS: 9537 / BS : 31
18	Accessories for rigid steel conduits for electrical wiring	IS: 3837 / BS - 31
19	Flexible steel conduits for electrical Wiring	IS: 3480
20	Rigid non metallic conduits for electrical installations	IS: 9537 / BS: 4607 (2)
21	Fittings for rigid non-metallic conduits	IS: 3419 / BS: 4607 (2)
22	PVC insulated cables for working voltage up to and	IS: 694

	including 1100 V	
23	Tubular steel poles	IS: 2713
24	Specification for copper rods and bars for electrical purposes	IS: 613
25	Code of practice for phosphate iron and steel	IS: 6005 / BS: 3189
26	Fittings for rigid steel conduits for electrical wiring	IS: 2667

## **7 Lighting Fixtures (Luminaries)**

- a) Luminaries shall be designed for continuous trouble free operation without reduction in lamp life or without deterioration of materials and internal wiring. Outdoor fittings shall be weather proof and rain proof type.
- b) The luminaries shall be designed so as to facilitate easy maintenance, including cleaning, replacement of lamps / starters etc.
- c) Connections between different components shall be made in such a way that they will not work loose by small vibration.
- d) For each type of luminaries the Contractor shall furnish the utilisation factor tables to indicate the proportion of the light emitted by the bare lamps which falls on the working plane.
- e) All Luminaries shall be supplied complete with lamps suitable for operation on a supply voltage and the variation in supply voltage, frequency and combined voltage and frequency of  $\pm 10\%$ ,  $\pm 5\%$  and  $\pm 10\%$  respectively.
- f) The Luminaries and accessories shall be designed to have low temperature rise. The temperature rise above the ambient temperature shall be as indicated in the relevant standards.
- g) Mercury vapour and sodium vapour type Luminaries shall be complete with accessories like lamps, ballasts, power factor improvement capacitors, starters, rewirable fuse and fuse base. These shall be mounted as far as possible in the luminaries housing only. If these cannot be accommodated integral with the Luminaries then a separate metal enclosed control gear box shall be included to accommodate the control accessories together with a terminal block suitable for loop-in, loop-out connections. Outdoor type fixtures shall be provided with outdoor type weather proof box.
- h) Each luminary shall have a terminal block suitable for loop in, loop out and T off connection by 250 / 400 V, 1 core, PVC insulated copper / aluminium conductor wires up to 4 sq. mm in size. In outdoor areas the termination at the luminary shall be suitable for 1100 V, PVC insulated, copper/aluminium conductor, armoured cables of sizes up to 6 sq. mm conductor. Terminals shall be of stud or clamp type. The internal wiring should be completed by means

of standard copper wire of minimum 1 sq mm size and terminated on the terminal block. Terminal blocks shall be mounted with minimum two fixing screws.

- i) Mounting facility and conduit knock outs for the luminaries shall be provided.
- j) **Earthing**
- i) Each luminary shall be provided with an earthing terminal suitable for connection to the earthing conductor of 12 SWG GI wire.
- ii) Where separate control gear box is provided for housing the accessories the same shall be provided with an earthing terminal suitable for connecting earthing conductor of 12 SWG GI wire.
- iii) All metal or metal enclosed parts of the luminaries/control gear box shall be bonded and connected to the earthing terminal so as to ensure satisfactory earthing continuity.
- k) **Painting / Finish**
- i) All surfaces of the luminaries / control gear box housing accessories shall be thoroughly cleaned and degreased. It shall be free from scale, rust, sharp edges and burrs.
- ii) When enamel finish is specified, it shall have a minimum thickness of 2 mils for outside surface and 1.5 mils for inside surface. The finish shall be non porous and free from blemishes, blisters and fading.
- iii) The luminary housing shall be stove enamelled / epoxy stove enamelled vitreous enamelled or anodised as indicated under various types of fittings.
- iv) The surface shall be scratch resistant and shall show no sign of cracking or flaking when bent through 90° C over 1/2" dia. mandrel.
- v) The finish of the luminaries shall be such that no bright spots are produced either by direct light source or by reflection.
- vi) External control gear box provided for housing accessories shall be painted or galvanized.

## **8 Incandescent / Mercury vapour/ Sodium vapour luminaries**

### **1. Bulk Head Luminary**

The luminary shall be of robust construction, with cast aluminium / vitreous enamelled housing, heat and shock resistant prismatic or clear glass cover fixed with neoprene gaskets for sealing. For mechanical protection to the glass cover, round steel wire guard with vitreous enamelled finish shall be provided.

The luminary shall be suitable for incandescent lamp up to 150 watts, for direct mounting to ceiling / wall / column and used for general purpose indoor lighting.

### **2. High and Medium Bay Luminaries**

High and medium bay luminaries shall be with cast aluminium housing, anodised aluminium mirror polished reflector canopy with eye bolt for suspension, cooling fins and glass cover.

The luminary shall be suitable for mercury vapour lamps up to 1000 watts and sodium vapour lamps up to 400 watts. The control gear accessories shall be mounted integral with the luminary.

High bay luminaries shall be used when the mounting height is above 8 metres while medium bay luminaries shall be used when the mounting height is around 6 to 8 metres.

**9 Outdoor Lantern Luminaries**

**1 Post top Lantern**

Post top lantern luminaries shall be generally outdoor weather proof type for illumination of walkways, gate posts, gardens etc.

The luminary shall have cast aluminium spigot of 50/60 diameter finished with corrosion proof paint for mounting, opal acrylic or high density polyethylene (HDP) diffuser bowl, complete with integral mounted control gear, neoprene gaskets, earthing terminal etc.

The luminary shall be suitable up to 200 W incandescent lamp, 125 W mercury vapour lamps or 70 W sodium vapour lamp.

**2 Substation Lantern**

Substation lantern shall be generally outdoor weather proof type for illumination of switchyard equipment.

The luminary shall have cast aluminium housing finished with corrosion proof paint, spigot for mounting on pole, prismatic glass refractor dome to give distribution of light in horizontal plane, anodised aluminium reflector to give light distribution at an angle 20 to 40 degrees, above the horizontal plane, complete with integral mounted control gear, neoprene gaskets, earthing terminal etc.

The luminaries shall be suitable up to 200 watts incandescent lamp, 125 W mercury vapour lamp or 70 W sodium vapour lamp.

**10 Mercury vapour and sodium vapour luminaries**

Street light mercury / sodium vapour luminaries shall be outdoor weather proof type for illumination of main roads, traffic islands etc.

The luminary shall be of semi cut off with cast aluminium housing, acrylic or prismatic cover, polished aluminium reflectors, complete with integral mounted control gear, neoprene gaskets and with rear pipe entry.

The luminaries shall be suitable up to 400 watts mercury or sodium vapour lamps and for mounting heights from 4 metres to 12 metres.

**11 Portable Emergency Light Luminary**

Emergency light of installite luminary shall be indoor type for providing emergency light during failure of normal AC supply.

The luminary shall be with CRCA sheet steel enclosure, complete with metalised mirror reflector, leak proof re-chargeable battery rated for two hour discharge, battery charger, charger-on lamp, push button switches, automatic changeover switch/relay, two metre length cord with plug, mounting pads and other accessories required for satisfactory operation of the luminary.

The luminary shall be suitable for connection to 240 V, 50 Hz single phase supply. On failure of normal A.C. supply the luminary shall pick-up automatically and on restoration of A.C. supply the luminary shall switch off automatically.

The luminary shall be suitable for incandescent lamp up to 40 W or fluorescent lamp up to 20 W.

## **12 Accessories for Luminaries**

### **12.1 Reflectors**

The reflectors shall be made of CRCA sheet steel/aluminium/silvered glass/chromium plated sheet copper as indicated for above mentioned luminaries .

The thickness of steel/aluminium shall comply with relevant standards. Reflectors made of steel shall have vitreous enamelled finish. Aluminium used for reflectors shall be anodized/epoxy stove enamelled/mirror polished. The finish for the reflector shall be as indicated for above mentioned fittings.

Reflectors shall be free from scratches or blisters and shall have a smooth and glossy surface having an optimum light reflecting coefficient so as to ensure the overall light output specified by the Contractor.

Reflectors shall be readily removable from the housing for cleaning and maintenance without disturbing the lamps and without the use of tools. They shall be securely fixed to the housing by means of positive fastening device of captive type.

### **12.2 Lamp / Starter Holders**

Lamp holders shall have low contact resistance, shall be resistant to wear and shall be suitable for operation at the specified temperature without deterioration in insulation value. They shall hold the lamps in position under normal condition of shock and vibration met with under normal installation and use.

Lamp holders for the fluorescent lamps shall be of the spring loaded bi pin rotor type. Live parts of the lamps holder shall not be exposed during insertion or removal of lamp or after the lamp has been taken out. The lamp holder contacts shall provide adequate pressure on the lamp cap pins when the lamp is in working position.

Lamp holders for incandescent, mercury vapour and sodium vapour lamps shall be of Edison Screw (E.S.) type.

The starter holders shall be so designed that they are mechanically robust and free from any operational difficulties. They shall be capable of withstanding the shocks met within normal transit, installation and use.

### 12.3 **Ballasts**

The ballasts shall be designed to have a long service life and low power loss. The ballasts shall be of the inductive, heavy duty type copper wire wound, filled with thermosetting, insulating, moisture repellent polyester compound filled under pressure or vacuum. Ballasts shall be provided with taps to set the voltage within the range of variation in supply voltage of  $\pm 10\%$  of 240 V. End connections and taps shall be brought out to a suitable terminal block rigidly fixed to the ballast enclosure. Ballasts shall be free from hum and such of those which produce hum shall be replaced by Contractor free of cost.

Ballasts shall be mounted using self locking, anti-vibration fixings and shall be easy to remove without demounting the fittings. They shall be in dust tight, non combustible enclosures.

Separate ballast for each lamp shall be provided in case of multi lamp luminaries, except in the case of 2 x 20 Watts luminaries.

### 12.4 **Starters**

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

### 12.5 **Capacitors**

The capacitors shall have a constant value of capacitance and shall be connected across the supply of individual lamp circuits.

The capacitors shall be suitable for operation at specified supply voltage conditions and shall have a value of capacitance so as to correct the power factor of their corresponding lamps circuit to the extent of 0.95 lag or better.

The capacitors shall be hermetically sealed preferably in a metal enclosure to prevent seepage of impregnant and ingress of moisture.

### 12.6 **Lamps**

Lamps shall be capable of withstanding small vibrations and the connections at lead in wires and filaments / electrodes shall not break under such circumstances.

High intensity discharge lamp

These lamps include high pressure mercury vapour lamps and high pressure sodium vapour lamps.

High pressure mercury vapour lamps shall be with quartz discharge tube, internal coated shell, quick re-strike time (of within 5 minutes) and with burning life (about 5000 hours) in standard ratings up to 1000 watts.

High pressure sodium vapour lamps shall be with polycrystalline translucent, coated discharge tube, coated shell, quick re-strike time (of within 5 minutes) and with burning life (about 10,000 hours) in standard ratings up to 400 watts

#### **12.7 Drawings and Data**

As part of proposal the bidder shall furnish relevant descriptive and illustrative literature on lighting fixtures and accessories dimensioned drawings/data for the respective lighting fixtures with manufacturer's catalogue numbers.

It shall be the responsibility of the bidder on award of contract to work out a detailed layout for the complete plant in order to provide the levels of installation as indicated under Design Criteria and shall be furnished for the approval of the Purchaser's representative before commencement of installation.

#### **12.8 Lighting System Equipment**

##### **12.8.1 Main Distribution Boards and Lighting Panels (AC)**

###### **Constructional Features**

Boards and panels shall be sheet steel enclosed and shall be fully dust and vermin proof, providing a degree of protection of IP 52. Outdoor panels shall in addition be completely weather-proof with a sloping canopy for protection against rain and providing a degree of protection of IP 54. The sheet steel used for frame, frame enclosures, doors, covers and partitions shall be cold rolled 2 mm thick.

All boards and panels shall be provided with hinged doors for access to equipment. Doors shall be gasketed all round with neoprene gaskets. For the main floor mounted distribution boards with the switch fuse units arranged in tier formation, the hinged door of each unit shall be interlocked so as to prevent opening of the door when the switch is ON and to prevent closing of the switch with the door not fully closed. However, a device for by-passing the door interlock shall be provided to enable the operation of the switch with the door open, when necessary, for examination / maintenance. For wall mounting 1-phase ways lighting panels when provided with MCBs, a hinged, latched front door shall be provided with key-locking facility and a slotted bakelite sheet shall be provided inside. Only the MCBs operating knobs or the fuse cap covers shall project out of the bakelite sheet slots for safe operation and neat appearance. Incomer to lighting panels shall be provided with TPN MCB with ELCB.

All accessible live connections / metals shall be shrouded and it shall be possible to change individual fuses, switches, MCBs from the front of the boards / panels without danger of contact with live metal.

For floor mounting type distribution boards, adequately sized mounting channels shall be supplied and for wall/column/structure mounting type panels suitable mounting straps shall be provided.

Adequate interior cabling space and suitable removable cable entry plates shall be provided for top/bottom entry of cables through glands and or conduits as required. Necessary number of glands to suit the specified cable sizes shall be provided. Cable glands shall be screwed on type and made of brass.

Two earthing terminals shall be provided to suit the earthing conductor.

All sheet steel parts shall undergo rust-proofing process which should include degreasing, de scaling and a recognised phosphating process. The steel works shall then be painted with two coats of Zinc chromate primer and two coats of final stove enamelled finish paint of specified colour.

### **Bus bars**

Bus bars shall be of copper conductor of hard drawn (HD) and high conductivity. Bus bars shall be fully insulated by encapsulation in epoxy resin with moulded caps protecting all joints or heat shrinkable PVC sleeves and tapes.

Bus bars shall be provided with at least the minimum clearances in air as per applicable standards for 500 V, 3 phase system.

Bus bars shall be adequately sized for the continuous current rating such that the maximum temperature of the bus bars, bus bar risers / droppers and contacts does not exceed 85° C under site reference temperature.

The bus bars, bus bar connections and bus bar supports shall have sufficient strength to withstand thermal and electro mechanical stresses of the fuse / MCB's let through / cut off current associated with the specified short circuit level of the system.

Bus bar supports shall be made from suitable insulating material such as Hylem sheets, glass reinforced moulded plastic materials, permali wood or cast resin. Separate supports shall be provided for each phase of the bus bars. If a common support is provided for all three phases, anti-tracking barriers shall be incorporated.

The neutral bus of the main 3 phase, 4 wire distribution board shall be rated not less than 50 % of the phase bus bars. The neutral bus of the 1 phase ways lighting panel shall be rated



same as the phase bus bars. The neutral bus should have sufficient terminals and detachable links for full number of single phase outgoing lighting circuits.

#### **12.8.2 Panels / Boards Component Equipments**

##### **Switches / Miniature Circuit Breakers (MCB)**

Switches / MCBs shall be hand operated, air break, quick make, quick break type conforming to applicable standards.

The switch shall be protected by fuse and the MCB shall be provided with overload / short circuit protective device for protection under overload and short-circuit conditions. The minimum breaking capacity of MCBs shall be 6 kA rms at 415 V / 220 V DC.

Switch shall have provision for locking in both fully open and closed positions. MCBs shall be provided with locking facility.

The connections between switch and fuse shall be insulated and all live connections shall be shrouded.

##### **Fuses**

Fuses generally shall be of the HRC cartridge fuse-link type having a certified rupturing capacity of 80 kA at 440 V. Fuses up to 63A for distribution systems of medium short circuit levels may be of HRC cartridge screw-cap, D type, having a certified rupturing capacity of not less than 46 kA at 440 V and 16 kA at 250 V D.C.

Fuses shall be provided with visible indication to show that they have operated.

Cartridge fuses shall preferably be mounted in moulded plastic carriers. If fuse carriers are not provided, insulated fuse pulling handle shall be provided for each size of fuse for each switchboard.

##### **Indicating Instruments and Meters**

Whenever required, instruments and meters shall be of the flush mounting type. They shall be suitably mounted so as to provide for easy access to CTs and small wiring.

Instruments shall be of minimum 96 mm square size, shall have provision for zero adjustment outside the cover and black numerals on white dial.

Watt hour meters shall be of direct reading electro dynamometer type complete with cyclometer type dials and reverse running stops.

Ammeter / Voltmeter selector switches having 3 positions and off, with stay put contacts rated 10 A shall be provided when specified.

Potential fuses shall be provided at the tap-off point from the bus bars for the voltmeters.

##### **Instrument Transformers**

Current and voltage transformers shall be of the dry type, of metering accuracy class 1.0.

Unless otherwise specified, it shall be the responsibility of the Contractor to ensure that the VA burden of the instrument transformer is adequate for the meters connected to it.

Test links shall be provided in both secondary leads of the CTs to easily carry out current and phase angle measurement tests. Facilities shall be provided for short-circuiting and grounding the CTs at the terminal blocks.

Voltage transformers shall be provided with suitably rated primary and secondary fuses.

### **Indicating Lamps**

Indicating lamps shall be of the filament type and low watt consumption. Lamps shall be provided with series resistors.

### **Internal Wiring**

Panels / boards shall be supplied completely wired, ready for the external connections at the terminal blocks. Wiring shall be carried out with 650/1100V grade, PVC insulated, stranded aluminium/copper conductors. Conductors of adequate sizes shall be used to suit the rated circuit current.

Engraved identification ferrules, marked to correspond with the wiring diagram shall be fitted at both ends of each wire.

All wiring shall be terminated on terminal blocks. Terminal blocks shall be one piece moulded rated 500 V, of reputed make, preferably stud type for higher current ratings such that wires are connected by cable-lugs and complete with nuts and washers. Terminals shall be adequately rated for the circuit current, the minimum rating shall be 20 A.

Terminals for circuits with voltage exceeding 125 V shall be shrouded.

Terminals shall be numbered and provided with identification strip for identification of the circuit.

Terminal blocks for C.T. secondary lead wires shall be provided with shorting and disconnecting / earthing facilities.

#### **12.8.3 Labels & Diagram Plate**

All door mounted equipment as well as equipment mounted inside the switchboard/panels shall be provided with individual labels with equipment designation/rating. Also the boards/panels shall be provided on the front with a label engraved with the designation of the board/panel.

Labels shall be made of non-rusting metal, 3-ply lamicaid or engraved PVC

Inside the door of the 1 phase ways lighting panels a circuit diagram/description shall be fixed for reference and identification.

#### **12.8.4 Light Control Switches**

Light control switches of ratings and types, i.e. decorative/industrial shall be supplied as required. The switches shall be suitable for use on 240 V, 1 Ph, 50 Hz supply.

Switches shall be of flush type for mounting behind an insulated plate or incorporated with a switch plate for mounting flush with the surface of wall or switch box/suitable enclosure. The

switch box/enclosure may be recessed into or mounted on a wall as per the requirement of project layouts.

The size of enclosure boxes shall be chosen to accommodate the number of switches to be installed at the particular location. The enclosures shall be 18 gauge sheet steel galvanized. The enclosure box shall be covered with perspex / insulating cover. An enclosure intended for surface mounting shall not have holes or gaps in its sides other than those expressly provided for cable entry.

#### **12.8.5 Receptacle Units**

Receptacle units shall consist of socket outlet with associated switch and plug. The socket outlet and switch or MCB shall be flush mounted within galvanized 18 gauge steel enclosure with insulation cover. The box may be recessed into or mounted on a wall as per requirements of project layouts.

The receptacle units shall be suitable for 240 V, 1 ph - N, 50 Hz / 415 V, 3 Ph - N, 50 Hz supply as required.

Single phase receptacles shall be associated with a switch/MCB of same current rating and the receptacle shall become live only when the associated switch/MCB is in "ON" position.

Three phase receptacles shall be associated with a TPN switch housed in the same enclosure. The receptacle shall become live only when the associated switch is in "ON" position.

The plugs shall be provided with cord grips to prevent strain and damage to conductors / wires at connection and entry points.

#### **12.8.6 Lighting Wires**

The wires for wiring in lighting system shall be 250/440 V, 1/C, PVC insulated, un armoured with stranded copper conductors.

The minimum area of conductors shall be 1.5 sq mm for light fittings and 5 A Receptacles and 2.5 sq mm for receptacles rated 15 A and above.

The wires shall be coded white for phase/positive of DC and black for neutral / negative of DC.

#### **12.8.7 Conduits**

Rigid steel / non metallic conduits and their associated fittings as required shall conform to applicable standards. The minimum size of conduit shall be 20 mm for surface installation and 25 mm for concealed installation.

Steel conduits shall be seamed by welding and hot dip galvanized. They shall be supplied in standard lengths of 5 m.

Supply of conduits shall include all associated fittings like couplers, bends and tees as required for lighting system installation work.

#### **12.8.8 Junction Boxes**

Junction boxes with terminals shall be supplied for branching and terminating lighting cables when required for outdoor areas, 3 phase receptacles etc.

The junction boxes shall be dust and vermin proof and shall be fabricated from 14 gauge sheet steel and shall be complete with removable cover plate with gaskets, two earthing terminals each with nut, bolt and washer. Boxes shall be additionally weather proof.

The boxes shall have provision for wall, column, pole or structure mounting and shall be provided with cable / conduit entry knock outs, terminal blocks, HRC fuses as required.

The terminal blocks, with specified number of terminals, shall be mounted securely on brackets welded to the back sheet of the box. The terminals shall be 600 V, grade, one piece construction complete with terminals, insulation barriers, galvanized nuts, bolts and washers and provided with identification strips of PVC. The terminals shall be made of copper alloy and shall be of box clamp type.

The boxes shall be painted with one shop coat of red oxide zinc chromate primer followed by a finishing coat of paint.

#### **12.8.9 Lighting Poles and Flood Light Pole Mounting**

Lighting poles for street lights and flood lights shall be of stepped tubular steel poles construction as per applicable standard. These poles shall be coated with bituminous preservative paint on the inside as well as embedded outside surface. Exposed outside surface shall be painted with one coat of red lead oxide primer. After completion of installation two coats of aluminium paint shall be applied.

Poles for mounting flood lights shall be supplied whenever required and as per typical attached drawing. Unless otherwise specified poles, shall be painted with red lead oxide primer and two coats of aluminium paint. A steel ladder shall be provided. The length of each step of the ladder shall be at least 300 mm and spacing between two adjacent steps not more than 300 mm.

The supply of poles shall be complete with fixing bracket/necessary pipe reducer for fixing the fitting and also include the necessary associated pole mounted junction boxes. The required sizes of poles and the junction box shall be as indicated in the attached drawings.

#### **13 Drawings and Data**

The following shall be furnished as part of the tender:

General arrangement drawings of panel showing plan, elevation and typical sectional views.

Technical literature on the equipment offered.

### **EXHAUST FAN**

- a) The exhaust fan with all parts shall be according to IS: 2312- 1967 & its latest amendment with IP-55 specification.
- b) The exhaust fan shall have rigid frame with rubber mounting for silent feature.
- c) The exhaust fan shall have epoxy powder coating with specially pretreated components for better resistance to corrosion and acid alkali flumes.
- d) The exhaust fan shall have aerodynamically contoured blades handle maximum air with minimum power consumption.
- e) The exhaust fan shall have totally enclosed highly efficient heavy duty motor with pressure die cast aluminum rotor mounted on two ball bearings.

Rating & Size of exhaust fan are as following:

Impeller Dia.	Phase	Power Input (watt)	Free air delivery ( M <sup>3</sup> /H)	Speed (RPM)
457 mm	Single	370	6800	900

## **FIRE EXTINGUISHERS**

Providing fire extinguisher CO<sub>2</sub> charged of reputed make as per IS: 2878 & latest revision of capacity 3.0 kg. Construction of cylinder shall be as per IS: 7285 & valve shall be brass forged & as per IS: 3224. Charge shall be CO<sub>2</sub> confirming to IS: 307 & filled with liquefied CO<sub>2</sub> gas filling ratio  $\leq 0.667$ . It shall be properly finished & duly painted in synthetic enamels red / fire red epoxy polyester coating. It shall be provided with wall mounting brackets.

## **Non Contract Type Radar / Ultrasonic Technology Based Equipment**

Non Contract Type Radar / Ultrasonic Technology Based Equipment : Ultrasonic / Radar type sump/ tank water head measuring device sensor : Ultrasonic / Radar type the sensor should be non contract type Mounting : Field mounting type, Housing :: Weather proof , MOC : PVC / Equipment suitable for Field mounting sensor / transmitter : Field ounted, Indicator :Microprocessor base with digital display, mounting : panel / wall mounting type , range : 0-10 meters, Power Supply : 230 V AC : 50 Hz +10 % , Dispaly :: Red LED / LCD type, power & single cable : suitable lenght and size as per site requirements 3 crore, Suitable size as per manufacture's standards / suitable to site requirements. and Fixing charges for installation testing and commossioning of Ultrasonic / Rdar type Sump / tank water head measuring device at site with all required length and sizes of cable mounting hardware, Line unloading , jointing / welding . Nuts bolts etc. Complete.

This item shall be executed as per Latest IS & as per instruction of Engineer in charge

## **INSTALLATION, TESTING AND COMMISSIONING**

### **1. Erection - General**

- 1.1. 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.
- 1.2. 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.
- 1.3. 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.
- 1.4. 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.
- 1.5. 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.
- 1.6. 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.

- 1.7. 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.
- 1.8. 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.
- 1.9. 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.
- 1.10. 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

#### **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 passes 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 ingression.
- 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 I	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 conforming to IS: 1180 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 Switchyard bus, shielding and grounding.
- 02 Lightning arrester
- 03 Isolator
- 04 Insulator
- 05 Power Distribution Transformer
- 06 HT Switchgear Panels (if any)
- 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**

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. Bucchoz 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.



## **10. SPECIFICATIONS OF DOL, S/D and ATS MCC PANEL**

Supply of fully automatic air break MCC Panel for operation on 415V, 3Ø, 50 Hz AC supply. The details of the equipments/accessories for the control panel shall be as per the given Boar data sheet and rating chart. The control panel manufacturer must bed approved vendor list and must also possess ISO: 9001 certificate with Design, Development, Manufacture and Supply criteria.

### **ENCLOSURE:**

The MCC panel shall be dust and vermin proof, fabricated out of minimum 14 SWG sheet. It shall be wall mounting cum pedestal type/free standing type. All the items inside the control panel shall be mounted on minimum 16 SWG steel base plates. All the metal parts shall be thoroughly cleaned, digressed and made free from rust after the application of zinc cromate primer. The MCC panel shall be powder coated. The colour shade shall be as per shade 631 of IS 5. The degree of protection shall be IP 51. The MCC panel shall have channel/legs/angle iron stand of 300 MM height for easy termination of I/C and O/G cables. The I/C and all O/G cables shall have bottom entry only.

### **WIRING & TERMINALS :**

Power and control wiring shall be done with PVC insulated copper conductors and shall be terminated with adequately sized compression type lugs for connections to the equipment terminals and terminal strips. Each wire shall be identified at both ends by ferrules. Not more than two wires to be terminated at one terminal and size of terminals shall be used keeping in view the components for which they are used, so that adequate surface contact can be achieved. I/C and O/G to be made at terminals only.

The minimum distance between the cable gland plate and the termination shall be 300 MM. Control wiring shall be done with 1.5 sq mm only. Wires used shall be of ISO 9001 accredited company.

### **EARTHING :**

2 Nos. of earthling's terminals shall be provided for connecting the earth. All non current carrying metallic parts of the equipment shall be earthed. A separate CU strip 19 X 3 MM shall be provided through-out the width of the panel.

### **MAIN INCOMING:**

A MCB/MCCB/ACB shall be provided as the Main I/C. The switchgear selection shall be as per type 2 co-ordination.

Depending on the fault withstand ratings, up to 40A rating; MCBs with suitable tripping characteristics shall be used. Above 40A and up to 630A, MCCB shall be used. Above 630A, ACB

Shall be used. ACB shall be manually operated, D/O type with U/V trip, S/C trip and O/L trip. MCB in the Main I/C shall be of motor duty only.

MCCB shall be TP+N with shunt trip.

Moreover, the following components shall be provided in the MAIN I/C feeder.

- (1) R.Y.B Phase indicating LED lamps.
- (2) 20A X 415V HRC control fuses with 6A HRC links.
- (3) Sq-96, Digital Voltmeter and Ammeter with selector switch.
- (4) Suitable range CTs for Ammeter.
- (5) A C/O cam switch shall be provided for operating either of the two pumps.

### **SUB MAIN INCOMING :**

A FSU/Isolator of AC-23 duty with door interlocking facility shall be provided as the Incoming of each feeder panels. The rating of FSU/Isolator and HRC fuses shall be as per the rating chart in IS :13947 (Part 3) 1993.

### **CONTACTORS :**

Contactors of AC-3 duty of 415V or with wide band coil of 320-480V shall be provided. The ampere rating shall be as per the rating chart and the data sheet.

### **TIMER :**

An electronic timer for S/D change-over having 50 msec pause time delay shall be provided for S/D and ATS control panels only. In case of ATS control panels, a master timer electronic) shall also be provided. This master timer shall operate within 15 seconds, if the S/D timer fails to operate within 10 seconds.

### **O/L RELAY :**

O/L relay of suitable range shall be provided as specified below. The O/L relay shall have inbuilt SPP feature and must have manual reset facility. In case of DOL and ATS panels, relay range shall be decided by multiplying min. 1.3 times and max. 1.5 times the HP rating of the motor. In case of S/D panels, it shall be decided by multiplying 0.6 of min. 1.3 times and max. 1.5 times the HP rating of the motor.

### **INDICATING LAMPS :**

22.5 dia, clustered LED type indicating lamps with inbuilt resistor shall be provided as specified in the data-sheet.

### **PUSH BUTTONS :**

22.5 dia, Red, Green, Yellow and Black pushbuttons shall be provided for STOP, START, TIMER and O/L RESET respectively for ATS panels. Red, Green and Black pushbuttons shall be provided for STOP, START and O/L RESET respectively for DOL and S/D panels.

### **SINGLE PHASING PREVENTOR :**

S.P.P of negative phase sequence principle, voltage operated with U/V and O/V cut off at 320V and 480V respectively shall be provided.

### **EARTH LEAKAGE RELAY :**

ELR having 0.5 seconds time lag to avoid nuisance tripping and with suitable dia C.B.C.T shall be provided of 0.5 to 2.5A range. E.L.R shall have a bypass toggle switch to bypass the same in case of emergency.

### **AMMETER :**

Digital Ammeter of 96 sq mm size shall be provided. An Ammeter selector switch shall also be provided to read current in each phase.

### **CONTROL FUSES :**

20A X 415V HRC control fuses along with 6A HRC fuse links shall be provided for the control circuit.

### **AUTO-TRANSFORMER :**

Air cooled auto-transformer of 6 starts/hour having 60%, 70%, 80% tapings shall be provided. It shall be copper wound with 'E' class insulation. The winding shall withstand starting current for at least 15 seconds. It shall be vacuum impregnated for longer life. The % regulation shall not exceed 10%. It shall be in accordance as per the latest IS 13947 (Part 4/sec 1) of 1993 (for ATS panels only).

### **CAPACITOR FOR MOTORS :**

A capacitor of 415V shall be provided as per the rating chart. Capacitor shall be MPP type, GEB tested (certificate required). HRC fuses shall be provided before capacitor. The rating of the HRC fuses shall be as per rating chart. An electronic Delay timer along with contactor as per rating chart shall be provided for automatic switching of capacitor. The capacitor shall switch on after one- minute the motor starts. A selector switch for AUTO-MANUAL selection shall also be provided. STOP-START pushbuttons shall be provided in case of manual operation. A LED indicating lamp shall be provided for 'ON' indication.

### **CAPACITOR FOR POWER TRANSFORMER :**

In order to take care of Inductive load of Power transformer, a MPP capacitor bank rated for 415V shall be provided along with HRC fuse protection as mentioned in the rating chart. The kVAR of capacitor shall be provided to ensure a power factor of 0.99.

### **BUSBARS:**

TPN Busbars shall be of Aluminum, duly sleeved with heat shrinkable colored sleeves. The current density of the Al. busbars shall be  $1 \text{ Sq mm} = 1\text{A}$ . The size of the phase busbars shall not be less than the Ampere rating of the Main Incoming. The neutral bus bar shall be of 50% of the phase busbars. Bus bar supports shall be of SMC/DMC type.

### **LIGHTING FEEDER :**

Nos. of 63A FSU/Isolator of AC-23 duty shall be provided along with HRC fuses in a separate compartment for domestic lighting.

### **THERMISTOR and MLC :**

Thermostat and Moisture level controller (MLC) shall be supplied along with bypass toggle switch in case of Sewage control panels only. Relevant indicating lamps for each unit shall also be provided on the front door of the panel. The control panel shall be as per the enclosed rating chart, data sheet and Makes specified only. The contractor shall have to submit 2 copies of GA drawing, Bill of Materials and Wiring diagram for the approval to the Executive Engineer, prior to manufacturing.

Following tests shall be carried out at manufacturer's works at his own cost and risk

- (1) Single phasing in each phase and 15% unbalance voltage tripping.
- (2) U/V and O/V cut off at 320V and 480V respectively.
- (3) Leakage current test.
- (4) H.V test at 2.5 KV for Power circuit & 1.5 KV for Control circuit.
- (5) H.V test between phases.
- (6) Temperature rise test on ATS as per IS 13947 (Part 4/Sec I)-1993.
- (7) Percentage regulation test not exceeding 10%.
- (8) Megger test.

## RATING CHART FOR O/G FEEDERS

Sr. No.	HP Up to	SFU/ SWITCH		HRC FUSES		CONTACTORS FOR STAR, DELTA, MAIN CAP.		HRC FUSES FOR CAP.	CAP. KVAR
1	2	3	4	5	6	7	8	9	10
01	DOL 5.0	16A	16A	---	---	16A	16A	10A	2
02	DOL 7.5	25A	25A	---	---	25A	16A	16A	3
03	S/D 10.0	25A	25A	16A	16A	16A	16A	16A	4
04	S/D 15.0	32A	32A	25A	25A	25A	16A	16A	5
05	S/D 20.0	40A	40A	32A	32A	32A	16A	16A	6
06	ATS 25	63A	50A	16A	25A	70A	16A	20A	7
07	ATS 30	100A	63A	25A	32A	70A	25A	20A	8
08	ATS 35	100A	80A	32A	40A	70A	25A	25A	9
09	ATS 40	100A	80A	32A	40A	80A	25A	25A	10
10	ATS 45	100A	100A	32A	40A	95A	25A	32A	12
11	ATS 50	125A	100A	40A	70A	100A	32A	32A	13

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Sr. No.	HP Up to	SFU/ SWITCH		HRC FUSES		CONTACTORS FOR STAR, DELTA, MAIN CAP.		HRC FUSES FOR CAP.	CAP. KVAR
1	2	3	4	5	6	7	8	9	10
12	ATS 55	125A	125A	40A	70A	125A	32A	40A	14
13	ATS 60	125A	125A	40A	70A	125A	32A	40A	15
14	ATS 70	200A	160A	40A	70A	170A	40A	63A	17
15	ATS 75	200A	160A	45A	100A	170A	40A	63A	18
16	ATS 80	200A	160A	50A	100A	200A	40A	63A	19
17	ATS 90	200A	160A	50A	100A	200A	40A	63A	21
18	ATS 100	200A	160A	50A	125A	200A	65A	80A	23
19	ATS 125	250A	225A	70A	140A	250A	65A	80A	27
20	ATS 150	300A	250A	110A	170A	300A	100A	100A	33
21	ATS 170	400A	350A	150A	200A	300A	125A	100A	37
22	ATS 200	400A	400A	170A	200A	400A	125A	125A	42
23	ATS 250	630A	500A	200A	300A	630A	150A	160A	50

Note:-The contactors used inside the control panel shall be of one make only. Usage of different makes of contactors is not at all permissible

## **2.0 TECHNICAL SPECIFICATION FOR 11 KV RING MAIN UNIT SWITCH GEAR**

### **1.0. SCOPE**

Design, Engineering, manufacturing, testing at manufacturer's site, delivery at site, unloading,, Erection, Installation, testing & Commissioning of Ring Main units outdoor type SF6 filled , with various combinations of load break isolators & breakers. (One Incoming And Two Outgoing for 1000 KVA (2 Nos.) Transformer)

The RMUs should be provided with necessary take off terminal units for future automations and all these units should be shielded in a outdoor metal-body for making them suitable for outdoor use. The insulation/dielectric media inside the stainless steel welded tank should be SF6 gas. The RMUS should be of extensible type on both sides with provision of attaching/connecting with SNAP FIT arrangement W/o External Busbars additional **Two** load break switches and circuit breakers in future wherever required. **a)** 3-way , 11KV ,Gas (SF6) Insulated RMU with 2Nos 630A load break switch and 1No. SF6 insulated VCB of suitable rating. (One Incoming And Two Outgoing for 1000 KVA (2 Nos.) Transformer)

**PLEASE NOTE: THE NOMINAL CURRENT RATING OF VCB SHALL BE ACCORDING TO LOAD OF THE FEEDER AND ACCORDINGLY SUITABLE RELAY SHALL BE PROVIDED AND ANY CHANGE IN COMBINATION/CONFIGURATION SHALL BE EXECUTED WITH THE APPROVAL OF ENGINEER IN CHARGE.**

- 1.1 This Specification provides for design, manufacture, inspection and testing before dispatch, packing and delivery F.O.R.(Destination) of SF6 insulated RMUs with necessary take off terminal units for future automations, other accessories and auxiliaries equipments and mandatory spares, described herein and required for their satisfactory operation.
- 1.2. The objective of the RMUs is for extremely small construction width, compact, maintenance free, independent of climate, easy installation, operational reliability, Safe and easy to operate, minimum construction cost, minimum site work and minimum space requirement.
- 1.3. The RMUs shall conform in all respects to high standards Of Engineering design, workmanship and latest revisions of relevant standards at the time of offer.
  - a. The type of the 11 KV circuit breaker shall be VCB and insulating medium for load break isolators, Earth switch, 11 KV Buses and other associated equipments should be SF6 gas.
    - Necessary current sensors / transformers for protection and metering (wherever required).
    - All necessary dry (potential-free) contacts for indications relevant to RMU monitoring status and control.
    - A PT Panel including auxiliary power transformer for measurement of system voltage and for charging the batteries.
    - Battery and battery charger, to provide stable as per motor rating, 24 VDC, power for the RMU's motors.
    - Capacitor voltage dividers serving live-line cable indicators.

### **2.1 GENERAL**

The Ring Main Unit shall be installed at 11 KV junction points to have continuous supply by isolating faulty sections. The RMU shall be extensible on both sides and consists of the following combinations of load break switches and Circuit breakers for a nominal voltage of 12 KV for 11 kV RMU using SF6 gas as insulating and Vacuum as arc quenching medium.

The RMU and combination shall be tropicalised and outdoor metal enclosed type. The RMU metal parts shall be of high thickness, high tensile steel which must be grit/short blasted, thermally sprayed with Zinc alloy, phosphate or should follow the 7 tank pre-treatment process and be subsequently painted with polyurethane based powder paint. The overall paint layer thickness shall be not less than 80 microns.

Relevant IE rules for clearances, safety and operation inside the enclosure shall be applicable. The enclosure shall be IP54 and type tested from recognized laboratories by National Accreditation Board of Laboratories (NABL).

All live parts except for the cable connections in the cable compartments shall be insulated with SF6 gas. The SF6 gas tank shall be made of TIG welded stainless steel, to have the best weld quality. The gas cubicle shall be metal enclosed with stainless steel of minimum 2 mm thickness and should be provided with a pressure relief arrangement away from operator.

The gas tank shall be of completely welded construction. The connection of different welded sections of gas tank by gasket and bolts, to form a RMU chamber is not acceptable.

Both the load break switches and the tee off circuit breaker must be motorized.

The cable box of isolators and circuit breakers both should be of front access type. The side and rear access cable box are not preferred as they require greater space for cable connection and maintenance at site.

Any accidental over pressure inside the sealed chamber shall be limited by the opening of a pressure-limiting device in the rear-bottom part of the enclosure. Gas will be release to the rear of the switchboard away from the operator and should be directed towards the bottom, into the trench to ensure safety of the operating personnel and the pedestrians / civilians. All the manual operations should be carried out on the front of the switchboard.

The Entire units of RMU shall be enclosed in a single compact metal clad, outdoor enclosure suitable for all weather conditions. The switchgear/ steel gas tank shall be filled with SF6 as per IEC/IS Standards relative pressure to ensure the insulation and breaking functions. The steel gas tank must be sealed for life and shall meet the “Sealed pressure system” criteria in accordance with the IEC 298 standard. The RMU must be a system for which no handling of gas is required throughout the 20 years of service life.

The RMU shall have a design such that in the event of an internal arc fault, the operator shall be safe. This should be in accordance with IEC 298 and relevant Test certificates shall be submitted.

### **3.0 GENERAL TECHNICAL REQUIREMENTS**

1. Fixed type SF-6 gas insulated / Vacuum circuit breakers. It should be maintenance free, having stainless steel robotically/ TIG / MIG welded enclosure for IN DOOR / OUTDOOR RMU. However, offer with high quality of the welding which has necessary extensive leakage test with leak rate of 0.1% per annum can be accepted. The RMUs to be used are only outdoor type.
2. Low gas pressure devices- 1.2 Bar pressure. RMU should have full rating with 0.0 Bar gas pressure.
3. Live cable indicators- High operator safety.
4. Fully Rated integral ear thing switch on each device.



5. Self powered Microprocessor Based relay- Does not require any external source of power.
6. Units fully SCADA Compatible. Retrofitting at site possible at a later date. Line switches (Load break switches) as well as T- OFF circuit Breaker can be operated by remote. ( Manual operations should be possible in case of motor failure.)
7. For indoor Cable boxes should be front access and interlocked with earth switch. No rear /side access required. For outdoor RMUs cable boxes shall be on front.
8. Cable testing possible without disconnection of cables.
9. Compact in dimension.
10. Circuit Breaker with self powered O/C & E/F RELAY.
11. Low pressure, sealed for life equipment, can operate at “0” bar pressure.
11. Cable earthing switch on all switching device-standard, for operator safety.
12. Enclosure with IP 54 standard protection for OUTDOOR RMUs and IP2X for INDOOR RMUs.
13. All live parts should be inside a stainless steel enclosure for outdoor type RMU & minimum 2 mm thickness of stainless steel robotically/TIG/MIG welded enclosure for Outdoor / indoor RMU.

### **3.1 TECHNICAL AND GUARANTEED PARTICULARS:**

The bidders shall furnish all guaranteed technical particulars as called for in Schedule “A” of this specification. Particulars which are subject to guarantee shall be clearly marked. Bids lacking information in G.T.P are liable to be rejected

The Entire units or minimum three functions of RMU shall be enclosed in a single compact metal clad, outdoor enclosure suitable for all weather conditions. The switchgear/steel gas tank shall be filled with SF6 as per IEC/IS Standards relative pressure to ensure the insulation and breaking functions. The steel gas tank must be sealed for life and shall meet the “sealed pressure system” criteria in accordance with the IEC 298 standard. The RMU must be a system for which no handling of gas is required throughout the 20 years of service life.

The RMU shall have a design such that in the event of an internal arc fault, the operator shall be safe. This should be in accordance with IEC 298 and relevant Test certificates shall be submitted with the Tender.

The offered switchgear and control gear should be suitable for continuous operation under the basic service conditions indicated below. Installation should be in normal indoor conditions in accordance with IEC 60694.

Ambient temperature – 10 degree C to + 50 degree C

Relative humidity - up to 95%

Altitude of installation - up to 1000m, IEC 60120

The RMU shall be tested for an internal arc rating of 20 kA for 1 Sec. for 11 KV RMU. Suitable temperature rise test on the RMU shall be carried out & test reports shall be submitted with tender for technical bid evaluation.

Each switchboard shall be identified by an appropriately sized label, which clearly indicates the functional units and their electrical characteristics.

The switchgear and switchboard shall be designed so that the position of the different devices is visible to the operator on the front of the switchboard and operations are visible as well.

The entire system shall be totally encapsulated. There shall be no access to exposed conductors. In accordance with the standards in effect, the switchboards shall be designed so as to prevent access to all live parts during operation without the use of tools.

The entire 11 KV RMU are insulated by inert gas (SF<sub>6</sub>) suitable for operating voltage up to 13.8KV respectively. The 11 KV circuit breakers must be VCB breaker. It is necessary to fit an absorption material in the tank to absorb the moisture from the SF<sub>6</sub> gas. The SF<sub>6</sub> insulating medium shall be constantly monitored via a temperature compensating gas pressure indicator offering a indication at different temperature ranges, like -25, 0, 20, 40, 60 deg centigrade, having distinctive RED and GREEN zones for safe operation.

The RMUs must be routine tested for the following at factory in India:-

Micro-ohm test for the assembly inside the tank.

- Circuit breaker analyzer test so as to ensure the simultaneous closing of all poles for VCB.
- SF<sub>6</sub> gas leak test.
- Partial Discharge test on the complete gas tank so as to be assure of the proper insulation level  
and high product life.
- High voltages withstand.
- Secondary test to ensure the proper functioning of the live line indicators, fault passage indicators and relays.

#### **4.0 Sulphur Hex fluoride Gas (SF<sub>6</sub> GAS)**

The SF<sub>6</sub> gas shall comply with IEC 376, 376A and 376B and shall be suitable in all respects for use in 11 KV RMUs under the operating conditions. The SF<sub>6</sub> shall be tested for purity, dew point air hydrolysable fluorides and water content as per IEC 376, 376A and 376B and test certificate shall be furnished to the owner indicating all the tests as per IEC 376 for each Lot of SF<sub>6</sub> Gas.

#### **5.0 DIELECTRIC MEDIUM**

SF<sub>6</sub> / VCB GAS shall be used for the dielectric medium for 11KV RMUS in accordance with IEC376. It is preferable to fit an absorption material in the tank to absorb the moisture from the SF<sub>6</sub> / VCB gas and to regenerate the SF<sub>6</sub> / VCB gas following arc interruption. The SF<sub>6</sub> / VCB insulating medium shall be constantly monitored via a temperature compensating gas pressure indicator offering a simple go, no-go indication.

#### **6.0 General structural and mechanical construction:**

The offered RMU should be of the fully arc proof metal enclosed, free standing, floor mounting, flush fronted type, consisting of modules assembled into one or more units. Each unit is made of a cubicle sealed-for life with SF<sub>6</sub> / VCB and contains all high voltage components sealed off from the environment.

The overall design of the indoor switchgear should be such that front access only is required. It should be possible to erect the switchboard against a substation wall, with HV and LV cables being terminated and accessible from the front.

The units should be constructed from Minimum 2 mm thick stainless steel sheets. However, Offer with type test report of pressure withstand test for gas filled compartment with pressure relief device test as per cl. no. 6-103-1 of IEC 62271-200-2003 can be accepted for 2mm stainless steel tank thickness. The design of the units should be such that no permanent or

harmful distortion occurs either when being lifted by eyebolts or when moved into position by rollers.

For outdoor RMUs a weather proofing process shall be carried out. SHEET METAL MUST BE GRIT BLASTED /THERMALLY SPRAYED AND POLYURETHANE PAINTED WITH ABOUT 70 MICRON THICKNESSES, TO ACHIEVE OUTDOOR WORTHINESS AND CORROSION PROOFNESS.

- RMU ENCLOSURE MUST BE SHIELDED AGAINST SOLAR IRRADIATION AND TESTED FOR AN AMBIENT OF 45 DEGREE C WITHOUT DERATING OF THE EQUIPMENT.

The cubicle should have a pressure relief device. In the rare case of an internal arc, the high pressure caused by the arc will release it, and the hot gases are allowed to be exhausted out at the bottom / top / rear of the cubicle. A controlled direction of flow of the hot gas should be achieved.

The switchgear should have the minimum degree of protection (in accordance with IEC 60529)

- IP 67 for the tank with high voltage components
- IP 2X for the front covers of the mechanism
- IP 3X for the cable connection covers
- IP 54 for the outdoor enclosure.

## **7.0 STANDARDS**

Unless otherwise specified elsewhere in this Specification, the RMU, Switchboard (Switchgear), Load break isolators, Instrument Transformers and other associated accessories shall conform to the latest revisions and amendments thereof to the following standards.

Sr. No.		
1	IEC 60298/IEC 62 271-200/IS 12729:1988	General requirement for Metal Enclosed Switchgear
2	IEC60129/IEC62271-102/IS 9921	Alternating current disconnector's (Load break isolators) and earthing switch
3	IEC 62 271-100/IEC 60 056/IS 13118:1991	Specification for alternating IEC 62 271-200 current circuit breakers.
4	IEC 62 271-1/IEC 60694	Panel design, SF6/Vacuum Circuit Breakers
5	IEC 60044-1/IEC 60185/IS 2705:1992	Current Transformer
6	IEC 60265/IS 9920:1981	High voltage switches
7	IEC 376	Filling of SF6 gas in RMU.
8	IEC 60273/IS :2099	Dimension of Indoor & Outdoor post insulators with voltage > 1000 Volts.
9	IEC 60529/IS 13947(Part-1) -	Degree of protection provided by enclosures for low voltage switchgear and control gear.

## **10) Indian Electricity Rules/Bills**

Equipment meeting with the requirements of any other authoritative standards, which ensures equal or better quality than the standard mentioned above shall also be

acceptable. If the equipments, offered by the Bidder conform to other standards, salient points of difference between the standards adopted and the specific standards shall be clearly brought out in relevant schedule. In case of any difference between provisions of these standards and provisions of this specification, the provisions contained in this specification shall prevail. One copy of such standards with authentic English Translations shall be furnished along with the offer. (Hard copy)

### **7.1 Applicable Standards**

The RMUs shall be manufactured to the highest quality consistent with best practice and workmanship and in full accord with the Supplier's quality assurance plan. The RMUs shall conform to the Indian or IEC international standards that are applicable. These include the standards listed in Table 1. No text of specified style in document.-1 below.

**TABLE 1: Applicable Standards**

<b>Standard</b>	<b>Description</b>
IS 3427	AC metal enclosed switchgear and control gear for rated voltages above 1 kV and up to and including 52 kV
IS 12063	Classification of degrees of protection provided by enclosures of electrical equipment.
IS 9920 (Parts 1 to 4)	High Voltage Switches
IS 9921 (Parts 1 to 5)	Specification for AC disconnectors and earthing switches for voltages above 1000 V
IS 13118	HV AC Circuit Breakers
IS 10601	Dimensions of terminals of HV Switchgear and Control gear
IS 12729	General requirements of switchgear and control gear for voltages exceeding 1000
IEC 1330	High voltage/Low voltage prefabricated substations
IEC 60694	Common clauses for MV switchgear standards
IEC 6081	Monitoring and control
IS 2705	Current Transformer
IS 3156	Voltage transformers
IS 8686	Specification for Static Protective Relays
IEC 62271-200	Standards for high voltage metal clad switchgear up to 52 KV.
INDIAN ELECTRICITY REGULATION 2011	This is to be as per Central Electricity Authority (Safety Requirement for Construction, Operation & Maintenance of Electrical Plants and Electric Lines) Regulations, 2011

**7.2 THE STANDARDS MENTIONED ABOVE ARE AVAILABLE FROM:**

<b>REFERENCE / ABBREVIATION</b>	<b>NAME AND ADDRESS FROM WHICH THE STANDARDS ARE AVAILABLE</b>
IEC	INTERNATIONAL ELECTRO-TECHNICAL COMMISSION, BUREAU CENTRAL DE LA COMMISSION, ELECTRO TECHNIQUE INTERNATIONALE, 1, RUE DE VEREMBE, GENEVA, SWITZERLAND
ISO	INTERNATIONAL STANDARD ORGANISATION

**SPECIFIC REQUIREMENTS IN RMU:-**

The RMUs going to be installed in the field network , will be hooked with SCADA Through RTUs and hence , RMUs used shall be compatible with SCADA.

**8.0. CLIMATE CONDITIONS**

The climatic conditions under which the equipment should operate satisfactory are as under:

Maximum ambient air temperature	: 50 deg. C
Minimum ambient air temperature	: 10 deg.C
Maximum daily average ambient air temperature	: 40C
Maximum humidity	: 100%
Altitude above M.S.L. (maximum)	: 1000 metres
Average annual rainfall(mm)	: 925
Max. wind pressure(Kg/sq.m)	: 200
Seismic level (Horizontal accn.)	: 0.3 g
Iso-ceraunic level(Days per Year)	: 50
Average thunder storm days per annum	: 50

**9.0 Distribution Network Electrical Parameters**

The main parameters of the distribution network are as follows:

☐Nominal system voltage: 11 kV (rms)

☐Highest system voltage: 12 kV (rms)

☐Number of phases: 3

☐Frequency: 50 Hz

Variation in frequency: 49.5 Hz to 50.5 Hz

Type of earthing: Solid

☐Power frequency withstand voltage: 28 kV

☐Basic impulse withstand voltage : 75 kV

**10.0 RMU OUTDOOR METAL CLAD ENCLOSURE.**

The RMU enclosure must be a metallic, it shall follows an industrialized process of manufacturing. The RMU and combination shall be tropicalized and outdoor metal enclosed type. The RMU metal parts shall be of high thickness, high tensile steel which must be grit/short blasted, thermally sprayed with Zinc alloy, phosphate or should follow the 7 tank pre-treatment process and be subsequently painted with polyurethane based powder paint. The overall paint layer thickness shall be not less than 80 microns.

The rating of enclosure shall be suitable for operation on three phase, three wire, 11 KV, 50 cycles, A.C. System with short-time current rating of 20KA for 3 seconds with RMU Panels.

The enclosure should have two access doors one for the operation and relay monitoring and other for the cable access. Both the doors should have the locking facility to prevent the access to operating mechanism to avoid unauthorized operating of RMU and relay.

### **13.0 RMU Design Features**

All design features of the proposed RMU, as described in the supplier's bid and in the bid's reference materials, shall be fully supported by the equipment actually delivered. The key design features include those that relate to:

- Maintainability, expandability, and life span
- Ability to operate in severe outdoor environmental conditions.
- Immunity to electrical stress and disturbance.
- Acceptable insulation properties.
- Convenient FRTU interconnection features.

#### **13.1 INDOOR RMU**

1. MODULAR DESIGN, PANEL TYPE WITH FRONT CABLE ACCESS.
2. RMU MUST BE MADE OF ROBOTICALLY / TIG / MIG WELDED STAINLESS STEEL.
3. Offered RMU must be extensible.

#### **13.2 OUT DOOR RMU**

1. Stainless steel enclosure for OUT DOOR RMU application. The manufacturers shall conform the normal current ratings mentioned in GTP at 45 deg. Ambient without derating or as per IEC Standard
2. Enclosure with I.P.54 standard protection.
3. Offered RMU must be extensible.
4. Cable boxes shall be on Front/ side sides.
5. RMU ENCLOSURE MUST BE SHIELDED AGAINST SOLAR IRRADIATION AND TESTED FOR AMBIENT OF 45 DEGREE C. The manufacturers shall conform the normal current ratings mentioned in GTP at 45 deg. Ambient without derating, however, design for higher ambient temperature than 45 degree may be admissible.

### **14.0 TAKE OFF TERMINAL UNITS FOR FUTURE AUTOMATION :**

The RMU should be provided with necessary take off terminal units for automations, located in the front recesses / LV cubical of the RMU. The connectivity to the FRTU for SCADA purpose shall be provided. Refer Annexure-1 for general arrangement of the terminals.

### **15.0. ISOLATORS (LOAD BREAK TYPE)**

The load break isolators for Incoming and Outgoing supply must be provided. These should be fully insulated by SF6gas. The load break isolators shall consist of 630 Amp fault making/load breaking spring assisted ring switches, each with integral fault making earth switches. The switch shall be naturally interlocked to prevent the main and earth switch being switched "ON" at the same time. The selection of the main and earth switch is made by a lever on the facia, which is allowed to move only if the main or earth switch is in the off position. The load break isolators should have the facility for remote operation. Each load break switch shall be of the triple pole, simultaneously operated, automatic type with quick break contacts and with integral earthing arrangement.

The isolating distance between the OFF and the ON position in the isolator should be sufficient to withstand dielectric test as per IS/IEC, so as to have enough isolating distance for ensuring safety during DC injection for Cable testing.



**Load break switch should have the following**

- Motor operated 12 KV, 630A Load Break switch and manually operated Earthing Switch with making capacity.
- “Live Cable” LED Indicators thru Capacitor Voltage Dividers mounted on the bushings.
- Mechanical ON/OFF/EARTH Indication
- Anti-reflex operating handle
- Cable Testing facility without disconnecting the cable terminations, cable joints and terminal protectors on the bushings.
- Cable terminations
- Cable boxes suitable for 1 X 3C x 300 sq mm XLPE Cable with right angle Cable Termination Protectors.

**16.0 EARTHING OF ISOLATORS AND DISTRIBUTION TRANSFORMER BREAKERS (EARTH SWITCH)**

Necessary arrangements are provided at Load break isolators / Distribution Transformer Breaker for selecting Earth position. Mechanical interlocking systems shall prevent the RMU function from being operated from the ‘ON’ to ‘Earth’ on position without going through the ‘OFF’ position.

**17.0 DISTRIBUTION TRANSFORMER/FEEDER BREAKER (VACUUM)**

The VCB breaker for the controlling of DT/Feeder Breaker must be provided inside welded stainless steel SF6 gas tank with the outdoor metal clad enclosure. The VCB circuit breaker must be a spring assisted three positions with integral fault making earth switch. The selection of the main/earth switch lever on the facia, which is allowed to move only if the main or earth switches is in the off position.

The manual operation of the circuit breaker shall not have an effect on the trip spring. This should only be discharged under a fault (electrical) trip; the following manual reset operation should recharge the trip spring and reset the circuit breaker mechanism in the main off position.

The circuit breaker shall be fitted with a mechanical flag, which shall operate in the event of a fault (electrical) trip occurring. The “tripped” flag should be an unambiguous colour differing from any other flag or mimic.

Both the circuit breaker and ring switches are operated by the same unidirectional handle.

The protection on the circuit breaker shall comprise of the following components:-

- 3 class X protection CT’s,
- a low burden trip coil and
- a self powered (No external DC or AC source required) IDMT protection relays (Numeric/Micro processor based) 3 x over current and earth fault element shall be Definite Time type relay . The protection system should be suitable for protecting transformers of rated power from 1000 KVA (Two Transformer) . The relay should be housed within a pilot cable box accessible.

Circuit Breaker should have the following:

- Motor operated 200 A / 630A SF6 insulated Vacuum circuit breaker and Ear thing Switchwith making capacity
- Mechanical tripped on fault indicator

- Auxiliary contacts 4NO and 4NC
- Anti-reflex operating handle
- “Live Cable” LED Indicators thru Capacitor Voltage Dividers mounted on the bushings.
- O/C + E/F self powered relay
- Shunt Trip circuit for external trip signal
- Mechanical ON/OFF/EARTH Indication
- Cable boxes suitable for 1 X 3C x 300 sq mm XLPE Cable with right angle Cable Termination/ protectors / boots

## 18.0 TECHNICAL DATA

### 18.1 Ring Main Unit, Electrical data Electrical data and service conditions

	<b>Rated voltage</b>	<b>KV</b>	<b>12/15.5 KV</b>
1	Power frequency withstand voltage	KV	28 / 35
2	Impulse withstand voltage	KV	75 / 95
3	Rated frequency	Hz	50
4	Rated current busbars	A	630
5	Rated current (cable switch)	A	630
6	Rated current (T-off)	A	200/630
7	Active load	A	630
8	closed loop (cable switch)	A	630
9	off loa cable charging (cable switch)	A	135
10	earth fault (cable switch)	A	200
11	earth fault cable charging (cable switch)		115
12	short circuit breaking current(T-off circuit breaker)	kA	20/21
13	Rated making capacity	kA	52
14	Rated short time current 3 sec.	kA	20/21
<b>Ambient temperature:</b>			
15	Maximum value	°C	+ 50
16	Maximum value of 24 hour mean	°C	+40
17	Minimum value	°C	0
18	Altitude for erection above sea level 4	m	...1000
19	Relative humidity		Max 95%

**18.2 Ring Main Unit Technical data (11KV/22KV)**

No.	General data, enclosure and dimensions	
1	Standard to which Switchgear complies	IEC
2	Type of Ring Main Unit	Metal Enclosed, Panel type, Compact Module.
3	Number of phases	3
4	Whether RMU is type tested	Yes
5	Whether facility is provided with pressure relief	Yes
6	Insulating gas	SF6
7	Nominal operating gas pressure	1.4 bar @ 20° C. However offer with Nominal operating gas pressure shall be as per manufacturer standard and suitable to satisfy the rated dielectric strength can be accepted.
8	Gas leakage rate / annum	0.075%
9	Expected operating lifetime	30 years
10	Whether facilities are provided for gas monitoring	Yes, temperature compensated manometer can be delivered.
11	Material used in tank construction	Stainless steel sheet, minimum 2 mm

**19.0 BUSHINGS**

The units are fitted with the standardized bushings that comply with IEC standards. All the bushings are the same height from the ground and are protected by a cable cover.

**20.0 CABLE BOXES**

All the cable boxes shall be air insulated suitable for dry type cable terminations and should have front access only. Side and rear cable entry / access should be avoided,

so not to have extra space at site for cable connection and cable testing. The cable boxes at each of the two ring switches should be suitable for accepting Suitable cable wire.

The cable boxes for an isolator in it's standard design should have sufficient space for connecting two cables per phase. Necessary Right angle Boot should be supplied to the cable terminations .The type of the Right angle Boot should be cold applied insulating Boot.

**21.0 CABLE TESTING FACILITY**

It shall be possible to test the cable after opening the cable boxes. The cable boxes should open only after operation of the earth switch. Thus ensuring the earthing of the cables prior to performing the cable testing with DC injection.

**22.0. VOLTAGE INDICATOR LAMPS AND PHASE COMPARATORS**

**The RMU shall be equipped with a voltage indication to indicate whether or not there is voltage on the cable. There should be a facility to check the synchronization of phases with the use of external device.** It shall be possible for the each of the function of the RMU to be equipped with a permanent voltage indication as per IEC 601958 to indicate whether or not there is voltage on the cables.

**23.0. EXTENSIBLE**

Each combination of RMU shall have the provision for extension by load break isolators / breakers in future, with suitable accessories and necessary Bus Bar. The equipment shall be well designed to avoid any kind of extension / trunking chamber for connecting and housing extensible Bus bars. Extensible isolators and circuit breakers shall be individually housed in separate SF6 gas enclosures. Multiple devices inside single gas tank / enclosure will not be acceptable. In case of extensible circuit breakers, the Breaker should be capable of necessary short circuit operations as per IEC at 20 KA, and the Breaker should have a rated current carrying capacity of 630 A.

#### **24.0. WIRING & TERMINALS:**

The wiring should be of high standard and should be able to withstand the tropical weather conditions. All the wiring and terminals (including take off terminals for future automation, DC, Control wiring), Spare terminals shall be provided by the contractor. The wiring cable must be standard single-core non-sheathed, Core marking (ferrules), stripped with non-notching tools and fitted with end sleeves, marked in accordance with the circuit diagram with printed adhesive marking strips.

The wiring should be of high standard and should be able to withstand the tropical weather conditions. All wiring shall be provided with single core multistrand copper conductor wires with P.V.C insulation.

The wiring shall be carried out using multi-strand copper conductor super flexible PVC insulated wires of 650/1100V Grade for AC Power, DC Control and CT circuits. Suitable colored wires shall be used for phase identification and interlocking type ferrules shall be provided at both ends of the wires for wire identification. Terminal should be suitably protected to eliminate sulphating. Connections and terminal should be able to withstand vibrations. The terminal blocks should be stud type for controls and disconnecting link type terminals for CT leads with suitable spring washer and lock nuts.

Flexible wires shall be used for wiring of devices on moving parts such as swinging Panels (Switch Gear) or panel doors. Panel wiring shall be securely supported, neatly arranged readily accessible and connected to equipment terminals, terminal blocks and wiring gutters. The cables shall be uniformly bunched and tied by means of PVC belts and carried in a PVC carrying trough.

The position of PVC carrying trough and wires should not give any hindrance for fixing or removing relay casing, switches etc., Wire termination shall be made with solder less crimping type of tinned copper lugs. Core identification plastic ferrules marked to correspond with panel wiring diagram shall be fitted with both ends of each wire. Ferrules shall fit tightly on the wire when disconnected. The wire number shown on the wiring shall be in accordance with the IS.375.

All wires directly connected to trip circuits of breaker or devices shall be distinguished by addition of a red color unlettered ferrule.

Inter-connections to adjacent Panels (Switch Gear) shall be brought out to a separate set of Terminal blocks located near the slots or holes to be provided at the top portion of the panel. Arrangements shall be made for easy connections to adjacent Panels (Switch Gear) at site and wires for this purpose shall be provided and bunched inside the panel. The bus wire shall run at the top of the panel. Terminal block with isolating links should be provided for bus wire. At least 10% of total terminals shall be provided as spare for further connections. Wiring shall be done for all the contacts available in the relay and other equipment and brought out to the terminal blocks for spare contacts. Color code for wiring is preferable in the following colours.

- Voltage supply - Red, Yellow, Blue for phase and Black for Neutral
- CT circuits - Similar to the above
- DC circuits - Grey for both positive and negative
- 250V AC circuits - Black for both phase and neutral
- Earthing - Green

The wiring shall be in accordance to the wiring diagram for proper functioning of the connected equipment. Terminal blocks shall not be less than 650V grade and shall be piece-molded type with insulation barriers.

The terminal shall hold the wires in the tight position by bolts and nuts with lock washers. The terminal blocks shall be arranged in vertical formation at an inclined angle with sufficient space between terminal blocks for easy wiring. The terminals are to be marked with the terminal number in accordance with the circuit diagram and terminal diagram. The terminals should not have any function designation and are of the tension spring and plug-in type.

### **25.0. EARTHING**

The RMU outdoor metal clad, Switch Gear, Load break isolators, Vacuum circuit breakers shall be equipped with an earth bus securely fixed along the base of the RMU. The size of the earth bus shall be made of IEC/IS standards with tinned copper flat for RMU and M. S. Flat for Distribution Transformer, earth spike and neutral earthing. Necessary terminal clamps and connectors shall be included in the scope of supply.

All metal parts of the switchgear which do not belong to main circuit and which can collect electric charges causing dangerous effect shall be connected to the earthing conductor made of copper having CS area of minimum 75 mm<sup>2</sup>. Each end of conductor shall be terminated by M12/equivalent quality and type of terminal for connection to earth system installation. Earth conductor location shall not obstruct access to cable terminations.

The following items are to be connected to the main earth conductor by rigid or copper conductors having a minimum cross section of 75 mm<sup>2</sup> (a) earthing switches (b) Cable sheath or screen (c) capacitors used in voltage control devices, if any.

The metallic cases of the relays, instruments and other panel mounted Equipment shall be connected to the earth bus by independent copper wires of size shall be made of IEC/IS standards. The colour code of earthing wire shall be green. Earthing wires shall be connected on the terminals with suitable clamp connectors and soldering shall not be permitted.

### **26.0 ACCESSORIES & SPARES:**

The following spares and accessories shall be supplied along with the main equipments at free of costs. This shall not be included in the price schedule.

- 1) Charging lever for operating load break isolators & circuit breaker of each RMU.
- 2) The pressure gauges indications – 1 numbers

Provision shall be made for padlocking the load break switches/ Circuit breaker, and the earthing switches in either open or closed position with lock & master key.

### **27.0.TESTING OF EQUIPMENT & ACCESSORIES:**

Provision for testing CTs, Relays, Breakers and Cables shall be made available. Procedure and schedule for Periodical & Annual testings of equipments, relays, etc. shall be provided by the supplier.

### **28.0.TYPE TEST**

The Tenderers should submit copies of all Type test certificate of their make in full shape as confirming to relevant ISS/IEC of latest issue obtained from a International/National Govt. Lab/Recognized laboratory after the work allotted.

The above type test certificates should accompany the drawings for the materials duly signed by the institution who has type test certificate.

#### **28.1 ACCEPTANCE AND ROUTINE TESTS**

All acceptance and routine tests as stipulated in the latest IEC- shall be carried out by the supplier in the presence of GWSSB representative & Third Party. The supplier shall give at least 7 days advance intimation to the GWSSB to enable them to depute their representative for witnessing the tests. The partial discharge shall be carried out as routine test on each and every completely assembled RMU gas tank and not on a sample basis. As this test checks and guarantees for the high insulation level and thus the complete life of switchgear.

#### **29.0 TRAINING:**

The supplier shall give rigorous training to the engineers & staff at the site for 2 days in attending trouble shooting and maintenance. The contractor has to arrange this training.

**30.0 SCADA CONNECTIVITY:**

Provision shall be made in all the RMUs with necessary take off terminal units for automations and connectivity with FRTU. The all RMUs shall be motorized type and compatible for SCADA operation. All the I/O signals need to be brought to the Terminal Strip on a Din Rail, also the Din Rail should have space to mount the MFT's provided by SIA. All the DI's, AI's and DO's should be provided as potential free and control contacts. The CT/PT should provide metering grade core for connecting MFT provided with FRTU. The RMU will also supply 230VAC 500VA for FRTU.

The RMU should be provided with provision of following minimum signals available at separate SCADA terminal box.

<b>Minimum signals for SCADA/DMS - to be wired to Separate TBs</b>	
CB close / open	potential free contacts
LBS close / open	potential free contacts
LBS & CB Earth Switch close /open	potential free contacts
CB Test/Service Position	potential free contacts
Spring charge Status indication	potential free contacts
SF6 gas pressure low	potential free contacts
O/C Operated	potential free contacts
E/F Operated	potential free contacts
Local/Remote	potential free contacts
Common Power Supply Healthy	potential free contacts
Motor MCB Healthy Status	potential free contacts
Battery charger Fail	potential free contacts
RMU Door Open	potential free contacts
CB Trip Coil Healthy	potential free contacts
CT & PT	For SCADA Metering
FPI Control	FPI remote resetting for SCADA
CB control	Control from SCADA
LBS Control	Control from SCADA

**31.0 DOCUMENTATION and DRAWINGS**

All drawings shall conform to relevant International Standards Organization (ISO) Specification. All drawings shall be in ink and suitable for microfilming.

The tenderer shall submit along with his tender dimensional general arrangement drawings of the equipments, illustrative and descriptive literature in triplicate for various items in the RMUs which are all essentially required for future automation.

- Schematic diagram of the RMU panel
- Instruction manuals
- Catalogues of spares recommended with drawing to indicate each items of spares
- List of spares and special tools recommended by the supplier.
- Copies of Type Test Certificates as per latest IS/IEC.
- Drawings of equipments, relays, control wiring circuit, etc.

- Foundation drawings of RMU and D.T. Structure.
- Dimensional drawings of each material used for item Vii.
- Actual single line diagram of RMU/RMUs with or without Extra combinations shall be made displayed on the front portion of the RMU so as to carry out the operations easily.

**32.0. NAME PLATE:**

Each RMU and its associated equipments shall be provided with a name plate legible and indelibly marked with at least the following information.

- (a) Name of manufacturer
- (b) Type, design and serial number
- (c) Rated voltage and current
- (d) Rated frequency
- (e) Rated symmetrical breaking capacity
- (f) Rated making capacity
- (g) Rated short time current and its duration
- (h) Purchase Order number and date
- (i) Month and Year of supply
- (j) Rated lighting impulse withstand voltage
- (k) Feeder name(Incoming and Out going),DTs structure name, 11000Volts Dangers etc.

**NOTE:** i) The word rated need not appear on the name plate. Recognized abbreviations may be used to express the above particulars.

- ii) Whether the circuit breaker is fitted with closing/tripping devices necessitating an auxiliary supply shall be stated either on the circuit breaker name plate or any other acceptable position

**33.0. FAULT PASSAGE INDICATORS (FPI):**

These shall facilitate quick detection of faulty section of line. The fault indication may be

on the basis of monitoring fault current flow through the device. The unit should be self-contained requiring no auxiliary power supply. The FPI shall be integral part of RMU. The FPI shall have **LCD/LED display**, automatic reset facility. The sensors to be bushing mounted. FPI Reset from SCADA will be through momentary closure of a potential free contact from FRTU.

The sensors to be bushing mounted. The number of FPI should be put in all the three phases of the outgoing branch of the RMUs. FPI should have suitable connectivity with the FRTUs for the SCADA purpose.

The FPI inside the RMU may be non communicable and hard wired to the TB for the signals.

Fault Passage indicator OK
Fault Passage indicator operated

**34.0. TROPICALISATION**

Due regard should be given to the climatic conditions under which the equipment is to work. Ambient temperature normally vary between 10 °C and 45 °C, although direct sun temperature may reach 50 °C. The climate is humid and rapid variations occur, relative humidity between 60% and 95% being frequently recorded, but these values generally correspond to the lower ambient temperatures. The equipment should also be designed to prevent in gress of vermin, accidental contact with live parts and to minimize the ingress of



dust and dirt. The use of materials which may be liable to attack by termites and other insects should be avoided.

**35.0 Motorisation :**

All the functions within the RMU i.e Isolators / Breakers should be fitted with motor mechanism and closing coil making it suitable to make it ON from remote.

Control Supply and Auxillaries : Following Auxillaries has to considered

- (i) Shunt trip coil – 24VDC for Isolators and Breakers
- (ii) Closing Coil – 24VDC
- (iii) Motor Mechanism – 24VDC
- (iv) 6NO+6NC – Potential free auxillary contacts for breakers / isolator
- (v) Auxiliary supply should be – 24VDC
- (vi) Battery/ Battery charger with battery backup of at least 1hours (Vii) Local / Remote switch for breaker and Isolators

**36.0 Metering:**

Separate Metering Module consisting of bus connected PTs And metering CTs to be provided for VCB function along with Provision of installing Multifunction meter to be provided. The PTs and CTs provided shall made up of epoxy cast resin with an Accuracy class of 0.5. The CT ratio shall be as per transformer Rating. The metering is required only in breaker functions.

**Principal Features of R.M.U.**

Sr. No.	Description	DT Breaker
1	Circuit Label	Yes
2	Mimic Diagram	Yes
3	Supply Voltage Indication	Yes
4	Current Transformer	Yes
5	Self Powered Based Microprocessor IDMT Relay (3OL)/EL	Yes
6	Anti - Reflexing Relay	Yes
7	Interlock to defeat the operation of the line side earthing when the line side isolator is ON	Yes
8	Interlock to defeat the operation of the earthing when the breaker is in Service position and is ON	Yes
9	Breaker ON / OFF indication	Yes
10	Spring Charge indication/ Spring Assisted mechanism	Yes
11	Fault Tripping Indication	Yes
12	Bus bar end caps	Yes
13	Whether the SF6 gas pressure gauge pressure and filling arrangement	Yes
14	Whether the spring assisted mechanism with operating handle ON/OFF	Yes
15	Whether the earth positions with arrangement for padlocking in each position and independent manual operation with mechanically operated indicator are provided	Yes
16	RMUs are provided with necessary take off terminals for future automation.	Yes

**Earthing switch for 11 KV Line side Isolation and DT**

- Rated short time current : 20 KA.
- Rated short time : 3s

- Rated peak withstand current : 50 KA
- Interlocking facility: 1) Between 11 KV Line side isolator "ON" & Earthing.
- Between 11 KV DT side breaker on close condition & Earthing.

**Current Transformers for breaker**

- CT Type : Tape wound
- CT Description : The CTs of DT breaker shall be suitable for sensing the minimum primary variable current in the order of 10-100 A (Depending on Transformer rating 1000 KVA ) and the secondary current for the CT is 1 A. The CT shall be housed in outside SF6 chamber for testing and Maintenance.
- Accuracy Class : class X/5P10 protection
- Rated burden : Suitable for self-powered relay

**ANNEXURE\_1 (For R.M.U.)****SCHEDULE OF GUARANTEED PARTICULARS FOR OUTDOOR METAL CLAD**

1	Manufacturer's Name and Country of origin	
2	Manufacturer's Design / Type ref/Model.	
3	Material used for making the body of the enclosure	
4	Standards of manufacturing	
5	Whether painting for RMU metal enclosure is done as per high standards	
6	Whether the enclosure is fire resistive, anti-corrosive	
7	Whether the RMU metal clad is provided with sufficient space for integration of a) Minimum 2 numbers load break isolators and 1 number SF6/Vacuum Circuit breaker. b) Sufficient space for inspection, testing, etc c) Earthing arrangements d) Terminal output points for future automation e) Sufficient arrangement for future extension with Load break isolators/Breakers f) Space for motorization of Load break isolators/ Breakers in future.	
8	Maximum temperature with stand of enclosure.	
9	Spacing between live part to Earth	
10	Whether the enclosure are designed to withstand the in all weather conditions (Seashore area, Chemical industries polluted area)	
11	Period of guarantee of the RMU enclosure	
12	Over all dimensions of the RMU enclosure (L x B x H)	
13	Gauge of the Material used for the fabrication of the RMU enclosure	
14	Whether the RMU enclosure is manufactured as per IEC/IS standards to hold SF6 gas without leakage.	
15	Whether the RMU enclosure made provision for sensors for temperature compensated pressure measurement in the relevant gas compartment to monitor the pressure of SF6 gas.	
16	Whether the RMU enclosure is sealed pressure system.	
17	Weight of RMU complete with operating mechanism.	

18	RMUs are provided with necessary take off terminals	
19	Whether the gas chamber is made of stainless steel / Metallised Cast Resin	

**ANNEXURE – 2 (For R.M.U.)**

**SCHEDULE OF GUARANTEED PARTICULARS FOR DT BREAKER**

1	Manufacturer's Name and Country of origin	
2	Manufacturer's Design / Type ref/Model.	
3	Material used for making the body of the breaker	
4	Standards of manufacturing	
5	Whether the breakers are manufactured as per IEC/ IS standards	
6	Maximum temperature with stand of the breakers	
7	1)Spacing between live part to Earth inside the breaker 2)Spacing between poles	
8	Period of guarantee of the breaker	
9	Rated frequency	
10	Rated voltage	
11	Highest system voltage	
12	Rated current	
13	Short time current rating with duration	
14	Certificate or report of short circuit type test	
15	Rated operating duty cycle	
16	Short circuit breaking current (a) Symmetrical (b) Symmetrical at rated voltage (c) Asymmetrical at rated voltage (i) Per Phase (ii) Average (d) DC Component	
17	Arcing time (At rated breaking current) in ms	
18	Opening time	
19	Total break time in milli sec. (a)At 10% rated interrupting capacity (b)At rated interrupting capacity	
20	Breaking Current (a)Rated out of phase current (b)Rated cable charging current (c )Rated kilometric fault level (d)Rated capacitor breaking current	
21	Make time in ms.	
22	Maximum temperature rise over ambient (a)Main contacts Terminals	
23	Rated restriking voltage at 100% and 50% rated capacity.	

	(a)Amplitude factor (b)Phase factor (C)Natural frequency (d)R.R.R.V.(Volts/micro sec.)	
24	Dry 1 minute power frequency withstand test voltage (a)Between line terminal and earth KV RMS (b)Between terminals with breaker contacts open KV RMS.	
25	1.2/50 full wave impulse withstand test voltage (a)Between line terminal and earth KVp. (b)Between terminals with breaker contacts open KVp.	
26	SF6 /VCB interrupter make	
27	Contact separation distance	
28	Type of main contacts	
29	Contact pressure	
30	Contact resistance	
31	Life of the interrupter (in number of operations)	
32	(i)Tripping at rated current (ii)Tripping at maximum fault current. (Allowable maximum erosion 3 mm) (iii)Mechanical operations.	
33	Details of main contacts making contact with the breaker truck with the panel	
34	Control circuit voltage AC/DC.	
35	Whether trip free or not	
36	Whether all the interlocks provided	

### ANNEXURE – 3 (For R.M.U.)

#### SCHEDULE OF GUARANTEED PARTICULARS FOR LOAD BREAK ISOLATORS & EARTHING ARRANGEMENTS

1	Manufacturer's Name and Country of origin	
2	Manufacturer's Design / Type ref/Model	
3	Material used for making the body of the isolators.	
4	Standards of manufacturing	
5	Whether the isolators & earth positions are manufactured as per IEC/IS standards	
6	Maximum temperature with stand of the isolators & earth switches	
7	1)Spacing between live part to Earth 2)Spacing between fixed and moving contacts in the open position	
8	Period of guarantee of the isolators	
9	Rated frequency	
10	Rated voltage	
11	Highest system voltage	
12	Rated current	
13	Short time current rating with duration	
14	Certificate or report of short circuit type test	

15	Rated operating duty cycle	
16	Short circuit breaking current	
17	Arcing time (At rated breaking current) in ms.	
18	Opening time	
19	Whether all the interlocks provided	
20	<b>Whether Sufficient arrangements are made to operate the isolators through SCADA in future, also to be ensured for provision of space for accommodation of motor in future</b>	
21	Fault passage indicator 1) Type/Model 2) Self powered Yes/No 3) Current readings 4) Fault currents 5) Phase currents	

**ANNEXURE – 4 (For R.M.U.)**  
**SCHEDULE OF GUARANTEED PARTICULARS FOR CURRENT TRANSFORMERS**

1	Manufacturer's Name and Country of origin	
2	Manufacturer's Design / Type ref/Model	
3	Applicable Standards	
4	1)Type of CT 2)Ratio	
5	Rated Primary current	
6	Rated secondary current	
7	Rated frequency	
8	Transformation ratio	
9	Number of cores	
10	Rated output (a) For Core-I	
11	Class of insulation	
12	Class of accuracy For Protection	
13	Short time current rating and its duration	
14	Secondary resistance at 70 Deg °C	
15	Continuous over load (percentage)	
16	One minute power frequency dry withstand voltage	
17	1.2/50 micro sec. impulse withstand test voltage	
18	One minute power frequency withstand test voltage on secondary	
19	Instrument safety factor	
20	Type of primary winding	

21	Literature/leaflets pamphlets about the current transformer offered	
22	Period of guarantee	

**ANNEXURE – 5 (For R.M.U.)**

**SCHEDULE OF GUARANTEED TECHNICAL PARTICULARS FOR SELF POWERED MICRO PROCESSOR BASED NUMERICAL RELAYS**

1	Manufacturer's Name and Country of origin		
2	Manufacturer's Design / Type ref/Model.		
3	Applicable Standards		
4	Current Setting range for (a) Over current relay	IDMT	
	(b)Earth fault Element	Definite Time	
5	Whether the relay has the in-built facilities of IDMT, OL, EL		
6	Details of IDMT Characteristics		
7	Accuracy for different settings and limits of errors		
8	Whether Alpha numeric / LED display		
9	Whether compatible for 1 A CT Secondary		
10	Whether draw out type		
11	Types of case		
12	Reset time		
13	Burden of relay		
14	Maximum and Minimum, operating ambient air temp.		
15	Whether technical literature pamphlets about the relay offered.		
16	Period of guarantee		
17	Certificate of Proof for Electro Magnetic Interference.		

**ANNEXURE – 6 (For R.M.U.)**

**SCHEDULE OF GUARANTEED TECHNICAL PARTICULARS FOR DRAWINGS**

The contractor shall supply the following drawings

01	RMU	
02	General arrangement drawing of panels in station	
03	Engineering drawing for each panel including foundation details	
04	Wiring schedule	
05	Terminal block arrangement drawing	
06	Descriptive operation and maintenance manual for individual items such as relays, meters, switches recorders etc.	
07	Any other drawing required for complete understanding of the equipments supplied.	

Three copies of the drawings shall be submitted to this office for approval.