



**GOVERNMENT OF ODISHA
DEPARTMENT OF WATER RESOURCES**

BID DOCUMENT

FOR

**MEGA LIFT IRRIGATION PROJECT
CLUSTER NO.- XXIX**

Bid Identification No. 06ML/2026-27

Name of work:

Execution of 04 nos. of Lift Irrigation Schemes with intake points on Surubali jore (Surubali jore ISS), Harihar jore (Harihar jore ISS), Mahanadi River (Near Godheneswar ISS / ISS Kapasira) having Command area between 500Ha. to 2000 Ha. in Cluster No. XXIX in the district of Sonepur including its distribution network, up to 1 Ha Chak having total planned Culturable Command Area of 6,710Ha. on “EPC –Turn Key” basis including power system connectivity and Operation & Maintenance of complete commissioned schemes for fifteen years.

VOLUME – II

TECHNICAL SPECIFICATION

(EPC-TURN KEY CONTRACT)

**Office of Chief Engineer, Megalift
Bhubaneswar**

**Plot No. - A 8/2, Bhoinagar, Bhubaneswar, Odisha
PIN-751022**

VOLUME-II

TECHNICAL SPECIFICATIONS

VOLUME-II

TECHNICAL SPECIFICATIONS

INDEX

Sl no.	Section No.	Particulars
1	Section I	General A. Extent of Work B. Submissions to be made on Detailed Engineering of the cluster of LI schemes C. Design criteria for structural design
2	Section II	A. Survey, Investigation, Planning, Design and Drawing B. Land Acquisition
3	Section III	Technical Specification for Civil Works a. Excavation/Earth Work b. Drilling & Blasting c. Dewatering d. Drilling & Grouting e. Building Works f. Trash Rack & Gates
4	Section IV	a. Concrete Works b. Reinforcement Steel & Structural Works c. Road Works
5	Section V	Technical Specification for Pumps & Electro-Mechanical Works a. Pumps - V T Pumps& SCF Pump - Drainage Pump b. Electrical Works of Pumping Station c. Mechanical Works of Pumping Station
6	Section VI	Part-A Pipe Lines A. R.C.C Hume Pipe B. MS Pipeline C. PSC Pipeline D. HDPE Pipeline E. D.I Pipeline F. GRP Pipeline Part-B Appurtenance
7	Section VII	Technical Specification for Power System Connectivity A. "Construction of over head lines (Sub-transmission, HT & LT) and Construction Practices for Main Step-down Distribution Sub-Station(MSDSS) and Distribution Sub-Staion (DSS)". B. "Supply of equipments & materials & respective Guaranteed Technical Particulars (GTP)".

SECTION-I

GENERAL

SECTION – I

GENERAL

THE SPECIFICATIONS CONTAINED UNDER DIFFERENT SECTIONS IN THIS DOCUMENT ARE FOR GENERAL GUIDANCE. IN CASE OF DISAGREEMENT BETWEEN THE SPECIFICATION OF THE DEPARTMENT AND STANDARD PRACTICES BEING FOLLOWED AND/OR SPECIFICATIONS NOT PROVIDED SPECIFICALLY, THEN RELEVANT SPECIFICATIONS UNDER LATEST INDIAN STANDARDS, CWC GUIDELINES & “MANUAL ON WATER SUPPLY AND TREATMENT” PUBLISHED BY CENTRAL PUBLIC HEALTH AND ENVIRONMENTAL ENGINEERING ORGANISATION (CPHEEO), MINISTRY OF URBAN DEVELOPMENT, GOVERNMENT OF INDIA, RELEVANT REGULATIONS OF CEA/CERC/OERC AND APPROVED MANUFACTURER SPECIFICATIONS SHALL PREVAIL.

Section – I

General

Index

Sl. No.	Particulars	Page No.
1	A. EXTENT OF WORK	2
2	B. SUBMISSIONS TO BE MADE ON DETAILED ENGINEERING OF THE CLUSTER OF LI SCHEMES	8
3	C. CRITERIA FOR DESIGN OF CIVIL STRUCTURES	15

A. EXTENT OF WORK

1.0 GENERAL

Execution of 04 nos. of Lift Irrigation Schemes with intake points on Surubali jore (Surubali jore ISS), Harihar jore (Harihar jore ISS), Mahanadi River (Near Godheneswar ISS / ISS Kapasira) having Command area between 500Ha. to 2000 Ha. in **Cluster No. XXIX** in the district of Sonepur including its distribution network, up to 1 Ha Chak having total planned Culturable Command Area of 6,710Ha. on “EPC –Turn Key” basis including power system connectivity and Operation & Maintenance of complete commissioned schemes for fifteen years.

The Basic Project Profile and scope of work of execution of the Lift Irrigation schemes under the cluster has been detailed in volume –I of the bidding document.

I. Details of works covered in the Scope of Work for each LI Scheme under the cluster is as below :

(A) Detailed Engineering of each of the scheme along with Micro Irrigation compatible System and for power connectivity of the cluster conducting Survey, Investigation, Planning and component designs and preparation of estimates.

(B) Civil Works

- I. Construction of RCC Intake works in the river with RCC Duct/pipe up to the Pump house, Filtration System including all river protection works.
- II. Constructing Pump House with Panel Room & Operating rooms
- III. Approach roads to Pump House
- IV. MS/DI Pipeline for Transmission of Water up to delivery chamber(optional) / Pressure main, Surge Control Devices / Water Hammer Control Devices, other appurtenances,
- V. Delivery Chamber(optional) and the Irrigation Distribution Network such that Micro Irrigation System can be adopted at later stage through pipes

(B) Mechanical Works

Pumping Machinery & all related mechanical equipments

(C) Electrical Works

Electrical Equipments

(D) Instrumentation Works

Instrumentation Equipments

(E) O & M for Civil, Mechanical & Electrical Works for 15 years

O&M for Civil, Mechanical, Electrical & Instrumentation Works for 15 yrs. Mandatory Spares, Tools & Tackles required for after Operation & Maintenance period of 15 yrs.

(F) Miscellaneous Works

ROU (Right of Use)/ROW, Land acquisition processing, forest & environment & other statutory clearances

II. Details of works covered in the Scope of Work for Power System Connectivity to all LI Schemes under the cluster is as below :

- a) Power System connectivity to each LI schemes from the identified local Grid Stations as defined under the “Basic Project Profile in Volume-I.
- b) O&M for “User’s Installation” for period of 15 yrs and 33 kV Sub-Transmission Line shall be with concerned DISCOM.

2.0 PUMPING STATION COMPLEX**(A) Intake well/Intake system**

- I. Water shall be drawn from the river for providing Kharif water supply to the command area and Rabi water supply in case of water availability in the river and as decided by Government.
- II. The Intake works shall be constructed to draw required quantum of water with provision of arrangement for trash racks, gates and hoists for operation & maintenance. The maximum velocity in the intake works should be limited for minimising losses and silt entry.
- III. Necessary earth work & Protection works in the river is to be constructed.
- IV. All RCC construction of Intake Works will be with M-25 grade concrete as per detailed specification narrated in this document. TMT reinforcement bars and all other ancillary civil work shall be as per the detailed specification in the same volume. However latest IS codal provisions to be followed.
- V. Any suitable type of intake system can be chosen by the EPC contractor depending upon site condition with proper justification and detailed design to be approved by the CE, Mega lift.
- VI. Necessary temporary arrangements to be made by the EPC contractor by constructing low height check structures for sourcing of water in to the intake system during khariff operation

(B) Construction of Pump House Building

The Pumping Stations shall be adequate to accommodate required no. of pumps , valves, accessories, panel board, Filtration System, working area for maintenance of pump sets, facilities for proper O&M, cable ducting, pump foundation, pipes support, valve supports, floor drainage arrangement for draining the water from outside the Pump House, delivery pipeline connections, provision is to be made for sufficient ventilation, lighting to Pump House with exhaust arrangement. Access between floors shall be provided through RCC stair case / ladders. Pump House shall also have sufficient head room for electrically operated over head crane for loading and unloading the equipment. The Pump House shall be designed so as to maintain the noise level inside the Pump House within the permissible limit and to absorb vibration of pump sets while running. The P.H. bottom level is to be provided considering bottom of suction pit of RCC sump for positive suction. Further as the Pump House, Panel Room shall be adjoining to sump, necessary RCC retaining wall shall be provided to withstand the loads as per the design requirement. The minimum inner width of operating floor of pump house shall be 7.5 m and the control room floor width be 8 m.

Construction of an isolated 3 storied building for watchman and operator with plinth area of about 650 sq. Ft. In each floor in the pumping station is within the scope of the Contract.

The components will include but not limited to Pumping Stations

- a) Required nos. of Pumps (working and one standby) and associated motors at Pumping Stations.
- b) Power, control and instrumentation systems, associated accessories and cabling.
- c) Pump bowl assembly & Pump discharge pipe work, Non-Return Valves, Expansion Bellows, electrically operated butterfly Valves, etc. on pump suction and delivery. The delivery of each pump shall be connected to a common designed dia MS pipe manifold header line.
- d) Surge & Water Hammer protection devices.
- e) Necessary RCC blocks to support pipeline with thrust blocks as per requirement.
- f) Raw water sump with water level indicators & control panel.
- g) Raw water / suction chamber water level indicator (Physical)
- h) Emergency push buttons near to HT motors
- i) Switch gear and accessories
- j) Capacitors for main pump motors and for Auxiliary LT load
- k) Arrangements for receiving power from OPTCL and stepping down to required voltage, power distribution etc.

- l) Arrangements of HT overhead line/ cabling from new MSDSS power supply to 6.6 kV switch yard incomer.
- m) Lighting, earthing and lightning protection system, fire extinguisher
- n) DC system
- o) Any other equipment like EOT Crane / system not mentioned above but required for satisfactory operation of the Pump House

Design Considerations

The Sump well cum Pump House shall be of RCC structure square/circular shape depending on hydraulic performance of pumping constructed in minimum M-25 grade concrete. The grade of reinforcing steel in the sump / suction chamber structure shall be of TMT steel. It shall be a R.C.C. vertical wall for P.H. up to plinth level and RCC framed structure with brick masonry walls above the roof of the Pump House shall be of RCC slab with waterproofing. The design of the Pump House and its foundation shall take into account the worst combination of loads and forces such as service loads, wind load, uplift forces, seismic loads for the zone, dynamic forces due to vibration of pumps, ensuring total structural safety.

3.0 WATER TRANSMISSION MAINS

- 3.1 General arrangement of lifting raw water and also necessary filtration system for Micro Irrigation System at later stage for the desired command area and designated maximum discharge from various schemes under the cluster has been detailed in Volume – I & under the Vol-II.
- 3.2 The contractor has to Survey, plan, design most economical transmission line MS Rising main/Pressure main with MS Pipe with External Coating and Internal Epoxy Painting 406 Micron as per detail specification Or Ductile Iron Pipe Line of K9/K7 as per design and external & internal coatings as per the detailed specification.
- 3.3 **Design considerations for MS Pipeline System**
 - 3.3.1 Submerged Arc welded Hot finished Mild Steel bevelled pipes manufactured from MS plate confirming to IS 2062-1999 or hot rolled steel coils confirming to IS 10748 and fabricated pipes procured from manufacturer shall bear ISI mark as per IS 3589 / 2001, and pipes with inside 406 microns food grade epoxy coating as per detailed specification and outside 700micronsPU coating as per IS 16719:2018 or latest revision / amendments if any shall be used. The pipeline shall be buried.
 - 3.3.2 Appropriate bedding / concrete encasement in accordance with loading on pipeline, anchor / thrust blocks, saddle supports for pipeline above ground level and other accessories shall also be considered for design.

- 3.3.3 The pipeline shall be provided with required number of Double Orifice Tamper Proof Air Valves with Isolation Valves at a distance, not more than 500 M along the length and at humps.
- 3.3.4 Isolating / Butterfly Valves in main line shall be provided with at a distance not more than 5 Km along the pipeline with manhole arrangement.
- 3.3.5 The pipeline shall be provided with required sizes & type of scour valve / Sluice Valves as per requirements.
- 3.3.6 The pipeline shall also be provided with Surge Control Devices / System as per the design at required chainage / length.
- 3.3.7 The technical requirements of different type of valves are as per the technical specifications – under Indian Standards or International Standards for the related items of the valves and appurtenances.

4.0 OPERATION & MAINTENANCE STAFFING FOR LI SCHEMES OF CLUSTER

The contractor shall provide all the necessary operating staff and maintenance personnel to operate and maintain the works for fifteen years Operation and Maintenance contract period under the contract. Contractor will train local personnel of Pani Panchayat and engage them in the O&M so that the capacities of Beneficiaries are enhanced and they become capable to effectively manage the Scheme. The contractor shall provide a detailed proposed staffing schedule covering all categories of his staff with duties, responsibilities, qualification, experience and their salaries, etc. The staffing schedule shall be prepared on assumption that the system will be operated on a 24 hours per day basis with three equal shifts of 8 hours each for the crop calendar period. The inspection vehicles and staff required for the maintenance and operation of the pipeline shall also be considered for three equal shifts of 8 hours.

5.0 EQUIPMENT & OTHER ANCILLIARY WORKS FOR RAW WATER PUMPING SYSTEM FOR PUMPING STATIONS

The equipments shall include but not limited to:

- a) Piping, valves, fitting and all accessories within or in connection with system units and ancillary structures.
- b) Mechanical and other equipments such as trolleys, pallets and hoists for handling, storing and lifting of plant items concerned.
- c) All pipelines including connections, interconnecting pipe works including making connections, tapping where necessary, procurement of all materials, fabrication of pipes, bends, tapers, flanges, manholes, fittings, valves, flushing connections, washouts, flexible couplings, dismantling / expansion joints, linking, finishes, pipe protection, supports, anchor block, thrust block etc.

- d) Painting, lining, finishing after erection of all plants required for water pumping plant, commissioning tests and performance tests, operation and maintenance of raw water pumping plant during entire O & M period of 15 years.
- e) The surge control devices are to be provided as per contractor's own design and approved by Department.

6.0 PUMPING PLANTS AND DESIGN PARAMETERS

The plant shall be designed, selected and installed taking into account local site ambient conditions.

7.0 LIFE EXPECTANCY OF WORKS

The contractor shall design the works for a life expectancy as follows:

Concrete Structures	:	60 Years
Mechanical Plants	:	20 Years
Electrical Plants	:	25 Years
Buried Earth Electrical System	:	50 Years
Control Panels	:	25 Years
External Instrumentation Systems:		15 Years
MS Pipe Line	:	30 Years
Distribution Pipe Line	:	30 Years

8.0 ELECTRICAL SYSTEMS

All supply and installation works required for appropriate functioning of the plant.

9.0 SUPERVISORY /ANNUNCIATION SYSTEMS

Instruments, indicators, measuring and transmitting devices, meters (flow meters) at entry, gauges, gauge plates, consoles, annunciation panels / cubicles, stands, connections, cabling and wiring and other equipments, material and accessories necessary for interconnection of earthing and lighting with starter grids.

10.0 SERVICE WATER INSTALLATIONS

Pumps, motors, valves, station pipe works and all accessories necessary for service water systems for water supply for plants.

11.0 GENERAL UTILITIES

Other utilities necessary for the proper functioning of the proposed works which shall be included under this Contract but not limited to the following for Pumping Stations are:

- a) Fire Fighting arrangement in the Pump House shall be provided as per the Indian Standards
- b) Site development includes ecological development, boundary wall with suitable gates. Site development also includes raising GL at Pumping Station by selected excavated earth including proper ramming, watering, consolidation of earth work, etc. The finished ground level of the plot shall be brought to Level atleast one meter above the local Flood Level. The filling shall be done in uniform layers of 15 cm. to 20 cm. thick and shall be well watered and well compacted with suitable power roller.
- c) Internal roads & approach road required to Head Works from existing road, etc.
- d) Electric substation and distribution of power supply to all necessary points.

12.0 APPLICABLE STANDARDS

Reference to all the standards shall be meant for the latest revision of that standard and all the equipments shall be of approved make only.

SUBMISSIONS TO BE MADE ON DETAILED ENGINEERING OF THE CLUSTER OF LI SCHEMES

1.0 DRAWINGS, DOCUMENTS, CERTIFICATES, MANUALS

The envisaged LI schemes in the cluster are independent catering to command areas between 500 Ha to 2000 Ha. Hence the Detailed Survey & Investigation works, Planning and Design Works can be taken up simultaneously. All the components have to done LI scheme wise. The detailed scope of services for Survey & Investigation and Design & Engineering has been explained in Volume – I.

1.1 Submission and review of Engineering Documents

1.1.1 The contractor will submit **within 180 days** from award of contract, the following designs and drawings for review and approval of the Engineer In-charge generally in the sequence given below:

- (a) General layout plan of the entire Lift Irrigation Scheme on village maps
- (b) Designs and drawings for all electrical, instrumentation and mechanical equipment
- (c) General arrangement drawings for all units of works
- (d) Structural design calculations and drawings for all units of work shall be prepared and signed by registered structural engineer. As far as possible all structural drawings shall be drawn with the appropriate scale, neatly giving all the sections and details necessary for the easy understanding of structural details and smooth execution of the work.

- (e) Architectural drawings for all buildings and landscaping for entire plant plumbing and electrical drawings.
- 1.1.2 After review by the department/consultant of the department, Engineer-in-Charge will convey comments, within 30 days from receipt of details from contractor, which the contractor shall incorporate by modifying designs and drawings accordingly.
- 1.1.3 In no case will design, calculations / drawings be considered complete or acceptable, if
- (a) They are not duly signed by respective Architect/ Civil/ Structural/ Electrical/ Mechanical Design Engineer(s).
 - (b) They are not thoroughly checked and duly signed in the appropriate places by contractor and Sub Contractor (if any).
 - (c) Design calculations are not accompanied by supporting engineering, drawings or appropriate sketches.
 - (d) Design calculations are incomplete or not fulfilling the design requirements or are shabbily done or are without adequate reference, or other necessary back-up data.
 - (e) Any comments previously made are not incorporated on revised drawings /calculations.
- 1.1.4 Such unaccepted drawings / designs as described above shall be summarily rejected and contractor will be informed. Contractor shall arrange to resubmit the same duly checked, revised and signed within 15 days. No claim from contractor for extension of time or for extra cost on this account will be entertained under any circumstances.
- 1.1.5 The review of civil design calculations and drawings shall be carried out only in respect of correctness of centre-to-centre distances, elevations, important / typical details, orientation and sizes of important members, general design principles and approach, adherence to requirements of the relevant IS or other statutory codes, compliance with the Technical Specifications, general or specific notes and with the requirements of good engineering practice and whether the details shown on drawings conform to design calculations. Check for any interference and taking remedial action is the responsibility of the Contractor.
- 1.1.6 No check will be specifically carried out by the Engineer-in-Charge to verify arithmetical / numerical accuracy of the calculations, which shall remain entirely the Contractor's responsibility, irrespective of any approval that may have been accorded thereto by the Engineer-in-Charge.
- 1.1.7 All values / dimensions / elevations, etc. without supporting back-up data adopted / assumed by the contractor in his calculations / drawings shall be taken by the Department to be incorrect unless they are specified.

1.2 Form of Drawings

- 1.2.1 All drawings submitted for approval shall be ISO standard size sheets, prepared on computer with Auto CAD 2012 & above. Every drawing shall have a title block in the bottom right corner showing:

Drawing Title:

Job:

Client: DEPARTMENT OF WATER RESOURCES, ODISHA
CHIEF ENGINEER, MEGA LIFT, BHUBANESWAR

Consultant:

Contractor:

Drawing Number:

Revision Number:

Date:

1.2.2 Drawings / Documents

Drawings & Documents to be submitted have been outlined under Appendix- Design & Drawing of Volume-I. In addition the following documents are to be furnished.

- a) Preliminary outline drawings indicating details of pump, motor, civil foundation, clearances etc.
- b) Cross sectional drawings of all equipments showing bill of material & relevant standards.
- c) Test reports for chemical analysis of Major components like impeller, shaft, casing etc.
- d) All performance test reports.
- e) O. & M Manual & spare part list
- f) Quality assurance plan to be submitted for approval.
- g) Start / Stop instructions.
- h) Dimensional similarity / interchange ability certificates.

- 1.2.3 Each pump shall be provided with stainless steel name plate indicating following detail as minimum requirements.

- a) Rated capacity : M³/hr.

- b) Total Head : MWC
- c) Speed : RPM
- d) Rated power : KW at 50 Hz
- e) Test pressure : Kg / cm² or Kg / m²
- f) Make & Model
- g) Manufacturer Sr. No. :
- h) Weight of pump :
- i) Material of casing and impeller:
- j) Detail of bearing with grade of lubricants:

1.2.4 Each drawing shall bear the signature of the Authorised Project Manager on behalf of the contractor to the effect that the drawing (whether his own or from any other source) has been checked by the contractor before submission to the Engineer-in-Charge.

1.2.5 Each revision shall be properly recorded to show the number, date, specific description of revision/s carried out, and signature of the Project Manager in the revision block. The contractor shall be responsible for incorporating all the comments issued by the Engineer-in-Charge/ Consultant in the subsequent revision.

1.3 Programme of Submission

1.3.1 The contractor shall furnish a programme for submitting all designs, drawings, and documents to Engineer-in-Charge within three weeks of award of Contract for pre-construction review. The program shall make reasonable provision for resubmission of unapproved designs, drawings and documents and for the time needed to review and transmit such designs, drawings and documents. No designs, drawings and documents will be accepted for review until the programme for submission has been approved by Engineer-in-Charge. The Engineer In-charge will approve / convey his comments on the submitted programme within one week from receipt of programme by him.

1.3.2 The contractor shall provide six copies of all submissions for review / approval. One copy will be returned to the contractor with comments / approval.

1.3.3 The review period of pre-construction documents shall be as per conditions of contract.

1.3.4 After approval, the contractor shall submit to Engineer-in-Charge one tracing, soft copy of design & drawings and minimum six copies of all approved drawings with the date of approval marked. Depending requirement of use in the project the contractor shall provide additional copies as requested.

1.4 Approval of Designs and Drawings

- 1.4.1 EPC contractor shall ask manufacturer to submit the Quality Assurance Plan(QAP) for the equipment manufactured by them. The QAP will indicate clearly the tests to be carried out at manufacturer's works which will be as per I.S. and as specified in technical specifications of the tender documents. The QAP shall be approved by Employer. The Engineer-in-charge can depute third party inspector /consultant's representative / Client representative to witness the tests as per approval given for quality assurance Plan and technical specifications of the equipment given in the tender.
- 1.4.2 Approval from Engineer-in-Charge to the Contractor's design or drawings shall not relieve the contractor of any of his contractual obligations or liabilities under the Contract or his responsibilities for correctness of dimensions, materials of construction, weights, quantities, design details, assembly fits, performance particulars and conformity of the suppliers with the Indian statutory laws as may be applicable, nor does it limit the Engineer-in-Charge's rights under the Contract.
- 1.4.3 Should it be found at any time after approval has been given by Engineer-in-Charge that any designs, drawings or documents submitted by the contractor are not consistent with any design, drawings or documents submitted or approved previously or deviate from any major aspect of the Contract Document, then such alternations or additions as may be deemed necessary by the Engineer-in-Charge shall be made therein by the contractor and the works carried out accordingly for which no extra payment shall be made.
- 1.4.4 No revision shall be made by the contractor after design, drawings or documents are "approved" by the Engineer-in-Charge. In case the contractor desires to incorporate any minor amendments in the "approved" drawing, he shall resubmit the same for formal approval. Contractor shall not make any revision in design / drawings, which is not related to the comments conveyed by Engineer-in-Charge.
- 1.4.5 The design would have to be got approved from department & authorized agencies. All compliance of technical requirements is to be fulfilled.

1.5 Certificates

- 1.5.1 Where certificates are required by the Specification or relevant Reference standard, the original and one copy of each such certificate shall be provided by the Contractor.
- 1.5.2 Manufacturer's and supplier's test certificates shall be submitted as soon as the tests have been completed and in any case not less than seven calendar days prior to the time that the materials represented by such certificate are needed for incorporation into the Works.
- 1.5.3 Certificates of test carried out during the construction or on completion of parts of the Works shall be submitted within 7 days of the completion of the test.

1.6 Scheme Wise Instruction Manuals

- 1.6.1 The contractor shall submit to the Engineer-in-Charge prior to the delivery of all major items of Plant to Site, five copies of instructions appropriate to the erection, commissioning, testing, operation and maintenance of that item of plant. These instructions shall form a draft of the relevant parts of the Instruction Manual and their submission and approval by the Engineer-in-Charge shall be a condition precedent to the issue of a Taking over Certificate for that section of the Plant. During erection, commissioning and testing, draft instructions and associated diagrams shall be checked against the plant, and amended as necessary to relate accurately to the Plant as installed.
- 1.6.2 The manuals shall cover the setting to work, commissioning, testing, Operation and Maintenance of the works. The greatest importance is attached to completeness and clarity of presentation.
- 1.6.3 Information supplied by sub-Contractors and manufacturers employed by the contractor shall be co-ordinated into the comprehensive manual. The instruction manuals shall describe the installation as a whole and shall give a step-by-step procedure for any operation likely to be carried out during the life of each item of Plant, including erection, commissioning, testing, operating, maintaining, dismantling and repair.
- 1.6.4 Maintenance instructions shall include charts showing lubrication, checking, testing and replacement procedures to be carried out daily, weekly, monthly and at longer intervals to ensure trouble-free operation. Where applicable, fault location charts shall be included to facilitate tracing the cause of malfunction or breakdown.
- 1.6.5 A section dealing with procedures for ordering spares shall also be included in the manual.
- 1.6.6 Six draft copies of the manual shall be submitted to the Engineer-in-Charge prior to commissioning the works. Ten final copies of the amended and corrected manuals and drawings shall be provided by the contractor at the commencement of the Period of Maintenance.

1.7 Operating Instructions

The instructions shall be written in a simple language. Wherever possible, instructions shall be presented in a tabular form easy to understand.

1.7.1 General Instructions

- (a) List of Plant alarms, giving possible causes for alarm initiation and sequence of remedial actions to be taken.
- (b) Instructions on monitoring of Plant performance and sample log sheets for each plant item, to be filled by Operators on a routine basis.

- (c) Safety precautions to be taken in the handling of equipments, action to be taken in case of accidents, including first aid instructions.
- (d) Basic maintenance procedures such as flushing of pumps, cleaning of tanks after use and washing down of spillage.
- (e) Do's and don'ts in Plant operations. Operators' attention shall be drawn to all operations considered to be dangerous to operators or likely to cause damage to the Plant.
- (f) A detailed description of Plant start-up and shutdown procedures supported by Process and Instrumentation Drawings.
- (g) A detailed description of day to day Plant operation procedures.

1.7.2 Maintenance Instructions

A maintenance manual in four copies shall be provided as a supporting document to the equipment manufacturer's instructions.

(a) Maintenance Manual

- i) Checking, testing and replacement procedures to be carried out on all Mechanical and Electrical plant items on a daily, weekly and monthly basis or at longer intervals to ensure trouble free operations.
- ii) Fault location and remedy charts to facilitate tracing the cause of malfunctions or breakdown and correcting faults.
- iii) A complete list of recommended lubricants, oils and their charts.
- iv) A spares schedule which shall consist of a complete list of itemized spares for all Electrical and Mechanical items with ordering reference and part numbers.
- v) A complete list of manufacturer's instructions for operation and maintenance of all bought out equipment.
- vi) Preventive maintenance details.

(b) Manufacturer's Instructions

Manufacturer's instructions for Operation and Maintenance of all bought out equipments shall be provided. The instructions shall be supplied complete with Electrical / Mechanical drawings

CRITERIA FOR DESIGN OF CIVIL STRUCTURES

1.0 INTRODUCTION

This section forms the engineering design basis for structural design. The content of these documents is to form the guidelines for engineering design of Structures and to provide information about other disciplines concerned.

This is technical specification summarizes the concept and relevant IS codes (Latest Revision) to be followed for buildings and water retaining structures.

2.0 GEO-TECHNICAL INVESTIGATION

The contractor will be responsible for the geo-technical exploratory survey to obtain accurate information about soil condition at the site. The depth, thickness, extent, composition of each stratum and the depth of ground water shall be determined. Provide a geo-technical report based on survey data which includes boring logs, field and laboratory test results, interpretation of data, building foundation and earthwork recommendations.

3.0 BASIC ENGINEERING DATA: DATUM AND SITE LEVELS.

The Plinth Level of the Pump House and other Building and Electrical works shall be fixed depending on Local maximum flood level with a minimum Plinth Height above Finished Ground Level - 0.6m or otherwise specified

4.0 LIST OF DESIGN CODES AND STANDARDS

All designs shall be based on the latest International or Indian Standard (IS) Specifications or Codes of Practice. The design standards adopted shall follow the best engineering practice in the field based on any other international standard or specialist literature subject to such standard reference or extract of such literature in the English language being supplied to and approved by the Employer's Representative. In case of any variation or contradiction between the provision of the IS Standards or Code and the specifications given with the submitted tender document, the provision given in the Specification shall be followed.

Design of various structures shall be carried out as per Technical specification and relevant IS Codes (Latest Version). List given below is indicative. Appropriate Codes & Manuals can be followed subjected to approval of Chief Engineer.

(i) Foundation Engineering

IS 1080 : Design and construction of shallow foundation on soils.

IS 6403 : Determination of bearing capacity on shallow foundations.

IS 8009 : Part I & Part II Calculation of settlement of foundations.

IS 2974 : Code of practice for design and construction of machine foundations

(part1 to 4)

IS: 13301 : Guidelines for vibration isolation for machine foundations

(ii) Loading standard codes and Design Aids :

IS 456 - 2000 Code of Practice for plain and reinforced concrete

IS 875 - 1987 Code of Practice for design loads for buildings and structures

Part I – dead loads.

Part- II – Live loads.

Part III – Wind loads

Part V- Special Loads and Load combinations

IS 3370 - Code of Practice for concrete structures for the storage of liquids

Part-I - General Requirement (2009)

Part- II - Reinforced concrete structures (2009)

Part-III - Pre-stressed concrete structures (1967)

Part-IV - Design tables (1967)

IS 1893 - 2002 Criteria for earthquake resistant design of structures

IS 4326 - Earthquake design and construction of buildings - Code of Practice.

IS 13920 - Ductile detailing of Reinforced Concrete Structures subjected to
Seismic forces.

IS 1911 - Schedule of unit weights of building materials

(iii) Reinforcement

IS 1786 : High strength deformed steel bars

IS 2502 : Bending and fixing of bars for concrete reinforcement

IS 5525 : Recommendation for detailing of reinforcement in concrete works

(iv) Brickwork and Hollow block

IS – 1077 Common burnt clay building bricks

IS - 2212 Brick work

IS - 2185 Cement Concrete Block. Part- I , Part-II - Hollow cement concrete
blocks.

(v) Cement and Fine & Coarse Aggregates:

IS-455 Portland slag cement

IS-1489 Part 1 Portland Pozzolana Cement (PPC) fly ash based

IS-1489 Part 2 PPC Calcined clay based

IS-8112 43 grade Ordinary Portland Cement

IS-12330 Sulphate Resisting Portland Cement

IS-12269 53 grade ordinary Portland cement

IS-383 Coarse and Fine aggregate

(vi) All structural steel design shall generally conform to the following publications of the Indian Standards Institution:

I.S. 800 Code of Practice for general construction in steel

I.S.806 Code of Practice for use of steel tubes in general building construction

I.S. 807 Code Of Practice For Design, Manufacture, Erection And Testing

Structural Portion Of Cranes And Hosts

I.S. 808 Dimensions for hot rolled steel beam, column channel and angle section

I.S. 813 Scheme of symbols for welding

I.S. 816 Code of Practice for use of metal arc welding for general construction in mild steel

(vii) Miscellaneous

IS:1172 Code of basic requirements for water supply, drainage and sanitation

IS:1742 Code of Practice for building drainage

IS:3067 Code of Practice for general design details and preparatory works for damp proofing and water proofing of buildings

SP:16 Design Aids for reinforced concrete to IS:456

SP:20 Handbook on masonry design and construction

SP:22 Explanatory handbook on codes for earthquake engineering

SP:24 Explanatory handbook on Indian Standard Code of Practice for plain and reinforced concrete

SP:25 Handbook on causes and prevention of cracks in buildings

SP:31 Handbook of concrete reinforcement & detailing (SCIP)

IRC:37:2012 Guidelines for design of flexible pavements

IRC:73:1983 Geometric design of roads

5.0 METHOD OF ANALYSIS

The analysis for all structures (RCC as well as Steel Structures) is to be carried out by STAAD-pro or Employer's approved software and designs of the same for the worst/governing combination as per latest International or Indian Standards.

6.0 METHOD OF DESIGN

Design shall be done as per following:

RCC footings:	Limit state method of design
RCC columns:	Limit state method of design
RCC column in pumping station:	limit state method of design
& Water Retaining Structure	
RCC beams and slabs:	Limit state method of design
Retaining wall:	Working stress /Limit state method of design
RCC water retaining structures:	Working stress method of design
Steel Structures:	Limit State/Working Stress method of design

6.1 Also provide the seismic design calculation of R.C.C Water retaining structures as per IS:-1893 (Part II ,2014/latest Revision).

7.0 DESIGN BASIS

- a) Foundation shall be designed to carry all the loads from equipment or super structure, which they support in accordance with the relevant codes.

Net safe bearing capacity of soil shall be considered as per geo-technical report.

Type of foundation is to be decided based on above data and report.

- b) For buildings and structures: As per geo-technical report
- c) Allowable increase in soil bearing capacity in event of storm(wind) 25%, Earthquake 25%, factor of safety as per IS 1904 against overturning 1.5, Sliding 1.5, and buoyancy 1.2 unless otherwise higher values are specified in the latest code.

- d) As a general rule following features will be adopted, unless decided otherwise in a specific or exceptional case:
- e) Top of footing will be horizontal and flat/Trapezoidal as case.
- f) Minimum depth of footing is considered as per geotechnical report for various locations of the proposed structure.
- g) Foundation plinth for structural columns and equipment supports shall extend not less than 5 mm from the edge of base plate.
- h) The clear distance between a standard mild-steel anchor bolt or anchor sleeve and the face of the foundation shall be not less than 75 mm.
- i) Minimum thickness of lean concrete layer shall be 75 mm and shall extend 75 mm beyond the foundation edge.
- j) For heavier loads and restricted settlements pile foundation may be considered as an alternative as per IS 2911.
- k) Where ever columns are very near, pedestals of footing are considered combined to take care of unbalance loading. Sufficient reinforcement is provided to take care of unbalance load. Centre of footing and combined loading is to match to nullify eccentricity in load.
- l) Where stresses due to wind (or seismic) and temperature are combined with those due to other loads, the allowable stresses in concrete and reinforcement steel shall be increased by 33.33% in case of working stress design.
- m) All building shall have a minimum 1.0 m wide, 100 mm thick plinth protection paving in M15 grade concrete or stone slabs/tiles. All plinth protection shall be supported on well compacted strata.

DESIGN CONDITIONS FOR UNDERGROUND OR PARTLY UNDERGROUND LIQUID RETAINING STRUCTURES

All underground or partly underground liquid containing structures shall be designed for the following conditions:

- (i) Liquid depth to be considered up to full height of wall and no relief due to soil pressure from the other side to be considered.
- (ii) RCC water retaining structures like storage tanks shall be leak proof and designed as uncracked section.
- (iii) Structure empty condition (i.e., empty of liquid, any material, etc.) :full earth pressure with saturation and surcharge pressure wherever applicable, to be considered.

- (iv) Partition wall between dry sump and wet sump: to be designed for full liquid depth up to full height of wall.
- (v) Partition wall between two compartments: to be designed as one compartment empty and the other full for both the directions.
- (vi) Structures shall be designed for uplift in empty conditions with no live load with the water table indicated in the geotechnical report or high flood level, whichever is maximum. No reduction factor for the uplift forces shall be considered. Use of pressure relief valves to reduce uplift pressure due to ground water table shall not be allowed.
- (vii) Walls shall be designed under operating conditions to resist earthquake forces from earth pressure mobilization and dynamic water loads.
- (viii) Underground or partially underground structures shall also be checked against stresses developed due to any combination of full and empty compartments with appropriate ground/uplift pressures from below to base slab. A minimum factor of 1.2 shall be ensured against uplift or floatation and due to other loads shall be 1.5 unless otherwise higher values are specified in the latest codes.
- (ix) Soil bearing capacity is to be considered as per soil investigation report.

8.0 DESIGN LIFE

The design life of all structures and buildings shall be 60 years.

9.0 DESIGN LOADING

All buildings and structures shall be designed to resist the worst combination of the following loads / stresses under test and working conditions; these include dead load, live load, wind load, seismic load, Equipment load, Piping Anchor and Restraint loads, Crane, Monorail & Elevator loads, Earth Pressure load, Hydrostatic Pressure load, stresses due to temperature changes, shrinkage and creep in materials, dynamic loads, impact load and other specific loads.

a. Dead Load

This shall comprise all permanent construction including walls, floors, roofs, partitions, stairways, fixed service equipment and other items of machinery.

Openings (doors, windows, ventilators etc.) in the masonry are ignored.

i. Material Densities

(i) Weight of water	: 10.00kN/m ³
(ii) Weight of soil	: As per field test results
(iii) Weight of plain concrete	: 24.00 kN/m ³

(iv) Weight of reinforced concrete	: 25.00 kN/m ³
(v) Weight of brickwork (exclusive of plaster)	: 19 kN/m ³ per
(vi) Weight of plaster to masonry surface	: 18.00 N/m ² per mm thickness
(vii) Weight of granolithic terrazzo finish or. rendering screed, etc	: 24.00 N/m ² per mm thickness
(viii) Weight of Filling in Sunk Slab etc.	: 10 kN/m ³
(Ix) Weight of ceiling plaster 6/8 mm thick	: 20 kN/m ³
(x) Light weight concrete with aggregates	: 10 kN/m ³
(xi) Rubble Masonry	: 22.00 kN/m ³
(xii) Electrical Panel Load, Instrumentation Panel Load, Battery backup Load etc.	:As per Actual Panel Loads

ii. Slabs

Floor Finished on working floors	– 1.0 kN/m ²
Floor Finished on Terrace	– 1.0 kN/m ²

iii. Beams

Self weight/	: - Weight density x width x total depth
Brick masonry	: - Weight density x wall thickness x wall height

b. Live Load

Live loads shall be in general as per I.S. 875. However, the following minimum loads shall be considered in the design of structures:

(i) Live load on roofs (accessible)	: 1.50 kN/m ²
(Non-accessible)	: 0.75 kN/m ²
(ii) Live load on floors supporting Equipment such as pumps, blowers, Compressors, valves, etc or as required by equipment supplier whichever is greater.	: 10.00 kN/m ²
(iii) Live load on all other floors Walkways, stairways and platforms.	: 5.00 kN/m ²

- (iii) Live load on all residential floors : 3 KN/m²
- (iv) Live load on Toilets : 2.5 KN/m²

Live load reduction shall be in accordance with the provisions of IS: 875 and IS: 1893 in case of seismic analysis. In the absence of any suitable provisions for live loads in I.S. Codes or as given above for any particular type of floor or structure, assumptions made must receive the approval of owner prior to starting the design work. Apart from the specified live loads or any other load due to material stored, any other equipment load or possible overloading during maintenance or erection / construction shall be considered and shall be partial or full whichever causes the most critical condition.

c. Wind Load

Wind loads shall be as per I.S. 875.

In design of structures, wind force on equipments supported on frame including all fixtures, piping, staircases, ladders, handrails etc. shall also be considered.

d. Earthquake Load

This shall be computed as per I.S. 1893. An importance factor appropriate to the type of structure shall be considered for design of all the structures.

For all structures and buildings Response Spectrum Method of design shall be used. The importance factor for all buildings and structures shall be taken as 1.5

e. Dynamic Load

Dynamic loads due to working of items such as pumps, blowers, compressors, switch gears, travelling cranes, etc. shall be considered in the design of structures as per manufacturer's data.

f. Earth Pressure Load

Earth pressure for all underground structures shall be calculated using coefficients of earth pressure at rest or coefficient of active earth pressure (whichever is applicable). In addition to earth pressure a minimum surcharge load of 20 kN/sqm shall also be considered for the design of all underground structures or railway load (in case the railway track is located nearby) whichever is critical. The underground structures shall be subjected to sub surface water pressure. Calculations shall be based on the weight of the soil plus full hydrostatic pressure. The full upward pressure of water below base raft shall be taken over the entire area.

g. Hydrostatic Pressure Load

Ground water level for calculation of load shall be considered as indicted in the geotechnical report or high flood level whichever is maximum / at Finished Ground Level.

h. Impact Factor

Loads for cranes, hoists and elevators shall be taken as per IS: 875(Part 2). The minimum impact factors to be used in design shall be as follows:

i. Crane Loads

- a. For vertical force, an impact factor of 25% of the maximum static loads.
- b. A lateral crane surge of 10% of the weight of the crab plus lifted load applied at the top of crane rail acting on any one crane track rail. For frame analysis, this force shall be applied on one side of the frame at a time in either direction.
- c. A longitudinal surge of 5% of the maximum static wheel loads of the crane applied at the top of the rail.

j. Monorail Loads

- a. Impact factor of 10% of lifted load of hoist for monorail and support design
- b. Impact factor of 25% of lifted load for electrical pulley and support design.

k. Temperature Load

Expansion and contraction due to changes of temperature of materials of a structure shall be considered and adequate provisions shall be made for the effects produced (as per provision in relevant IS codes). Suitable expansion joints shall be provided in the longitudinal direction wherever necessary. The maximum distance of the expansion joint shall be as per the provisions of IS: 800 and IS: 456 for steel and concrete structures respectively.

Coefficient of thermal expansion of steel shall be taken as per IS: 800. Coefficient of thermal expansion for concrete shall be taken as per IS: 456.

l. Vibration Loads

Vibration Loads shall mean the vibration forces caused by heavy vibrating equipment or machinery and dynamic forces caused by fluids in the normal operation. Frames, structures and foundations for machinery or equipment causing vibration shall be designed to limit vibrations to an acceptable level. It shall be designed such that whether they are independent or part of the building, it shall not only safely carry the loads for such items but also prevent resonance. Natural frequencies of frames, structures and foundations must differ by more than 20% from that of the machinery under operating conditions. While carrying out dynamic analysis of foundations/structures supporting dynamically loaded equipments, the loads indicated by vendor in his documents shall be used.

m. Load Combination

Load combination for checking of bearing capacity of soil and design of steel structures (working stress)

- $DL + 1.0 LL$
- $DL \pm 1.0 WL (1.0 EQ)$
- $DL + 1.0 LL \pm 1.0 WL (1.0 EQ)$
- Load combination for design of RCC structures and Steel Structures (Limit state)
- $1.5DL + 1.5 LL$
- $1.5DL \pm 1.5WL (1.5 EQ)$
- $0.9DL + 1.5 WL/EQ$ shall be used for stability against overturning is critical.
- $1.2DL + 1.2 LL \pm 1.2 WL (1.2EQ)$
- Load combination for water retaining structures
- $1.0DL + 1.0LL$
- $1.0DL + 1.0 LL + 1.0$ uplift
- $1.0DL + 1.0LL + 1.0$ uplift + 1.0 Water load

Appropriate factor of live load shall be taken as per IS 1893 for seismic load calculation.

The load combinations giving the most critical conditions on foundations, structures or individual members shall be taken in to account.

10.0 RCC DETAILING**Minimum Cover to main Reinforcement**

The minimum clear cover to reinforcement in all R.C.C structures shall be as per IS: 456/IS: 3370 (Part –II), except as mentioned for following:

The following minimum clear cover shall be provided for RCC works.

- Slab (roof & floors, Canopies, chajjas, waist slab in stair etc.)	25 mm
- Beams, lintels	40 mm
- Grade beams	40 mm
- Columns, pedestals	40 mm

- Dry pits / retaining walls
 - i. Face in contact with earth - 50 mm
 - ii. Free face - 50 mm
- Water / Liquid retaining structures
 - i. Face in contact with liquid 50 mm
 - ii. Away from liquid but in contact with earth 50 mm
- Footing
 - i. Sides and top 50 mm
 - ii. Bottom 60 mm

Increased cover thickness may be provided when surfaces of concrete members are exposed to the action of harmful chemicals (as in case of concrete in contact with earth faces contaminated with such chemicals, acid vapour, saline atmosphere, sulphurous smoke (as in case of steam operated railways) etc. and such increase of cover may be between 15 mm and 40 mm beyond the figures given above as may be specified by the engineer-in-charge.

Concrete cover blocks of different and necessary sizes and shall use as and when required for providing the adequate and specified cover to the reinforcement. Such cover blocks shall be made so in advance and properly cured to take the load of reinforcement. Cement mortar blocks in CM (1:1) shall be used for making cover blocks.

Minimum diameter of bars

Main steel in foundation	:	10 mm
Main steel in column	:	12 mm
Main steel in beam	:	10 mm
Main steel in slab	:	8 mm
Stirrups & Ties	:	8 mm
Main steel in wall & Wall footing:		10 mm **
Main steel for water retaining structure:		10 mm **

** 8 mm, if requirement falls to minimum steel criteria

Minimum thickness of PCC

- 1) For all RCC building foundation : 75 mm Thick –M 15
And Trenches etc
- 2) For Brick masonry wall foundation : 100 mm Thick – M 15
- 3) For all water retaining structures : 100 mm Thick –M 15

Minimum percentage of steel

- 1) For buildings : As per IS 456-2000
 - 2) For liquid retaining structure : As per IS 3370: 2009 (Part-2)
- (For thickness more than or equal to 150 mm, reinforcement shall be provided on both faces)

11.0 MINIMUM THICKNESS OF STRUCTURAL MEMBERS

The following min. thickness shall be used for different reinforced concrete members
Irrespective of design thickness.

CIVIL MEMBER	WIDTH (mm)
Walls for liquid retaining structures	225
Roof slabs for liquid retaining structures	125
Bottom slabs for liquid retaining structures	225
Floor slabs including roof slabs, walkways canopy slabs	100
Walls of cables/pipe trenches, underground pits etc	125
Column footings	300
Parapets, chajja	100
Precast trench cover	75
Beam	230 (width) 300 (depth)

12.0 SPACING OF REINFORCEMENT

Minimum distance between two parallel main reinforcement bars shall placed as per Relevant Indian Standards (Latest Revision).

In locations where reinforcement is congested, grouping of bars by touching one another may be permitted provided the requirements of minimum horizontal distance as specified

above are complied with and provided further that development length is adequately increased.

13.0 RCC/PCC SPECIFICATIONS

Footings - M25 ($F_{ck} = 25 \text{ N/mm}^2$)- for buildings

Super structure – M25 ($F_{ck} = 25 \text{ N/mm}^2$)

Raft foundation – M-25 for water retaining structure

Water retaining structure – M 25 ($F_{ck} = 25 \text{ N/mm}^2$)

Slabs – M-25 ($F_{ck} = 25 \text{ N/mm}^2$)]

PCC for column footings – As per tender specification

PCC for wall footings and plinth beams – As per tender specification

Reinforced steel high yield strength deformed (HYSD bars /TMT Bars)

14.0 JOINTS

Movement joints such as expansion joints, complete contraction joints, partial contraction joints and sliding joints shall be provided and designed to suit the structure as per relevant IS specification. However, contraction joints shall be provided at specified locations spaced not more than 7.5 m in both right angle directions for all walls and rafts. Expansion joints of suitable gap at suitable intervals not more than 30 m shall be provided in all walls, floors and roof slabs of water retaining structures. Construction joints shall be provided at right angles to the general direction of the member. The locations of construction joints shall be decided on convenience of construction. To avoid segregation of concrete in walls, horizontal construction joints are normally to be provided at every 2-m height. PVC water stops of 150 mm width shall be used for walls and 230 mm width for base slabs. Alternatively contractor can use G.I. Sheets of 18 gauge and 200 mm wide. Expansion joints for non-liquid retaining structures shall be provided as per IS 3414. Expansion joint if required shall be furnished in detail drawings.

15.0 NOMINAL STRIPPING TIME (Based on IS 456)

In case when the cube strength at seven days are found to be low or in the cases when other cements are used, stripping time and removal of props may have to be extended. In normal circumstances, (generally where temperatures are above 20°C) and where ordinary Portland cement is used, forms may generally be removed after expiry of following periods:

	Type of Formwork	Minimum period before striking formwork
a)	Vertical formwork to columns, walls, beams,	3 days
b)	Soffit formwork to slabs (Props to be re-fixed immediately after removal of formwork)	18-24 days
c)	Soffit formwork to beams (Props to be re-fixed immediately after removal of formwork)	7 days
d)	Props to slabs:	
	I. Spanning up to 4.5 mt.	7 days
	II. Spanning over 4.5 mt.	14 days
e)	Props to beams and arches:	
	I. Spanning up to 6 mt.	14 days
	II. Spanning over 6 mt.	21 days

16.0 CURING OF DIFFERENT ITEMS

During construction, curing shall be carried out especially from 7.00 AM to &. 7.0 P.M even on holidays with proper manpower, necessary pumps and pipe lines, connections etc.

Exposed surfaces of concrete shall be kept continuously in a damp or wet condition by poundings or by covering with a layer of sacking, canvas, Hessians or similar material and kept constantly wet for at least 14days from the date of placing concrete in case of OPC and at least 10 days where mineral admixtures or blended cements are used. The period of curing shall not be less than 21 days for concrete exposed to dry and hot weather conditions and where mineral admixtures or blended cements are used. For the concrete containing PPC or Portland slag cement, period of curing may be increased. For, other items the curing shall be done as follows or as directed by the engineer-in-charge.

a)	Brickwork- at least for	-	10 days
b)	Plaster work	—	at least for 7 days
c)	Sand faced plaster	—	at least for 15 days
d)	Tiles or stone flooring and dado	-	at least for 10 days.

17.0 Special Consideration for Steel Structures**a. Steel Stairs**

All steel staircase shall normally clear width (back to back of stringer) of 1000 mm and maximum inclination with horizontal of 35°75'. However, in case of space restriction, minimum clear width up to 750 mm and slope up to 45° may be provided with prior approval.

The vertical height between successive landings shall not be exceed 2.75m. Channels (min. MC150) shall be provided as stair stringers. Treads shall be minimum 250 mm wide made of chequered plate / grating, with suitable nosing, and spaced equally so as to restrict the rise to maximum 180 mm.

b. Steel Ladders

Ladders shall be provided to platforms, walkways, instruments and equipments that do not require frequent access. Ladders shall preferably be vertical and its angle with vertical shall not exceed 5°. Ladders shall be minimum 450 mm clear width with 20 mm dia. MS rungs spaced at 300 mm (maximum)

Ladders of more than 4.5 m height shall be provided with safety cage. However safety cages to start at 2.5 m above the lower landing level.

c. Platforms and Walkways

All steel platforms above grade shall be constructed with kick plates at edge of platform to prevent tools or materials from falling off. It shall consist of 8 mm thick steel plate projecting 100 mm above the platform surface. Kick plate shall be painted with the same type of coating as the material to which it is attached.

d. Special Consideration for Brick / Stone Masonry

All Masonry works shall be designed in accordance with IS: 1597, IS: 1905, IS: 2212, IS: 4326 and other relevant IS codes as applicable. Structural design of Brick / Block Masonry shall be in accordance with criteria specified by section 4 of National Building Code of India Part IV.

All Masonry walls for buildings shall be raised on plinth beams.

Bricks shall be of minimum compressive strength of 50 kg/sq.cm conforming to IS: 1077. Brick masonry shall generally be in cement mortar 1:6 (1 cement : 6 sand). However, 115 mm thick masonry shall be constructed in cement mortar 1:4 with 2 nos. of 6 mm dia. Reinforcement provided after every fourth layer.

e. Grouting

Non-shrink flowable grout shall be used for under pinning work below base plate of columns.

Non-shrink cum plasticizer admixture shall be added in the grout. For grouting of base of machine foundation high strength ready mixed non-shrink flowable grout shall be used.

Crushing strength of the grout shall generally be one grade higher than the base Concrete.

Minimum grade of grout shall be M 25.

Nominal thickness of grouting shall be at least 50mm for columns and pedestals of major equipment. For secondary posts, stair and ladder base, etc. grouting shall not be less than 25mm thick.

18.0 Soil Bearing Capacity

The contractor has to assess soil bearing capacity for all works at his own cost and design the structures on the basis of data received after investigation. The soil investigation report has to be submitted to Department.

19.0 Filtration System

The contractor has to assess the size of the particle in the raw water and size of the maximum particle allow for Micro Irrigation System to be adopted at later stage. The design standard of the Primary as well as Secondary filtration system should be as per IS or general practice.

SECTION – II
SURVEY, INVESTIGATION, PLANNING,
DESIGN AND DRAWING

SECTION – II

SURVEY, INVESTIGATION, PLANNING, DESIGN AND DRAWING

INDEX

Sl. No.	Particulars	Page No.
1	A. SURVEY, INVESTIGATION, PLANNING, DESIGN AND DRAWING	1
2	B. LAND ACQUISITION	19

SECTION – II**A. SURVEY, INVESTIGATION, PLANNING, DESIGN AND DRAWING****1.0 DEFINITIONS:**

Definitions of most of the terms used in the Contract document are as follows:-

- A. **RISING MAIN:** Main pipe line taking off from the Pump house for carrying water to the delivery chamber (optional). If delivery chamber is not provided, then the Rising Main should be considered upto the last off taking of Minor.
- B. **PRESSURE MAIN:** Equivalent to Rising main taking off from the pump house for carrying water till the last offtaking of Minor.
- C. **GRAVITY MAIN:** Main pipeline or pipelines take off from intake or Delivery chamber (optional) or Ridge of Rising main/Pressure main which follows positive gradient and carries gravity flow for distribution of water. The gravity Main should end at the last offtaking of Minor.
- D. **CONVEYANCE SYSTEM :**
 - a. **Distributaries:** All pipelines taking off from Rising main/Pressure mains or delivery chamber (optional) for conveying water to Minor.
 - b. **Minors and sub-minors:** Consisting of minors serving an area of about 200 to 500 Ha off taking from Rising main/Pressure main/distributaries and sub minors off taking from Distributaries/minors.
 - c. **Field pipeline:** Water distribution system beyond minor and sub minor Outlet upto end use i.e. Sub Chak (1 Ha)
- E. **Culturable Command Area (CCA)**

For Design purpose:

The Culturable Command area for design purpose will be the area of the village/villages that can be irrigated, worked out from Revenue Record after deducting (i) Un-commandable higher lands, (ii) Pastures, (iii) fallow land iv) Gochar, v) cremation ground vi) roads, vii) devasthanam and (vi) abadi area.

Chak:

It is a sub division of C.C.A. typically about 20 Ha in size. The area can be vary upto 20% as per Chak boundary condition. The outlet point is preferably expected to be on middle area within a chak. Sub Chak is the sub division of the Chak about 1 ha in size. The last outlet point should be such that two sub Chak can be served at one location. The size of the Branch Field pipe and distribution pipe along with field pipe upto 1 Ha should be sufficient to convey the minimum discharge of 6.0 lps. The Velocity should be within the permissible limit as per guideline and IS as applicable..

- 1.1** The above definitions are only for guidelines and the Contractor is at liberty to use and incorporate latest technology for regulating piped flow for irrigation.

2.0 SCOPE OF WORK :

- 2.1** The scope of work to be carried out for **each of the Lift Irrigation Schemes** under the cluster shall be as under :-

- 2.1.1** Construction of Permanent Bench Marks.

- 2.1.2** Conduct hydrology study(Yield & flood) at the intake location for estimating water availability for kharif crop, scour depth computation, HFL and normal flood levels.

- 2.1.3** Survey work for block contouring at 50 cm intervals on the revenue village maps, planning, design and estimate of each Lift Irrigation Schemes under the cluster having components of Intake Works, Pump House, Rising main/Pressure main, Delivery chamber(optional) associated appurtenant including its distribution net work down to 1 Ha chak. Survey work will be used for preparation of land acquisition cases, Water User's Association formation proposal, operation and maintenance manual.

- 2.1.4** Preparing a General Arrangement Plan for each scheme with Planning of Rising main/Pressure main and furnishing most economical and feasible diameter & alignments proposal with alternative survey wherever necessary should be conducted. After getting approval of the alignment from the competent project authorities contractor has to take up survey & investigation of distributaries, minors & sub-minors etc. up to outlet point, preparing & obtaining approval for the most economical and feasible alignment from the competent project authority and furnish the following details :

- A.** Kilometer wise L-section and design statements of Rising main/Pressure mains with apex details, location of CD works, detailed designs of curves, part village map showing the alignment of that KM, cross sections at 150 M. interval on alignment for complete Rising main/Pressure mains on village maps. Distributary /Sub Distributary/Minor alignment map with apex details, kilometer wise L-section, location of control works, detailed designs of curves, cross sections at 90 M. interval on alignment. Complete distributary, minors and sub-minors network on revenue village maps indicating bearing of the centre line of pipe line with reference to boundary stones of survey numbers.

Detailed topographical survey including contour mapping of the command area on revenue village maps with contour at 50 cm interval including details of chak wise and distributary/minor wise irrigable area and planning of complete distribution system with outlet details.

Final location survey including marking of pipe line alignment on revenue village maps with contours at 50 cm intervals, showing of B.M etc.

Preparation of land acquisition cases in required proforma and sketch on revenue village maps as per Odisha Land Acquisition Act.

B. Details to be surveyed

The objective of the survey is to provide sufficient detail to enable the design of the whole LI schemes including the irrigation distribution networks. The survey shall include, but not be limited to the following:

- I. Establishment of a network of triangulated control points incorporating benchmarks or with a separate system of benchmarks. Existing monuments should be used wherever possible and their accuracy confirmed. In addition, where control point or benchmarks are not available, new points are to be established at the head of each Distributary, Minor and Sub-minor. Where the distance between these points exceeds 2.0 Km, intermediate point are to be established.
 - II. Pucca, kacha and all other motorable roads and accesses including bridges and railways.
 - III. Principal footpaths and foot bridges.
 - IV. Location, invert level and principal dimensions of all irrigation off-takes, cross drainage structures, regulators etc. whether temporary or permanent for existing irrigation work within the command area.
 - V. Location and type of all tube wells and open wells, village hand pumps etc.
 - VI. Village boundaries (tri-junction marker pillars) where these are located on the ground. Due note of the village name within each boundary shall also be made.
 - VII. Services and utilities including electricity, water supply, sewerage, cable etc. and their supporting high tension poles or posts:
 - VIII. Drainage courses including nallas, ditches, check dams or any other structures on drainage courses etc;
 - IX. Raised field boundaries or any other such points that cannot be used in the Digital Terrain Model for contour generation unless they are at a level that represents the prevailing ground surface.
 - X. Water bodies including rivers, lakes, tanks and ponds, rock outcrops borrow pits and quarries forestry (protected, reserved, preserved, private or otherwise) other significant ground cover where cultivation cannot take place.
- C.** After getting approval to the alignment from the project authorities, the contractor has to fix the chainage stone at 150m interval along alignment on central line and apex stones at every deviation of alignment duly indicating apex No .and chainage. The chainage stones and apex stones shall be of size 20x20x75 cms. Projection of the stone above ground level will be 25cms.
- D.** Permanent Bench marks with values should be furnished on site. The permanent bench mark (PBM) shall have to be established by the contractor at the Pump House along the Rising main/Pressure main, delivery chamber(optional)s, along distributaries & minors in

command area in the cluster by double leveling and cross checking. Their location shall however be decided in consultation with the project authorities.

For Power System Connectivity

- E. For Planning & development of suitable system connectivity for all the Lift Irrigation schemes from the Local Grid. The contractor shall conduct Preliminary route survey, finalization of route alignment, detailed survey, structure (tower/pole) spotting, geo-technical investigation, optimization of structure location and check survey in respect of overhead lines. On approval of the route alignment, Design, selection and installation of foundation for structures, poles for single/double circuit over head lines. The design, testing, supply and erection methodology of 33kV, HT (6.6 KV) & LT single/double circuit support structures (low based tower structure/M.S rail pole/RS Joist/ H poles/PSC poles), associated cross arms, nuts, bolts & washers, D-shackles, support stays and accessories like danger plates, anti-climbing devices, structure identification plate and earthing devices.
 - F. Planning & Design of conductors, insulators, insulator hardware, earth wire, joints, clamps for conductors, earth wire clamps and accessories including stringing;
 - G. Design of special structures/towers including design and construction of foundations for crossings like Railways, Rivers, power lines etc; the slack span connections of conductors from terminal structures to the sub-station gantry structure at Transmission and/or Distribution licensees interface (i.e. point of supply).
 - H. Planning, design of MSDSS (33/6.6 kV), Distribution sub-station (6.6 /0.415kV or 33/0.415kV) for power requirement. and all related “Consumer Installation” including EMS with appropriate instrumentation and operation & maintenance of the installation for a specified period as detailed in the bid document.
- 2.1.5 **Furnishing alignment proposal:** DISNET planning should be designed such that energy consumption is minimised. Apart from kilometer wise L-section of Rising main/Pressure main, distributary, minors and sub-minors, contractor has to furnish the detailed network of the distribution system on revenue village maps with contours of 0.50 m. intervals, showing distributaries/ Minors/Lateral outlets and sub blocks with ROR details. A Command Area Information Data Base showing the village map Number with irrigable area, names of beneficiaries etc in each Chak should be furnished.
- 2.1.6 **Design and drawing of Rising main/Pressure main** (If delivery chamber is not provided, then the Rising Main should be consider upto the last off taking of Minor.) **and related works:** Design of Rising main/Pressure mains, economical diameter and all components should be as per IS, CPHEEO, MOST/ Departmental and other prevalent norms. Contractor has to prepare and get approved Longitudinal Sections, Design Statement of Rising main/Pressure mains and main distributary and minors of entire package length of each scheme which should be furnished duly considering losses including head losses. Cut off statement should be reach-wise and should indicate gross command area and irrigable command of the blocks coming under the reach, designed discharge, discharge required, roughness coefficients with respect to type of pipe selected. Distribution net work should be designed for the reaches

shown in the cut off statement and got approved from the competent authority. For design of head work, detailed hydraulic calculations, water thrust etc., should be analysed, suitable water hammer reducing majors and devices to be designed and transition curves and smooth joints should be designed and got approved.

- 2.1.7 **Preparation of Schedule of quantities: Estimate and Schedule** of quantities should be furnished separately for entire project. Item of work should be in accordance with the **specification and rates** mentioned in the current “Schedule of rates” of the state of Odisha and prevailing market rates for non-scheduled items supported by rate analysis and quotations from manufactures of selected material. The detailed estimates in triplicates sets and also in soft copy which shall include detailed report, estimates and detail survey sheets. The same shall be approved by the CE, Megalift.

3.0 CONSTRUCTION OF BENCHMARK STRUCTURES AS PER SPECIFICATION :

- 3.1 The contractor will collect the details of Survey of India bench marks in the area. With this as a datum additional net-work of Temporary Bench Marks (TBMs) shall have to be established by the Contractor on an average not more than 1 No/100 ha of C.C.A. by double leveling and cross checking. Their locations shall however be decided in consultation with department. Contractor shall fix temporary bench mark preferably on permanent structures in the command area. Values of such bench marks shall be fixed with reference to the Permanent Bench Mark established by SOI as indicated by the Engineer-in-Charge. The representatives of the Engineer-in-Charge not below the rank of Assistant Engineer shall remain present and check the survey while establishing the temporary bench marks and permanent bench marks.

A proper system shall be evolved for numbering the TBMs as directed by Engineer-in-Charge. A plan to a scale of 1:15000 indicating location and levels of all PBMs established in the command area shall be prepared and submitted to the Department.

3.2 Construction of Permanent Bench Marks (PBMs):

The PBMs shall be constructed at location as may be directed by Engineer-in-Charge. This should be located preferably at one corner of the field or field boundary, Govt./no man's land which will not hamper the agricultural operations or as instructed by the Engineer-in-Charge. A 10 mm dia anchor about 300 mm in length with steel plate 120 x 120 x 6 mm. Shall be embedded in the concrete, and the top of the steel plate shall be 100 mm below the top level of concrete and truly horizontal. The level of PBM shall be established on top of steel plate. Adequate care shall be taken by the Contractor for curing the concrete laid for the PBMs. The PBMs shall be numbered in oil paint for identification. Where black cotton soil is met with the foundation will have to be taken to extra depth and filled with M-10 c.c. & standard size bench marks shall be constructed over this.

4.0 FIELD TO FIELD SURVEY FOR BLOCK CONTOURING WITH CONTOURS at 50 cm INTERVAL AND PREPARATION OF VILLAGE MAPS SHOWING CONTOURS AND FIELD DETAILS :

For plotting contours at 50cm intervals, ground levels must be taken for each survey number covering all corners and the centre of the fields with spot levels at every 50 m intervals and

reading shall be taken up to 5mm accuracy. Additional spot levels shall be taken on roads, nalla, drain, railway etc. The leveling staff should be placed in the field and not on the field bunds as to represent the local topography. The levels must be taken at point in the field shall also be marked on the village sheet. Additional spot levels must be taken at points that appear abnormally higher or lower than the general elevations of the plot so that the ridge and valley lines can be marked and ascertained. For drawing valley lines, the levels of the bottom of the nalla must be taken. All Kachha and Pucca roads, ditches, well, house, railway lines, high tension lines, electric poles, telephone poles, nalla, irrigation pipe lines, and all other prominent features etc. shall be shown on the map. The reduced levels shall be marked on village map at the corners of each field and additional spots as taken. Thereafter contours shall be marked in broken lines and full meter contours shall be marked with continuous full line. Concurrent checking of survey, investigation etc, shall be done by the departmental officer posted at work site. At least ten percent field levels shall be got checked by the Engineer-in-Charge.

The leveling work should commence from the permanent Bench Marks, whose value is known. The BMs shall be constructed as per standard specifications. All the BMs shall be connected by double leveling accurately. Every day's work shall be closed on any one of the bench mark mentioned above and the accuracy of the day's work checked by Engineer's representative present throughout the activity. The contour map is to be prepared in the same scale of village maps and plotted on them.

4.1 Contouring

All relevant topographical survey data shall be incorporated in the Digital Terrain Model (DTM) using GIS applications. The contractor shall take sufficient spot heights to ensure adequate generation of contours at 0.50m interval and as done as per guidelines provided in SOI publication "MAP EDUCATION" 1993 for generation of final product or using appropriate acceptable computer software. Complete mosaic of the whole command area shall also be prepared and supplied in appropriate contour interval.

4.2 Survey Accuracies

a) General

The Contractor will be required to ensure the various minimum levels of accuracy outlined below until such time as he can demonstrate supplemented with codal provisions or in vogue with examples to the satisfaction of Engineer-in-charge in the best interest of the work and these variation of accuracies should be at no additional cost to the Employer.

b) Control Points

In the case of triangulated control points and traverse work, maximum closure accuracies are to be better than 1:25,000 in plan of the distance traversed and 15 mm per kilometer vertically. All angles are to be measured to the nearest 1 second and all distances are to be measured to the nearest millimeter, Co-ordinate pairs for control points are to be reported to the nearest millimeter.

4.3 Co-ordinate System

A local grid system, based on the SOI projection, shall be established for each distribution network such that all co-ordinates within the scheme are positive. This shall be agreed with the Contractor at the start of the Contract and linked to the Survey of India (SOI) grid where suitable coordinated control points are identified and the Contractor advised of the corresponding offsets. Where applicable, suitable azimuth control will be applied and the methodology adopted outlined in the report. The geographic information or geographical information system (GIS) software should be used for preparation all maps, plans and depiction of topography. Modern GIS technologies rely on digital information, for which there are a number of collection methods. The most common method of data creation is digitalization, where a hardcopy map or survey plan is transferred into a digital medium through the use of a CAD program, and geo referencing capabilities.

4.4 Satellite Imagery

Satellite imagery of 0.8 m or higher resolution from NRSA, Hyderabad, covering the complete project area is to be procured as part of the Contract. The imagery shall be cloud free and of the Rabi/Kharif 2010-11 period such that field boundaries are clearly distinguishable. The imagery is to provide a crosscheck of the location of existing major infrastructure and where relevant, field boundaries. The imagery is to be procured in hard copy and in digital format as well. This imagery will become the property of the Employer at the completion of the Works.

4.5 Collection, Storage and Processing of Field Data

All field measurements together with their relevant field codes are to be automatically stored in electronic data-loggers either within the field instrument or attached to field instruments and downloaded from storage remotely or directly to computer for processing. Recording by hand and transcription of field data is not considered appropriate for this project given the time frame available and will not be permitted. GIS application should be used.

5.0 Surveying, Planning, Designing and estimation including preparing land plans and schedules for land acquisition and also collecting data of roads and cart tracks in the command area for

5.1 Distribution network

i) Marking alignment on SOI Maps:

Besides marking the Intake works, pump house of each scheme, the alignment of Rising main/Pressure main, (If delivery chamber is not provided, then the Rising Main should be consider upto the last off taking of Minor.)distributaries are to be marked and boundary of block for which the contractor is required to plan, design and estimate distribution network shall be indicated on The Survey of India Maps to a scale of 1:50000/1:10000 with contours

a) Rising main/Pressure main, Delivery chamber (optional) & distributaries

Following broad principle shall be followed while fixing the initial alignment

- i. On the contour map valley lines and ridge lines should be marked.
- ii. The alignment of the Rising main/Pressure main & distributary should be marked so as to command maximum possible area.
- iii. The alignment shall be straight as far as feasible. Smooth curves shall be provided where necessary to minimize head loss.
- iv. Alignment should be away from village site by about 50 m.
- v. Major crossing of railways, roads and drains should preferably be at right angles;
- vi. Have minimum number of road or cross drainage works.
- vii. Permanent structures such as wells/tube wells, house etc. should as far as feasible be kept away from alignment.
- viii. The Delivery chamber (optional) shall be as far as possible in wasteland/Govt. lands.
- ix. Delivery chamber (DC) shall be provided on the basis of topography and design philosophy. However DC is not mandatory.

Automated Primary Filtration System at Pumping Station (multi at other location if necessary) shall be provided. Necessary provisional arrangements shall be made in Distribution network at 20 Ha. Chak towards installation of Secondary filtration unit for future requirement.

b) Culturable Command Area Planning:

After marking the alignment of the Rising main/Pressure main (If delivery chamber is not provided, then the Rising Main should be consider upto the last off taking of Minor.) and distributary As it is a pipe line system CCA will be on both sides of it. Spread of a CCA will be between the pipe line and the drainage line and should, as far as possible, be limited to revenue boundary of a village. In cases where a village is divided by the distributary and if the sub divided areas of village are large enough there will be two CCA and if the areas are small they should be clubbed with adjoining CCA. The byelaws governing the formation of Water Use Association (WUA) shall be kept in mind while delineating CCA.

c) Minors and Sub- Minors:

A minor is a pipeline off-taking from the distributary or Rising main/Pressure main. It serves generally command area of typically about 200-500 ha. In a few cases where distance between Rising main/Pressure main and the command boundary is less, a minor can serve more than one village with the upper limit of command area raised to about 1000 ha. A minor shall off-take from the Rising main/Pressure main or distributary at the highest level in the CCA. All the principles listed for fixing alignment of a distributary shall be followed. If the command area of a village as intercepted by a drain or a railway line or a major road, it may be necessary to take out a sub minor to serve the command on the other side

All the exercises mentioned at (a) (b) & (c) above shall be carried out jointly by the Department officers or their authorized PM consultants and the contractor.

ii) Reconnaissance survey:

After fixing the alignment of Rising main/Pressure main, distributaries and minors on SOI Sheet the contractor shall carry out reconnaissance survey in field to verify that the ground features as shown on plan tally with actual as existing on site. Any variation as a result of subsequent events such as development of brick kilns, new artificial drains, roads, pipe lines, transmission lines, railway lines, wells, buildings or farm houses etc shall be noted and alternation in the alignment fixed earlier may be done after Engineer-in-charge visiting the site. On the basis of the levels available either from SOI sheet or at corners of fields, if taken, a line diagram shall be prepared to determine exit water head required at chak head, CCA head and the distributary head. During reconnaissance survey special attention shall be given to ascertain that the drainage lines marked on map on the basis of contours do actually exist on site. This can be done by local inquiry and site observations. If any variation is noticed the chak boundaries should be refixed.

5.2 Minor/Sub-Minor pipelines:**A- chak planning:**

These shall be generally aligned along field boundaries. After fixing the alignment of sub minor with consideration of formation of WUA, the contractor shall carryout reconnaissance survey in field to verify if the features on the plan tally with actual ground conditions and structures such as tube wells, houses, gharbadi plots etc. are not located along the alignment fixed. The location of the outlet, command area having each point for every field shall also be verified on the field to confirm that the 20 Ha chak outlet with little variation about 10% shall be proposed preferably at the middle point in the Chak. In the same way the last outletting point (at two ha level) should be as far as possible in the middle reach of the common boundary between two sub Chak so that the friction losses in MIS shall be minimum. The Engineer-in-charge shall examine the layout, have discussion with the contractors and if necessary, visit the site jointly and suggest alternatives regarding adjustment of sub-chaks, drainage layout etc.

Chak outlets shall be provided inside the designated CCA. The outlet management system (OMS) including SCADA Central control unit has to be provided in PLC room of pump house.

5.3 After observing these formalities layout may be considered as approved by the department and the contractor shall proceed with detailed survey according to the specifications.

5.4 Final layout:

5.4.1 **After approval** of the preliminary layout as provided under 5.3 above, the contractor shall proceed with the work of field to field surveys for taking longitudinal sections of the alignments, collecting the field data for the approved pattern.

5.4.2 The survey work should commence from an established TBM and end on established

TBM only at the end of the day's work. The closing error should not exceed the permissible limit.

- 5.4.3 Levels shall be taken at 30 m interval for all L-Section covering apexes, lowest point of depressions, highest point of ridges and turnout. However, Contractors are responsible to locate all turnouts/outlets at the highest possible locations to serve the maximum possible command. Apex locations shall be fixed by giving location sketches with reference to the survey Nos/Block No. boundaries of fields. Contractor shall demarcate the apexes, tangent points and turnout point locations of the distributaries, minors & sub minors, and demarcate the apices on sub minors and branch sub minors by excavating a pit of size 60 cm x 60 cm x 60 cm which shall be shown to the Department authority at the time of inspection. On approval by department the Contractor shall arrange to construct the reference Pillars of size 15cm x 15cm x 75cm.

The contractor shall submit final layout prepared as stated above to the Engineer-in- Charge for approval. The Engineer-in-charge shall scrutinize the proposal and convey his observations to the contractor within fifteen days. The contractor shall promptly comply with the remarks and/or if necessary discuss the proposal made by him with the Engineer-in-charge and sort out differences. The Engineer-in-charge shall convey the final approval within one month.

- 5.4.4 Checking of works done by contractor :

The department officer posted at works site shall concurrently check the work of transfer of PBM and TBM surveying & leveling by arithmetical checking plotting of survey work on village map checking of contours, pipe line alignment marked on village maps & verifying same actually at site also.

6.0 DESIGNS AND PREPARATION OF PLANS & ESTIMATES:

After receiving approval to the final layout, the contractor shall proceed with the task of preparing final designs of Intake Works, Pump House and appurtenances, Rising main/Pressure mains, delivery chamber(optional)s and distribution system, its detailed designs, fixing permanent bench marks along the alignment of intake works, pumping station, Rising main/Pressure main, delivery chamber(optional)(optional), distributaries and minors and preparation of plans and estimation of the complete system.

All system shall be designed using relevant IS codes and prevalent practices. Contractor shall also furnish details of land to be used for Rising main/Pressure main distributaries, minors, sub minors, and drainage lines in prescribed format after marking land width and curves on village plans. Contractor shall construct and establish permanent bench marks at the rate of no less than one nos. per five KM grid and temporary bench marks on average not more than one no per 100 Ha of CCA along the approved alignment of Rising main/Pressure main, distributaries and minors. EPC contractor shall furnish Bill of Quantities within 30 days of approval of detail drawing and design.

7.0 DETAILED DESIGN OF THE SYSTEM

The system is to be designed in such a way that the Filtration System should be at the start of the Rising Main within the Pumping site. The network should be designed in such a way that it can be capable for operating in conventional practice of gravity application of water beyond 1.0 ha Sub Chak level up to field as well as applicable by Micro Irrigation System at

latter stage. The network has to be designed for ultimate requirement as per Micro Irrigation System with 0.6 lps per Ha (Over Design Factor of 5% extra above 0.6 lps/Ha shall be considered while designing) with 16m residual head at 1 Ha Sub Chak level. The same network has to be checked for initial stage requirement of 0.75 lps per Ha with minimum 2.0m residual head at 1.0 ha Sub Chak level. For this, necessary modification if required should be taken while finalisation of distribution networks. The Head losses in the primary automated filtration as well as secondary manual filtration system should be taken in to consideration while finalisation of pipe network as well as Pumping and Motor finalisation for ultimate system. However, total system shall be compatible with plug-in Micro irrigation attachments and operation.

BASIC DELIVERY CAPACITIES:

The designed duty shall be 0.6 lps/Ha for the design hydraulics up to 1.0 Ha Sub Chak level with minimum residual Head of 16 Mt. Minimum discharge capacity should be 6 lps for 1 Ha. Sub chak. Over Design Factor of 5 % extra above 0.6 lps/Ha shall be considered while designing. The rotational Irrigation is allowed only within the 20 Ha. Chak for 1 Ha. Sub Chak. Minimum pipe dia should not be less than 110mm.

CONVEYANCE LOSSES:

The conveyance losses for underground pipeline system shall be taken as per Indian standards/any approved guidelines. Additional flow requirement for compensation of conveyance water losses of 5 % with pipe network.

Designed Exit gradient & Velocity:-

The complete irrigation system consists of underground pipeline system and the undulating topography & soil type should be considered for micro irrigation. The velocity in pipelines and exit gradient at outlets are to be kept as per the following criteria.

- Minimum residual head of 16.0 m at the end of field pipe ie network upto 1 Ha Sub Chak.

Velocity for maximum about 1.8 m/sec and minimum 0.6 m/sec in hydraulic calculation for M.S/D.I/HDPE pipes as per Standard practice.

SERVICE AREA:

The size of Sub Chak shall generally be about 1 Ha. The entire command of the project will be subdivided into service area of about 200 to 500 ha which will be the basic unit for allocation of water to the WUAs. The service area would be combined to limits of a single village. The contractor is required to study Pani Panchayat Act of Odisha and study the local habits and suggest model operational plan to be implemented or to be enforced for safety of project and smooth functioning of the system. Each chak should be controlled by outlets as per the operational plan.

8.0 SURVEYING, COLLECTING, PLOTTING, PREPARING DESIGNS DRAWINGS AND ESTIMATES OF STRUCTURES FOR IF ANY AS PER APPROVED PLANNING AND DESIGN

- a. Intake Works
 - b. Pump house Design of pumps and electrical accessories, Automated Filtration System.
 - c. Rising main/Pressure mains
 - d. Delivery chamber(optional)
 - e. Distributaries
 - f. Minors and sub-minors
 - g. All related components detailed under the power system connectivity
- 8.1 The contractor is expected to take at least 1 trial pit of 1.5 m x 1.5 m x 2 m deep below pipe lying level or GL whichever is lower or up to hard rock level only at each of the structure on distributaries & minors. The Engineer-in-charge shall check and certify the classification of the type of strata of trial pits before acceptance of final report submitted by the contractor.
- 8.2 For the structures on Rising main/Pressure main and distributaries, the contractor shall carry out the survey over sufficient area by taking levels at 3x3 m interval in either direction. The contractor shall also plot L-Sec along the centre line for a length of 200 m & plot cross sections at the centre and at the end points of the L-Sec. In case of structures on minors similar grid shall be prepared over sufficient area by taking levels at 3x3 m interval in either direction. L-Section shall be plotted along the centre line and cross sections shall be plotted at the centre and either end of the L-Section.
- (a) The necessity, location and type of structures shall be governed by site condition and head loss etc.
 - (b) In case of construction of sub-minors the contractor is not required to submit individual design & drawing of each structures. However typical design and drawing shall be furnished for each structure with a statement showing location and relevant levels and dimensions of the structures separately for each scheme. However, the contractor shall have to give separate estimate for each individual structure.
- 8.3 The hydraulic and structural design for all of the structures shall be done as per latest guidelines provided in 'Manual on Water Supply and Treatment' published by Central Public Health and Environmental Engineering Organisation (CPHEEO), Ministry of Urban Development, New Delhi and relevant latest I.S./International/MOST code and practices in vogue for such type of irrigation works.

All delivery chamber (optional)s/ structures shall be deemed to be water retaining structures so far as application of IS-7784-Part-I 1975, IS-7784-Part-II-Section-I, 1983 and IS-456-2000 and IS- 3370-1967. However the latest version of the codes shall prevail for the detailed planning, design and execution. Unless otherwise specified, the design will be carried out by working stress method.

9.0 ADDITIONAL POINTS :

- I. As far as possible Intake works, pump house, delivery chamber (Optional) should be situated in government land.
- II. Each water delivery pipeline must end in a tail escape in natural drain. Pressure release device should be provided at inlet to control flow of water and regulate it to exact requirement particular minor/sub-minor.
- III. Standardized notation will be supplied by the Department along with the format for drawings (dimensions, lettering, name plate etc.)
- IV. Though design details have been supplied or referred to, the Contractor will be responsible of design of a workable and economical system.
- V. Proposed irrigation pattern and type of irrigation for the area on the basis of topography and soil characteristic of the area.
- VI. It is envisaged to fill the village ponds and suggest suitable common point of raw water discharge to meet the water need of the village and delivery shall be designed to cater for such needs. The cost of water supply shall also be incorporated in estimates.

The contractor if asked will have to justify both technically and economically any of the design and layout details suggested by him and if he is not able to do so, shall have to accept changes as suggested.

10.0 ADDITION/MODIFICATIONS :

Should circumstances arise which call for addition/modifications in the design criteria, the department shall intimate the additions/modifications to the contractor. These additions/modifications will have to be taken into account. On approval of the proposal, contractor shall submit final presentation. All drawings shall be prepared in computer. Separate layers should be used to depict different details in Auto CAD drawings.

- I. Index map to the scale of 1:15000 showing alignment of Rising main/Pressure main, distributaries, CCA boundaries, important roads, railways, major drains and village boundaries etc.
- II. A combined contour map to a scale of 1:15000 shall be prepared showing alignments of distributaries, minors, type and location of structures, chak, link/ main drains, roads and cart tracks, S.O.I. bench marks and permanent bench marks constructed in one mosaic.
- III. Contour maps of CCA in villages to a scale of 1:4000 (village map) showing there on alignments of minors and sub minors, type and location of structures, head at off-take

and structure location, chak and sub-chak layout alignment of drainage network any type and details of structures provided thereon, location of permanent bench marks, kachha and pucca roads, ditches, wells, houses, railway lines, high tension line, electric poles, telephone poles, irrigation pipe lines, Water Supply pipe lines, ONGC/IOC pipe line and all other important prominent features.

- IV. Contour map of CCA to a scale of 1:4000 showing contours plotted at 50 cm interval with all field details.
- V. Plan and sections of Delivery chamber (optional)s showing hydraulic details, location and type of structures etc. trial pit details etc.
- VI. Cross section of laying details of Rising main/Pressure mains and distribution network.
- VII. Detailed drawings of structures to a scale of 1:50. In case of layout etc. the scale can be 1:100 and in case of details of components the scale can be 1:25.
- VIII. Line diagram of pipe lines and distribution network CCA wise.
- IX. Pipe line wise land plan schedule.
- X. Alignment strip plans and land width of pipe line networks on village map to a scale of 1:4000 m showing apexes, tangent lengths, curve lengths, land width required to be acquired etc.
- XI. North lines for plans shall be in same direction.

Note:

1. In case where all the details cannot be accommodated in one volume there can be two or more sections but in such case care should be taken that complete details of an item is covered in one section.
2. Where map can not be accommodated in one drawing, the overlap of 5 cm on all sides shall be provided.
3. A uniform block shall be provided on the right side bottom corner as per the details given by the Engineer-in-charge.
4. Drawings: All drawings, map plans should be computer printed on transparent sheet by plotter. A proper numbering system should be used. Each such tracing should be accompanied by 5 legible ammonia print on superfine paper / photo copy taken out from it.
5. Estimate and Statements: 3 legible copies of estimates/statements/design notes/reports etc. typed on computer and its print out in laser jet printer.
6. Land acquisition proposals in the formats as per requirement of revenue department in six legible copies typed on computer and its laser print out.
7. The Contractor shall submit original tracing and field books. The contractor shall also return the documents furnished by the Department.

8. All above record in CD and one hard disc with operating software. Submission of complete animated proposal in Media Player or in Flash showing all components of work and working animated model so as to give terrain depiction, showing villages, towns, boundaries, river, intake works, pumping station, water conductor systems virtual working model.
9. Operation and maintenance manual draft of the project with master control.

11.0 Specifics

- I. Survey work will be handed over to the Departments in Auto CAD 2007 format drawings, separate layers will be used for each attribute and standardized blocks will be used to portray repeated features such as telegraph poles. A list of such layers and corresponding line-types and blocks as the Contractor proposes shall be agreed prior to the commencement of drawing production.
- II. Drawing shall be prepared at a scale of village map and shall include a map location legend and scale bar on each sheet.
- III. Drawing shall be on standard A 1 sheets. All drawing shall have a 20 mm border on all sides. The title block shall be in the bottom right hand corner of the page and the title block area above it shall be 100 mm wide. No part of the model space drawing shall extend into the title block margin above it all notes, scale bars and legends shall be located in the margin above the title block.
- IV. All survey data shall be presented in model space (with Auto CAD) and all other non spatial data and constructions (title block, legend, frame etc) shall be located in paper space.
- V. Each drawing shall include a 100 m x 100 m grid with clearly referenced co-ordinates using GIS along the drawing border.
- VI. Where these occur within limits of drawings, the drawings shall show the location of benchmarks and control points used during the survey. Each shall be fully referenced and its details included in the report.
- VII. Each drawing shall show the details agreed with the Departments, the remaining layers though present in the drawing file, shall remain hidden.

12.0 Survey & Investigation for System connectivity

12.1 SURVEY AND MARKING:

- 12.1.1 **The preliminary Survey:** - Walk over survey, theodolite survey, and profile survey (if required) shall have to be carried out to establish the Route alignment by the Contractor for new lines. Survey shall cover all crossings like railways, roads including NH, power lines, telecommunication lines (under P&T Deptt), rivers, forest area, proximity to buildings etc and should be clearly indicated in the route map. Rly crossing shall be indicated clearly by color code or by bold letter. **Route alignment shall be plotted on Survey of India topographical maps [size (1:25,000) or (1:50,000) where ever available].**

12.1.2 Preliminary Survey Reports: Three copies of the alignment reports along with other information, if any, shall be submitted in report form, to Executive Engineer in charge of the Division with copy marked to C.E, Mega lift Project for approval.

The detailed survey: - It should be taken up only after the route map is approved.

Preliminary route alignment in respect of the proposed line may undergo changes due to alteration of place and other unavoidable constraints. Detailed survey shall be covered by the following general guide lines:

- Route of the electric line shall be as short as possible.
- The line is as near as possible to the available roads in the area. Difficult and unsafe approaches are avoided
- Good farming areas, religious places, forest, civil and defense installations, aerodromes, public and private premises, ponds, tanks, lakes, gardens, and plantations are avoided as far as practicable.
- Involvement of Forest land should be least & restricted as far as possible.
- The line should be far away from telecommunication lines as reasonably possible. Parallelism with these lines shall be avoided as far as practicable.
- Angle points in the route shall be minimized. Railway and road crossing shall be minimum on the line route and in case it is not possible to avoid the same the crossings at right angles shall be preferred but the crossings shall not be less than 60° in any case.
- The survey shall be conducted along the approved alignment only.
- Relevant drawings & data shall be furnished to the appropriate authorities and obtain statutory clearances for Railway crossings, Highway/Roads, Telephone/ Power line crossings etc. All such clearances are the responsibility of the contractor.
- Owner shall arrange all required consent/approvals including civil aviation, road, river, railway, canal, power line crossings and environmental and forest clearance etc. from the concerned authorities.
- Owner in accordance with the requirement of construction shall arrange right of way and way leave clearances. Compensation for right of way and way leaves shall be given as per applicable laws, rules, regulations, guidelines/ directives of local administration/ revenue authorities.
- For river crossing/ Crossing of nallas : Taking levels at 25 meter interval on bank of river and at 50 meter interval at bed of river so far as to show the true profile of the ground and river bed. In case of railway/ Road Bridge, road, the levels shall be taken at least 100 m. on either side of the crossing alignment. Both longitudinal and cross sectional shall be drawn preferably to a scale of 1:2000 at horizontal and 1:200 vertical.

- To facilitate checking of the alignment, suitable reference marks shall be provided. For this purpose, concrete pillars of suitable sizes shall be planted at all angle locations and for others with suitable wooden/iron pegs.

12.2.2 Detailed Survey Reports: After completing the detailed survey, the contractor shall submit the followings along with compliance reports, if any, to Executive Engineer in charge of the Division with copy marked to C.E, Mega lift Project, for final approval by DoWR.

❖ **final profile and tower schedule/ pole schedule**

❖ **bill of quantity (BoQ)**

After approval, the contractor shall submit **six** more sets of the approved documents along with a **soft copy** for record purpose and submission to concerned Distribution Licensees (WESCO/SOUTHCO).

12.3 Way-Leave and Tree cutting:-

- 12.3.1 Way-leave permission which may be required by the contractor shall be arranged at his cost. While submitting final-survey report for approval, proposals for way-leave right of way shall be submitted by the contractor. DoWR may extend help/ facilitate to get the permission within a reasonable time for which due notice shall be given by the contractor in such a way so that obtaining permission from appropriate authority do not hinder the continued and smooth progress of the work.
- 12.3.2 The employer shall not be held responsible for any claim on account of damage done by the contractor or his personnel to trees, crops and other properties.
- 12.3.3 The contractor shall take necessary precaution to avoid damage to any ripe and partially grown crops and in the case of unavoidable damage, the employer shall be informed and necessary compensation shall be paid by the contractor.
- 12.3.4 All the documents required for application to the statutory authorities must be prepared by the contractor & submitted to the employer for submission of the application towards approval of Railway Crossing etc. However, the responsibilities lie with the contractor to get the clearance.
- 12.3.5 Trimming of tree branches or cutting of a few trees en-route during survey is within the scope of survey to be done by the contractor. Contractor shall arrange for necessary way-leave and compensation in this regard. During erection of the line, compensation for tree cutting, damage caused to crops, actual cutting and falling of the trees including way-leave permission for such route clearance shall be arranged by the contractor at his cost. The contractor will identify the number of trees and detail of obstructions to be removed for erection of the line and intimate the employer well in advance in case of any help. Other related works like construction of temporary approach roads, etc. as required, shall be done by the contractor and the same will lie within the scope of contractor's work and such cost shall be considered to be included in the rates quoted by him.

12.4 Check survey:-

The contractor shall undertake the check survey during execution on the basis of the alignment profile drawing and pole/ structure schedule approved by DoWR. If during check survey, necessity arises for minor change in route to eliminate way leave or other unavoidable constraints, the contractor may change the said alignment after obtaining prior approval from the authorized Engineer, DoWR.

13.0 Work Ownership

Following completion of the survey work and final payment of all dues the survey work including all data and computations satellite imagery and drawings shall become the property of the Employer. The Contractor shall not distribute copies of the Work to third parties except the Departments, without the prior written consents of the Employer.

14.0 Back-up Copies

The Contractor shall submit all records with licensed software in Compact Discs (DVD) in 5 copies with proper referencing and interlinking of data with references so as to access data as web page. The data shall also be supplied in an appropriate capacity hard disc with all operating software used. The data shall also be available with contractor till the expiry of defect liability period and if required by department the same shall be supplied in soft copies.

B. LAND ACQUISITION

THE LAND ACQUISITION CASES ARE TO BE PREPARED AND SUBMITTED IN THE FORMATS PRESCRIBED BY THE REVENUE AUTHORITY COMPETENT TO PASS THE AWARDS. ODISHA LAND ACQUISITION ACTS, RULES AND REGULATIONS IN RESPECT OF LAND ACQUISITION AS ENFORCED FROM TIME TO TIME ARE TO BE STRICTLY FOLLOWED

SECTION-III
TECHNICAL SPECIFICATION FOR CIVIL WORKS

TECHNICAL SPECIFICATION FOR CIVIL WORKS

SL. NO.	PARTICULARS	PAGE NO.
1	A. EXCAVATION/EARTH WORK	1
2	B. DRILLING & BLASTING	10
3	C. DEWATERING	17
4	D. DRILLING & GROUTING	21
5	E. BUILDING WORKS	26
6	F. TRASH RACKS & GATES	60

CONTRACTOR

EXECUTIVE ENGINEER

A. EXCAVATION/EARTH WORK

- 1.1 Scope.
- 1.2 Scope of work.
- 1.3 Clearing the site.
- 1.4 Layout.
- 1.5 Excavation.
- 1.6 Excavation in rock.
- 1.7 Removal of loose rock etc.
- 1.8 Classifications.
- 1.9 Maintenance of slopes in excavation.
- 1.10 Slips Responsibility.
- 1.11 Use of excavated stuff.
- 1.12 Deposition of excavated stuff, clear off traffic lines etc.
- 1.13 Sorting and stacking of materials.
- 1.14 Surplus Materials
- 1.15 Stacking in stock and Waste piles.
- 1.16 Excavated Materials shall be stacked within area
- 1.17 Silting of excavation.
- 1.18 Silting due to flood.
- 1.19 Box excavation.
- 1.20 Excavation in wet condition and dewatering.
- 1.21 Contractor to dewater whenever required
- 1.22 Preparing and testing of foundation.
- 1.23 Scaling and trimming of foundation.
- 1.24 Treatment of weak local spots.
- 1.25 Final finished surface of foundation.
- 1.26 Testing for soundness
- 1.27 Excavation outlines.
- 1.28 Blasting.
- 1.29 Observing rules regarding blasting.
- 1.30 Storing of explosives.
- 1.31 Restrictions of blasting.
- 1.32 Excavation in hard strata with chiseling and/or controlled blasting.
- 1.33 Excavation in hard strata.
- 1.34 Chiseling manually or excavation by pneumatic rock breakers.
- 1.35 Alternative technique approved by the Engineer-in-Charge.

EXCAVATION

1.1 SCOPE OF WORK:

The item shall include clearing site, excavation for Pump house & similar other.

All the excavation and removal of excavated material and its disposal in a manner hereinafter specified, the rate for the item of excavation shall also include.

- i) Clearing of site.
- ii) Setting cut works, profiles etc. according to sanctioned plan, or as directed by Engineer-in-charge and setting up benchmarks and other reference marks.
- iii) Providing and subsequently removing shoring and strutting if and when necessary.
- iv) Necessary protection including labour, materials and equipments to ensure safety and protection against risk or accident.
- v) Supply of facilities for inspection and measurements at any time to the concerned Govt. officials.
- vi) Compensation for injury to life and damage to property if any caused by contractor's operations connected with this item

1.2 CLEARING THE SITE :

The site of excavation shall be cleared of all grass vegetation, fencing, bushes, and trees as directed by the Engineer-in-charge. The materials, obtained from such clearance shall be the property of the Govt. and shall be stacked as directed by the Engineer-in-charge so as not to cause obstruction to the work.

1.3 LAY OUT :

All materials such as pegs, bamboos and strings and templates for marking out slopes, and tools required for line out shall be provided by the Contractor at his own cost. The centre line of excavation shall be clearly marked by pegs or by stones at each chain or change of direction or at shorter intervals on curves, in the beginning. The final line out will be done by fixing reference stone at suitable distances on either side of the centre line, so that they are not disturbed during the construction period. The position of these stones will be marked on the cross section.

No change in the sanctioned plans and designs is permissible without the written permission of Engineer-in-charge.

Before starting the work, the Contractor shall have to sign the field books and plans showing the working longitudinal sections and cross sections of the portions of the alignment, that he has to tackle. If the Contractor fails to sign them within three days of being called upon to do so, the levels and sections as recorded by Engineer-in-charge or his Assistant will be final & binding on the Contractor.

Contractor shall provide and maintain the quarry roads and temporary roads required for conveying and transport of materials at his cost.

For the points, which are not covered by these specifications, the instructions given by the Engineer-in-charge shall be final and binding on the Contractor.

The material available from all excavation and remaining surplus after use on the work from adjacent work etc. can be used by the Contractor free of cost provided these materials are used solely for the specific contractor work and prior approval of the Engineer-in-charge is taken.

1.4 EXCAVATION

Section shall be excavated as shown on the drawings or as directed by the Engineer - in - charge. Suitable arrangements for drainage shall be provided to take surface water clear of excavation during the progress of work.

Excavation may be carried out by manual labour or by excavating machine

1.5 EXCAVATION IN ROCK:

Excavation in rock shall be mostly controlled blasting so as not to endanger surrounding structures. All sharp points of rock are chipped off. Blasting in a manner, which is likely to produce over breakage, which in the opinion of Engineer-in-charge is excessive, shall not be permitted. Special care shall be taken to prevent over-breakage or loosening of materials on bottom and side slopes. Excavation in excess of the prescribed section shall not be permitted and no payment will be made for such excess excavation.

The material excavated shall be stacked on either side as specified on the drawing or as directed by the Engineer - in - charge.

The Excavation shall be carried out according to the design with side properly slopped as shown in the drawings and as directed by the Engineer - in - charge. The cross section adopted in cutting is likely to change in side slopes according to the depth of different strata during actual excavation. The Contractor therefore shall get clear instructions from Engineer - in - charge, before commencing any cutting work.

No claims for any variations in quantity of excavation resulting from the deviation from the instructions of the Engineer - in - charge shall be accepted. In portions where deep cutting of more than 6 m. is to be done, the mode of excavation to be followed must be got approved from the Engineer - in - charge, before starting the work.

The excavation shall actually be carried out in steps. The steps shall have such width and depth that after they are cut, the required final side slopes is attained. Cutting of steps shall be done when altered level is reached and after one monsoon.

1.6 REMOVAL OF LOOSE ROCK ETC:

Before any work of excavation is taken up all loose rock, semi-detached rock in /or close to the areas to be excavated, that is liable to fall or otherwise endanger the workmen on the project shall be

stopped. The methods employed shall be such as will not shatter or render unstable and therefore unsafe any rock that was originally sound or safe. Any material not requiring removal as contemplated herein, but which may later become loosened or unstable shall be promptly and satisfactorily removed. The cost of such clearing shall be deemed to have been included in the unit rates accepted under the different items under excavation.

1.7 CLASSIFICATIONS:

The Classification of strata shall be as under.

i) SOFT STRATA :

This shall include all kinds of weathered rock shale, clay, soil, silt sand and gravel, soft average and hard murum and any other materials, which can best be removed with a shovel after loosening with a pick and or bar. It shall also include isolated boulders up to 0.1 cubic meters each. Which does not need blasting and could be removed with a pick / bar and shovel.

ii) HARD STRATA :

This shall include all rock occurring in masses in all types of geological formations that could best be removed by blasting, where such blasting is permissible. It shall also include rock which owing to the proximity of buildings, structures, electric lines & public roads or for any other reasons has to be cut by means of chisels or wedges. It shall also include boulders in mass and isolated boulders over 0.1 cubic meter each that required blasting or wedging and breaking for easy removal. Merely use of explosives in excavation shall not be considered a reason for classification in hard strata unless regular blasting is clearly necessary in the opinion of the Engineer - in - charge. The hardness of strata or material to be excavated presence of different type of geological constituents requiring; increased drilling efforts, consumption of explosives, labour and use of machinery shall not be considered as reason for claim / increase in contract rates.

In case of the disputes over the classification of strata met with during execution, the decision of the Engineer - in - charge will be final

1.8 MAINTENANCE OF SLOPES IN EXCAVATION:

Any shoring and strutting required during excavation and afterwards shall be deemed to be covered by the rates quoted for the items.

1.9 SLIPS:

Slips shall be avoided, but if any slips occur on account of any reason, the excavation shall be promptly restored to stability. No extra claims shall be entertained for such slips.

The Contractor shall have to make good the work at his cost.

1.10 USE OF EXCAVATED STUFF:

Excavation shall be done systematically. Only those excavated stuff, which will be permitted for use, shall be used.

1.11 DEPOSITION OF EXCAVATED STUFF CLEAR OFF TRAFFIC LINES ETC.

Disposal of all material from excavation shall be as per approved disposal plan of instructions of Engineer - in - charge, regarding the location and deposition of the stock piles, spoil banks of embankment. Before any excavation is started the deposition of spoil shall be carefully planned so as not to obstruct normal traffic and traffic lines required for the construction materials, and shall be dumped sufficiently clear off the edges of the excavation so as not to endanger stability of the slopes of the excavation and also to permit ample space for lorry paths, installation and lifting of dumping devices, stacking construction materials etc.

1.12 SORTING AND STACKING OF MATERIALS:

Excavated materials shall be sorted out and stacked as under.

a) All the excavated materials from the soft strata shall be sorted on. The material not useful shall be deposited as directed by the Engineer - in - charge. Materials useful shall be, sorted out and neatly stacked. Every stockpile of the material shall be of regular size and not less than 5 m. in height.

b) **HARD STRATA :**

Rubble and boulders from hard strata shall be stacked in separate area as directed by the Engineer - in - charge. Stockpiles shall be of regular shapes, allowing for easy measurement No stockpiles shall measure more than 200 Sq.m. In plan and more than 1.5 m. in height, unless specifically permitted by the Engineer - in - charge in writing.

1.13 SURPLUS MATERIALS:

The excavated materials, if not required shall be stacked in spoil banks with neatly made stable slopes at top and a suitable berm being left between the toe of bank, and edge of excavation, as directed.

1.14 STACKING IN STOCK AND WASTE PILES:

After sorting is done, useful materials of various types shall be stacked in stockpiles and rest may be disposed off as directed by the Engineer - in - charge.

Useful material shall be stacked in separate area as directed with reference to the nature of the material. Stockpiles shall be of regular shapes allowing for easy measurement No stockpile shall measure less than 60 m. length and 5 m. height unless specially permitted by the Engineer - in - charge

The excavated material shall be stacked within the area approved by the Engineer - in - charge. If the excavated material is deposited in unauthorized land, such work will not be measured for payment unless suitable action as may be directed by the Engineer - in - charge is taken by the contractor. In addition to non - payment of such work suitable amounts as directed by the Engineer - in - charge will be recovered from the Contractor as directed towards any extra cost which may have to bear on account of the Contractor's un-authorized action.

1.15 USE OF EXCAVATED MATERIALS

All the materials available from excavation will be the property of Govt. and shall be deposited as directed by the Engineer - in - charge. The Material of approved quality may be used by the Contractor in the item of work included in Schedule of requirement of the tender or on ancillary for preparatory work free of charge. Prior approval of the Engineer - in - charge for such free use shall however be taken.

1.16 SILTING OF EXCAVATION:

1.17 SILTING DUE TO FLOODS, EMPLOYER NOT RESPONSIBLE:

If excavated pits get silted due to intervening floods, slips or any other cause, till completion of the work, the Contractor shall excavate and restore the pits and section to the required shape and dimensions without any extra cost.

1.18 BOX EXCAVATION :

Initially box excavation shall be carried out up to top of hard strata. There after stable slopes may be cut in soft strata as stated hereafter

On sinking hard rock in foundation trench the surface of this rock shall be exposed on all area of the trench and it shall be brought to the notice of Engineer- in - charge by the contractor. The Engineer - In - charge or his authorized representative shall take levels of the top of hard stratum along predetermined section in the presence of Contractor or continued up to foundation level to be fixed by the Engineer - in - charge.

1.19 EXCAVATION IN WET CONDITION AND DEWATERING:

Unless otherwise specified no distinction will be made as to whether the material being excavated is dry, moist or in wet condition.

1.20 CONTRACTOR TO DEWATER WHENEVER REQUIRED:

The area under all the works pertaining to this tender and adjoining area as necessary shall be maintained free of water.

The area shall also be maintained free of water after any part of the work is completed for inspection, safety and installation for any other reasons determined as necessary by the Engineer - in - charge. The sumps shall be well lighted and shall be readily accessible for inspection. The Contractor shall pump out all water from the site and appurtenance works and shall keep the foundation free of water, while excavating, concreting and placing masonry and continue to keep the works free of water for a period as may required from proper -setting of mortar or concrete or otherwise required for the completion of work.

The Contractor shall have to construct and maintain during construction of structures, cofferdams, diversion channels and other diversions or protective works as necessary after approval from Engineer-in-charge. The Contractor shall not be entitled to pay claims or damages on account of or by reason of any amount of leaking through under or around cofferdams, diversion channels and either diversion or protective works of overtopping of diversion works.

1.21 PREPARING AND TESTING OF FOUNDATION:

1.22 SCALING AND TRIMMING OF FOUNDATION:

After excavation to the required depth is completed scaling and trimming operations for the removal of all pieces loosened during excavation or partly separated from main rock mass by seams or cracks shall be carried out to the satisfaction of the Engineer-in-charge.

1.23 TREATMENT OF WEAK LOCAL SPOTS :

All weathered or partly decomposed pieces of rock shall be removed so as not to leave on the foundation any rock other than that which is an integral part of rock mass. Areas of low bearing capacity, steep inclined seams, faults, and Crushed zone in an otherwise good foundation, if permitted to be kept shall be cleared out to a sufficient depth and refilled and plugged with masonry or concrete as directed by the Engineer-in-charge.

1.24 FINAL FINISHED SURFACE OF FOUNDATION:

The finally prepared foundation shall present a rough surface in cross section to give added resistance to sliding. All smooth surfaces shall be roughened artificially to give a good bond. The surface shall be free from steep angles and the edges of benches shall be chamfered approximately to 45°. Pinnacles of sharp projection shall be knocked off and prominent knobs flattened.

1.25 TESTING FOR SOUNDNESS:

The finally finished foundation rock shall be tested by striking with a heavy hammer and if loosed portion of foundation rock is revealed by a hollow sound, it shall be excavated further (without blasting) till a clear ringing sound is obtained.

1.26 EXCAVATION OUT LINES:

All excavation shall be performed in accordance with the lines, grades, levels and dimensions shown in the drawing or established by the Engineer-in-charge. The dimensions shown in the drawing are tentative. During the progress of work it may be necessary or desirable to vary the slopes or the dimensions of excavation from those specified in the drawing. The side slopes of the excavations shall be as steep as would stand with safety as decided by the Engineer-in-charge. If the slopes established are found to be steeper and likely to slip, they shall be made flatter by removing the additional material and introducing suitable berms if possible and stable faces established.

1.27 BLASTING:**1.28 OBSERVING RULES REGARDING BLASTING:**

In conducting blasting operations proper precautions shall be taken for the protection of person, the work and property. All Government laws relating to the design and location of magazine, transport and handling of explosives and other measures for the prevention of accident shall be strictly observed. Warning signs shall be prominently displayed on the magazines, and warning signs given for each blast. Specifications for blasting given under the separate section shall be carefully and rigidly observed.

1.29 STORING OF EXPLOSIVES:

Explosives shall be stored in a safe place at sufficient distances from the work and under the special care of watchman so that in case of accidents no damage occurs to the other part of work. Explosives, detonators and fuses shall be each separately stored. No Objection Certificate from District Magistrate or inspector of Explosives shall be obtained as required by the Contractor.

1.30 RESTRICTIONS ON BLASTING:

- a) Blasting which may disturb or endanger the stability safety or the quality of the foundation will not be permitted.
- b) Blasting within 30 meter of masonry work in progress of a permanent structure shall not be permitted.
- c) Blasting operation shall be monitored so as not have peak practical velocity near important structures to exceed 10 ppv.
- d) Progressive blasting shall be limited to two third of the total remaining depth of excavation.

- d) No large scale blasting operation shall be restored to when the foundation excavation reaches the last half meter. Only small charges preferably black powder may be allowed so as not to shatter the foundation
- e) Rules of blasting are as appended.

1.31 EXCAVATION IN HARD STRATA WITH CHISELLING AND / OR CONTROLLED BLASTING:

1.32 EXCAVATION IN HARD STRATA:

Where the excavation in hard strata is involved, since usual blasting operations are likely to damage the adjoining houses, transmission lines or hinder the traffic on important roads. The excavation for a good length is required to be done under controlled blasting conditions and / or chiseling. The item will include excavation in hard strata to correct sections as shown in the drawings with chiseling and / or controlled blasting and depositing the excavated stuff as and where directed

The Contractor shall obtain written permission of the Engineer - in - charge before undertaking the work under this item for specific reaches.

The holes for blasting shall be drilled for a depth of only 40 cm thus increasing the number of holes and correspondingly decreasing the charge required for each holes.

The holes as far as possible shall be slant. All the holes after charging will be covered by grill of steel rods which shall be suitably loaded by gunny bags filled with sand or Murom. The steel grill shall be so lowered over the holes that it does not to cause any damage to the (use wire or charges and care shall be taken to see that the fuse wires remain free. The loading shall be sufficient to prevent the overthrow of rock after blasting In addition to the above loading; the steel grill shall be securely anchored to the adjoining rock by chains. The steel grill shall extend at least 3 meters beyond the area to be blasted.0

Chiseling manually or excavation by pneumatic rock breakers shall be restored to as directed by Engineer --in - charge where blasting cannot be permitted.

Any alternate technique approved by the Engineer- in - charge may be used, but approval to execute the work by the above mentioned method or alternate technique would not relieve the Contractor of the responsibility of damage to the power line and properties.

B. DRILLING AND BLASTING

- 2.1 General
- 2.2 Materials
- 2.3 Personnel
- 2.4 Storage for explosives
- 2.5 Use of explosives
- 2.6 Disposal of Deteriorated Explosives
- 2.7 Preparation of Primers
- 2.8 Charging of hole
- 2.9 Blasting.
- 2.10 Electrical firing
- 2.11 Precautions after blasting and misfire

DRILLING AND BLASTING**2.1****GENERAL**

Blasting where required will be permitted only when proper precautions have been taken for the protection of persons and property in accordance with IS 4081-1986 (Indian standard specification for safety code for blasting and related drilling operations). While carrying out excavation, adequate precautions in accordance with IS 3764-1992 (Indian standard specifications for safety code for excavation work) shall be taken.

Explosives such as gelatine, prilled ammonia nitrate detonators and fuse coils etc required for the rock blasting are to be procured by the contractor at his cost. The contractor has to purchase the blasting materials on the name of work and on the name of contractor. The materials without mentioning the above two names on the bill will not be accepted. It shall be the responsibility of the contractor to store the explosives purchased by him in accordance with the rules of the explosives act and other rules framed by Government of India. He should possess/acquire proper license for transport of explosives, portable magazines for possession and use of explosives and shot fires as per revised act 1983.

He shall also furnish the following details of portable magazines & transport vehicles:

Capacity	License No. and date	Validity period

The contractor shall acquaint himself with all the applicable laws and regulations concerning storing, handling and use of explosives. All such laws, regulations and rules, as prevalent from time to time shall be binding upon the contractor.

The Provisions detailed in the specification are supplementary to the above laws, rules and regulations, are also applicable. Further, the engineer may issue modifications, alterations and new instructions from time to time. The contractor shall comply with the same without these being made a cause for any claims.

A list of I.S code applicable is furnished below:

IS 4081-1986: Safety code of blasting and related drilling operations

IS 3764-1966: Safety code for excavation work.

In addition to the above I.S. codes, the specification of O.S.S and manual for quality control and inspection shall also be complied with.

2.2**MATERIALS:**

All the materials such as explosives, detonators, fuse coils, tamping materials etc. that are proposed to be used in the blasting operations shall have the prior approval of the Employer. Only explosives of required make and strength are to be used.

Black powder and safe explosive shall be used wherever possible. Explosives with nitroglycerine shall be used where the above explosives are not effective.

The use of fuse with only one protective coat is prohibited. The fuse shall be sufficiently water resistant as to be unaffected when immersed in water for thirty minutes. Rate of burning of the fuse shall be uniform and not less than 4 (four) seconds per 26 millimeters of length with 10% (ten percent) tolerance on either side. The fuse known as instantaneous fuse shall not be used. The fuse shall be inspected before use and the moist, damaged or broken ones discarded. The rate of burning of all new types of fuses shall be examined. When they have been in stock for a long time they shall be treated before use. The detonators used shall be capable of producing effective blasting of the explosives.

2.3 PERSONNEL:

Excavation by blasting will be permitted only under the personal supervision of competent and licensed persons and trained workmen employed by the contractor at his cost. All supervisors and workmen in-charge of makeup, handling, storage and blasting work shall be adequately insured by the contractor.

The person in charge of the explosive magazine shall be very reliable and his deployment shall be approved by the Employer.

The contractor shall make sure that his supervisor workmen are fully conversant with all the rules to be observed in storing, handling and use of the explosives. It shall be assured that the supervisor in charge is thoroughly acquainted with all the details of handling and blasting operations.

2.4 STORAGE OF EXPLOSIVES:

The contractor shall build a magazine or make suitable permanent arrangements at his cost for safe storage of the explosives. Contractor shall provide portable magazine for carrying the explosives to work-spot from the magazine at his cost. The site of the magazine, its capacity and design shall be subject to approval by the Inspector of Explosives before the construction is taken up. As a rule, the explosives should be stored in a clean, dry, well ventilated, bullet proof and fire proof building on an isolated site.

The contractor shall provide armed guard security of required number for explosive magazine or while transporting to work site as per rules in force at his cost.

The explosives detonators and fuse coils shall each be separately stored.

A careful and day to day account of explosives shall be kept by the contractor in a register in manner prescribed by the employer. The employer may also pay surprise visits to the storage magazine. In case of any unaccounted storage pay surprise visits to the storage magazine. In case of any unaccounted storage of the explosives or if the account is not found to have been maintained in a manner prescribed by the engineer, the contractor shall be liable to be penalized in which case he shall not be entitled to any compensation for the losses etc. The action taken under this clause shall be in addition to that which might be taken by the competent civil authorities in the court of law.

The magazine shall at all times be kept scrupulously clean.

No unauthorized person should at any time be admitted inside the magazine. A notice shall be hung near the storage prohibiting entrance of unauthorized persons.

The magazine on no account be opened during or on the approach of the thunder storm and no person shall remain in the vicinity of the magazine during such periods.

Magazine shoes without nails shall at all times be kept in the magazine and a wooden tub or cement trough about 300 millimeters high and 460 millimeters in diameter filled with water shall be fixed near the door of the magazine.

Persons entering the magazine must put on the magazine shoes which shall be provided by the contractor for the purpose and be careful.

- i) Not to put their feet on the clear floor unless they have the magazine shoes on
- ii) Not to allow the magazine shoes to touch ground outside the clean floor.
- iii) Not to allow any dirt or grit to fall on the clean floor.

Person with bare foot shall, before entering the magazine, dip their feet in water and then step direct from tub over the barrier (if there be one) on the clean floor.

A brush or broom shall be kept in the lobby of the magazine, for cleaning the magazine on each occasion it is opened for the receipt, delivery or inspection of explosives. No matches or inflammable material shall be allowed in the magazine. Light shall be obtained from the electric storage battery lantern.

No person having articles of steel or iron on him shall be allowed to enter the magazine.

Oily cotton, rags, waste and articles liable to spontaneous ignition shall not be allowed inside the magazine.

Workmen shall be examined before they enter the magazine to see that they have none of the prohibited articles on them.

No tools or implements other than those made of copper, brass, gun metal or wood shall be allowed inside the magazine. All tools shall be used with extreme gentleness and care.

Boxes of explosives shall not be thrown down or damaged along the floor and shall be stacked on wooden trestles.

Where there are white ants, the legs of trestles should rest in shallow copper, lead or brass bowls containing water. Open boxes of dynamite shall never be exposed to the direct rays of the sun. Empty boxes or loose packing materials shall not be kept inside the magazine. Magazines shall be inspected at least twice a year by any officer representing the engineer.

He shall see that all the rules are strictly complied with. The magazine shall have a lightning conductor which should be got tested at least once a year. The contractor shall comply with all the recommendations made by the officer testing the lightning conductor and also rectify the defects notified to him within 16 days failing which the engineer shall be entitled to comply with the same at the contractor's expense which shall not be open to question. The engineer may take any action that he may consider fit at the cost of the contractor.

The following shall be hung in the lobby of the magazine.

- a. A copy of rules both in English and in the languages which the worker concerned are familiar with.
- b. A statement showing the stock in the magazine on that day.
- c. A certificate showing the last date of testing of the lightning conductor.
- d. A notice that "smoking is strictly prohibited".

2.5

USE OF EXPLOSIVES:

For the transport of the explosives and detonators between the store and the site, closed and strong containers made of soft materials such as timber, zinc, copper, leather shall be used.

Explosives and detonators shall be carried in separate boxes. For the conveyance of primer, special container shall be used.

The boxes and containers used shall be kept closed. Explosive shall be stored and used chronologically earlier received shall be used first. A make up house and used chronologically earlier received shall be used first. A make up house shall be provided at each working place in which cartridges will be making up by competent and licensed men as required for the work. The makeup house shall be separated from other buildings. Only electric storage battery lamps shall be used in this house.

No smoking shall be allowed in the makeup house or generally while dealing with explosives.

2.6 DISPOSAL OF DETERIORATED EXPLOSIVES:

All deteriorated explosive shall be disposed off in an approved manner; the quantity of the deteriorated explosives to be disposed off shall be intimated to the engineer prior to its disposal.

2.7 PREPARATION OF PRIMERS

The primers shall not be prepared near open flames of fire. The work of preparation of primers shall always be entrusted to the same personnel. Primers shall be used as early as possible after they are ready.

2.8 CHARGING OF HOLES:

The work of charging of holes shall not commence before all the drilling work at the site is completed and the contractor's supervisor shall satisfy himself to that effect by actual inspection. While charging, open lamps shall be kept away. For charging with powered explosives, a naked flame shall not be allowed. Only wooden tamping rods, without any kind of metal on the rod shall be allowed to be used. The tamping rods shall have cylindrical ends. Bore hole must be of such size that the cartridge can easily pass down them, they shall not however be too big.

Only one cartridge shall be inserted at a time and gently pressed into the hole with the tamping rods, the sand, clay or other tamping materials used filling the holes completely shall not be tamped too hard.

2.9 BLASTING

Blasting shall be carried during the fixed hours of the day which shall have the approval of the engineer. The hours once fixed shall not be altered without prior written approval of the engineer. The site of blasting operation shall be prominently demarcated by red danger flags. The order to fire shall be given only by the contractor's supervisor in charge of the work and this order shall be given only after giving the warning signal three times, so as to enable all the labour, watchmen etc., to reach safe shelters.

A whistle / bugle with distinctive note shall be used to give the warning signals. The whistle/bugle shall not be used for any other purpose. All the labour shall be made acquainted with the sound of the whistle/ bugle and shall be strictly warned to leave their work immediately at the first warning signal and to move for safe shelters. They are not to leave the shelters until all clear signals have been given.

All the roads and footpaths leading to the blasting area shall be watched.

In special cases, suitable extra precautions shall be taken. The Engineer may however permit blasting for underground excavation, without restriction of fixed time, provided that he is satisfied

that proper precautions are taken to give sufficient warning to all concerned and that the work of other agencies on the site is not hampered. For lighting the fuse, a lamp with a strong flame such as a carbide lamp shall be used.

The contractor's supervisor shall watch the required time for firing of the fuses and shall see that all the workmen are under safe shelters in good time.

2.10

ELECTRICAL FIRING

Only the contractor's supervisor in charge shall possess key of the exploder and short firing accessories and he shall keep it always with himself. Special apparatus shall be used as a source of current for the blasting operations power lines shall not be tapped for the purpose.

The detonators shall be checked before use. For blast in series, only detonators of the same manufacture and of the same group of electrical resistance shall be used. Such of the electrical lines as could constitute danger for work of charging shall be removed from the site. The firing cables shall have a proper insulating cover so as to avoid short circuiting due to contact with water metallic parts or rock.

The firing cables shall be connected to source of current only when nobody is in the area of blasting. Before firing the circuit shall be checked by a suitable apparatus. After firing with or without an actual blast the contact between the firing cable and the source of current shall be cut off before anyone is allowed to leave the shelters. During storm/rain, the blasting operations shall be suspended.

2.11

PRECAUTIONS AFTER BLASTING

After the blast, the contractor's supervisor must carefully inspect the work and satisfy himself that all the charges have exploded. After the blast has taken place in the under-ground works, workmen shall not be allowed to go to the place till all the toxic gases are evacuated from the face.

MISFIRES:

If it is suspected that part of the blast has failed to fire or is delayed, sufficient time shall be allowed to elapse before entering the danger zone. When fuse and blasting caps are used a safe time should be allowed and then the contractor's supervisor alone shall leave the shelter to see the misfire. None of the drillers are to work near this hole until one of the two following operations has been carried out by supervisor.

Either i) the supervisor should very carefully (when the tamping is of damp clay) extract the tamping with a wooden scraper or jet of water or compressed air (using pipe or soft materials) and withdraw the fuse with the primer and detonator attached after which a fresh primer and detonator with fuse should be placed in this hole and fired out

or (ii) the hole may be cleared of 300mm, of capping and the direction then be ascertained by placing a stick in the hole. Another hole may be drilled at least 226mm away and parallel to it. Then balance of the cartridge and detonators found in the muck shall be removed.

Before leaving his work, the contractor's supervisor should inform the supervisor of the relieving shift of any case of misfires and should point out the position with red cross denoting the same, also stating what action if any, he has taken in the matter. A register of misfires and their location and how they are dealt with shall be maintained by the contractor.

The contractor's supervisor should also at once report at the contractor's office all cases of misfires, the cause of the same and what steps were taken in connection there with.

The names of the day and night shift supervisors of the contractor must be noted daily in the contractor's office. If misfire has been found to be due to a defective detonator or dynamite the whole quantity of box from which the defective article was taken must be returned to the contractor's office for inspection and shall be disposed off.

Drilling holes not completed exploded by blasting shall not be permitted.

The contractor should produce his firer's/Blaster's license and furnish the particulars in the following statement.

Sl. No.	Name	No. of firer's/ Blaster's license & date	Validity period

Blasting operation, when considered necessary shall be resorted to only with the written permission of the Engineer. Prior inspection shall be carried out for the safety of the public and property. Blasting operations in the proximity of over-head power lines, communication lines, utility lines or other structures shall not be carried out until the operator or the owner or both of such lines have been notified and precautionary measures deemed necessary have been taken.

C. DEWATERING

- 3.1 Scope of work.
- 3.2 General.
- 3.3 Contractor responsible for diversion etc.
- 3.4 De-silting.
- 3.5 Repairs & removal of diversion channels bunds, etc.
- 3.6 Disposal of water. .
- 3.7 Item to include.

DEWATERING

3.1 SCOPE:

The item shall include all dewatering during construction work of intake structures, Pump House & pipeline etc. and diversion work required in a manner hereinafter specified.

3.2 GENERAL:

The area of work shall be kept dry by resorting to pumping or in combination with manual labour for bailing cut water with buckets, etc., or any other satisfactory method to be adopted shall be entirely left to the choice of the contractor provided dewatering is carried out satisfactorily and the scheduled programme is adhered to. The contractor shall plan, construct and maintain satisfactorily, safe and full proof arrangement for dewatering to ensure safe condition excavation and laying concrete and masonry in the dry condition. The contractor shall supply details of his proposals for approval of the Engineer, but such an approval will in no way release the contractor from his responsibility for the adequacy of dewatering arrangement and for the quality and safety of the work, for all of which the contractor shall be solely responsible.

Other approved methods may be used by the Contractor at his discretion and cost to prevent or reduce seepage and to protect the area to be excavated if the soil is porous.

PUMPING :

Adequate pumping arrangement shall be made for dewatering and keeping the same dry while laying pipes or concreting is in progress. Pumps of required capacity and required number and stage shall be provided to ensure the above. Pumping shall be done from a sump inside the excavation as necessary, in such a manner as to preclude the possibility of movement of water through any fresh concrete or masonry and washing away parts of concrete or masonry pumping shall be allowed during laying of concrete or masonry and for a period of at least 24 hours thereafter unless it is done suitable sump shall be separated from concrete or masonry by effective means. Pumping shall be done in such a way as not to cause damage to the work or property blow subsidence etc.

The contractor shall make his own arrangement for necessary labour, materials pumps, engines, well points and other suitable machinery and devices required for successful execution of item of dewatering.

3.3 CONTRACTOR RESPONSIBLE FOR DIVERSION ETC:

The Contractor shall plan, construct and maintain satisfactorily necessary diversion channels and other temporary diversion and protective works and furnish, install, maintain and operate all necessary pumping and for dewatering the various parts of the works and maintaining the work site as free from water as required for approved construction operations.

ADEQUACY OF DIVERSION:

All bunds diversion of flow and other arrangements proposed to be made shall be by prior discussion and approval by the Engineer. On approval, they shall be constructed and maintained at the Contractors cost. Approval of the plans for the diversion works will not relieve the Contractor of the responsibility for the adequacy of diversion and dewatering arrangements.

CONTRACTOR TO DEWATER WHENEVER REQUIRED:

The area under all works as necessary shall be maintained free from water. The areas shall also be maintained free of water after any part of the work is complete for inspection, safely and or for any other reasons determined as necessary. The Contractor shall pump all water from the site of the works and shall keep the work area free of water while excavating, concreting and continue to keep the works free of water for periods as may be required for proper setting of concrete or otherwise required for the completion of works.

The Contractor shall not be entitled to any claim or damages an account of or by reason of any amount of water leaking through under or around the bunds, diversion channels and other diversion or protective works or overtopping.

3.4 DESILTING:

It channel excavation is filled due to accumulation of surface flow during the progress of the work or during rainy season or due to any other cause, all pumping required for dewatering the pits and removing silt shall be done without extra cost.

3.5 REPAIRS AND REMOVAL OF DIVERSION CHANNEL, BUNDS ETC. :

After having served their purpose the temporary bunds shall be removed to the extent directed by the Engineer from time to time.

The diversion channel, bunds etc. are likely to be damaged due to floods or due to any other reason. If they are so damaged, they shall be redone as directed without extra cost to the Department.

Such removal or repair work shall be done in such a manner as not to damage any permanent works. This shall be done at Contractor's cost.

3.6 DISPOSAL OF WATER:

The water from the excavated area shall be disposed off in the manner detailed below or in any other manner in conformity with the rules in force and approved by the Engineer.

In undeveloped areas such as countryside where sewerage system has not been introduced the water may be led to the nearest natural drain or pond through properly laid and dug channels or through pipes.

Disposal of water shall in no case cause inconvenience or nuisance to the in habitants of the area or cause damage to property and structure nearby.

Government regulations shall be complied with the rights or private land owners shall be respected regarding disposal of water.

Contractor shall be responsible for all the incidental like obtaining permission of local bodies and persons concerned to lead the water to the open channels, making use of lands and properties owned by private persons or public bodies etc. and for the damage caused in the operation of this item.

3.7 ITEM TO INCLUDE:

1. All Labor materials, pumps, plants, equipments, staging, shoring, strutting, sumps and other arrangements necessary for dewatering during excavation and construction of other item requiring dewatering.
2. Dewatering construction area and keeping the same dry while excavation, masonry and concrete work is in progress and till the work comes above the water level and till the Engineer consider that the mortar or concrete has sufficiently set.
3. Dewatering till all the items requiring dewatering are fully complete. This shall also include time required for final section of structure and taking measurements of all the items requiring dewatering.
4. Removing stuff of any sort which might find access into the trenches by blowing, slip or due to any other cause whatsoever from the sides of bottom ,of the excavation or from elsewhere during or after or due to dewatering,
5. Leading water to the nearest natural or artificial drains, with all incidental requirements concerned any compensations etc.
6. Compensation for the injury to the workmen and the public or damage to the nearby properties during and on account of dewatering and disposal of water.

D. DRILLING AND GROUTING

- 4.1 General
- 4.2 Drilling Grout holes
- 4.3 Testing and preparation of holes
- 4.4 Clearing holes
- 4.5 Pressure grouting
- 4.6 Grouting equipment
- 4.7 Method of applying grout
- 4.8 Test for grouting work
- 4.9 Keeping Records of drilling and grouting operations
- 4.5 Grouting
- 4.6 Finishing
- 4.7 Calibration of pressure gauges and water meters etc.

DRILLING AND GROUTING**4.1 GENERAL :**

This includes drilling and exploration of holes, installation of grout pipes and fitting, pressure grouting and sealing of foundation etc during construction work.

4.2 DRILLING GROUT HOLES:

In such areas, as may be designated holes shall be drilled to a minimum size of 38 mm in diameter and to maximum depth of 15 meter. Drilling pattern shall be generally indicated on drawings. However, the drilling pattern may be varied according to the situation and shall be taken as directed by the Engineer - in - charge.

Holes for consolidation grouting of foundation rock shall be drilled by jackhammers, wagon drills etc. i.e. by the percussion method. Each hole shall have uniform diameter throughout its length.

Miscellaneous drilling in concrete or masonry or rock or combination of these for local drainage or shallow grouting shall also be done by percussion type drilling method.

Grout holes for consolidation of the foundation will be of varying depths into rock as directed. The consolidation grouting may be proposed to be done after the construction of masonry or concrete of required height for having adequate load on foundation rock.

All holes shall be drilled with equipment of the type specified most suitable for the particular job as approved by the Engineer-in-charge,

The depth and the requirements of the drill holes indicated are approximate and may be altered as per actual needs at the time of foundation excavation and the actual experience of washing and grouting of holes.

The grout holes shall be drilled normal to the surface of rock, or if so directed to any inclination, the directed as may be indicated without any extra cost.

As the construction work progresses the development of leakages or the unusually poor condition of surrounding foundation might require additional drilling and grouting of area which may have earlier been drilled, grouted and even covered by concrete masonry.

Re-drilling required, if any, in case of incomplete holes because of the contractors failure to clear the holes before the grout has set or for any other reason shall be performed at the contractors expense.

After the drilling of grout holes has been completed it shall be temporarily capped or plugged until it is grouted. Any hole that gets checked before it is grouted shall be opened to the satisfaction of the Engineer-in-charge and at the expense of the contractor,

4.3 TESTING AND PREPARATION OF HOLES:

The contractor shall furnish necessary equipment and shall make other pressure tests as directed by the Engineer-in-charge. The equipment shall have sufficient capacity to test grout holes and in the specified manner as directed. A suitable pressure gauge and water meter shall be installed to indicate pressure and water leakage from hole.

The contractor shall maintain a proper data as approved by the Engineer-in charge for all testing of drilled holes.

4.4 CLEARING HOLES:

Before grouting and when a suitable small grout of holes has been drilled, all but three holes (consecutive or as otherwise considered suitable for the purpose of clearing) shall be pumped under pressure as determined by the Engineer-in-charge, into two holes and allowed to escape from third until all possible loose material and mud etc. has been washed out of communicating seams or other passage ways, if any. Combination of these holes at the time shall thus be clean before applying any grout into the holes. Suitable valves shall be used to permit alternate or continuous Injections of air and water and for quickly switching of the flow from one hole to the other so as to produce turbulent action necessary to dislodge the softer materials. The water and air connections shall be interchanged at frequent intervals to cause water flow in every possible direction. The operation should be continued till reasonably clean water emerges out of the holes. In general the pressure of water and of air shall be such as to maintain the minimum possible velocity but sufficiently low to prevent heaving and movement of rock. The normal pressure should be about 2.75 kg/cm². High pressure shall be used where so directed by the Engineer-in-charge. The connected holes shall be blown clear of any detritus that might have settled in the seams therein, washing; shall be so timed as to immediately precede the grouting. Before the grouting of a hole is taken up, the adjoining holes shall be kept clear so that they are ready for grouting in case they are found connected to the hole under grouting.

4.5 PRESSURE GROUTING:

The proportion of cement and water will be as determined by the Engineer-in- charge. Cement and water shall be of the same quality as specified masonry and concrete in the dam.

The grout shall be applied as a low pressure (as may be specified by the Engineer-in-charge) initially and gradually but within the time as specified by the Engineer-in-charged, increased up to the maximum pressure specified at which it shall be maintained for maximum period of about 10 minutes Thereafter, care shall however, to be taken to release the pressure immediately should there be signs of any movements of any part of heaving rock, which might amongst other observations, be indicated of sudden and erratic fall in pressure- If grout appears at the surface, the cracks should be filled by lead wool, calking the same tightly in the cracks.

At the time when grouting has just been commenced in any hole, it is found that the grout has been freely flowing too far or fast from the hole at low pressure, grout shall be immediately thickened in order to block the leakages in sufficient distance from the hole and thus localize the area to be grouted for any particular hole or series of holes. As a hole approaches refusal the grout shall progressively be thinned and grouting operation continued to refusal at the specified maximum pressure maintained for a period of minimum 10 minutes, The consolidation grouting of the foundations shall be done at pressure up to 3 to 4 kg/cm² or by the engineer-in-charge.

Utmost care and precautions shall be taken to ensure that the masonry or concrete is not damaged during the grouting- Any damage caused to the concrete or masonry or any other element, material or structure in the present work or adjacent to it, shall be made good by the contractor at his own expenses and to the satisfaction of the Engineer -in-charge.

4.6 GROUTING EQUIPMENT :

The equipment for mixing and grouting shall be capable of effectively mixing in corrected specified proportions, agitating the grout and pumping it into the holes in an uninterrupted flow at the designated pressure up to a maximum of 15 kg/cm² There should be satisfactory arrangements for accurately measuring the quantity of water, cement and other ingredient Agitation shall have paddle of suitable design and shape to keep the mix in proper consistency till it is pumped into the hole - Standard equipment of approved quality shall be used.

The mixing and conveying system shall be laid out to provide sufficient capacity for a heavy flow of grout. The mixer shall be in two compartments or parts so that grout could be mixed in one when that from the other is being pumped. The components or parts shall be independently connected to pump. In general an uninterrupted flow of grout shall be maintained and the grout conveyed from the pump to the hole through a pipe.

The mixer shall be placed as near the hole as possible and long Pipe lines avoided. The flow of grout into the holes shall be controlled by a pressure relief valve by passing and returning to mixer, all grout not accepted by the hole at the desired pressure.

Proper pressure gauges shall be provided to measure the pressure of the grout pumped into the hole. They shall provide with diaphragm to prevent grout mix getting into the gauges & clogging them. The circulating System shall be so provided that the grout shall be kept circulating continuously at sufficient velocity to prevent settlement of cement or clogging of pipeline and fixings. The pumps and the pipelines shall be flushed with clear water at frequent intervals, to keep them clear. Deposit of grout in the pump, mixer, etc. not removed by flushing shall be removed by scrapping, chipping etc. A fine screen capable to being readily removed, cleaned and replaced would be desirable between the mixer and the pump. Proper arrangements shall also be provided with equipment to stock adequate quantity of cement etc. likely to be required for the grouting.

After the grouting operations are completed for the shift on the day the remaining unused grout mix shall be thrown away. Also a mix not used up completely within one hour after mixing of that which in the opinion of the Engineer-in-charge has set or clogged shall be thrown away.

4.7 METHOD OF APPLYING GROUT :

The grouting of hole shall be continued until the hole or a continuation of holes takes grout mix at a rate less than.

<u>Rate of grout</u>	<u>Time in Minutes</u>	<u>Pressure</u>
0.03 Cum	20	As decided by the Engineer-in-charge and depending upon the location

The grouting shall however, be stopped when the pressure gauge registered sudden rise or when other indications are seen on extension or upheaval of rock, under the pressure being applied

After the hole has been grouted it should be closed by means of a valve to maintain the grout under pressure in the seams or crevices into which it has been forced

After any hole is grouted, it should be examined of cement just settled unduly with water coming up, the amount of settlement depending on the proportion of mix used. Holes where such settlement has taken place are to be cleaned of all soft sediment and grouted again under pressure.

Grouting operations shall always be started in the side of pattern towards which the seams dip so that the trapped air may be more easily forced out.

Grouting shall be continued until at specified pressure the hole refuses to take grout more than specified above. If for any reason grouting operations must be stopped before a hole has been grouted to refusal, clear water shall be kept running into the hole until grouting is resumed. Where grouting of foundation is to be done after concrete or masonry has been placed, no hole or connection shall be grouted until all concrete or masonry within a radius of 15 m. and to a thickness of not less than 3 m. has attained sufficient strength. For grouting these areas after concrete or masonry is placed and has set, pipe nipples shall be installed where foreseen and necessary connection made for later grouting.

4.8 TEST FOR GROUTING WORK:

To test the efficiency and penetration of grouting fresh holes shall be drilled as directed by the Engineer-in-charge after the grouting operations are completed. These holes shall be tested by water under pressure equal to the maximum grout pressure adopted at the particular location and the amount and the rate of leakage if any measured in each such hole. If the Engineer - in - charge so directs such holes shall be grouted at pressure specified by the Engineer-in-charge. If not these

holes shall be left open. No extra payment will be made for testing the holes by water. If such holes are grouted under directions of the Engineer-in-charge such grouting will be paid for as ordinary grouting on the basis of quantity of cement actually forced in. Cost of drilling of such holes shall be paid under the appropriate item of drilling.

4.9 KEEPING RECORDS OF DRILLING AND GROUTING OPERATIONS :

Records shall be maintained by the contractor of drilling grouting and testing etc. neatly and systematically in the manner approved by the Engineer-in-charge the exact locations of all holes in relations to proper reference lines and accurate logs of all operations shall be detailed in the record maps and section shall be complied showing all conditions of holes grouted. All information regarding the grouting operations amount of grout taken effects observed in the surrounding holes and rock etc. shall be noted for each hole. Observation about behavior of holes under air and water pressure, appearance of wash water, quantity and proportion of grout used, time and pressure of grouting applications etc. shall be noted for each hole.

A copy of such records shall be submitted to the Engineer-in-charge daily during drilling and grouting operations.

4.10 GROUTING MUST BE DONE IN THE PRESENCE OF THE ENGINEER-IN-CHARGE:

Whenever pressure grouting is to be done, the contractor will give due notice thereof to the Engineer-in-charge, to enable him or his authorized representative to be present during the grouting operations, which will always be done in his presence.

4.11 FINISHING:

The grout mix, that might flow out or otherwise or split on the foundation rock or concrete or masonry or other surface shall be removed expeditiously without allowing any time for the grout to set on any of the aforesaid surfaces After the grout has set, the grout holes shall be plugged with cement mortar in the proportion of one to two by volume and the surfaces finished smooth in line with the floor at that location.

4.12 CALIBRATION OF PRESSURE GAUGES AND WATER METERS ETC:

The contractor should calibrate the pressure gauges and water meters from time To time at his cost as directed by the Engineer-in-charge. The contractor shall produce necessary test certificate for such calibration. The pressure gauges and water meters, which have been duly tested and calibrated, shall only be used for grouting and testing holes.

E. BUILDING WORKS

- 1.0 Brick Masonry
- 2.0 Plastering
- 3.0 Pointing
- 4.0 Steel/Aluminum doors & windows
- 5.0 Rolling Shutter
- 6.0 Flooring
- 7.0 Damp proofing
- 8.0 Fencing
- 9.0 Chequered Plate
- 10.0 Oil bound Distemper
- 11.0 Water Proofing
- 12.0 Water supply & Sanitary fitting (General)
- 13.0 Lighting Conductor

1.0 BRICK MASONRY

- 1.1 Scope
- 1.2 Bricks
- 1.3 Mortar
- 1.4 Preparation of foundation bed
- 1.5 Laying
- 1.6 Item to include

BRICK MASONRY

Providing first class kiln burnt brick /Fly Ash masonry with conventional/I.S. type bricks cement mortar 1:6 in superstructure including pointing with cement mortar 1:3 on outside exposed faces and racking out joints where plastering is to be done, watering and scaffolding complete.

1.1 SCOPE

The item refers to First class Kiln Burnt Brick/Fly ash masonry in superstructure of buildings required for construction of Control Room and Pump House Complex and other places wherever required.

1.2 BRICKS

Bricks shall be of first class of the type mentioned in the item.

1.3 MORTAR

Cement mortar or lime mortar as mentioned in the item shall comply with specifications and shall be of proportion as mentioned in the wording of the item.

1.4 PREPARATION OF FOUNDATION BED

If the foundation is to be laid directly on the excavated bed, the bed shall be leveled, cleared of all loose materials, cleaned and wetted before starting brick masonry. If the masonry is to be laid on concrete footing, the top of the concrete shall be cleaned and moistened. The contractor shall obtain the Engineer's approval for the foundation bed, before foundation brick masonry is started.

1.5 LAYING

Brick work shall be laid in English bond unless specified otherwise. Bricks in each course shall break joint with those in the course below and above. Brick work shall be constructed for the number of floors as specified or, the drawings. The fixtures, plug, frames of doors windows, cupboards etc. shall be housed in to the brickwork as the correct location and levels while laying brick work only. The iron and steel fixtures in brick masonry shall be laid in 1:3 mix cement mortar to prevent corrosion. The ends of steel beam resting on masonry shall be built round with space for repainting where necessary. If required to be embedded, they shall be protected with red lead primer coat and a thick coat of hot coal tar or embedded in 1:2:4 cement concrete, Portions of timber scantlings in contact shall be painted with 2 coats of hot boiling coal tar before fixing in masonry.

The beams shall be supported on templates of dressed stone or plain reinforced concrete fixed in the wall. The templates will not be paid for separately. Where the R. C. C. slabs bear on the walls, the top of the wall shall be leveled and finished smooth with 12 mm thick 1:4 cement mortar and cured. The plaster may be white washed or covered with paper to minimize friction when movement of slab is expected. Where required, rebates shall be cut into the brickwork to hold the

frames of doors, windows, etc. Holdfasts shall be built into the brickwork. Holes, sleeves, openings etc., of the required size and shape shall be left in the brick work during laying only for fixing pipes, service line, passage of water, etc. The dimensions of openings shall be as far as possible conform to the whole multiples of brick dimensions to minimize cutting of bricks. After the service lines, pipes etc. are fixed the extra hollow left in the hole shall be filled with 1:3 cement mortar or 1:3:6 cement concrete and shall be finished neatly with facing bricks. The frames of wooden doors and windows and heavy steel door and window frames shall be built in as the brick work is being constructed. But for ordinary steel doors and windows, required openings for frames, holdfasts, etc., shall be left in the wall and frames embedded later to avoid damage to the frames. Well seasoned tapered wooden plugs of the size shown in the drawings or directed by the Engineer shall be embedded in the brick work during laying only. The joints with frames etc shall be neatly finished while pointing or plastering.

The top of brick work for receiving slopping roofs, gables, etc. shall be finished to the required slope and the required height. No hollow space shall be left between the roof and the top of the wall. Anchors of roof trusses etc. shall be embedded in the masonry as it proceeds.

Fixtures (except wooden plugs) frame, anchors, templates etc. shall however, be paid for under separate items.

For the face of brickwork where plastering is to be done, joints shall be racked out to a depth not less than the thickness of joints. The face of brickwork shall be cleaned and mortar droppings removed the very day that brickwork is laid. Scaffolding shall be double.

Technical Specification for Fly Ash Bricks shall be as per IS :3812(PART-I)-2003 & IS:12894-2002

2.0 PLASTERING

- 2.1 Scope
- 2.2 Scaffolding.
- 2.3 Preparatory work.
- 2.4 Gauge.
- 2.5 Plastering
- 2.6 Finishing.
- 2.7 Molding.
- 2.8 Watering and curing
- 2.9 Bad work.
- 2.10 Cement plaster in two coats.
- 2.11 Tools and accessories
- 2.12 Programme of work in relation with plastering,
- 2.13 General precaution in plastering.
- 2.14 Finishing.
- 2.15 Item to include.

PLASTERING

Providing cement plaster 20 mm (about 3/4") thick In two coats in cement mortar 1:3 to concrete or brick surfaces, in all positions including scaffolding and curing complete.

2.1 SCOPE :-

Item refers to Plastering to the Brick masonry required for Construction.

Cement mortar shall have the proportion of cement to sand as mentioned in the wording of the item or in the special provisions and shall comply with specifications of cement Mortar.

2.2 SCAFFOLDING:

Scaffolding required for facility of construction shall be provided by the contractor at his expense.

Scaffolding shall be double or single as is warranted for the particular class of masonry. But the end of poles shall not be placed in the position of header stones. Scaffolding shall be erected with steel sections or pipes, bullies or bamboos of adequate strength so as to be safe for all construction operations. The contractor shall take all measures to ensure the safety of the work and working people. Any instructions of the Engineer in this respect shall also be complied with. The contractor shall be entirely responsible for any damage to property or injury to persons resulting from erected scaffolding, defective ladders and materials or otherwise arising out of his default in this respect. Proper scaffolding shall be provided to allow easy approach to every part of the work. Overhead work shall not be covered.

Pot log holes shall be made good by bricks to match the face work when scaffolding is removed after ensuring that all holes behind are solidly filled with M15 cement concrete.

2.3 PREPARATORY WORK:

All joints in the face work that is to be plastered shall be raked out to a depth equal to not less, than the width of the Joints or as directed by the Engineer. The raking shall be done taking care not to allow any chipping of brick masonry. In new work the raking out shall be done when the mortar in the joints is still green, Smooth surfaces of concrete, old plaster etc. must be suitably roughened to provide necessary bond for the plaster. All dirt, soot, oil, paint or any other material that might interfere with satisfactory bond shall be removed. The surface to be plastered shall be cleaned and scrubbed with fresh water and kept wet for 6 hours prior to plastering. It shall be kept damp during the progress of the work. The plastering shall not be commenced unless the Engineer-in-charge passes the preparatory work in writing.

2.4 GAUGE:

Patches of Plaster 15 cm x 15 cm. (about 6" x 6") shall be put on about 3 m (about 10') apart as gauges to ensure even plastering in one plane.

2.5 PLASTERING:

In all plaster work the mortar shall be firmly applied with somewhat more than the required thickness and well pressed into the joints and on the surface and rubbed and leveled with a flat wooden rule to give required thickness. Long straight edges shall be freely used to ensure a perfectly plane and even surface. All corners must be finished to their true angles or rounded as directed by the Engineer, The surface shall be finished to plane or curved surfaces as shown on the plan or directed by the Engineer and shall present a neat appearance.

The mortar shall adhere to the masonry surface intimately when set and there should be no hollow sound when struck. Cement plastering shall be done in squares or strips as directed. Plastering shall be done from top downward.

2.6 FINISHING:

In any continuous face of a wall, finishing treatment of any type shall be carried out continuously and day to day breaks made to coincide with architectural breaks in order to avoid unsightly junctions.

2.7 MOULDING:

All mouldings shall be worked true to template and drawn neat, clean and level. All exposed angles and junctions with doorframes etc. shall be carefully finished, arises shall be beaded if ordered.

2.8 WATERING AND CURING:

All plasterwork shall be kept damp continuously for a period of 14 days, to prevent excessive evaporation on the sunny or windward side of the buildings in hot, dry weather. Matting or gunny bags may be hung over on the outside of the plaster in the beginning and kept moist.

Should the contractor fail to water the work to the satisfaction of the Engineer, the Engineer may engage requisite labour, materials or equipment to water the work properly at the cost of the contractor.

2.9 BAD WORK:

Should the mortar of the plaster perish through neglect of watering or for any other default and if the work is not done as specified above, the plaster shall be removed and redone at the contractor's expense.

2.10 CEMENT PLASTER IN TWO COATS :

When plaster is to be laid in two coats, the average thickness of first coat of plaster is generally 10 mm (about 3/8") on Brickwork. The first coat is applied as per specifications given so far but the surface is not floated or polished but roughened to give a key to the second coat of plaster. Before the first coat hardens, it shall be combed in way lines about 10 cm apart and 3 mm (about 1/8 ") deep. The first coat shall be kept damp for at least 2 days immediately following its application. It shall then be allowed to become thoroughly dry. Before starting to apply the second coat the surface of the first coat shall be damped evenly. The finishing coat shall be of such thickness as to make the total average finished thickness equal to the required plaster thickness as per item. The finished surface shall be true and even, and present a uniform texture throughout and all joining marks shall be eliminated.

2.11 TOOLS AND ACCESSORIES:

Tools and accessories used in plasterwork may advantageously conform to I.S. 1630 -1960. All tools shall be cleaned by scraping and washing at the end of each day's work or after use. Metal tools shall be cleaned after each operation all tools shall be examined to see that they are thoroughly cleaned before plastering is begun.

2.12 PROGRAMME OF WORK IN RELATION TO PLASTERING

The programming of other building operations before, during and after plastering shall be according to the instructions contained in clause 4 of I. S. 1661-1960.

2.13 GENERAL PRECAUTIONS IN PLASTERING :

All general precautions as specified in IS. 1661 - 1960 clause 9, shall be taken and preparation of the background shall be done as laid down in I.S. 1661-1960 clause 13. Care shall be taken to see that other parts of the work or adjacent works are not damaged while plastering.

2.14 FINISHING :

When no finish is specified the plastered surface shall be rubbed well to an even place with a wooden float for external surface and finished smooth with a steel trowel for internal surfaces.

When cement finish is specified, a coat of pure Portland cement slurry 1.5 mm thick shall be applied to the plastered surface while the second coat is still fresh

The thickness of the cement plaster shall be 20 mm (about 2/3") excluding cement finish.

3.0 POINTING

- 3.1 Scope
- 3.2 Raking of joints
- 3.3 Colour
- 3.4 Item to include

POINTING

Providing pointing with cement mortar 1:4 for brick work including scaffolding and curing complete.

3.1 SCOPE:-

Item refers to pointing to the Masonry Works required for Construction Work.

1. MATERIALS – CEMENT MORTAR :

Cement mortar for pointing shall be of the specified proportion and be as per specifications given in specifications for mortars. Normally the mortar mix shall be cement one part to sand 4 parts (1:4).

2. SCAFFOLDING:

Scaffolding to be as per specification for concrete/ Brick work/ plastering.

3. CONSTRUCTION DETAILS :

Unless other type of pointing is specified in the item or the special provisions pointing shall be of the grooved type. The joints in the masonry shall be raked out to a depth not less than the width of the joint or as directed in the special Provisions or by the Engineer, when the mortar is green. The joints are to be brushed clean of dust and loose particles with a stiff brush. The area shall then be washed and the joints thoroughly wetted before pointing is commenced.

3.1 The raked out joints shall be filled with mortar of the specified mix and required consistency and well pressed and rubbed smooth.

3.2 As semicircular depression 3 mm. (about 1/8") diameter shall be made in the joint by pressing a clean string with trowel keeping the sting exactly horizontal and on the centre line of the joint. The vertical joints shall be similarly marked. These depressed lines will then be immediately rubbed with a nayla till they become uniformly 6 mm (about 1/4") deep and 6 mm (about 1/4") wide. Intersection of the horizontal and vertical joints shall be finished neatly with the vertical line just touching the horizontal line but not crossing it. The pointing mortar shall not spread over the adjoining bricks, Mortar pointing shall be restricted to the width of the joints all superfluous mortar shall be removed with trowel.

3.3 RAKING OUT JOINTS:

Where the joints have not been raked out when the mortar is green the joints shall be chipped to the required depth, (without damaging the brick work) thoroughly cleaned of all loose particles and washed before pointing is done. The raked, joints shall be damp when cement mortar is being applied to them.

3.4 COLOUR :

If colour is ordered by the Engineer to be added to the mortar to match the colour of stones, approved pigment of the required colour shall be added to the cement in the mortar.

4. WATERING

The pointed face shall be kept continuously wet for 14 days after initial set.

Should the contractor fail to water the work as specified, the Engineer may if required in the interest of work and to keep the scheduled programme, supply labour; materials and equipment to water the work and charge the cost to the contractor.

5. BADWORK :

Should the mortar perish or deteriorate through neglect of watering or any other default and if the work is not done neatly and as specified above, the pointing shall be removed and redone at the expense of the contractor.

4.0 STEEL / ALUMINIUM DOORS & WINDOWS

- 4.1 Scope
- 4.2 Teak Wood boxing and architraves
- 4.3 Finishing
- 4.4 Item to include

STEEL/ALUMINIUM DOORS & WINDOWS

Providing and fixing steel doors of various sizes as per detailed drawings without / with hot dip zinc coating without/ with ventilators including fabrication, glazing with hot acetinic/ plain/ obscured glass panes of approved type and quality, kick plates all fixtures and fastenings, without/ with teak wood boxing and architraves and finishing with oil painting complete.

4.1 SCOPE:

The item refers to providing and fixing of steel door in a building for Control Room & Pump House. The steel doors shall conform to I.S. 1038-1968 and fixing and glazing the door shall be done as per I.S. 1081-1960.

Alternative type of door & window i.e. with Aluminium frame & is chosen. The same shall be got approved by Engineer-in-Charge.

4.2 TEAK WOOD BOXING AND ARCHITRAVES:

When included in the item teak wood boxing and architrave of 6 cm x 2 cm or other sizes shown in the drawings shall be provided all round the door from inside and the edges shall be finished with plaster or dado work as the case may be to obtain a finished job. The joints of the window frame with masonry shall be finished neatly with cement mortar.

4.3 FINISHING

The steel doors which are not hot dip zinc coated shall be finished with 2 coats of oil paint of approved colour and shade on a primer coat of red lead. The doors boxing and architraves shall be finished with 2 coats of oil paint approved color and shade on a primer coat of red lead. The wooden boxing and architraves shall be finished with 2 coats of oil paint of approved shade.

5.0 ROLLING SHUTTER

- 5.1 Scope
- 5.2 Finishing
- 5.3 Painting iron and steel work
- 5.4 Item to include

ROLLING SHUTTER

Providing and fixing rolling steel shutters fabricated from 18/20 gauge steel laths with side guides, bottom rail, brackets, door suspension shaft, rolling springs, locking arrangements and housing box at the top including painting complete.

5.1 SCOPE:

The rolling steel shutters required for Pump House Complex shall be of approved make and design & shall be suitable for fixing in the position ordered, i.e. outside, inside, on or below lintel or between jambs. The shutters shall be of manually operated pull or push up type up to 10 Sqm areas. If area of the shutters is between 10 Sqm three ball bearings shall be provided for easy operation. The particulars of the shutters shall generally be as under unless any other suitable changes are proposed by the approved manufacture and accepted by the Engineer

- a) The shutter shall be constructed with curved slats or laths from mild steel sheets of the specified gauge. The laths shall be machine moulded and straightened with an effective bridge depth of 16 mm (about 5/8"). These slats shall slide into one another forming a continuous hinge throughout their length and shall be fitted with alternating end lock.
- b) Side guide and bottom rail shall be built up from mild steel rolled sections but in the case of small shutter they may be of pressed steel. The sizes of these members shall be as shown on drawings or as approved by the Engineer. The guides shall be generally 6 cm. (about 2 1/2")
- c) Rolling springs shall be manufactured from tested unbreakable high tensile tempered spring steel wire or strip of adequate strength to balance the shutter in all positions.
- d) The springs assembly shall be supported on strong mild steel or brackets shaped to fit the lintel. The shutter when coiled up shall be housed in a box of 18 gauge steel metal.
- e) Locking arrangement shall be provided at the bottom of the shutter at both ends. The shutter shall be opened from outside.
- f) The shutter shall be complete with door suspension shafts, locking arrangements, pulling hooks, handles and other accessories.
- g) Firing shall be done in a workman like manner so that the operation of the shutter is easy and smooth. All work disturbed or cut away shall be made good to match the existing.

5.2 FINISHING:

The whole work shall be painted with 1 coat of red lead and 2 coats of aluminum or other paint of approved shade.

5.3 PAINTING IRON AND STEEL WORK:

In addition to specifications for oil painting "General " the following shall also apply for painting Iron and Steel Work -

Operation and workmanship for painting iron and steel work shall be as per I.S 1477 (Part I) 1959, code of practice for finishing of Iron and Steel in Buildings, painting and allied finishes. Subject to the following -

- i. The method of preparation of the surface for painting shall be as specified by Engineer in charge- Where Iron and steel works need repainting (maintenance), instructions detailed In clause n of I. S. 1477 (Part - I) 1971 shall be followed.
- ii. Red lead paint shall be used for primer coat unless other paints are specified. The number of primer coats shall be given in detailed specifications for each item where not given it shall be one coat.
- iii. Intermediate protective treatments (pre-treatments) shall be omitted unless specified in the special provisions.
- iv. The finishing coat shall be of the paint as specified for each item by the Engineer. The number of finishing coats of the required shade of colour shall also be specified for each item separately. They shall be two when the number is not specified.
- v. Actual date of painting girders, steel tanks and other steel structures shall be neatly marked by the contractor on the structure according to the instructions of the Engineer-in Charge.

6.0 FLOORING

- 6.1 General
- 6.2 Material
- 6.3 Construction Details.

FLOORING

Providing 50 mm thick Heavy Duty CC flooring with non metallic hardener in the sevice area. In other places, Providing and laying polished shahabad/Tandur kotah stone flooring 25 mm to 30 mm thick on top of slab on a bed of 1:4 cement mortar (20 mmthick) including cement float for mortar bedding cement pointing in c.m. 1:3 curing, cleaning etc. complete with all leads and lifts.

6.1 GENERAL

- i. All the stone slabs shall be square in shape. The dimensions of polished stone of appropriate size & pattern plain diamond as specified directed by the Engineer-in-charge. Tolerances in thickness shall be +/-3 mm.
- ii. The exposed surface of the specified stone flags shall be machine polished to a smooth, even and true plane and the edge machine cut square and to the required shape when necessary. Samples shall got to be approved by the Engineer-in-charge who will keep them in his office for reference.
- iii. The thickness of joints shall not exceed 1.5 mm.
- iv. Joints shall be grouted with neat cement slurry.
- v. When the bedding and joints of the flooring have completely set, the surface shall be machine polished to give a smooth, even and true plan to the floor and thoroughly cleaned.

6.2 MATERIALS

Polishing stone paving slabs.

The flag stones specified in the item shall be got approved by the Engineer-in-charge. At it's thinnest part, no stone shall be thinner than 25 mm. polished stones shall be hard. Sound, durable resistant to wear. rectangular in shape or square if directed by the Engineer-in-charge and of the specified width. They shall have plain surface. Uniformity of size shall generally be maintained in any one room. The stone polished shall be without any soft veins, cracks or flows and shall have a uniform colour. They shall have even natural surfaces free from broken flakes on top and shall be chiseled on edges to half its depth. true and square to ensure uniform width of joint. The evenness of the surface and edges of the slab shall be allowed for the slabs. The edges shall be quite straight. The under face may be left as quarried. Samples of stone slabs to be used and their dressing shall be got approved by the Engineer-in-charge and the slabs to be used shaft conform to the approved sample.

BEDDING

Cement mortar for the bedding and cement mortar pointing shall be of the proportion as specified on the item, cement mortar shall comply with para 7.9 used for bedding.

6.3 CONSTRUCTION DETAILS

BEDDING

Base of cement concrete shall be laid and compacted to a reasonably true plain surface and to the required slopes and below the level of the finished floor to the extent of the thickness of the slab and mortar bedding. Cement mortar for bedding be mixed by a mechanical mixer, Amount of water added shall be the minimum necessary to give just sufficient plasticity for laying and satisfactory bedding. Care shall be taken in preparing the mortar to ensure that there are no hard lumps that would interfere with the even bedding of the stones. Before spreading the mortar, the sub-floor or base shall be cleaned of all dirt, scum or laitance and of loose material and then well wetted without forming any pools of water on the surface. In case of R.C.C. floors, the top, shall be left a little rough. All points of level for the finished paving surface shall be marked out. The mortar shall then be evenly and smoothly spread over the base by the use of screed battens only over so much area as will be covered with slabs within half an hour. The thickness of the mortar bedding shall not be less than 1 mm not more than 25 mm. The required slope shall be given to the bed.

FIXING STONE SLAB:

Before laying the stone polished shall be thoroughly wetted with clean water. Neat cement grout of honey like consistency shall be spread on the mortar bed over as much areas as could be covered with the slab within half an hour. The specified type of stone polished shall laid on the here cement float and shall be evenly and firmly bedded to the required level and slope in the mortar bed. Each stone polished shall be gently tapped with a wooden mallet till it is firmly and properly bedded. There shall be no hollows left. If there is a hollow sound on gentle tapping of the slabs, such slabs shall be removed and reset properly. The mason shall make the joints of uniform thickness and in straight lines. The joint thickness shall not exceed 1.5 mm and filled solidly with mortar for their full depth. The joints shall be struck smooth but there shall be no smearing on mortar over the slabs. When pointing to be done, the joints shall be marked W for not less than the width of the joints when the mortar is green. The stone polished shall be laid so as to give continuous parallel long joints with cross joints at right angles to them. The edges of the adjoining slabs shall be in one plane. Where the slabs cover open edges of floor or windowsills the edges neatly rounded off. This shall be included in the rate.

When diamond pattern paving is provided in the item, the slabs shall be square and laid to the diamond pattern with triangular shaped slabs to make up the edges. In plain pattern stones on each course shall break joint those in the next.

POINTING:

When pointing is to be done, the joints shall be pointed with cement mortar of the proportion mentioned in the wording of the item para 7.13. If the slabs are smeared with mortar they shall be cleaned immediately after pointing. When pointing is not specified joints shall be struck.

CURING:

The flooring shall be kept well-wetted with damp sand or water for fourteen days. It shall be kept undisturbed for at least seven days.

CLEANING:

All flooring shall be thoroughly cleaned and handed clean free from any mortar stains etc.

7.0 DAMP PROOFING.

- 7.1 Scope
- 7.2 Materials
- 7.3 Laying
- 7.4 Item to include

DAMP PROOFING

Laying damp-proof course for the basement with latest technology shall be adopted.

7.1 SCOPE:

The item pertains to the provision and laying of damp-proof course basement including the primer, bitumen binder and bitumen felts required for slabs of Pump house & other buildings.

7.2 MATERIALS:

The following materials shall be used for damp proofing.

1. Flexible materials like Butyl rubber, hot bitumen, continuous plastic sheets under floors, bituminous felts, sheets of lead, copper etc.
2. Semi rigid material like mastic asphalt.
3. Rigid materials like impervious bricks, stones, slates, cement mortar with water proofing compound or cement concrete painted with bitumen etc.
4. Coarse sand layer under floors.

Specification of above materials shall be taken from the relevant IS Codes.

8.0 FENCING

- 8.1 SCOPE.
- 8.2 MATERIALS.
- 8.3 ITEM TO INCLUDE.

FENCING

Providing & erection of 2.4 m high chain link fencing 50 x 50 mm x 10 gauge fixed with horizontal 30 x 30 x 3 mm M.S. angles and 20 x 3.15 mm M.S. Strips with nuts & bolts & welding including inclined barbed wire fencing 8 rows @ top supported on M.S. angles 65 x 65 x 6 mm including fixing angles in C.C. 1:3:6 blocks of size 0.50 x 0.50 x 1.00 @ 2 m c/c fastening the chain link and barbed wire painting the M.S. angles & strips with one coat of lead zinc primer & two coats of oil paint with all leads & lifts etc. complete.

8.1 SCOPE :

The works covers providing chain link fencing around the work area.

The item pertains to the provision & erection of chain link fencing 2.4 m high of 50 x 50 x 10 gauge (3.25 mm dia.) supported on vertical M.S. angles 65 x 65 x 6 mm. Fixed with horizontal 30 x 30 x 3 mm M.S. angle & 20.3.15 mm M.S. strips with nuts & bolts & welding as mentioned in the item & drawings including providing & laying C.C. 1:3:6 for foundation blocks, fastening. The chain link and barbed wire and painting M.S. angles & M.S. strips with one coat of primer and two coats of oil paint.

8.2 MATERIALS :

Chain link fencing 50 x 50 x 10 gauge (3.25 mm dia.) shall be used & it shall be of the usual commercial type, Barbed wire shall confirm to IS 278-1969.

Structural steel i.e. M.S. angles, M.S. strips etc. shall be as per Std. Specification for structural steel work.

C.C. 1:3:6 for foundation blocks shall be as per standard specification for cement concrete.

9.0 CHEQUERED PLATE

9.1 Scope

9.2 Material

9.3 Erection

9.4 Item to include

CHEQUERED PLATE

Providing and fixing in position 8 mm. thick chequered plate with welding jointing, overlapping as per drawing including necessary fixtures and fastening with all leads and lifts etc. complete.

9.1 SCOPE

The work covers providing laying of chequered plates in the Pump house and other work complex.

The item provides for 8 mm, thick chequered plate flooring with M. S. Angle 50 * 50 * 6 mm for support of the flooring at landing level and opening near pumps.

9.2 MATERIALS

The M. S. chequered plate & M. S. Angle shall conform to I. S. 225 – 1969 & IS 800-2007 & shall be of required size & shape. The length of M. S. angle shall be 2.97 m.

9.3 ERECTION

The M. S. angle firstly fixed in wall/or over block out on arrangement for support to chequered plate as directed by Engineer – in – charge or as per detailed drawing. After fixing the angle in concrete chequered plate of required size shall be cut and welded to M. S. Angle.

10.0 PAINTING OF BUILDINGS & OTHER CIVIL WORKS

- 10.1 Scope
- 10.2 Priming coat
- 10.3 Application of distemper
- 10.4 Item to include

PAINTING OF BUILDINGS & OTHER CIVIL WORKS**10.1 SCOPE**

All External surfaces of the building shall be of weather coat type as per Paints manufacturers specs.

Providing and applying washable oil bound distemper of approved colour and shade to internal surfaces, in 1/2/3 coats, including scaffolding, preparing the surface to receive the priming and finishing coats complete.

PAINT

Washable oil bound distemper of approved make, colour and shade shall be used. It shall conform to I.S. 6278:1971, SP 1650:1973. Approved quality distemper like Shalimar, Berger, Asian paints, Nerolac etc. or of equivalent type shall be used.

SCAFFOLDING

This may be provided as per requirement to serve the purpose of a safe working area for painters.

PREPARING THE SURFACE

The surface to be distempered shall be cleaned and all cracks, holes and surface defects shall be repaired with gypsum and allowed to set hard. All irregularities shall be sand-papered smooth and wiped clean. The surface so prepared must be completely dry and free from dust before distempering is commenced. In the case of walls newly plastered, special care shall be taken to see that it is completely dry before any treatment is attempted.

For the old surface which had earlier been distempered, the surface shall be cleaned of grease, dust etc. The flakings of previous coatings if any, shall be taken off. All cracks, holes and surface defects shall be repaired with gypsum and allowed to set hard and then sand papered smooth and wiped clean. But in case the surfaces are coloured or white washed, the wash must be removed thoroughly first.

10.2 PRIMING COAT

The priming coat shall be applied over the completely dry surface in the manner recommended by the makers in the case of patent distempers. When no priming coat is specified by the manufacturer a finely powdered chalk mixed with a thin solution of glue shall be applied to prepare a good, hard background, the coating when dry being rubbed as clean and smooth as possible.

10.3 APPLICATION OF PAINT

The instructions of the makers shall be followed regarding preparation of the surface and application of priming and finishing coats. Paint shall not be mixed in a larger quantity than is actually required for a day's work. Hot water should be used to prepared the mixture. Distempers shall be applied in dry weather with a broad stiff brush in long paralld strokes. The treated surface shall be allowed to dry and harden. The next coat of distemper shall be laid on in exactly the same manner as the first one but only after the earlier coat laid has thoroughly dried. The number of coats of distemper to be applied shall be as mentioned in the item. The

brushes used should never be allowed to rest on the bristles and after the use they should be carefully and thoroughly cleaned.

WATER PROOFING

- 11.1 General
- 11.2 Materials
- 11.3 Laying
- 11.4 Item to include

WATER PROOFING

Water Proofing on roofs and wall water retaining structures shall be done as per the IS Specification using water proofing compounds of reputed manufacturers approved by the owner.

12.0 WATER SUPPLY & SANITARY FITTINGS

12.1 GENERAL

All the items under this group shall conform to the specifications given for each of the items, in addition to the bye-laws of the local bodies within whose jurisdiction the items are executed.

Where the bye-laws of the bodies differ from the detailed specifications for an item, the bye-laws shall override these specifications.

All damage done to floors, walls, etc., during the process of fixing water supply draining and sanitary installations shall be restored to their original condition.

All the pipes, fittings and appliances shall be free from cracks and other flaws before fixing and shall be undamaged in all respects during and after fixing. Any damage shall have to be rectified satisfactorily.

All the pipes, fittings and appliances shall be thoroughly cleaned before fixing and particular care shall be taken to see that no extraneous material gets into them during fixing.

All items required for ensuring leak proof and efficient functioning of the pipes and appliance shall be carried out without extra claims.

All cutting and waste of pipes involved in fitting them shall be included in the rate.

All diameters of pipes shall be the diameters of the inside bore.

All the pipes, appliances, fixtures and all other materials to be used shall be new and of good quality.

All the water supply and sanitary items shall be carried out by experienced and / or licensed plumbers to the entire satisfaction of the municipal bye-laws and the Engineer.

13.0 LIGHTNING CONDUCTOR

- 13.1 General
- 13.2 Materials
- 13.3 Fixing
- 13.4 Testing
- 13.5 Item to include

LIGHTNING CONDUCTOR

Providing and fixing copper lightning conductor including copper rod, upper terminal, tape conductor, earth plate excavating, laying the conductor and refilling complete.

13.1 GENERAL

The item pertains to the provisions and fixing of lightning conductor including the upper terminal, conductor and the earth plate.

13.2 MATERIALS

- (a) Copper tape conductor, 25mm x 3mm (1" x 1/8").
- (b) Solid copper rod upper terminal 19mm (3/4") diameter 1.5m long with a knob at the end with a conical spike on top.
- (c) Suitable clamps to fix the conductor to the wall.
- (d) Copper earth plate 1.5mm thick and one square meter in area.
- (e) Charcoal and sand for filling.
- (f) Cast iron pipe of 60mm diameter including fittings shall conform to I.S. 1230-1968.

13.3 FIXING

The upper terminal shall be fixed vertically at the highest point on the building and shall be at least 1.5m long. The terminating cone on the knob shall have a height equal to the radius of its base.

The conductor tape shall be attached to the upper terminal at the lower end by double riveting and soldering and shall be fixed along the building face from outside, most exposed to rain, with suitable hold-fasts at every 1.3m or less. The conductor shall preferably be in one piece and shall be straight as far as possible. If required to be bent, the straight length between the ends of bend shall not be less than half the curve length. For a height of 3 meters from the ground the conductor shall be enclosed in a 60mm diameter cast iron pipe secured to wall for protection from injury or theft. All metal surfaces, ridges, roofs, gutters, etc., shall be connected to the conductor with metal connections.

All joints in copper rod and tapes besides being well cleaned, sand papered, screwed, scrapped or riveted, shall be soldered in addition.

The lower extremity of the conductor shall be carried to 1 meter under the ground. Necessary trench and pit shall be excavated for laying of the conductor and the copper plate. The trench shall be 10 to 13 meters long and one meter deep and shall lead to a spot 5 to 6 meters from the building.

A copper tape of 25mm x 3mm shall then be riveted and soldered to the lower end of the conductor and carried along the trench up to the spot where the copper plate shall be buried. The other end of the tape shall be connected to the copper plate by riveting and soldering.

All the joints from the upper end of the top terminal to the earth plate shall be mechanically and electrically perfect.

The copper plate shall as far as possible be buried 60cm to one meter below the subsoil water level in the driest season of the year. Where the permanent water level is deep, it is necessary to provide shallow earths in trenches laid away from the building, the depths varying from 3cm in clay soils to 60cm in sand or shingle through which the rain percolates more freely. The length of these trenches shall be from 10m to 30m in dry soil.

Alternatively the conductor tape may be attached to a copper plug suitably riveted and soldered. This plug shall then be inserted into a water supply pipe by coupling or T joint.

The earth plate shall be surrounded with charcoal. The copper conductor shall be laid in charcoal and the trench filled with sand.

The surface drainage shall, as far as possible be directed towards the trench.

Generally copper tape and rod should not be painted. If so directed by the Engineers for architectural purposes the upper terminal and the conductor shall be painted with a red oxide base and two coats of paint to match the adjacent wall.

13.4 TESTING

The lightning conductor shall be tested for the resistance by a suitable apparatus. The overall resistance of the complete conductor system from the top finial to the earth in wet weather should be about 1 to 2 ohms. It should never exceed 10 ohms. If the results are beyond the above limits, the defects shall be rectified so as to get satisfactory results.

F. TRASH RACKS AND GATES**GENERAL:-****1.1 SCOPE OF WORK**

The Scope of the work covers the following items of work as per relevant IS Codes of Gates, Trash Racks & Hoists.

(a) Manufacturing and supplying including painting (field and workshop both), transport, erection, testing and commissioning of vertical gates with suitable hoisting arrangements.

(b) The scope of work also covers manufacture, transport, supply and erection of all the anchorages including first stage and second stage embedded parts required to be embedded in the first stage / second stage concrete for above gates. The scope of work also includes providing 2nd stage cement concrete of approved grade in block outs as per approved manufacturing drawings.

1.2 The scope of work also covers proper storing of all components, sub-assemblies, electromechanical parts etc. of the items to be furnished under this tender and keeping them in safe custody till they are taken over by the owner in the final installed form.

1.3 The Contractor shall furnish at his own expense all the materials, consumables, tools, plants, equipments, machinery etc. and labour and supervision required for carrying out manufacture / fabrication , transportation, supply installation, painting (both field and shop), testing and commissioning of the above mentioned components and equipments of the gates and hoists as per the conditions and specifications, in these tender documents and as per drawings as may be approved by the Engineer-in-Charge The Contractor shall also carry out at his own expense all the preliminary and enabling works and all other incidental works such as establishing a field workshop and stores, furnishing and installing erection aids, cranes if necessary, scaffoldings, ladders, temporary bracings and supports etc. complete as required to facilitate execution of work and shall also carry out at his own expense all other operation covered under the meaning and intent of conditions and specifications in the tender documents. The cost tendered by the Contractor for the above items shall be deemed to be inclusive of all expenses required to be incurred by him for executing the work.

1.4 APPLICABLE B.I.S. CODES:

All materials & methods and procedures for the work of design, manufacture, transport, supply and installation shall conform to latest edition Indian Standard Specification and other publication listed below unless otherwise specified.

IS : 800 Code of Practice for General Construction in Steel.

IS : 808 (Part – 1) Dimensions for Hot Rolled Steel Beams M.B. Series.

IS : 808 (Part – II) Dimensions for Hot Rolled Steel Column Series.

IS : 814 All parts Specification for covered Electrodes for Metal Arc Welding of structural steel, Welding Sheets.

IS : 815 Classification and coding of covered Electrodes for Metal Arc Welding of Structural steel.

IS : 816	Code of Practice for Use of Metal Arc Welding for General Construction in Mild Steel.
IS : 961	High Tensile Structural Steel
IS : 1028	IS : 1458 Bronze Bushing
IS : 7205	Safety code for erection of structural steel.
IS : 7215	Tolerances for fabrication of steel structure.
IS : 8500	Weldable structural steel (Medium & High strength qualities)
IS : 9595	Recommendations of metal Arc welding of carbon and carbon manganese steels.
IS : 9917	Specification for calcium base heat stable grease.
IS : 9954	Pictorial surface preparation standard for painting of seal surface.
IS : 11228	Recommendations for design of screw hoists for Hydraulic gates.
IS : 11855	General Requirements for Rubber seals for Hydraulic gates.

The above list is only indicative & in no way complete or exhaustive. Any other materials necessary as per approved drawings have to be procured and used by the Contractor within quoted rates.

1.5 TECHNICAL PROVISION FOR GATES

The materials shall conform to the specifications as mentioned in the approved drawings and as per direction of the Engineer-in-charge. The Contractor shall go through the approved drawings thoroughly and bring to notice of the Engineer-in-charge immediately of any discrepancy or deficiency before taking up fabrication. The Engineer-in-charge shall not be responsible if any problem arises due to discrepancy in the drawings noticed during or after fabrication. The Contractor shall be fully responsible for smooth operating of the gates under all conditions. The gates shall be capable of being operative at any opening under all conditions of unbalanced operations and shall be free from vibrations at all conditions of gate operation. The leakage through the gates shall not exceed the permissible limits.

1.6 METAL WORK, FABRICATION AND MACHINE WORK:

1.6.1 General workmanship.

All fabrication work under the contract shall be done in accordance with the specifications and works shall be performed and completed in a thorough workman like manner as per the practice in manufacture and fabrication of materials of the type covered by the specification. The work, shall in all cases, be of the highest quality and carefully performed to the specification of the Engineer-in-Charge. All materials and workmanship furnished by the Contractor be free from injurious defect. He shall replace free of cost to the Engineer-in- Charge , any defect in material or workmanship noticed during erection and shall bear all cost of the modification in the field of any defect for which he is responsible. Workmanship shall conform to the latest standards, laid down in Indian Standard specification.

All members shall be free of twists, bends or other deformations and all surfaces that will be in contact shall be thoroughly cleaned before assembling. Parts shall be adjusted to line and fit and shall be firmly bolted or otherwise held securely together so that surfaces are in close contact before drilling, reaming or welding is commenced.

If weight limitations and transport clearances do not permit anchorages and miscellaneous embedded parts, they shall be fabricated into sub-assemblies. The Contractor shall submit a drawing showing the sub-assemblies into which he proposes to fabricate the gates, anchorages, miscellaneous assemblies and embedded parts and hoists for transporting them to site.

Plates with laminations discovered during cutting, welding or at any other time shall be rejected. Minor surface imperfections can be repaired wherever possible with the prior approval of the Engineer-in-Charge. Materials not supplied or workmanship not performed in accordance with the approved drawings and / or with the specifications shall be rejected and replaced.

All parts of the gates, hoists shall be fabricated in accordance with the specifications and approved drawing. The Contractor shall take special care in fabrication of the parts affecting strength, rigidity and water tightness of the gates. The seal bases shall be finished after the plates have been welded to the skin plate and the finished surfaces of the seal bases shall be in the same plane within the tolerances as specified elsewhere.

1.6.2 FITS AND TOLERANCE

Fits used for difference components shall be according to the best modern shop practice. Due consideration shall be given to the special nature of function of the parts and to the corresponding accuracy required to secure proper operation. The fits shall be in accordance with the Indian Standard “Guide for the Selection of the Fits (First Revision) IS: 2709.

1.6.3 SCREW THREADS

The threads for bolts and nuts shall have metric threads of International Standards Organisation and conforming to Indian Standards “ISO Metric Screw Threads Diameter Pitch Combination IS: 4218 Part.II.

1.6.4 MACHINE FINISH

The type of finish, unless otherwise specified shall be that most suitable for the part to which it applies and shall be smooth, average or rough as defined under Indian Standard “Assessment of Surface Roughness (With Amendment No.1 to 3) IS:3073. A smooth finish (Three Delta, that is 0.20 to 0.8 micrometers) will be required for all surfaces in sliding / rolling contact, an average or commercial finish (Two Delta, that is 1.6 to 6.3 micrometers) for surfaces in contact where a tight joint is required and a rough finish (Single Delta, that is 12.5 to 25 micrometers) for all other machined surfaces which are not in contact, but which require finished for dimensional accuracy.

1.6.5 FABRICATION OF STRUCTURAL STEEL:

1.6.5.1 The structural steel work for the equipments covered by the specifications shall confirm to the requirements of “Reamed work and shall conform to the following requirements unless otherwise called for in these specifications.

1.6.5.2 STRAIGHTENING

Before being laid off or worked in any manner, structural materials shall be straight without twist, bends or kinks and if straightening is necessary, it shall be done by methods that will not injure or mark the materials. Heating or hammering shall not be permitted. All steel surfaces to be welded shall be cleared of dirt, rust and mill scale prior to fabrication.

1.6.5.3 SHEARING, CHIPPING AND GAS CUTTING:

Shearing, chipping and gas cutting shall be done carefully by torch or by arc and all portions of the work which shall be exposed to view shall present a neat appearance. Gas cutting shall be mechanically controlled. Re-entrant cuts and copes in beams and channels shall be filled before cutting.

1.6.5.4 PLANNING OR FINISHING EDGES:

Planning or finishing of the sheared or cut edges of plates or rolled shapes shall not be required except otherwise specified for welded edges or as shown on the Contractor's drawings, approved by the Engineer-in-Charge

1.6.5.5 WELDED EDGES:

The edges of plates or shapes to be joined by welding shall be properly formed to suit the selected type of welding. Sheared edges of plates and shapes to be jointed by welding shall machined or chipped to sound metal before welding.

1.6.5.6 BENT PLATES AND SHAPES

Where bending of plates or forming shapes is required, these shall be bent to the proper curvature by cold forming. Heating and hammering to correct curvature shall not be permitted.

1.6.5.7 DRILLING AND REAMING:

Holes shall be accurately located drilled and reamed perpendicular to the face of the member and if necessary a template shall be used. Holes in material 20mm, or less in thickness shall be sub-punched or sub-drilled before assembly and reamed to full size during assembly. Holes in materials more than 20mm in thickness shall be sub-drilled 3mm. smaller than the normal diameter of the rivet or bolt before assembly and reamed to full size during assembly.

Counter boring shall be done carefully to meet the requirements for clearance and fill the weld studs. Anchor bolt holes shall be punched or drilled out to full size. All holes shall be made by the following methods.

1) Punching.

Punching of holes to full size shall not be permitted. For sub-punching, the diameter of the punch shall be 4.5mm smaller than the nominal diameter of the bolt used and the diameter of the punch shall not be more than 2.50mm larger than the diameter of punch. All holes shall be clean cut without any burn or ragged edges or burrs.

2) Drilling and reaming

For sub-drilling, the diameter of the drill shall be 3mm. smaller than the nominal diameter of bolt used except where tapping is required for tight fit bolts. Ribbed bolts or dowel are to be used full size drilled or reamed holes shall not be less than 1.5mm nor more than 2.5mm larger than nominal diameter of the bolt used. Holes for ribbed bolts shall be drilled or reamed to 1.5mm. less than the diameter of the ribbed shank of the bolts to ensure a tight fit. Reaming of sub-punched or sub-drilled holes shall be done with machines after assembly. The templates shall be used when assembled reaming is impracticable. Tapped holes shall be drilled to the proper diameter for the tap used and shall be tapped carefully so that the threads will be continuous, smoothly cut and free from imperfections.

1.6.5.8 ACCURACY OF PUNCHING, DRILLING AND REAMING :**1) Before assembly :-**

The accuracy of all holes shall be such that during assembly, a cylindrical pin 3mm. less in diameter than the normal size of the holes shall be entered perpendicular to the face of the member.

2) During assembly :-

The accuracy of reaming and drilling during assembly shall be such that not less than 85 percent of any group of continuous holes in the same plane shall show no offset greater than 0.5mm between adjacent thickness of materials, unless a greater degree of accuracy is called for on the drawings approved by the Engineer-in-Charge- in these specifications.

1.6.5.9 WELDED STUDS:

Welded studs wherever used shall be welded in place with automatic end-welding guns. Templates of sufficient thickness to afford good alignment shall be used to accurately locate the studs during the welding cycle and to locate matching holes in other materials. Bushing shall be used for template holes, if necessary to ensure angular alignment of the studs and location, accuracy required for proper fit of parts to be assembled.

1.6.6 PATTERNS:

The price bid shall include the cost of all necessary patterns. Patterns shall remain the property of the Contractor. While making patterns, care shall be taken to avoid sharp corners or abrupt changes in cross section and ample fillets shall be used. The Contractor shall provide pattern thickness as will conform to his standard foundry practice and as may be necessary to ensure that all metal thickness of the finished castings shall be in accordance with the dimensions shown on the Contractor's drawings approved by the Engineer-in-Charge

1.6.7 WELDINGS :**1.6.7.1 PREPARATION FOR WELDING :**

Members to be joined by welding shall be cut accurate to size, and where required shall be rolled or pressed to the proper curvature in accordance with the dimensions shown on the Engineer-in-Charge's drawings. The edges of the member to be joined by welding shall be sheared, flame cut or machined to suit the required type of welding and to allow through penetration. The cut surface shall expose sound metal, free from laminations, surface defects caused by shearing or flame cutting operations and other injurious defect. The surfaces of plates to be welded shall be free from rust, grease and other foreign matter for a distance of at least 50mm, back from the edge of the weld. In assembling and during welding the components parts of built up members shall be held in place with sufficient and proper clamps or other adequate means to keep all parts in proper position.

1.6.7.2 WELDING TECHNIQUE :

All welding shall be performed by electric arc process using coated electrodes or other means whereby the atmosphere is excluded from the molten metal and where applicable, automatic machines with correct precision control shall be used. After being deposited, the weld shall be cleaned of slag or flux and shall show uniform section, smoothness of weld metal, feature edges without overlap and free from porosity and clinkers. Visual inspection at the edges and ends of welding shall indicate good fusion with the base metal. When weld metal is deposited in successive layers, each layer except the last shall be peened moderately with a tool before the next layer is applied. Particular care shall be taken in aligning and separating the edges of members to be joined by butt welding, so that complete penetration and fusion at the bottom of the joint shall be ensured. All pin holes, cracks and other defects shall be repaired by chipping or grinding the defects to sound metal and re-welding. Where fillet welds are used, the member shall fit closely and shall be held together during welding. The welding rods used for manual welding shall be of heavily coated type and shall be suitable for all position welding where required. While welding precaution shall be taken to minimize stresses due to expansion and contraction and distortion due to heat by using the proper sequence in welding i.e., by peening the welds while hot or by other satisfactory methods.

Rectification of distortions by blows after welding shall not be permitted. Welds shall not be primer coated until they have been inspected and approved by the Engineer-in-Charge. The welding shall conform to Indian Standard “Code of practice for use of Metal Arc welding for general construction in mild steel IS: 816. All skin plate welds shall be continuous and water tight and shall develop the full strength of plate. The electrodes shall conform to the “Indian Standard Specifications for covered Electrodes for Metal Arc welding of structural steel for welding products other than sheets and for welding sheets (Part-I and II) IS: 814.

The Contractor shall prepare shop and field welding procedure including stress relieving and preheat requirements and shall submit this procedure to the Engineer-in-Charge for approval. The procedure shall be in accordance with the best modern welding practice and shall be such as to minimize residual stresses and distortion of the finished members of the structure. Approval of any procedure, however, shall not relieve the Contractor of the sole responsibility for producing a finished product meeting all requirements of these specifications. Welds in contact with rubber seal shall be ground flush, all corners and corner welds in contact with rubber seal shall be rounded.

1.6.7.3 APPROVAL TEST OF WELDING PROCESS :

Specification of the welding procedure that are proposed to be used shall be established and recorded and a copy of such procedure, specifications together with certified copies of reports of results of tests made in accordance with the procedure specifications shall be furnished by the Contractor. The procedure specifications shall conform to the Indian Standard “Approval Tests for welding procedure Part-I Fusion Welding of Steel IS: 7307 (Part-II).

1.6.7.4 QUALIFICATION OF WELDERS :

All welders assigned to the work shall have passed qualification test for welders. If at any time, work of the welder appears to be questionable, such welder shall be required to pass additional qualification test conforming to Indian Standard “Code of Practice for Training and Testing of metal Arc welders “ IS:817 and Indian Standard “Approval test for welding procedure part-I Fusion welding of steel IS: 7307 (Part-I).

1.6.8 CASTINGS : DELETED

1.6.9 FORGINGS : DELETED

1.6.10 ERECTION OF BOLTS, NUTS, WASHERS AND OTHER FASTENERS:

Erection of bolts, washers and other fasteners shall be furnished in the amount of 15 percent the bolts, nuts, washers and other fasteners whichever is greater, in excess of the nominal nature of each size and length required for complete installation of equipment.

Bolts in tension shall have net section at root of thread 15 percent in excess of the net section required in tension.

1.6.11 WASTAGE OF STEEL

There shall be some wastage of steel section and plates during fabrication & cutting losses. It is the responsibility of the Contractor for minimizing such losses & the cost of such lost steel shall be deemed to have been included in the Bid price. Contractor s also shall not be compensated for the wastage of steel under price variation clause.

1.7 CLEANING, SURFACE PREPARATION AND PAINTING :**1.7.1 GENERAL**

The Contractor shall furnish, prepare and supply all materials for cleaning surface preparation and painting of metal work as hereinafter specified. The cost of furnishing, preparing and supplying all materials which are required for cleaning, surface preparation, painting and coating operations including supply of all labour, tools and equipments shall be included in the rate quoted.

1.7.2 CLEANING AND SURFACE PREPARATION:**1.7.2.1 Cleaning of different components**

(i) Gate Leaves/Hoist and Hoist bridges:

All the surface (except non ferrous surface and machined mating ferrous surface) of the gate leaves for the gates , hoist & hoist bridges etc. shall be cleaned and prepared for painting in accordance with the “METHOD –A specified vide section 1.7.2.2.1 below.

(ii) Embedded parts :

The surface (except non-ferrous surface and machined matting ferrous surface) of all the embedded parts for all the gates shall be cleaned and prepared for painting as under.

All the exterior ferrous surfaces of the embedded parts which are to come in contact with concrete shall be cleaned by the “METHOD-B” specified vide section 1.7.2.2.2 below.

The ferrous unfinished surfaces of the embedded parts which will be exposed to water or atmosphere shall be cleaned and prepared for painting in accordance with the “ METHOD –A” specified vide section 1.7.2.2.1 below.

(iii) All the exterior surfaces of the hoist and heads including non-matting finished surfaces and unfinished surfaces of hoist stems, coupling and stem retaining device shall be cleaned and prepared by the “METHOD-A” specified vide section 1.7.2.2.1 below.

(iv) The ferrous surfaces of the pipes and other fittings for the surfaces of hoist support frames and girders, ladders , hand railings, grating etc. shall be cleaned and prepared by the “METHOD – B” specified vide section 1.7.2.2.2 below.

(v) The exposed external surfaces of the bought out components like gear boxes, worm reducers etc. which are shop coated by their respective manufacturers shall be cleaned by suitable means in a manner which will avoid any damage to the components. The damaged portion (if any) of the shop coat on such items shall be repaired.

(vi) Any other metal work not specifically mentioned in the foregoing paras (i) to (v) above but which requires painting shall be cleaned and prepared for painting as directed by the Engineer-in-Charge.

1.7.2.2 METHOD-A AND METHOD-B**1.7.2.2.1 The METHOD-A shall be as under:-**

The weld surfaces shall be de-slugged and weld splatters, burrs and other objectionable surface irregularities shall be removed carefully. All rust, mill scale and other foreign substances shall be removed from the surfaces by scrapping, chipping, vigorous wire brushing, blasting or other effective means. Care shall be taken to avoid excessive brushings of steel. All oil, grease, dirt and all other contaminants shall then be removed by the use of clean mineral spirits, xylol or white gasoline and clean wiping materials.

1.7.2.2.2 METHOD-B:

In case rust forms on the surfaces become otherwise contaminated in the interval between cleaning and painting, re-cleaning shall be carried out by the same method as herein above specified for the respective items. Surfaces of stainless steel, Nickel, Bronze and machined surfaces adjacent to metal work being cleaned or painted shall be protected by masking tape or by other suitable means during the cleaning and painting operation.

1.7.3 PAINT MATERIALS AND PAINTING :**1.7.3.1 GATE LEAF :**

All the surfaces (except non-ferrous surfaces and machined mating ferrous surface) of the gate leaves for all the gates shall be after cleaning as per section 1.7.2.2.1 above, applied with 1(one) coat of Epoxy Base Primer followed by 2(two) coats of COAL TAR EPOXY. The Epoxy Base Primer and coal tar epoxy paint shall generally conform to the particular given in the relevant IS Codes or as directed by the Engineer-in-Charge. The first coat of the Epoxy Base Primer shall be applied within 4 hours of cleaning. The dry filling thickness (DFT) of each coat of zinc rich primer shall be at least 50 microns. The dry filling thickness (DFT) of each coat of coal tar epoxy paint shall be at least 100 microns.

1.7.3.2 EMBEDDED PARTS :

The surfaces (except non-ferrous surface and machined mating ferrous surfaces) of all the embedded parts for all the gates after cleaning as per the relevant foregoing para shall be coated as under:

- i) All the exterior ferrous surfaces of the embedded parts which are to come in contact with concrete shall be given 2(Two) coats of cement wash mixed with 5% potassium dichromate. The first coat shall be applied immediately after cleaning and second immediately before pouring concrete.
- ii) The ferrous, unfinished surfaces of the embedded parts (except stainless steel) which will be exposed to water or atmosphere shall be painted with the same paint materials (viz. Epoxy Base Primer and Coal tar epoxy paint) and coated in same manner as specified for the gate leaves vide foregoing section 1.7.3.1.

1.7.3.3 HOISTS AND OTHER PARTS

- i) All the exterior surfaces of the hoist stem (screw hoist) machined mating finished surfaces shall be given one coat of Epoxy Base Primer at a coverage rate of approximately 6 square meters per liter. This shall be followed by two coats of aluminium paint of suitable grade at a coverage rate at 5 square meters per liter per coat, without thinning. The hoist stems, couplings and stem retaining device shall be given four or more coats of red lead priming paint to achieve a total dry film thickness of 0.15 mm.

- ii) Miscellaneous items such as hoist support frames and girders, control cabinets, ladders hand railings, and gratings etc. shall be given 2 coats of Alkyd priming paint or machinery grade paint or Aluminum paint as directed by the Engineer-in-Charge. The exterior surfaces of the bought out items like electric motors, gear boxes etc. which are shop coated by the manufacturer shall be given one additional coat of the same paint as original shop coat or one coat of Alkyd priming paint or machinery paint or Aluminum paint as directed by the Engineer-in-charge.

1.7.3.4 APPLICATION PROCEDURE :

- a) Painting shall not be done when the ambient temperature is less than 10 degrees C and when relative humidity is more than 80%.
- b) Primer coats shall be applied without any time lag after the cleaning and surface preparation as per clause 9.7 above and care shall be taken to ensure that paint is not applied to damp surface.
- c) Painting shall be discontinued during rain and dust storm and shall not commence until the surfaces are perfectly dry and clean.
- d) Welds and adjacent parent metal shall not be painted or touched up prior to de-sludging inspection and approval.
- e) All materials shall be in a thoroughly mixed conditions at time of application and shall not be thinned unless otherwise specified. When paint is applied by spraying, suitable means should be provided to prevent segregation during the painting operation.
- f) Any warming of the paint materials shall be performed by means of hot water bath and except as specifically provided. Paints shall not be heated to a temperature higher than 38°C.
- g) Each coat of paint shall completely and uniformly cover the surface and shall be free from runs and sags. Each coat shall be allowed to dry or harden sufficiently as per manufacturers recommendations before the next coat is applied.
- h) The detail application procedure indicating method of preparing and applying etc. shall be evolved in consultation with the paint manufacturer which shall be followed by the Contractor.
- i) Surface to be painted that will be inaccessible after installation shall be completely painted as per schedule prior to installation.

1.7.4 REPAIR AND PROTECTION OF COATINGS :

Metal work that has been shop painted or field painted should be handled with care so as to preserve the coatings in best practicable condition. Before proceedings with a fresh coat the Contractor shall clean and repair all areas of the previous coat which are defective or damaged. Previous coat on the areas where the coating is loose, weakly bonded blistered, abounded or otherwise defective shall be removed to clean metal by scrapping, chipping, power wire brushing or other effective means. Areas thus prepared shall be cleaned of all dust, dirt and other contaminations using clean rags and clean solvent. These surfaces shall then be repainted in accordance with the painting schedule. Hair line cracks or areas where the thickness of coating is less than specified but which are otherwise damaged shall be cleaned of all dust and other contaminations if any, and shall be recoated with additional paint to build the coating to specified DFT. All repaired areas of paint will be required to pass

acceptance tests performed by the Engineer. The cost of cleaning and painting of damaged and defective areas shall be borne by the Contractor.

1.7.5 INSPECTION OF PAINT MATERIALS AND ACCEPTANCE TEST FOR PAINT COATINGS:

The Contractor shall use the paint materials made by reputed manufacturers whose paint have been successfully used on the underwater high head gates of other comparable hydro project in India. The particulars of the paint product intended to be used and name of the manufacturers shall be furnished to the Engineer-in-Charge for approval prior to making any use of any paint materials in the works.

All paint and coating materials shall be made available for sampling at least 30 days prior to use and no paint or coating materials shall be used until they have been tested and/or approved by the Engineer-in-Charge

1.8 SHOP TESTS AND INSPECTIONS:

1.8.1 GENERAL

All materials and components of the equipments offered under the specifications shall be tested by the Contractor prior to fabrication. After fabrication the equipment shall be assembled in the shop and shop tests shall be performed by the Contractor to ensure accuracy in fabrication and workmanship. The Contractor shall carry out such tests as may be required by the Engineer-in-Charge in order to determine that the gates, hoist will fulfill the functions for which they have been designed. The Contractor shall be responsible for all modifications and adjustments required for the work as a result of such tests. The test shall be repeated, if necessary, until they are successfully carried out to the satisfaction of the Engineer-in-Charge

1.8.2 TESTS OF MATERIALS :

All materials, supplied parts and assemblies thereof being used in the work to be done under these specifications shall be of tested quality and all works performed shall be subjected to rigid inspection and no article or material or supply shall be dispatched until all tests analysis and sub-inspection have been completed and certified copies of reports of results and analysis have been accepted by the Engineer-in-charge.

1.8.3 SHOP ASSEMBLY AND TESTS

1.8.3.1 GENERAL :

The gates hoists along with hoist bridge shall be completely assembled in the shop for inspection and to ensure that all parts to be connected are fitted properly and that all the dimensions, clearances and tolerances called for in these specifications and / or shown in the drawings of Engineer-in-Charge are obtained. Any template or layout plates required to ensure correct matching of holes in connecting parts for erection shall be furnished by the Contractor to the Engineer-in-Charge. The gates and the hoists shall be assembled in a vertical / inclined position to ensure proper alignment and holes for field connections shall be carefully drilled or reamed while the gates are being shop assembled. The gates shall be shop assembled as considered necessary to check fabrication and all parts shall be carefully match marked to facilitate erection at site.

1.8.4 INTERCHANGEABILITY

Where possible all similar items and removable parts of similar equipments of gates, hoists and their embedded parts shall be interchangeable with each other.

1.9 TRANSPORTATION AND STORAGE**1.9.1 GENERAL**

All the components to be furnished against items of BOQ and all the spare parts as may be ordered by the Engineer-in-Charge shall be transported by the Contractor as per the requirements stated below. The Contractor shall be also responsible for proper storage of the above mentioned components (till the acceptance of the final installed forms) at his field store or field workshop near project site. The land for establishing the field store / workshop is the responsibility of the Contractor for which no extra cost will be paid.

1.9.2 TRANSPORT

i) All the components shall be transported (including loading and unloading) by the Contractor from his workshop or any other place of their manufacturer as the case may be to the said field store / workshop near project site. The transport of the fabricated components from workshop to the said field shall be done after all shop tests are completed and after obtaining clearance from the Engineer-in-Charge. Such clearance given by the Engineer-in-Charge shall not be construed as acceptance of any components and the same shall in no way absolve the Contractor of his responsibility for satisfactory performance of the equipments or any office obligations under this contract. It shall be ensured that respective components are transported and brought to project site sufficiently in advance of the programme for their erection.

ii) The Contractor shall be responsible for any damage or loss in transport as well as for all claims to accident if any occurs in transporting the components. The necessary transit insurance for the equipment up to destination shall be the responsibility of the Contractor and insurance cost shall be borne by the Contractor.

iii) Disassembly for dispatch

After completion of required shop assembly shop tests and inspection the equipment shall be disassembled into minimum no. of sub-assemblies convenient for transport and storage without damage to any parts of the equipment to the satisfaction of the Engineer-in-Charge

iv) Unit marking, match marking and transportation designation

Each part of the cross regulator, head regulator and escape gates and their respective parts, hoists etc. which is to be transported as a separate piece shall be marked to show the unit of which it is a part and match marked to show its relative position in the unit to facilitate assembly in the field. Unit marks and match marks shall be made with heavy steel stamps and paints.

Each piece sub-assembly or package transported separately shall be labeled or tagged with transportation designation consisting of the specification number and the mark number of such piece or the no. of parts grouped in such sub-assemblies or contained in package.

v) Weighing , packing and preparation of transportation

All assemblies or parts shall be packed by the Contractor in a secured manner in boxes or crates and adequate skids and lifting slings provided where necessary. All

protruding pieces or long slender parts shall be adequately protected from damage. All exposed finished surfaces of the equipments shall be adequately protected from abrasion.. All packing shall be allowed for easy removal and checking at sites. Special precautions shall be taken to prevent rusting of steel and iron parts during transit. The methods proposed to be adopted for protection against moisture shall be subject to the prior approval of the Engineer-in-Charge. The Contractor shall provide an wooden blocking to prevent deflection and vibration of all parts of the gates and hoists during transport handling and storage. All opening shall be covered and all parts shall be tightly coated with a rust preventing compound as specified. Rubber seal shall be dismantled after shop assembly and shall be transported separately. They shall be rapped and boxed to protect them from any element which would adversely affect their size, shape or physical properties before their field assembly to the gates. The gates, hoists shall be prepared for transportation so as to permit minimum amount of field assembly.

All projecting plates etc. shall be kept in shape in timber or angles bolted to them. All straight bars and plates except small pieces shall be transported in convenient bundles, temporarily bolted or bound together. All slander pieces shall be adequately supported and blocked. All bolts, nuts, washers, plates under 0.3m and generally such small article as may be selected shall be tacked in a strong case and made secure for transportation to site. All bolts and nuts of different sizes shall be packed in separate bags each having a label indicating the contents of the bag. All packings shall become property of the Engineer-in-Charge

All oils shall be drip drained from hoists an all connection for piping and valves shall be metal plugged or otherwise closed watertight and dust tight to the satisfaction of the Engineer-in-Charge

vi) **MANUFACTURERS' NAME PLATE**

The Contractor shall be permitted to attach a metal plate indicating his name, address etc. on equipment at suitable locations approved by the Engineer-in-Charge. Cast lettering except pattern number will not be permitted on any of the casting. Suitable name plates shall be provided in the controlled cabinets and other locations where necessary. The name plates shall be made of laminated material suitable for engraving, shall be opaque and consist of black lettering over white background or white lettering over black background. All the name plates shall be in English language.

vii) Each case or packing shall be clearly marked with name of work and the items to which the contents pertain and shall contain a packing list which will also include similar details. Copies of the packing list shall also be sent to the Engineer-in-Charge by registered post for record.

viii) **Maintenance and Operation Instructions**

One set of the following manuals in English shall be furnished by the Contractor alongwith the respective equipment at the time of transport.

- 1) Technical and design data

- 2) General description of main components
- 3) Operating instructions.
 - a) General
 - b) Specific (Dealing with any useful features of safety precautions)
- 4) Maintenance and repair instructions
- 5) Lubrications
- 6) Materials and part identification list
- 7) Adjustments
- 8) Two sets of drawings as-built and
- 9) List of all special tools required to follow correctly the servicing procedure along with a set of such tools.

After the final approval, the Contractors shall complete the submitted documents in order to constitute 6 complete approved sets of maintenance and operation instructions. All these instructions shall be written in English.

- 1.9.3** All the fabricated components shall be in the custody of the Contractor for work under this tender till they are taken over by the Engineer-in-Charge in final installed form. These components shall be stored on suitable platforms and shall be supported in a manner which will not cause damage / distortions or bendings due to their own or superimposed weight. All components shall be protected from all sides against rustings or any other deterioration which may affect their performance. The machined parts and other precision components of hoists and sills etc. shall be stored in godown or a closed shade with proper locking arrangement as directed by the Engineer-in-Charge

The Contractor should make all arrangements at his own cost for establishing his field store / workshop. All other facilities and arrangements required for storage of the components in the above stated manner and for proper watch and word of the component while in storage shall be provided by the Contractor at his own expenses. In case of any bending, deformations or any other injury occurs during storages, transportations and handlings before and during installations they shall be rectified to the satisfaction of and in a manner specified by the Engineer-in- Charge, without any extra cost. Decision of the Engineer-in-Charge shall be final and binding.

9.9.4 Notwithstanding anything stated in these clauses, the Contractor shall be entirely responsible for loss, damage or depreciation of stores during transport, handling, storage or installations. Separate payment shall not be made for transport and storage of the equipments as per the requirements of these specifications and all costs for the same shall be deemed to have included in the rates tendered for in the items of BOQ.

1.10 INSTALLATION, TESTING AND COMMISSIONING

1.10.1 GENERAL:

- 1) The items covered under the scope of the work also covers installations, operational trials and commissioning of the various equipments and components to be furnished under this contract. The Contractor shall carry out installations, testing, operational trials etc. as per the requirements of contract specifications and conditions of approved

drawings and as directed by the Engineer-in-Charge. He shall ensure that all equipments and components furnished by him under this contract are properly installed, tested and commissioned and shall be wholly responsible for the satisfactory performance of the same.

- 2) Not less than 45 days prior to commencing any erection, the Contractor shall submit to the Engineer-in-Charge:
 - a) Detailed programme of erection prepared in accordance with relevant provision in these tender documents. He shall also indicate the methods and procedures intended for transport, handling and installing the equipments and components to be furnished under this contract.
 - b) Erection drawings indicating the identification of the components and their relative positions, field welds and connections and any other relevant details.
- 3) The Contractor for the work under this tender shall fully co-operate and work in close co-ordination with the Contractor for construction of other related works of the project and other appurtenant work.
- 4) The Contractor shall at his own expense provide to install bracings and temporary supports, fixtures etc. necessary for safe transport, handling, erection and testing of the various components and equipments to be furnished under this contract. The platforms, scaffoldings, false works, erection aids and other facilities required for accurate installation and inspection and testing of the equipments and components supplied shall also be provided by the Contractor at his own expense.
- 5) The reference lines, centre lines of openings and levels having relations to completed civil structures shall have to be established on site by the Contractor so as to facilitate installation at proper locations. Installation in the field shall be done by bolting and / or electric arc welding, or by any combination of these as shown on the approved drawings or described in these specifications and the Contractor shall be prepared to perform this class of work. The requirements "Welding", "Bolting" etc. stipulated under relevant foregoing clauses shall apply to all weldings, boltings etc. performed during installation.
- 6) The Contractor shall keep posted at the project site his one senior qualified engineer and foreman having adequate experience in fabrication and installation of gates and hoists and mechanical equipments. The Contractor's crew for the work shall also be experienced in the type of work involved under this contract.

1.10.2 EMBEDDED PARTS AND GATES

- 1) All the embedded parts, gates and hoists shall be accurately assembled and installed in lines, levels and plumbs as shown on the approved installation drawings and as directed by the Engineer-in-Charge. All match marks shall be followed carefully, while installing these parts members shall not be over stressed. Hammering that will injure or distort the members will not be permitted. Bearing surfaces and surfaces to be in permanent contact shall be carefully cleaned before the members are assembled or installed. The work shall be performed duly adhering to the tolerance stipulated.
- 2) The Contractor shall furnish erection gauge with each type of gate and the same shall be used to check the alignment of gate frame for required tolerances. The

anchor bolts shall be located accurately and shall be held rigidly in position while the concrete in the structure is being placed. Frames and guides shall be placed in position and be adjusted accurately to exact position and alignment by means of adjusting nuts and turn buckles on the anchor bolts or by means of erection beams. Exceptional care shall be taken to ensure that all frames and guides are installed such that the gate sealing surface of each frame is even and true and lies in a true plane and that bearing surfaces of the tracks and gate guide on each frame lies in the same plane, so that, when slide gates are installed the gate seal and seats will bear evenly without leakage, all these operations being to the satisfaction of the Engineer-in-Charge

- 3) After the second stage embedded parts are erected, aligned and secured properly and rigidly by the Contractor, the Contractor shall provide and place 2nd stage concrete for their embedment after all necessary field trials or as directed by Engineer-in-Charge. It is to be insured by the Contractor that the gates are operational to the design requirements after 2nd stage concreting. The Contractor shall provide and fix all necessary dressings, supports etc. and ensure that 2nd stage embedded parts are not damaged or their alignment is not disturbed due to the placement of 2nd stage concrete.
- 4) Unless otherwise directed by the Engineer-in-Charge the gate leaves shall not be inserted before curing of the 2nd stage concrete. Sealing strips and seals shall be cut accurately to the required length and shall be attached to the gates as shown on the approved drawings or as directed. The Contractor shall locate carefully holes to be drilled in the sealing strips. The seal clamps shall be used as templates for drilling holes in the rubber seals where required. At joints, the end of the seals shall be cut so as to butt evenly. All gates shall be raised and lowered several times and all adjustments shall be made to the satisfaction of the Engineer-in-Charge. Each set of gate shall be tested for satisfactory operation and leakage by lowering and raising the same in their respective grooves.

1.11 INSPECTION:

The inspection of all gates their accessories, shall be carried out in accordance with Indian Standard recommendations for inspection, testing and maintenance of fixed wheels and slide gates part-II, inspection and testing at the time of erection part-III – IS:7718.

1.11.1 INSPECTION AT THE TIME OF INSTALLATION:

1. It shall be ensured that sill beam is correctly positioned in level and location.
2. The parts to be embedded, i.e., track plates, guides, seal, seats shall be checked when all these parts are in final position from bottom to top of the groove. Check shall be carried out both in location and levels, with respect to sill beams already established in position. Each part shall be checked first individually and thereafter relatively to other parts.
3. The track plates and seal seats shall be in true alignment. The alignment of track plates and seal seats shall be checked at 300mm. intervals from bottom to top side of the gate / stop log opening. Alternatively, diagonal checking or any other satisfactory method can be adopted for checking the alignment.

4. After checking the track plates and seal seats on both sides it shall be ensured that they are in their respective planes.
5. Guide and guide shoes shall be checked for true location and alignment first individually and then relatively.
6. Groove corner protection angles shall be checked for true location and alignment.
7. The following critical dimensions shall be checked at intervals 300mm from bottom to top of the groove for embedded parts.
 - (a) Centre to Centre distance of track plates.
 - (b) Centre to centre distance of side seal seats.
 - (c) Face to face distance of guides.
 - (d) Face to track plates to face of side seal seat and
 - (e) Face of track plate to centre line of guide.
8. Eccentricity provided to gate for its fine adjustment in the grooves, shall not be accounted for while erecting parts to be embedded.
9. The groove concreting shall be done only after satisfying all these details including field trial and keeping proper record thereof. Recheck of alignment of embedded parts shall be done after concreting.
10. It shall be ensured that there is offset of joints while extending the embedded parts.
11. All the gates shall be inspected on site before lowering them in the respective grooves. Overall dimensions shall be checked to ensure that the respective gates match correctly in the respective grooves.
12. The following critical dimensions shall be checked at an interval of at least 300mm., wherever applicable for gate.
 - (a) Centre to centre distance between thrust pad treads.
 - (b) Centre to centre distance between side seals / bases.
 - (c) Face to face distance between guide shoes / rollers.
 - (d) Face of seal base to pad treads and
 - (e) Centre line of guide shoes / roller to pad tread in zero position.
13. Seals and seal base shall be checked to ensure that they are coplanar. All pads shall be adjusted to ensure that pad treads are in proper alignment.
Seal bolts shall be tightened adequately and uniformly.
15. To check the effectiveness of seal, actual seal interference shall be compared with that provided in the design.
16. It shall be ensured that installation of the various parts of the hoisting arrangements along with gates has been done to specified locations and alignment, particularly in respect of correct positioning and attachment of stem of the gates as well as hoists.
17. Connections like shaft couplings, connection of stem rods to the gates and hoists, connection of stem links, connection of hoist components to the base shall be checked.
18. It shall be ensured that intermediate supports for the stem rods are provided at the required levels and permit free movement of stem rod for the entire gate travel.
19. It shall be ensured that electric installations have been properly earthed.
20. The hoists provided for the operation of the gates shall be independently tested when not connected to the gates to ensure satisfactory workings. The hoists shall be kept running for a sufficient period so as to ensure independent working. Bearings shall be checked to ensure that there is no undue friction.

1.11.2 INSPECTION AFTER INSTALLATION At an appropriate stage (as decided by the Engineer-in-Charge) after installation of respective gates the Contractor shall give field tests as directed in these specifications. The Contractor shall at his own expenses make all arrangements and provide all necessary equipments, materials, tools, tackles and labour necessary for carrying out the said field tests. The inspection after installation shall cover following points and any other point considered necessary by the Engineer-in-Charge

1. Drain holes of the components of the gates shall be so checked that they do not get clubbed with silt causing accumulation of water in the horizontal girders.
2. Inspection of gates shall be carried out to detect defects, if any, after erection and when the canal is full. The gate shall be operated up and down several times to make sure that they function well, without vibrations.
3. Inspection, after erection shall consist of visual inspection of exposed surfaces of embedded parts, sill beams, seal seats, gate leaves, hoisting equipments, hoist supporting structures and checking of important dimensions. In case of inaccessible parts necessary inspection shall be carried out with the help of arrangements to be provided by the Contractor at his expense.
4. Inspection shall be carried out for connection, for structures, gate, tightness of all fittings, soundness of the welds, leakage through gates, lubrication of all bearings, guide shoes, machineries and equipment, wear and tear, corrosion, sealing, pitting of all metal work and machineries (soundness of metal).

1.12 FIELD TESTS:

1.12.1 Field tests shall be for all the gates and shall include

1. Operational tests in dry.
2. Operation steps with stipulated full supply level, and
3. Leakage tests.

The tests will be repeated, if necessary, until they are successfully carried out to the satisfaction of the Engineer-in-Charge.

i) Operation tests in dry

Operational tests in dry will be carried out after completion of erection. The tests will include at least 2 complete traverses from the maximum raised position to the full seated position. All adjustments, clearances etc. shall be checked and adjusted by the Contractor for proper operation.

ii) Operational tests with full supply level

These tests will simulate the actual operating conditions as early as possible. At least one complete traverse shall be made from the fully closed position to the normal raised position as follows:-

- a) When the gates are closed, raise the gates to their normally opened position and
- b) Lower the gates to the fully closed positions.

iii) Leakage Tests

Leakage tests will be carried out with the gates lowered unto the sill. Before the observation for leakage, the gates will be raised and lowered suitably in order to dislodge any debris it might have been lodged in the side and bottom seals. The leakage

then shall be measured and it shall not be more than the amount specified in the relevant code. The tests shall be repeated if necessary, until they are successfully carried out to the satisfaction of the Engineer-in-Charge. Leakage tests and operation tests will be carried out at the convenience of the Engineer-in-Charge after completion of other portions of the work and when the canal is at full supply level. However, the Engineer-in-Charge will have the right to carry out such tests when the canal is at a level lower than the full supply level. The Engineer-in-Charge shall also have the right to carry out the leakage tests by jetting water at 1.5 times the normal working pressure on the sealing position from bottom to top.

1.12.2 The Contractor, without claiming any extra cost or compensation, shall carry out all adjustments, modifications, which in the opinion of the Engineer-in-Charge based on the above mentioned field tests are necessary to ensure satisfactory performance of the equipment furnished under this contract.

TRASH RACKS

- 2.0 Trash racks are to be provided to eliminate entry of debris to the sump chamber of the pump houses of the schemes. It is proposed to provide trash racks at two places to effectively prevent any floating or submerged debris, both organic & inorganic entering the pump bellmouth. The primary function is to protect pumping equipment & appurtenances.
- 2.1 Design requirements.
- 2.2 Hydraulic Design requirements.

The net area of flow in any trash rack should be enough to allow the required flow with a velocity not more than 0.6 meters/sec. This is necessary to avoid any excess head loss by generating higher velocity through slots of the trash rack. Very close spacing to keep out small size floating debris or fish, may get clogged frequently necessitating clearing at closer intervals.
- 2.3 Structural Design

Structural design of the trash racks shall strictly follow the standards as specified in B.S. Code No. IS-11388:1995. (Re affirmed 2000) or latest. The size & shape shall be designed based on the openings of pipes/conduits for the intake & the opening of the entrance at pump bays.
- 2.4 The trash racks being of small dimensions needs to be designed as removable pieces, & bolted to embedded structural steel in face of the openings, to facilitate cleaning repairing, painting etc. during off season.
- 2.5 Selection of structural steel should be done as per requirement and specification as mentioned in the specification for gates, as per IS Codes applicable. Similarly manufacturing, transporting, painting & fixing, should be done as per specification made in previous chapter for gates.

SECTION IV

CIVIL WORKS-CONCRETE, STEEL & ROADS

TECHNICAL SPECIFICATION FOR CIVIL WORKS

SL. NO.	PARTICULARS	PAGE No.
1	CONCRETE	1
2	REINFORCEMENT BARS	19
3	ROADS	23

CONCRETE WORKS

- 1.1 Scope of work
- 1.2 Cement
- 1.3 Sand
- 1.4 Coarse aggregate
- 1.5 Water
- 1.6 Grading and relative proportion
- 1.7 Mix variation
- 1.8 Design mix
- 1.9 Tests for cement concrete
- 1.10 Forms
- 1.11 Placing concrete
- 1.12 Compaction
- 1.13 Curing and protection
- 1.14 Finishing
- 1.15 Nominalmix

CONCRETE**1.1 SCOPE OF WORK:**

The work covered by this item shall consist of Cement Concrete for Sump well-cum-Pump house covered in this contract & other components of work like intake works, delivery chamber and bed concrete for pipes.

- i) Furnishing all materials, equipment and labour for the manufacture, transport, placing and curing of concrete and performing all the functions necessary and ancillary thereto including the concrete to the required shape as per drawing.
- ii) No extra payment will be made for the installation of this embedded metal work or for delays or for interruptions arising there from.
- iii) Providing and removal of all form work comprising furnishing all materials, equipment and labour for the manufacture, transport, erection, keeping in place with necessary fixtures and supports oiling etc. complete.
- iv) Necessary sampling and tests for material and concrete,
- v) Compensation for injury to persons and damages to work or property.

THE FOLLOWING SPECIFICATION WILL APPLY IN GENERAL OF ALL TYPES OF CONCRETE WORKS INCLUDING R. C. C. WORK.

1.2 CEMENT

Cement shall be obtained by the Contractor and conform to the Bureau of Indian Standard for Portland pozzolana.

1.3 SAND

SOURCE AND SIZE:

Sand used for concrete or mortar shall be river creek sand or crushed trapped stone or mixtures of both in specified proportion. The maximum size shall be limited to 5 mm and the sand shall be used on weight basis.

QUALITY :

The sand shall consist of hard, dense, durable, uncoated siliceous gritty materials obtained from rock fragments. It shall be free from injurious amount of dust, clay lumps soft and flaky particles, shale, alkali, organic matter, mica and other deleterious substance. The texture should necessarily be coarse, matching grading specifications. The maximum percentage of deleterious, substance in the sand delivered for use in concrete or mortar shall not exceed the following values.

	PERCENTAGE OF WEIGHT
Materials passing No.200 sieve B.S. or I.S. No.8	4%
Average opening 0.0029	
Shale	1%
Clay Lumps	1%
Coal	1%
Total of other deleterious substances such as alkali, Mica coated grain, soft and flaky particles.	2%

The sum of the percentage of all deleterious substances shall not exceed 5 % by weight. The sand shall be free from injurious amounts of organic impurities Sand producing colour darker than the standard in colori-Metric test for organic impurities shall be rejected.

MECHANICAL ANALYSIS:

The sand shall be well graded and the sieve analysis shall conform to the following limits of gradation.

Sieve A.S.T. M.No.	Equivalent I.S.S.	Cumulative percentage by Weight retained on sieve
3/8	3/8	Nil
4	480	0 to 8
8	240	10 to 25
16	120	25 to 45
30	60	50 to 70
50	30	75 to 90
100	15	90 to 97

FINENESS MODULUS:

The sand shall have fineness modulus ranging between 2.60 and 3.00. The modulus shall be computed by addition cumulative percentage of sand retained on the 6th standard screen from No.4 to No.100 both inclusive (A.S.T.M. standard) or (480,240, 120, 60, 30, and 15 sieves of the I. S. Designation) and dividing the sum by 100. Any deviation from the specification in respect of the gradation and the fineness, modulus shall not be permitted without the permission of the Engineer-in-charge.

ALLOWANCE FOR BULKAGE:

If the collected sand is required to be washed or obtained after its washing is found to be moist, bulkage will be measured and allowed provided sand is stacked at site at least for 48 hours before use. Bulkage of such a stack will be measured regularly as directed by the Engineer-in-charge and allowed, according to these, observations. Observations for bulkage will be made as per Indian Standard Procedure and allowance will be made as under.

Bulkage observed	Allowance to be made
5 to10	Nil
10 to 15	5 percent
15 to 20	10 percent
20 to 25	15 percent
25 to 30	20 percent
30 to 35	25 percent
	30 percent

1.4 COARSE AGGREGATE.**QUALITY:**

Coarse aggregate for concrete shall consist of hard dense, durable uncoated crushed rock and shall be free from injurious amount of soft, feeble thin elongated or laminated pieces alkali, organic mater or other deleterious substances. Flaky and weathered stones shall not be used.

IMPURITIES:

The broken stone shall be free from dust and dirt and shall be washed if necessary to ensure that all faces or the stones are perfectly clean. The maximum individual percentages by weight of deleterious, substances of any size of coarse aggregate shall not exceed the following values.

Material passing through No.150 microns IS. sieve percent by weight.

Shale	1 Percent by weight
Coal	1 Percent by weight
Soft fragments	1 Percent by weight
Clay lumps	1/4 Percent by weight
Other deleterious substance	1 Percent by weight

The sum of the percentage by weight of all the deleterious substances in any size shall not exceed five percent, by weight.

The aggregate containing impurities above the specified permissible limits shall be screened / wash/ or treated as directed before use in producing concrete.

GRADING :

The approximate range in grading of coarse aggregate shall be as under, coarse aggregate shall be of such size as shall be retained on a mesh 5 mm.Sq.

Maximum size of aggregate	Normal range mm	Percentage of coarse aggregate (mm)				
		40 to 80	20 to 40	5 to 20	10 to 20	5 to 10
20 mm	10 to 20	--	--	100	50 to 67	33 to 45
40 mm	20 to 40	--	40 to 50	50 to 60	28 to 40	18 to 30
80 mm	40 to 80	20 to 366	16 to 36	35 to 44	10 to 30	13 to 29

The grading between the limits specified above shall be such as shall produce a dense concrete of the specified Proportions and consistency that will work readily into position without segregation and without the use of excessive water content.

The use of gravel fraction left behind sieving river sand for winning fine aggregates shall be permitted in the bending of coarse aggregate if asked for after suitable experiments and without rate variations.

SIZE :

The maximum size of coarse aggregate for a particular grade or concrete shall be as large as possible but normally not greater than 1/4th of minimum thickness of the concrete member provided that in the case of R.C.C. this size present no difficulty to surround the reinforcement

thoroughly and fill up the corners of the form work fully and is less than the minimum cover by 6 mm.

For heavily reinforced concrete members such as ribs of beams, etc. the maximum size of aggregate shall be restricted to 6 mm less than the minimum clear lateral distances between the reinforcement bars or 6 mm, Less than the cover whichever is smaller.

Generally a maximum size of 20 mm should be found satisfactory for reinforced concrete work.

The grading between the maximum size and minimum size of 5 mm shall be such as to produce a dense concrete of the specified proportion and consistency that will work readily into position without segregation and without the use of excessive water content.

The Contractor shall at all times maintain a minimum storage of all grades of the aggregate for the days requirements at work site failing which the work may not be commenced. The contractor shall furnish representative samples of aggregate proposed for use in the work at least two months before aggregates are required for use.

1.5 WATER:

Water used in concrete shall be clean and free from objectionable quantities of silt organic matter, alkali, salt and other impurities which are likely to be injurious. The turbidity of water forming shall not be more, than 200 parts per million and shall preferably be lower.

1.6 GRADING AND RELATIVE PROPORTION :

Grading of the aggregates (fine and coarse) brought on the site shall be done by the contractor and shall be got approved from the Engineer-in-charge. The grading of sand and coarse aggregate is liable to be modified beyond the limit specified above to suit local condition in order to obtain required strength and workability. The grading as well as relative proportion of sand and coarse aggregate are liable to be charged at the discretion of the Engineer-in-charge, in order to produce dense concrete of required strength which can be worked readily into position without segregation in a given ratio of cement and total aggregate (sum of volume of sand and coarse aggregate). No compensation is payable for adjustment in relative proportion and grading of aggregates.

1.7 MIX VARIATION:

Cement variation in the concrete mix is not liable for compensation

1.8 DESIGN MIX:

The ratio of the Volumes of the fine and coarse aggregate may be varied within limit of 1:1.5 to 1:2.5 as directed by the Engineer-in-charge to suit the maximum size of coarse aggregate the grading, density, workability and strength without extra cost.

The quantity of water shall be just sufficient, but not more than sufficient to produce a dense concrete of required workability for its purpose. An accurate control shall be kept on the quantify of mixing water. An allowance shall be [Trade for surface moisture present in the aggregate when computing water content as indicated in LS.456 - 2000.

Exact proportions in which the materials are to be used for different part of the work shall be determined by carrying out mix design to obtain the specified strength of the concrete. The design of mix shall be submitted by the contractor and got approved from Engineer in charge at least one month before commencement of the work. The design may be changed at any given time at the discretion of the Engineer-in-charge during progress of the work. The samples of aggregates and cement and the resulting concrete as well as the concrete mix design shall be tested as per relevant I.S. code method. The tests shall be made by the contractor at frequent intervals as decided by the Engineer-in-charge, so as to secure the required workability, density, impermeability, strength & economy.

All the materials going in each batch of concrete shall be weighed before use. The amount of each individual size of aggregate entering each batch of concrete shall be determined by direct weighing. The amount of water shall be added after weighing or volumetric measure. All measuring equipments shall be calibrated correctly and certificate from the competent authority shall be obtained as and when demanded by the Engineer-in-charge. All Measuring equipments shall be so designed and operated that the combined inaccuracies in feeding and measuring the materials will not exceed, one and half percent for water or cement and two and half percent for each size of aggregate. Any batch of concrete not satisfying this requirement is liable to be rejected. No cement older than 60 days from the date of dispatch from the manufacture shall be used on the work. The cement to be used shall be in the order of its receipt so that no stock remains unused for duration longer than 60 days. Cement older than 60 days shall be removed from site as per the directives of Engineer-in-charge.

The ingredients of concrete shall be properly mixed in mixers, designed so as to positively ensure uniform distribution of all the component materials through the mass at the end of the mixing period. The mixing of each batch shall continue about one and half to two minutes depending upon the revolutions per minute of the mixer and experience after all materials except for the full amount of water are added in the mixer. The minimum mixing period specified above assumes proper control of the rotation of the mixer and of introduction of the materials, including water. The mixing shall be increased at the discretion of the Engineer-in-charge when the charging operation fails to produce concrete of the required uniformity of composition and consistency within the batch and from the batch to batch Contractor shall not be entitled for any extra payment for such increase in mixing time. Excessive mixing requiring the addition of the water to preserve the required concrete consistency shall be avoided. If the mixing and charging operations are such that the required uniformity of the concrete is obtained in shorter mixing time than the minimum specified, without sacrifice of needed workability,, the mixing time maybe shortened under orders of the Engineer-in-charge. Mixing shall be by Mechanical means only.

Materials corresponding to one bag mix or half bag mix (depending upon the mixer capacity) shall be placed in' the skip in sequence of metal cement and sand. The skip shall be emptied into the drum and specified quantity of water added to material in drum.

The following general principles shall be followed in operation of mixing.

- 1) The ingredient shall be fed into the mixer simultaneously.
- 2) A portion of water (between 5 and 10 percent) shall precede and an equal quantity shall follow introduction of the other materials. The remainder of the water shall be added uniformly and simultaneously with the other materials.
- 3) Care shall be taken that mixing of concrete in the mixer is uniform.

CEMENT:

The cement shall be procured- in standard bags as received from the manufactures and is to conform to the specifications laid down by the Bureau of Indian Standards (Vide their specification No. I.S./8112 of 1989 for Portland cement).

1.9 TESTS FOR CEMENT CONCRETE.

A) STIPULATED CRUSHING STRENGTH :

The crushing strength in Newton per square millimeter on works cubes at 28 days for each nominal mix shall be as under

Nominal mix	Equivalent ISS mixes	Preliminary lab test at 28 days (N/mm ²)	Stipulated crushing strength in works tests	
			At 7 days (N/mm ²)	At 28 days (N/mm ²)
1:1:2	M-25	32	17	25
1:1:5:3	M-20	26	13.5	20
1:2:4	M-15	20	10	15
1:3:6	M-10	13.5	7.5	10
1:4:8	M-7.5	10	5	7.5

B) PRELIMINARY LABORATORY TEST :

Preliminary tests of cubes shall be carried out in the laboratory well in advance of commencement of work. These tests should indicate adequate margin over the stipulated strength.

C) WORKS TEST ON CONCRETE:

Tests for crushing strength shall be made on standard cubes as per the relevant Indian Standard Specifications. For works tests, samples shall be taken on the job as and when directed. For works tests, samples shall be taken once for every 30 cubic meter of each type- if concrete laid and at least three times a day, if out put is more than 75 cubic meter. The samples for work test is defined as a set of three cubes. The materials required for the samples (concrete, cement, sand and coarse aggregate) and mould as directed by Engineer in charge shall be supplied by the Contractor free of cost and the collection of samples, casting of cubes and testing shall be carried out by the YEPL at the cost of Contractor.

STANDARD OF ACCEPTANCE:

Not a single sample of work test cubes shall have at the age of 28 days, a crushing strength less than the stipulated crushing strength of concrete. The Engineer-in-charge may at his discretion occasionally accept the crushing strength of a sample, which is less than the stipulated strength but which is equal to or more than 85 % of the stipulated, strength. Each sample of work test cubes shall assume to represent 30 M3 concrete and amount of corresponding quantity of concrete showing crushing strength less than stipulated strength shall be recovered as under.

Crushing strength.	Amount to be recovered (Recovery rate)	
1)	Equal to or more than 95 %	Nil.
2)	Equal to or more than 90 % but less than 95 %	5 % of rate of Concrete in current Schedule of rate.
3)	Equal to or more than 85 % but less than 90 %	10 % of rate of Concrete in current Schedule of rate .

The recovery rate shall be approved by the Superintending Engineer.

If the crushing strength falls below 85 % of the stipulated crushing strength then the quantity of concrete represented by these samples shall be removed and redone by the contractor at his cost. Unit for acceptance or these tests will be one working season.

In addition to the 28 days strength tests, the Engineer-in-charge may at his discretion take 7 days strength tests and or 3 days (accelerated curing) strength tests and fix up the relation between such strength and 28 days strength after studying the actual values realized. If any time the tests i.e. 7 days or 3 days (accelerated curing) strength indicate that the strength may not be achieved as specified by the Engineer-in-charge, he shall have, authority to suspend the work of laying concrete until the reasons for low strength have been investigated and corrected. The contractors shall comply therewith without such suspension of work being made a reason for any claim. The Engineer-in-charge may at his discretion also order suspension of the work when the variation in the strength of the individual work test cubes from average of the set is in his opinion excessive. The contractor shall comply with such suspension until the reason for the variations are investigated and corrected and such suspension shall not be accepted as reason for any claim.

The average crushing strength shall not be less than stipulated crushing strength for each nominal mix as given below:

Grade	Nominal mix	Preliminary test Crushing strength at 28 days N/sq.mm.	Crushing strength at 7 days N/sq.mm. in work test.	Crushing strength at 28 days N/sq.mm. in work test.
M-25	1:1:2	32	17	25
M-20	1:1:5:3	26	13.5	20
M-15	1:2:4	20	10	15
M-10	1:3:6	13.5	7.5	10
M-7.5	1:4:8	10	5	7.5

D) SLUMP TESTS.

In order to test the consistency of the mixed concrete, slump test shall have to be made by the Contractor when and where required by the Engineer in charge, as per Indian Standard Specification. The allowable slump shall be decided by the Engineer-in-charge, depending upon the location of the concrete.

In the case of reinforced concrete work, the workability shall be such as the concrete will surround and properly grip all the reinforcement. Water cement ratio will be such as will give concrete just sufficiently wet to be placed and compacted without difficulty.

Concrete shall have a consistency such that it will be workable in the required position and in the case of R.C C. flow around reinforcing steel also.

For vibrated concrete slump shall range between 2.5 cm. To 5 cm. The slump shall be the less permitted by workability. The slump shall be determined as detailed in Appendix 'G' of LS.456-1978 and maintained throughout the concreting operation.

1.10**FORMS****GENERAL**

Form to confine the concrete and shape as required shall be used wherever necessary. The form shall have sufficient strength and rigidity to hold concrete and to withstand the pressure of ramming and vibration without excessive deflection from the prescribed lines the more so when the concrete is in vibration. The Contractor shall have to get the design and drawing of the centering approved from the Engineer-in-charge before erection. Form work shall be of any of the following types.

- a) Wooden shuttering with steel plates lining or plywood shuttering.
- b) Steel shuttering

For works costing more than Rs. One Crore, only steel shuttering is to be used. However as per need of site, wooden shuttering would be allowed only if it is free from warping and a fabricated true to line and shape. The decision of the Engineer-in-charge as to the suitability of wooden shuttering as per (a) above to be used by the contractor will be final and binding on the Contractor. The surface of all forms in contact with concrete- shall be clean, rigid, watertight and smooth. Suitable devices shall be used to hold corners, adjacent ends and edges of panel of other forms together in accurate alignment.

DESIGN

The detailed designs of the formwork and false work shall be prepared by the Contractor and got approved by the Engineer-in-charge well in time. Such an approval however, will not relieve the Contractor of his responsibility for the adequacy and strength of the formwork and false work.

Forms shall be as designed and constructed as in the removable in sections without damaging the surface of the concrete and with facilities of removal in ascending order without disturbing the remaining forms required to be removed later.

MATERIAL.

The forms and false work shall be made of wood or metal. The timber from which the forms are prepared should preferably be partially seasoned. It shall be free from sag, shakes, loose knots, wormholes or other defects. The planks and scantlings shall be sawn, straight and all edges and planes shall be straight and free from warps. Partially seasoned soft wood is generally preferable for formwork as it is difficult to drive nails in hard wood. The dimensions of scantlings should conform to the design. The strength of the wood shall not be less than that assumed in a design.

Metal form steel sheets of the designed gauge strengthened with framing of angle or other sections shall be used.

Wooden forms may also be lined within thin steel sheet or plywood to give the required surface or finish.

FABRICATION.

The timber planks and scantlings of the designed dimensions shall be used in the form work with appropriate spacing of studs, yokes, joists, girders, etc. as provided in the designs. All timbers in contact with concrete shall be brought on one face and two edges. The joints shall be made mortar tight. This may be done either by providing tongue and groove or rebated joint or by caulking or nailing to the construction operations. The nuts and bolts heads inside the formwork adjoining the concrete shall be countersunk. The formwork shall allow furnished concrete to have a smooth surface and conform to the shapes, lines and dimensions shown on the plans and true to line and grade. The effect of vibration shall be taken into account in the design and fabrication of the form and false work.

TREATMENT OF THE INNER SIDES OF FORMS.

Before placing concrete the inner side of the forms which come in contact with the concrete shall be coated with mineral oil or any other suitable materials approved by the Engineer-in-charge which will prevent adhesion of concrete to the forms but will not discolor the concrete. When oil is used it shall be applied before reinforcement is placed. Care shall be taken to see that reinforcement does not come in contact with coating or chippings. Saw dust and other rubbish shall be removed from the interior of the forms before concreting.

FALSE WORK

False work shall be built on foundation or base of sufficient strength to carry the loads without settlement. False work, which cannot be founded on solid footing, must be supported by piles or other similar devices. False work shall be designed to carry the full loads including that due to construction operation coming upon it.

ERECTION AND REMOVAL OF FORMS

The false work and form work shall be erected with an eye for absolute safety of the formwork and concrete work before and after pouring concrete. Watch should be kept to see that the behavior of centering and form is satisfactory during concreting. Erection should also be such that it would allow removal of forms in proper sequence without damaging either the concrete or the form to be removed later.

If there is failure of false work and / or form the Contractor shall be responsible for all the consequent damages to work, injury to life and damage to property and make good the damage at his cost.

- i) Before placing concrete, the surface of form shall be oiled with a suitable non staining oil such as raw linseed oil so as to prevent sticking of concrete and facilitate the removal of form.
- ii) The oil shall cover the form fully and evenly without excess over drip. Care shall be taken to prevent oil from getting on the surface of the construction joints and on reinforcement bars. Special care shall be taken to oil thoroughly the forms strips for narrow grooves so as to prevent swelling of the forms and the consequent damage to concrete prior to or during removal of forms. Immediately before concrete is placed, care shall be taken to see that all forms are in proper alignment and the supports and fixtures are thoroughly secured and tightened.
- iii) Where form for continuous surface is placed in successive units, the form shall fit tightly over the completed surface so as to prevent leakage of mortar from the concrete and to maintain accurate alignment of the surface.
- iv) Forms shall be left in place until their removal is authorised and shall then be removed with care so as to avoid injury to concrete.
- v) Removal of forms shall never be started until the concrete is thoroughly set and hardened adequately to carry its own weight, beside the live load, which is likely to come on the work during constructions. The length of time for which the forms shall remain in place shall be decided by the Engineer – in charge, with reference to weather conditions, shape position of the structure or structural member and the nature and amount of dead and live loads.

In normal circumstances forms shall be struck after the expiry of the following period:

a)	Walls columns and vertical faces of all	24 to 28 hours as may structural members be decided by the Engineer-in-charge
b)	Slabs (props left under)	3 days
c)	Beam soffits (props left under)	7 days
d)	Removal of Props under slabs	
	1. Spanning up to 4.5 m	7 days
	2. Spanning over 4.5 m	14 days
e)	Removing of props under beams and arches	
	1. Spanning upto 6 m	14 days
	2. Spanning over 6 m	21 days

NOTE: The number of props left under, their size and disposition shall be such as to be able to carry the full dead load of the slab, beam or arch as the case may be together with any live load likely to occur during curing of further construction.

In no case forms shall be removed until there is assurance that removal can be accomplished without damaging the concrete surface. No loads will be allowed to damage the concrete surface. Heavy load shall not be permitted until the concrete has reached its designed strength. The forms shall be removed with great caution and without harming the structure or throwing heavy forms upon the floor.

REUSE OF FORMS ETC

Forms required to be used more than once shall be maintained in serviceable conditions and shall be thoroughly cleaned and smoothened before reuse. Where metal sheets are used for lining, the sheets shall be placed and maintained on the forms with minimum amount of wrinkles, humps or other imperfections. All forms shall be checked for shape and strength before reuse.

INSPECTION

The forms and false work will be inspected, checked and approved by the Engineer-in-charge before concreting commences. But this will not relieve the Contractor of his responsibility for strength and safety of form and false work.

1.11

PLACING CONCRETE

PLACING

Concrete shall be placed only in locations where authorised and no concrete or mortar shall be placed until formwork, installations of embedded parts, preparation of surface or necessary clean up has been approved.

ROCK SURFACE.

Rock surface upon or against which concrete is to be placed, shall be prepared as specified in section excavation for foundation

MASONRY SURFACE.

1. Masonry surfaces on which or against which concrete is to be placed, shall be cleaned thoroughly with water jets.
2. If the old layer of masonry is required to be removed, it shall be back filled with concrete along with upper concrete layer at no extra cost.

CONCRETE SURFACE.

Before laying of concrete the surface of the concrete in day to day work, shall be cleaned by a wire brush and jets of water, so that the surface is thoroughly cleaned and wetted but pools of water are to be avoided. If the old concrete surface has remained exposed for more than two weeks, it shall be prepared by chipping to a depth of two centimeters and the surface coated or covered with a layer of cement mortar (1 :2) for a depth of 5 to 8 cm. The cost of such

preparation and also the cost of cement mortar shall be borne by Contractor. The concrete removed for roughening shall be at Contractor's expenses.

ALL SURFACES.

- i) The cleaned rock, masonry or concrete surface shall be applied with cement with cement slurry and then cement mortar coat.
- ii) The first few batches of concrete may, contain half the regular size of coarse aggregate without any extra claims.
- iii) The cost of such preparation work shall be borne by Contractor.

TIME FOR USE.

All concrete shall be placed directly in its final position within thirty minutes of mixing, Any concrete, which has become so stiff that proper placing cannot be assured without re-tempering shall be wasted at contractor's expenses. All surface of forms and metal work including reinforcement bars that have become encrusted with dried mortar or grout concrete previously placed shall be cleaned of all such mortar or grout before surrounding or adjacent concrete is placed.

METHOD OF PLACEMENT

Before starting placing of concrete, it should be made certain that the transporting and placing equipment is clean & in proper order and that equipment along with the operating staff is arranged to deliver the concrete in the final positions without undue delays and objectionable segregation. The methods and the equipment used for transport and placing of concrete shall be such as will permit the delivery of concrete of the required consistency into the work without objectionable segregation, porosity or excessive loss of workability. Excessive segregation from whatever cause shall be prevented in handling and placing operation by avoiding or controlling lateral movement of the concrete as in dumping at an angle depositing continuously at one point and allowing the concrete to flow. Concrete shall not be dropped from excessive heights and free fall should be kept to a minimum. Concrete shall be deposited in continuous horizontal layers in a thickness of approximately 30 cm in normal work to 45 cm. For mass concrete except that nothing herein shall be construed to permit placement of the additional horizontal layers of mass concrete before the entire area to be concreted is covered by previous layers. On flat, horizontal surfaces, where congestion of steel near the forms makes placing of concrete difficult, a mortar of the same cement sand ratio as used in the concrete shall be first deposited to cover the forms and shall stand included in the unit rate of concrete before the entire area to be concreted is covered by previous layers.

RATE OF PLACING.

Concreting shall continue without interruption until the structure or section is completed or until satisfactory construction joints can be made. Location of construction joints shall be as directed by the Engineer-in-charge. Concrete shall not be placed, faster than the placing crew can compact it properly In placing thin members and columns precautions shall be taken against too rapid placement, which may result in movement or failure of the forms due to excessive

lateral pressure. An interval of at least 12 hours and preferably 24 hours should elapse between the completion of columns and walls and the placing of slabs, beams or girders supported by them in order to avoid cracking due to settlement. All concrete shall be placed in approximately horizontal lifts not exceeding 1.25 meter in thickness per day. Concrete in arches shall be done in strips extending from one pier to another. No through joints shall be kept in the span.

CONCRETING AT NIGHT TIME.

If concrete is to be placed at night; adequate lighting arrangements shall be made as, directed by the Engineer-in-charge,

CONCRETING DURING RAINS.

When concreting is required to be done or continued while it is raining it shall be seen that the concrete is not damaged due to rain while it is being transported and placed. After placing the green concrete it shall be adequately covered for a period of 24 hours when it will be capable for being cured by splash of water. The surface of fresh concrete shall be maintained on a slope sufficient for resulting self-drainage of the rainwater. The work shall however be discontinued when the rain is so severe that water collects in pools or washes the surface of the fresh concrete and it is not possible to provide adequate shelter.

1.12

COMPACTION

GENERAL

In all concrete works required number of vibrators with stand by in working condition shall be kept ready at site as per the instructions of the Engineer-in-charge.

All concrete shall be vibrated by mechanical vibrator of approved type so as to ensure dense concrete. Hand tamping and rolling shall not be used for compaction of concrete except in special circumstances with the express permission of the Engineer-in-charge. When immersion type vibrators are used they shall be used vertically at about 45 cm apart. The vibrators shall be inserted to the full depth of the newly laid concrete layer. The concrete shall be thoroughly compacted during depositing to get a dense concrete and thoroughly worked in to the edges and corners of the form work and also along its faces and around reinforcement in the case of RCC by means of suitable tools such as trowel and rods to get a good finish without honey combing. The vibrator shall however, not vibrate concrete, which has commenced its final set. Special care shall be taken to see the vibrator touching the reinforcement of embedded part does not disturb the concrete below, which has concerned its final set. The concrete shall not be vibrated excessively so as to cause segregation.

Each layer of concrete, for surfaces which is required to be smooth and for all surfaces which will be permanently exposed to the weather and for all surfaces next to embedded metal work shall be worked and vibrated by mechanical vibrator of approved type only so as to obtain concrete of maximum density and imperviousness and to assure close contact of the concrete with forms, reinforcement bars and other embedded parts. If the methods of transporting and placement have been conducive to air entrainment segregation or stiffening, the work of compaction shall receive special attention.

For concrete surfaces exposed to flow of water special precaution shall be taken to minimize and to prevent surface pitting and protrusions without resorting to over manipulation of the concrete mix to the forms. No plastering for getting a smooth finish shall be permitted at these locations. Any protrusion shall be ground smooth.

1.13 CURING AND PROTECTION:

All concrete shall be protected against injury until final acceptance. Exposed finished surface of concrete shall be protected from the direct rays of sun for at least 72 hours after placement. Concrete shall be kept continuously moist for not less than 21 days. Construction joints shall be cured in the same ways as other concrete and shall also be kept moist for at least 72 hours prior to the placing of additional concrete upon the joints. Approximately horizontal surfaces shall be cured by sprinkling, ponding, or by covering; or by damp sand or may be cured by the use of wet quilts or mats. Covering with wet jute bags shall be used to cure vertical surfaces. If damp sand or quilting is used for curing, it shall be removed completely later. Should the concrete that has become dry or powdery through neglect of curing the Contractor shall rectify the work at his own extra cost. If curing arrangements by the contractor are not satisfactory the Engineer-in-charge may in his discretion engage labour and provide material and equipment for curing and recover expenditure thus involved from contractor.

1.14 FINISHING.

GENERAL

Only skilled workmen shall perform finishing of formed and unformed surface. All exposed concrete surface shall be cleaned of incrustations of cement mortar or grout. Unsightly stain shall be removed.

FORMED SURFACES.

Surface of concrete finished against form shall be smooth, free from projections and filled thoroughly with mortar. Immediately upon removal forms, all unsightly ridges shall be treated properly.

DRY BATCHING.

Dry patching mortar shall consist of one part of cement to 2 parts of sand by volume and just enough water so that the mortar so used, will stick together on being moulded into a ball by a slight pressure of hands and will not exclude water when pressed but will leave the hands damp. The mortar shall be placed in layers of not more than 2 cm thickness. After being compacted each layer shall be roughened by being scratched to provide an effective bond with the succeeding layers. The last or finishing layers shall be smooth to form a surface continuous with the surrounding concrete. All patches shall be bonded thoroughly to the surface of the chipped area and shall be sound and free from shrinkage cracks.

FINISHING PERMANENTLY EXPOSED SURFACE.

Except as otherwise specified or directed all permanently exposed concrete surface and other waterway surface requiring durability under water (except the outlet) shall be finished in the following manner. Immediately upon the removal of the form the surface shall be wetted and all surface pits and air bubbles filled by rubbing mortar composed of cement and fine sand in proportion (1:2) in to the pits burlap so as to secure a uniformly dense and smooth face.

The rubbing shall be performed in such a manner as to leave the surface free from mortar not used for filling the pits. Should the filling operation be unduly delayed and the surface of the pits becomes coated with dirt or other contaminating materials, they shall be thoroughly cleaned and washed and shall be maintained in a moist condition, until the mortar filling is placed. Such cleanings shall be done by means of air and water jets and chipping off brushing or other satisfactory means without damaging the surrounding, concrete. All operations in connection with the filling of surface pits shall be handled as, quickly as practicable to minimize the period during which the concrete and mortar filling are exposed to the drying. When the treatment of a surface has been completed the surface; shall be neat and have the same colour and texture as the adjoining concrete.

FINISHING CONCEALED SURFACE.

For exterior concealed surfaces below ground or back fill level or like surface not otherwise specified, no finish is necessary except that sand streaks metal pockets, honey combing or other imperfections which are of consequence in affecting strength, water tightness or protection of reinforcing steel from corrosion, shall be corrected and repaired as prescribed for formed surface.

FINISHING UNFORMED SURFACE.

Unformed surface shall be finished by one or more of the operation of screeding, floating and toweling of the surface shall be done at proper time employing experienced men, This shall be just sufficient to produce the desired finish, screeding which gives the surface its approximate shape by striking off surplus concrete immediately after compaction. This shall be accomplished by moving a straight edge or template with a sawing motion across wood or metal strips that have been established as guides. Where the surface is curved special screed shall be brought true to form and grade by working it with a wooden float. If a coarse textured finish is desired or if the surface is to be steel trowelled a section or final floating shall be performed after some stiffening has occurred and the surface moisture film or shine has disappeared. Where smooth dense finish is *desired* floating shall be followed by steel trowelling some time after moisture film or shine has disappeared from the floated surface and where the concrete has hardened sufficiently to prevent fine material and water from being worked out the surface Excessive toweling particularly at early time shall be avoided.

CHIPPING AND ROUGHENING CONCRETE SURFACE.

Surface upon or against which additional concrete is to be placed shall be chipped and roughened to a depth not greater than 25 mm. Roughening shall be performed by chipping or other satisfactory methods and in such manner as not to loosen. Crack or shatter any part of the concrete beyond the roughened surface. After being roughened surface of the concrete shall be cleaned thoroughly of, all loose fragments, dirt and other objectionable substances and shall be sound and hard in such conditions as to assure good mechanical bond between old and new concrete. All concrete which is not hard dense and durable shall be removed to the depth required to secure a satisfactory surface.

DAMAGE DUE TO FLOODS GOVT. NOT RESPONSIBLE.

In case of damage of any of the concrete works due to floods, Engineer will not be responsible and whatever corrective measures are required to be adopted shall be done by the contractor at his cost.

1.15 NOMINAL MIX.

The locations indicated in Column No.6 of the statement below are only suggestive. The nominal mix used for different components shall be as directed by the Engineer-in-charge according to requirement of detailed design. The Contractor shall not be entitled for any extra claim on account of the changes in location.

Sl. No.	Nominal mix	Cement content in	Maximum size of aggregate in	Stipulated strength at 28 days on 15x15x5 cm. Cubes (works tests) N/mm ²)	Indicated probable location for use
1	2	3	4	5	6
1	1:1:5:3 M-20	400	20	20	R.C.C. slabs, beams vertical walls, through columns and ribs of cross drainage works
2a)	1:2:4 M-15	363	20	15	Slabs, Krebs beams
b)	1:2:4 M-15	330	40	15	Abutment, pier caps, dirt walls
c)	1:2:4 (PCC) M-15	363	20	15	Wearing coat of bridges, canal lining in approaches of structures
d)	1:2:4 M-15	330	40	15	Foundation of structures on state highway
3a)	1:3:6 M-10	230	20	10	Side template steps, cast-in-situ lining
b)	1:3:6 (PCC) M-10	230	40	10	Foundation of O.D.R. approach slabs, cast in situ side lining.
4)	1:4:8 M-7.5	170	40	7.5	Foundation of structures other than state Highway.

M-30 mix shall be used for design of water tanks etc.

REINFORCEMENT STEEL WORKS

REINFORCEMENT

- 1.1 Scope of work.
- 1.2 Reinforcement bars.
- 1.3 Binding.
- 1.4 Distance between bars.
- 1.5 Splicing
- 1.6 Cover.
- 1.7 Inspection before concreting.
- 1.8 Anchor bars.

REINFORCEMENT BARS

1.1 SCOPE OF WORK:

The item shall include supplying bending and erecting in position steel reinforcement conforming to relevant Indian Standard Specification required for R.C. C. Works of Penstock Lining, Control Room & Power House Complex.

1.2 REINFORCEMENT BARS :

Steel reinforcement bars and fabrics shall be placed in the concrete as shown in the Drawing or as directed. Before steel reinforcement is placed in position the surface of the reinforcement shall be cleaned of rust, scale, dirt and grease and other objectionable foreign substances (heavy flaky rust and Mill scale that cannot be removed by firm rubbing with burlap or equivalent treatment is considered objectionable). The fact that early stage rust has not detrimental effect on bond shall not be used as an excuse of careless handling and storage of steel.

In storing bars of the same size, length, shapes and grade shall be assembled in racks and marked distinctly. Before the reinforcement bars are fixed in position it shall be verified that they are of specific size and bent in accordance with plans and specifications. They shall be accurately placed and secured in position by means of built-in concrete block, metallic chair, hangers; spacers and other suitable devices, at sufficiently close intervals, so that they will not sag between supports, nor be displacing the concrete or by any operation of the work.

Special care shall be exercised to prevent any disturbance of the reinforcement in concrete that has already been placed. The reinforcement after being placed in position shall be maintained in clean condition until it is completely embedded in concrete to prevent further damage to the concrete or unsightly rust stains on exposed concrete surface.

Reinforcement shall not be straightened or bent in a manner that will injure or weaken the materials. Bars with kinks or bends not shown on the plans shall not be used. Bars shall be bent to the shape and dimensions on the drawing or as directed, using a bar bender operated by hand or power, to attain the proper bending radius. The radius of bend shall not be less than 4 times the nominal size of the bar. Heating of reinforcement bars to facilitate bending will not normally be permitted when, however, such heating is permitted in the case of large diameter bars, the temperature of the steel shall not exceed the corresponding to a cherry red colour.

1.3 BINDING:

Wire for tying reinforcement shall be of soft and annealed steel. The wire may be of 1.22 mm to 1.63 mm and shall have to conform to IS 1786:2008. Metal support and spacers shall be fabricated from non-corrodible metal. Dissimilar metals shall not be placed in concrete in intimate proximity with each other or be joined by a connector especially in the continued presence of moisture unless it is known that galvanic action will not result.

1.4 DISTANCE BETWEEN BARS:

The distance between two parallel reinforcement bars shall be except as provided below in not less than the greatest of the following distances.

- a) The diameter of either bar, if their diameters are equal.
- b) The diameter of the larger bar, if their diameters are unequal.
- c) 6 mm more than the nominal maximum size of the coarse aggregate comprised in such concrete.

Note: A greater distance should be provided when convenient.

The vertical distance between two horizontal main steel reinforcements or the corresponding distance at right angles to two inclined main steel reinforcements shall be not less than 12 mm except at a splice or lap and except where one of such reinforcement is transverse to the other.

The pitch of the main bars in a reinforced concrete solid slab shall be not more than three times the effective depth of such slab, or 300 mm whichever is less.

1.5 SPLICING:

Bar splices as indicated in the drawing shall only be allowed. The lapped ends shall be placed to ensure full bond on each bar. Splicing shall not be done in the region of maximum bending moment, and splicing of adjacent bars shall be avoided as far as possible.

Welding of bars for splicing may be allowed in place of lapping at the discretion of the Engineer-in-charge at approved locations. When welding is resorted, instead of lapping, the bars to be spliced shall be lap welded or butt welded by Electric arc welding. Ends of bars to be spliced shall be cleaned of all dirt, scales, rust paint and foreign matter before welding. All welding shall confirm to the relevant Indian Standard Specification. Any weld will be considered un-satisfactory if it fails to sustain a tensile stress of at least 50 % of the tensile stress of the bar in which the weld has been made. The Contractor shall make necessary arrangements, for carrying out the tests as directed by the Engineer-in-charge.

1.6 COVER:

Sufficient concrete cover shall be provided to protect reinforcement from corrosion or as indicated in the drawings. All protruding bars from concrete or masonry to which other bars are to be spliced and which will be exposed to action of weather for an indefinite period shall be protected from rusting by a thin coat of neat cement grout.

The thickness of concrete cover (exclusive of plaster or other decorative finish) shall be as follow,

- a) At each end of reinforcing bar a cover not less than 25 mm or less than twice the diameter of such rod or bar.
- b) For a longitudinal reinforcing bar in a column cover not be less than 40 mm nor less than the diameter of such rod or bar. In the case of column of minimum dimensions of 180 mm or under, those bars that do not exceed 12 mm diameter, 25 mm cover may be used.

c) For a longitudinal reinforcing bar in a beam a cover not less than 25 mm nor less than the diameter of such rod or bar.

d) For tensile, compressive shear or other reinforcement in a slab a cover, not less than 12 mm. Nor less than the diameter of such reinforcement.

e) For all external work for work against each faces and also for internal work where there exists particularly corrosive conditions, the cover, of the concrete shall be increased by 12 mm. Beyond the figures given above (a to d)

Where because of splicing, the thickness of concrete in between reduces to less than the maximum size of the aggregate a concrete with reduced maximum size of aggregate shall be used so as to allow development of bond in the splice at contractor's cost.

1.7 INSPECTION BEFORE CONCRETING :

No concreting shall be started unless the reinforcement as laid is finally checked and certified by the Engineer-in-charge or his authorised representative, Before starting the concreting the contractor shall make certain that the measurements of the reinforcement placed in have been recorded and that the Engineer-in-charge certifies corrections of reinforcement used. Failure to do so may mean no payment or payment at the discretion of the Engineer-in-charge for the reinforcement concrete.

1.8 ANCHOR BARS:

The cost of extra anchor bars provided as per instructions of Engineer in charge shall be borne by contractor.

ROAD WORKS

ROAD WORKS**1.1 GENERAL**

1. Road shall be constructed to the lines, level and grade with sand and moorum fill having desired parameters of density cohesion, etc. so as to ensure the designed stability and performances of the whole road. The Quality Control Organization of the project may carry out requisite test for the suitability of construction materials well in advance and the contractor shall ensure that only approved materials are brought to place of fill and used for construction of Road.
2. The Contractor shall submit sequence of operation which he proposes to follow to the Engineer-in-charge and shall obtain approval to it prior to commencing work and shall adhere to the agreed sequence after modification if any by the Engineer-in-charge.
3. The methods and plants and equipments to be used by Contractor is subject to placing of the layers for the road portion programmed for construction in the season shall be continuous and approximately horizontal. In case the whole length of road is not constructed simultaneously, the incomplete end of the road shall be kept at slope not steeper than 1 in 4.
4. No materials shall be placed in any section of the road until the road seat for that section has been dewatered, suitably prepared and approved by the Engineer-in-charge. All portions of excavation made for test pits or other sub-surface investigations, all holes, hollows, and all other existing cavities found within the area to be covered and which extend below the established lines of excavation for road seats, shall be filled with suitable earth fill of the corresponding zone of the road and suitably compacted.
5. Pools of water shall not be permitted in the foundation for road and such water shall be drained and cleared prior to placing the first layer of road materials.
6. The contractor shall construct and maintain good diversion in case the existing communication is disturbed. Precautionary measures such as night lamp, danger facing signals, diversion signals etc. shall be provided by the contractor at his cost to avoid accidents on the communication lines because of contracts activities.
7. Proper care shall be taken to avoid any interference with or damage to works of other discipline such as water supply, sewerage, electricity etc.
8. The Contractor shall at all time carry out work in a manner creating least interference to the traffic during execution. The Contractor shall provide and maintain during execution a passage for traffic either along or as part of existing way under construction or a separate diversion road at his own cost.
9. Quality of all materials should be approved by Engineer-in-charge prior to collection at site. If any materials brought to site is found inferior and rejected shall be removed from site immediately by the Contractor at his own cost.
10. Construction traffic shall not be allowed to use the newly prepared surface without prior permission from Engineer-in-charge. Any damage arising out of such use shall however be made good by the Contractor at his own cost.
11. All measurements unless otherwise indicated shall be recorded / computed to the following limit
 - (i) Length and breadth –0.01 m.
 - (ii) Height, depth or thickness of earthwork, Sub base and base course-5mm.

(iii) Areas - 0.01 sqm.

(iv) Cubic content - 0.01 cum.

12. Works rejected by the Engineer-in-charge on ground of poor quality or workmanship shall be dismantled and redone by the Contractor at his own cost.
13. Complete stacking of materials like sand, moorum, H.G. chips as per requirement shall be carried out in 2Km. length before spreading, The collection shall always commence at one end and be carried continuously towards the other unless the Engineer-in-charge directs otherwise.

1.2 SETTING OUT OF THE WORK:

1. Before starting any work and during execution (if required) the contractor shall erect reference Bench Marks, reference lines and check profiles at convenient locations as per the direction of the Engineer- In-Charge. The centre line of the road and the reference line for all alignments for demarcation purpose shall be laid by properly dug-belling on the ground.
2. The Check profiles shall be located at 30M. apart or closer as directed by the Engineer-in-Charge so as to ensure execution of all slopes, steps and elevations, to the profile as indicated in the approved drawings. All important levels and all control points with respect to Bench Marks and reference lines shall be fixed and co-related by the Engineer-in-charge.
3. To ensure correctness of execution the edges of cutting, the lines of the road and those of spoil bank shall be marked carefully with pegs at close intervals. The pegs shall then be connected by stretching string from peg to peg and dug belling into ground along the strings. The lines so connected shall be corrected whenever necessary to provide a stream lined plan of the features. Special care shall be taken at curves to ensure uniform curvature of the alignment. The layout of the structures shall have to be given in appropriate manner with pegs & pillars.
4. All materials and labour for settings out works including construction of reference Bench Marks, reference lines check profiles and surveys, as may be required at various stages of the construction, shall be supplied by the contractor at his own cost. **The cost of such works shall be deemed to have been included in the costs of items for road work in schedule.**

1.3 PREPARATION OF SITE

1.3.1 CLEARING THE SITE

- (a) The contractor shall clear of all tree stumps, bushes, roots, brushwood, rubbish of all kinds, loose stones and all other objectionable materials in the entire area required for setting out. The ownership of all the useful materials so removed from clearing site and or excavation shall rest with the department. The roots of the trees shall be grubbed to full depth. The contractor shall dispose off all such materials as directed by the Engineer-in-charge.
- (b) No separate payment will be made to the contractor for complying the requirements of clearing the site and all cost shall be deemed to have been included in the rates quoted in schedule for the items.

1.3.2 RECORDING OF CROSS SECTION

Initial cross sections shall be taken at every 30 m interval or closer depending on nature of the ground upto sufficient distance outside the limit of work. Levels on these cross sections shall be taken at 5 m. or closer intervals as directed by the Engineer-in-charge and recorded in the field

and level books in the presence of the contractor or his authorised agent who shall sign the field book/level book in the token of acceptance. These c.s. shall form the basis of all future measurements and payments.

1.4 FOUNDATION PREPARATION

1.4.1 SOIL FOUNDATION

Soil foundation under the seat of road shall be scarified and loosened by means of a plough or other means to a depth of about 15 cm .to 20 cm .to the satisfaction of the Project Manager. Roots and other debris turned up during scarifying shall be removed from entire foundation area for the fill. Before placing of fill materials, the stripped surface of the road is to be initially compacted. The first layer of fill for the road shall be of depth of 10 cm to 15 cm and shall be carefully placed, ensuring uniform compaction and a satisfactory intimate bond between the foundation soil and fill materials. Heavy rubber type rollers or vibratory rollers may be used for compaction. Power Road Rollers shall be used for compaction of impervious soil and preferably vibratory type roller shall be used for compaction of all other soil.

1.5 BORROW AREA

1.5.1 GENERAL

All materials required for the construction of road shall be obtained from borrow areas duly approved by the Project Manager. The contractor has to arrange borrow area for necessary testing and approval of Engineer-in-Charge to borrow sandy soil, sand & moorum. Borrow pits shall be operated so as not to disfigure/disturb the appearance of any part of the work or any other property.

1.5.2. PREPARATION / STRIPPING OF BORROW AREA

All areas required for borrowing sand / sandy soil / moorum for road shall be cleared of all tree stumps, roots, bushes, rubbish and other objectionable materials. Borrow areas shall be stripped of top soil, and any other objectionable materials to the required depth as directed by the Project Manager. The work may be done manually or with suitable machine. Stripping operations shall be limited only to designated borrow areas. Materials from stripping shall be disposed of in exhausted borrow areas or in the approved adjacent areas as directed. Particular care shall be taken to exclude all organic matter from the materials. The cleared areas shall be maintained free of vegetable growth during the progress of the work.

1.5.3. HAUL ROADS AND APPROACH ROADS

Construction and maintenance of approach roads and haulage roads will be the responsibility of the contractor. The department will have full right of way to those roads for inspection purposes. Proper road sign as directed have to be provided for safety. For haulage of road materials, the contractor shall construct ramps and haul roads of sufficient width along the shortest but most practical route and shall maintain and illuminate them to a satisfactory manner. Watering of the haul road shall be done by the contractor as often as necessary to prevent raising of dust, formation of cuts and consequent deterioration of the surface. Whenever service roads meant for public thorough fare traverse through or run close to the borrow areas, the contractor shall direct his excavation and haulage operation in such manner as to ensure uninterrupted use of the service road and safety to the public. At the haul road and the service road crossing, the contractor shall install necessary check gates and road signs.

WEATHER CONDITIONS: Road materials shall be placed only when the weather conditions are satisfactory to permit accurate control of the moisture content in the road materials. Before closing work on road, the top surface shall be graded and rolled with a smooth wheeled roller to facilitate run off. Prior to resuming work, the top surface shall be scarified and moistened or allowed to dry as necessary and approved by the Engineer-in-Charge for resumption. The contractor shall provide suitable protection works to protect the slope from erosion due to rainwater. No payment whatsoever shall be made for providing such protection work and rectifying of monsoon damages.

1.5. 4. WATERING

Adequate watering to the sand fills are to be done to facilitate proper compaction. Similarly water content to moorum is to be controlled for proper compaction. No compensation will be made to the contractor due to held up of work for rain, fog and moisture content in the working process.

1.6 COMPACTION

GENERAL

- (a) Having decided on the filling materials to be used, standard compaction test shall be made on the materials proposed for road to indicate broadly which are the most suitable type of equipment to be used and the moisture content at which compaction should be undertaken and also to determine the effects of soil moisture content, thickness of layer and number of passes.
- (b) Having decided on the thickness of layer and range of moisture contents, tests should be made with different types of equipments available and the required number of passes should also be determined.
- (c) In all this work, the state of compaction should be measured in terms of dry density.
- (d) Density tests if felt necessary by Engineer-in-Charge shall be made after rolling. Standard proctor density test shall be carried out at regular intervals to account for variations in the borrow area materials as well as that in situ excavated materials.
- (e) The contractor shall supply all materials labour machinery and equipment at his cost for the work.
- (f) No extra payment shall be made for compaction operations as this shall be deemed to have been included in the price bid in schedule of Quantities for the respective item of work.

1.6.1 ROLLING

When each layer of materials has been prepared so as to have the proper moisture content uniformly distributed throughout the materials it shall be compacted by passing the vibrating roller or P. R .R .The exact number of passes for each layer to obtain specified density shall be designed by the field laboratory after necessary test. The layers shall be compacted in strips overlapping not less than 0.6 m. Rolling shall commence at edges and progress towards centre longitudinally. The rollers of loaded vehicle shall travel in a direction parallel to the axis of the road. Turns shall be made carefully to ensure uniform compaction. Rollers shall always be pulled. Density tests shall be made after rolling and dry density attained shall satisfy the compaction standards specified in relevant I.S. Codes.

1.6.2. COMPACTION OF COHESIONLESS MATERIALS

Where compaction of cohesion less free draining materials such as sand and gravel is required, the materials shall be deposited in horizontal layers and compacted to the relative density

specified. The excavation and placing operations shall be such that the materials when compacted shall be blended sufficiently to secure the highest practicable unit weight and best stability. Water shall be added to the materials as may be required to obtain the specified density by method of compaction being used. The thickness of the horizontal layers after compaction shall not be more than 10 cm, if compaction is performed by tampers and not more than 15cm, if by rollers.

1.6.3. DRESSING OF SLOPES

The slopes of road shall be neatly dressed to lines and grade as shown on the drawing as the placing of fill progress, compaction shall extend over the full width of the road and materials in slopes shall be compacted as for the rest of the road. To ensure proper compaction of the edges, the cross section of the fill during construction shall be kept wider as directed by the Engineer-in-charge and cross section shall be dressed to the designed requirement after compaction for which no extra payment shall be made as it is deemed to have been included in unit bid price for item of schedule of Quantities. Materials used to fill depression shall be of same type as used in the road and shall be thoroughly compacted and bonded to the original surface. Slopes shall be maintained until final completion and acceptance. Any material that is lost by rains, weathering or other causes shall be replaced at the cost of the contractor till completion of the works and taking over by the department.

1.6.4. SETTLEMENT ALLOWANCES

- (i) In the fill road, settlement allowances of 2% will be provided. Accordingly extra height shall be provided but payment for design height will be made. The base width of the road will not be increased to maintain the design slopes indicated in the drawing for the additional height as settlement allowances, but the following procedure will be adopted. Settlement allowances will be calculated at various levels where the slopes is to be changed and the elevations including settlement allowances will be derived keeping the road widths of the designed levels unchanged. The edges of road at the increased elevations (including settlement) when joined with the point where the slope has changed earlier bellow, shall give the slope to be adopted for constructions.
- (ii) If the road is raised in more than one season, provision for settlement shall be made in the last season's construction as described above.

1.7 MATERIALS

1.7.1 MOORUM AND SAND

The moorum shall have plasticity index not less than 6 as determined in accordance with I.S. 2720. It shall be free from all rubbish, dust and organic materials as well as clods of clay / black cotton soil. The moorum should be granular and gritty.

Sand shall consist of hard, dense, durable and uncoated silicious gritty materials. Sand to be used shall be natural as obtained from river bed from specified quarries. It shall be free from all rubbish, dust and organic materials as well as clods of earth loam and other deleterious substances.

1.7.2 STONE AGGREGATE

METAL

The hard granite crusher broken stone metal shall be obtained from quarries containing hard, tough, sound, durable stone of close texture, free from decay and weathering. Pieces of the

stone shall be angular and roughly cubical in shape. Round, elongated or flaky materials shall be rejected. The size of the metal shall be well graded as per specification.

Sample metals, collected from the quarries shall be got tested by the Contractor at his cost in the laboratory. The test results shall conform to the standard requirement laid down for metal to be used for this work.

The physical requirement for standard size metal shall conform to the test results as per IS:2386.

The grading requirement of coarse aggregates shall confirm to IRC specification.

17.3 CHIPS

Stone chips shall consist of regular fragments of clean hard, tough and durable rock of uniform quality throughout by crushing granite rock, and shall be free of elongated and flaky pieces, soft and disintegrated materials, and vegetable or deleterious matter. They shall satisfy the physical requirements set-forth as under.

Test	IS for Test Method	Requirements.
(i) Los Angels Abrasion value	IS:2386 (Part-IV)	35% Maximum
(ii) Aggregate impact value	-do-	30% Maximum
(iii) Flakiness index	IS:2386 (Part-I)	30% Maximum
(iv) Stripping value	IS:6241	25% Maximum
(v) Water Absorption	IS:2386 (Part-III)	2% Maximum.

Size of stone chips shall be as under :

- (i) For premix carpet 20mm to 12mm size: Passing 20mm sieve and retained on 10 mm sieve.
- (ii) For precoated seal coat 6mm and down graded size: passing 10mm sieve and retained on 2.36mm. sieve.
- (iii) Samples of stone chips collected from the quarries shall be got tested by the Contractor at his cost in laboratory. The test results shall confirm to the standard requirement as per BIS.
- (iv) Control on quality of material will be exercised by the Engineer-in-charge by carrying out the following tests at frequencies shown against each.

Type of construction material Test Frequency : Chips for carpet i) Aggregate impact value - One test per 100 M³ of aggregate and seal coat. ii) Flakiness index of aggregate – 1 test per 100 M³ of aggregate iii) Stripping value and water absorption - initially, one set of 3 representative absorption test of aggregates from specimens for each source of supply. Subsequently when warranted by changes in the quality of aggregates. iv) Grading of aggregates - One test for 100 M³ of aggregates.

1.7.4 MEASUREMENTS:

The materials such as sand, moorum, and crusher broken granite metals are to be separately stacked at approved stack yard beyond trafficable berm in standard stacks of 1.5mX1.5mX1m. Accounting deduction of voids, each such stack is to be measured and paid as 1 cum.

1.7.5 BITUMEN

Bitumen of 80/100 grade conforming to BIS as approved by the Engineer-in-charge, in writing shall be utilized in the work. Procurement of the bitumen will be made by the

Contractor at his own cost from reputed manufacturers on approval by the Engineer-in-charge. The contractor is to produce test certificate to be issued by manufacturer for each consignment separately.

1.8 CONSTRUCTION PROCEDURE

1.8.1 SUB-BASE BELOW PAVEMENT

- (i) Moorum and sand stacked separately shall be conveyed and mixed properly to make an admixture of moorum and sand in proportion as per direction of Engineer-in-charge.
- (ii) The formation after excavation or trimming shall be dressed to required camber and grade.
- (iii) The admixture of moorum shall be spread in sub base and also side shoulders in layers not exceeding 15cm. in thickness and should be adequately watered.
- (iv) Immediately following spreading of moorum admixture rolling will be started with 10 tonne capacity vibratory roller. The rolling shall begin from edges and then progress gradually to centre, parallel to the centre line of the road and over lapping uniformly each preceding rear wheel track by one half width and shall continue until the entire area of the course has been rolled by the rear wheel. In case of superlevated portions rolling shall proceed from inner edge to the outer edge. Rolling to continue till the admixture of moorum is thoroughly keyed. During rolling sprinkling of water is to be done as required for a dense compacted mix layer.
- (v) The rolled surface to be checked transversely and longitudinally and any irregularities, ruts and soft yielding places be corrected by loosening surface, adding or removing amount of admixture moorum and rolling entire surface to confirm desired grade and camber of 1 in 50 (not flatter than 1 in 72).

1.8.2 I.R.C. GRADE-I AND I.R.C. GRADE-III METALING

A) SPREADING OF COARSE AGGREGATE

- i) I.R.C. Grade-III metal (size 40mm to 25mm .) shall satisfy criteria described under sub-head criteria "materials" in preceeding paragraph
- ii) Stacking for Gr.-III shall be done after the spreading of Gr.-I metal.
- iii) The surface to receive I.R.C. Gr-I or Gr.-III water bound macadam course (metaling) shall be made free from dust and other extraneous material.
- iv) The respective grade metals shall be spread uniformly to achieve compacted nominal thickness of 11.5cm. and 10 cm for I.R.C. Grade-1 and I.R.C Grade-III metaling respectively.
- v) The spreading shall be done from stacks along the side of the roadways or approved stock yards. In no case shall aggregates be dumped in heaps directly on the surface prepared for the metaling nor shall hauling over un compacted or partially completed base be permitted. No segregation of large or fine particles shall be allowed. The surface of the aggregates shall be carefully checked with Templates and all high or low spots remedied by removing or adding aggregates as may be required by hand packing the same to proper grade and

camber.

vi) The bunds of earth or moorum one on either side shall be made along the outer edge of metaling prior to or simultaneously with spreading of metal. In addition wherever required turf edging are to be provided. These bunds and turf edging are required to prevent loose metal from spreading out beyond width of road to be metalled. No extra payment will be made for the bunding or turf edging as the same are deemed to be included in the unit rate of respective items.

vii) The course aggregate shall normally be spread more than 3 days in advance of the subsequent operation.

viii) Spreading of metal shall proceed only 200m. in advance of rolling operation.

B) CONSOLIDATION

- (a) Immediately following the spreading of the coarse aggregates, rolling shall be started with vibratory roller of 8 to 10 tonne capacity or equivalent vibratory roller. The weight of the roller shall depend upon the type of the aggregate and shall be as indicated by Engineer-in-charge.
- (b) Except on super elevated portions where the rolling shall proceed from inner edge to outer, rolling shall begin from the edges gradually progressing towards the centre. First the edge/edges shall be compacted with roller moving forward and backward. The roller shall then move inwards parallel to the centre line of the road, in successive passes uniformly lapping preceding tracks by at least one half wheel width.
- (c) Rolling shall continue until the aggregate is thoroughly keyed and the creeping of the aggregate ahead of the roller is no longer visible. During, rolling slight sprinkling of water may be done, if necessary. Rolling shall not be done when the sub-grade is soft or yielding or when it causes a wave like motion in the sub-grade or sub-base course.
- (d) The rolled surface shall be checked transversely and longitudinally with Templates and any irregularities corrected by loosening the surface, addition or removing necessary amounts of aggregates and re rolling till the entire surface conforms to desired camber and grade. In no case shall use of screenings be permitted to make up depression.
- (e) Moorum as blinding material shall be applied, successively in two or more thin layers at a slow and uniform rate. After each application, the surface shall be copiously sprinkled with water, the resulting slurry swept in with hand brooms or mechanical brooms to fill the voids properly, and rolled, during which water shall be applied to the wheels of the rollers, if necessary to wash down the blinding materials sticking to them. These operations shall continue until the resulting slurry after filling the voids, forms a wave ahead of the wheels of the moving roller.
- (f) After final compaction of water bound macadam course, the road shall be allowed to dry overnight. Next morning hungry spots shall be filled with screenings or binding materials as directed, lightly sprinkled with water, if

necessary & rolled .No traffic shall be allowed on the road until the macadam has set. The Engineer-in-Charge shall have the discretion to stop hauling traffic from using the completed water bound macadam course if in his opinion it would cause damage to the surface.

- (g) Material which crushed excessively during compaction or becomes segregated shall be removed & replaced with suitable aggregate.
- (h) It shall be ensured that shoulders are built up simultaneously along with water bound macadam courses.

C) CONSUMPTION OF MATERIALS

Consumption of material for specified thickness of pavement in case of both I.R.C. Gr.I and I.R.C. Gr. III metaling shall be as follows:

ITEM OF WORK	I.R.C. Gr.I	I.R.C. Gr.111
Over all (Nominal) thickness of layer laid	115 mm.	100 mm.
Compacted thickness	90 mm	75mm.
Consumption of metal	0.115 cum/sqm	0.100 cum/sqm
Consumption of moorum as blinding material.	0.028 cum/sqm	0.025cum/sqm

1.8.3 PREMIX CARPET AND SEAL COAT

(a) This work shall consist of laying an open graded carpet of 25mm thickness in a single course and 6mm thick pre-coated seal coat composed of suitable small sized aggregate premixed with bituminous binder on a previously prepared approved base.

(b) The quality and grading of materials shall satisfy provisions under sub-head materials.

(c) Carpet shall not be laid during rainy weather or when the base course is damp or wet and when the atmospheric temperature under shade is 160 ° C or below.

(d) The underlying base on which the bituminous carpet is to be laid shall be scraped with wire brushes, swept clean with brooms and finally dust removed with sacks as found necessary.

(e) Tack Coat

This work shall consist of application of a single coat of low viscosity bituminous material to under lying road surface duly cleaned preparatory to bituminous construction. The temperature of bitumen at the time of application shall be in the range of 160° to 175°C. Bitumen shall be heated to the temperature appropriate to the grade of bitumen used and approved by the Project Manager. The rate of spread in terms of straight run bitumen shall be 1kg per sq.m. area for untreated water bound macadam surface. The binder shall be applied uniformly with the aid of sprayers. The tack coat shall be applied just ahead of bituminous construction.

(f) Mixing

Bitumen Mixers of approved type shall be used for fixing aggregates with the bituminous binder. The binder shall be heated to the temperature raising from 150°C to 175°C as approved by the Engineer-in-Charge, avoiding local over heating and ensuring a continuous supply. Aggregates shall be dry before they are placed in the mixer. After about 15 seconds of dry mixing the heated binder shall be distributed over the aggregates at the rate specified. Kerosene to an extent of 4% to 6% of asphalt shall be provided by the Contractor according to the requirement at his cost. Mixing of binder with chips shall be continued until all chips are uniformly coated with the bitumen and a homogeneous mixture is obtained. The mix shall be immediately transported from the mixer to the point of use in suitable vehicles. The vehicles employed for transport shall be clean and be covered over in transit, if so directed by the Engineer-in-charge.

(g) Spreading

The mix shall be spread on the road surface with rakes to the required thickness and camber, or distributed evenly with the help of a drag spreader, without any undue loss of time. The camber shall be checked by means of camber boards and inequalities evened out to prepare the surface to specified line, grade and camber.

(h) Rolling

As soon as sufficient length of bituminous material has been laid, rolling shall commence. When the roller has passed over the whole area once, any high spots or depressions that become apparent shall be corrected by removing or adding premixed materials. The rolling will be done with a set of 8 to 10 tonne two wheel tandem rollers or equivalent suitable pneumatic roller as approved by Engineer-in-Charge. The roller speed will not be exceeding 5km. per hour. The roller wheels shall be kept damp to prevent the mix from adhering to them but in no case shall lubricating oil be used for this purpose. Rolling shall commence longitudinally from the edges and progress towards the centre except that in super-levated portion, it shall progress from lower to upper edge parallel to the centre line of the pavement. The roller should proceed on the fresh material with rear or fixed wheel leading so as to minimize the pushing of the mix and each pass of the roller uniformly over laps not less than one third of the track made in the proceeding pass. Rolling shall continue until the entire surface has been rolled and all the roller marks eliminated. The contractor shall provide necessary labour for keeping the roller wheels damp during rolling so as to prevent the premix from adhering to the wheels and being picked up. The edges along and transverse of the carpet laid and compacted earlier shall be cut to their full depth so as to expose fresh surface which shall be painted with a thin surface coat of appropriate bitumen before the new mix is placed against.

b. Seal Coat

Pre coated seal coat of approved thickness shall be applied immediately after laying of the bituminous course of carpet. Before application the surface shall be cleaned free of any dust or other extraneous matter. Mixing of chips and bitumen, laying the mix to proper thickness and rolling will be done similar to procedure for premix carpet described above. Blinding of rolled asphalt surface with course clean sand at the rate of 0.003 cum per Sq.m of road surface area shall be done by the contractor at his own cost as the same is included in the

unit price.

Traffic may be allowed only after final rolling when the premix material has cooled down to surrounding temperature.

Consumption of Material

Material		Consumption/ Sqm of road surface area	
A.	20mm thick premix carpet		
	1) 20mm to 12mm size H.G. chips		
	Nominal 20mm	0.015 Cum	
	-do- 10mm	0.008 Cum	
	Total	0.023 Cum	0.023 Cum
	2) Bitumen – VG-30 Grade		
	Tack coat -	0.907 Kg.	
	Precoating chips	1.270 Kg.	
	Misc. and Wastage	0.091 Kg.	
	Total	2.268 Kg.	2.268 Kg
B.	6mm thick precoated seal coat.		
	1) 6mm and down graded H.G. chips		0.006 Cum
	2) Bitumen – 80/100 grade		
	Precoating chips	0.680 Kg.	
	Misc. and Wastage	0.010 Kg.	
	Total	0.690 Kg.	0.690 Kg.
	3) Sand (for blinding)		0.003 Cum

- (i) The shoulders or berms on either side of the pavement over the embankment to be constructed with rolled moorum layer in conformity with the lines, grades and cross sections as per approved drawing and as directed by the Engineer-in-charge.
- (ii) Moorum shall be conveyed from the road side heaps or from stockyard and spread on the prepared base to lines and grade.
- (iii) Rolling will be done with 8 to 10 tonne capacity three wheeled vibratory rollers as per similar procedure laid for sub base.

SECTION V - A

TECHNICAL SPECIFICATION FOR PUMPS

&

ELECTRO-MECHANICAL WORKS

TECHNICAL SPECIFICATION FOR PUMPS
&
ELECTRO-MECHANICAL WORKS

CONTENTS

SL. NO.	PARTICULARS	PAGE NO.
1	Introduction	1
2	Vertical turbine (V.T) Pumps	2
3	Special tools, slings, consumables etc.	15
4	Spares	15
5	Paint & Finish	15
	Annexure I Technical data sheet	16
	Annexure II Material of construction	17
	Annexure III Declaration of the product offered	18
6	Submerged Centrifugal Pump	19
7	Technical specification of H.T Motors for VT Pumps	29
8	Technical specification of L.T Motors for VT Pumps	43
9	Drainage Pumps	52

Section - V

TECHNICAL SPECIFICATION FOR PUMPS AND ELECTRO MECHANICAL WORKS

1.0 Introduction

- 1.1. Overview of the Pumping system envisaged in the Lift Irrigation Schemes under the cluster is discussed. The contractor will be able to identify the brief details of each item.
- 1.2. As the suction lift of pumps would be more than six meter, It is proposed to have Vertical Turbine Pumps in RCC built Pump Houses nearer to the river. Its location must be such that it shall be safe from the high flood conditions of the river.
- 1.3. From the intake arrangement in shape of intake well or Intake wall suitable conduits shall be laid with proper gradient. Trash Rack arrangement for floating debris and silt cleaning has to be provided.
- 1.4. The pump house will have proper ventilation.
- 1.5. The control panels will be located in or nearer to the pump house Such that Pumps are visible from the electric control panel/ PLC operator.
- 1.6. The VT pumps are lubricated by external clear forced water. The details are covered in VT Pump specifications. The forced water pumps will be located in a suitable area of pump house outside pump house. These pumps will draw water from a RCC tank of 10,000 liters capacity. The water from rising main is drawn in this tank and allowed to settle, before being passed through filters etc.
- 1.7. The actual design of piping headers and instrumentation etc is not covered, since these will depend on actual design, and EPC contractors will have to prepare the lay outs and submit for approval. EPC contractor will be given the map showing the area to be irrigated by a specific pumping system and the, rate of discharge, at which, the pumps will deliver water in peak season. The EPC contractor has to carry out survey, locate the pump house site, decide piping route, and location of delivery chamber, collect data regarding max, min and high flood levels, compute friction losses etc before deciding head for each pump. Power System connectivity to the Pump house is also covered under the scope of contract.
- 1.8. The location of AIR valves and surge protection devices will be decided after carrying out surge analysis by EPC contractor.

1.9. MOTORS

VERTICAL TEFC/CACA motors required for vertical Turbine pumps only shall be provided.

1.10. DRAINAGE PUMPS

Drainage pumps shall be provided to dewater the sump before starting main VT pumps. This is necessary because the sand and silt will accumulate in the sump because of still water during idling of V T pump. These pumps are part of sump cleaning system.

2.0 VERTICAL TURBINE(V.T) PUMPS

2.1 GENERAL

V.T Pumps of required capacity for pumping design discharge at duty point head are necessary to be provided at the respective pumping stations of the different schemes proposed under the Cluster. The pump to pump spacing shall be provided as per CEA(Central Electricity Authority) guidelines.

The desired characteristics of the pumps are as follows.

- i. The pumps to be rugged in structure both mechanically and electrically to withstand rough weather conditions, & designed to run with minimum maintenance as the installation points are in remote inaccessible places.
- ii. The materials of construction for different components to be selected to withstand wear and tear.
- iii. The pumping units should be easy to handle, & install, and designed to withstand normal variation in power supply.

2.2 Pumps in Parallel

In each pump house, there shall be minimum two and one standby pump and maximum four pumps working in parallel as decided by the PD-um-CE. Number of pumps indicated in bid document is indicative only based on owner's preliminary study. Contractor should choose economical option

2.2.1 Stand by Pump : Each pump house shall have one stand by pump.

2.2.2 Pumps in a pump house shall be identical in all respect.

2.2.3 Contractor may choose similar types of pumps in all pump houses such that the pumps are interchangeable in case of emergency, and least quantity of spares can be stocked.

2.2.4 The motors for the scheme is preferably H.V Motors with 6.6 KV H.T Supply however V.T Pumps of smaller size may use Low voltage motors, where as for motors of,200 Kw and above shall be operated with 6.6 Kv HT supply and below 200 Kw shall be operated with 415 V LT supply. Contractors must consider suitable step down transformers for each scheme.

2.2.5 RCC pump house structure is required for VT pumps so as to protect the motors from rain, wind, dust, etc. The VT pump house floor level should be above High flood level. The delivery piping for these may follow contour of the land.

2.2.6 Each pump house will have following major components

2.2.6.1 Pump house with suitable EOT crane, bay for maintenance, space for control panel, sump for fore bay , ventilation system.

2.2.6.2 VT pumps with HT or LT motors, External forced clear water lubrication system

2.2.6.3 Dewatering pumps are required to remove sand and silt from the sump.

2.3 Codes and Standards:

The design, manufacture and performance of the V.T. pumps shall comply with all currently applicable statutes, regulations and safety codes in the locality area where the equipment will be installed. The equipment shall also confirm to the latest applicable Indian Standards. In particular the equipment shall confirm to the latest revisions IS 1710 -Vertical turbine pump for clear cold, fresh water.

2.4 Design Requirement:

2.4.1 The equipment shall be capable of developing the required total head at rated capacity for continuous operation. The total head discharge curve shall be continuously rising towards the shut off with highest shut off point. Pumps shall be identical and shall be suitable for parallel operation with equal load division. Impellers shall preferably be of non over- loading type. Pumps shall run smoothly without undue noise and vibrations. The magnitude of peak to peak vibration at slip will be limited to 100 microns(or as per IS) at the bearing housing. Pumps normally will be SINGLE STAGE vertical turbine type and suitable for the service condition stipulated in most efficient manner.

EPC Contractor may decide to install booster pumps in the system to achieve the economical option of running and capital cost. The Booster pumps can be HORIZONTAL SPLIT CASE/END SUCTION Coupled sets/submersible pumps in casing pipe. Feasibility with Economical consideration of running two pump houses with all facilities and control has to be decided. Required Pump start stop logics (interlocks) shall be provided between main Pumping Station and Booster pumping station(If required). Time lag shall be provided to start Booster pump after starting of main pumps to ensure sufficient water is available at Booster pump suction.

2.4.2 **Duty Point Pump Head:** The contractor shall have to account for all losses (in entry, strainer, bell mouth, bowl assembly, column pipes, discharge tee etc/) while designing the pumps in addition to head loss in delivery pipe, valves, fittings, rising mains and velocity head beyond discharge flange of discharge head / pumps casing etc. are to be calculated taken into account while designing pump.

2.4.3 **Duty Point Efficiencies:** The DUTY POINT efficiency shall be guaranteed by the EPC contractor along with other parameters. Overall efficiency shall be above 80% for each pumping installation.

2.4.4 **Head Range and Parallel Operations:** The pumps will satisfy the head requirement as per the system resistance curve, while operating in solo and in any combination up to maximum Nos. of duty pumps in parallel. The Pumps should be suitable for operation in head range of 10% above N.W.L. and 25% below N.W.L.

2.4.5 **Power Margin:** The specific gravity of water is to be taken as 1.03 while calculating power for the pumps. The pumps shall be capable of operating in the range as mentioned above without being overloaded at any point and keeping a margin of at least 5%or more of power in the motor of pump over entire operating range and 10% at rated Duty point whichever is higher. Requirement of power at shut off should not exceed power requirement at duty point. The pump should be capable of starting

against fully closed valve without being overloaded at any point up to valve fully open. The starting torque of each motor should be such that, all pumps should be capable of starting without any problem automatically from remote control system.

2.4.6 Pump Characteristics : The pump characteristics shall be of stable nature and such that the efficiency is fairly steady for the water level variation. The maximum efficiency point will be nearer to the duty point and fairly constant for larger range on either side. The pumps should run smoothly from a lowest head to rated duty head, without cavitations and vibration. The variation in the efficiencies for any point of operation in the entire operating range should be minimum.

2.4.7 NPSH Conditions (Net Positive Suction Head Conditions) : NPSH required by pumps offered by the Contractor should be lesser by at least 0.5 meters than N.P.S.H.A. at duty point and shall not exceed the N.P.S.H. available at any point of operation in the range with solo and parallel operations. The Contractor shall take following values of the corresponding parameters for the purpose of calculation of N.P.S.H. At the site

- a. Atmospheric pressure 9.6 Meter of column of water
- b. Vapour pressure of water 0.6674 Meters column of water (at 37.8 C Normal temperature)

2.4.8 Speed: Pump speed should be as recommended by manufacturer.

2.4.9 Solid Handling Capacity: The pump shall be suitable for pumping of raw river water containing silt, sand and suspended solids up to 20 mm size. The river water may contain weeds and other long roots etc, which may pass through trash racks. These may obstruct the pump impeller, diffuser and bearing holder spiders etc. Hence contractor should take special care to avoid such occurrences, while designing intake pipe. Contractor to get water analysis done and impellers and casings to avoid any damage due to abrasive material in raw water.

The Turbidity data of the river of Odisha Pollution Control Board and its analysis should be carried out by contractor.

2.4.10 Class of Operation : The pumps shall be suitable for nonstop continuous 24 hours operation without interruptions.

2.4.11 No. of Starts : Pumps shall be suitable, for two hot starts, and three cold starts per hour of corresponding motor.

2.5 Sump Model Testing :

The contractor must design the sumps of each scheme, to ensure vortex free and cavitations free operations of the pumps. If required contractor may carry out sump model test/or carry out sump design by mathematical modeling, at his own cost for vortex free operation. During the operation if it is required, the contractor has to modify the sump at his own cost without affecting the operation of the scheme.

2.6 Definitions of Efficiencies :

For all purpose of this contract, the various efficiencies will have the same meaning and effect as defined in the IS 1710-(latest version).

2.7 Characteristic Curves:

The contractor shall furnish characteristic curves of pump. The contractor shall furnish along with his tender the characteristic curves so prepared, superimposed on system head curves for single and multi pump operation.

2.8 Bowl Assembly:

A pump bowl shall be flanged with machined matching faces. The suction bell mouth to bowl assembly, to column and to discharge head, i.e, all joints shall be flange joints. The bowl shall be capable of withstanding a hydrostatic pressure equal to twice the duty head or 1.5 times shut off head whichever is greater.

2.9 Suction Bell mouth & Strainer:

A cast iron bell mouth shall be fitted to the suction nozzle to limit the velocity to 1.5m/sec maximum. The suction strainer shall be of Stainless Steel AISI 304. Net opening area in strainer shall not be less than 2.5 times of entrance area of bell mouth. The shape and curvature of the bell mouth shall be designed to streamline the flow of bowl suction. The thickness of bell mouth shall not be less than 10mm.

2.10 Impeller:

The impellers shall be dynamically balanced so as not to cause any vibrations & cavitation during operation. The impellers shall be closed type and shall be made in one piece and securely fixed to the stainless steel shaft, to assure accurate adjustment of each impeller. The water passage will be finished smooth by hand. Balancing holes/ devices for reducing hydraulic thrust shall not be provided.

2.11 Wearing Rings:

Wearing rings shall be renewable type. These shall be held in place by screwing against rotation, press fit or locked with pins, flanged and screwed. Wearing rings shall be provided on both casing and impeller.

Hardness of wearing rings shall be less by at least 50 BHN than the impeller.

2.12 Shaft:

The shaft shall be of stainless steel and finished to the close tolerance at the impeller / bearing fixing sizes.

The design of the shaft shall also take into consideration the critical speed of the shaft, which shall be at least 20% above / below the operating speed.

The shaft shall be properly balanced so as not to cause any vibrations during operation. The pump shaft bearings i.e. bush bearings would be stainless steel, water lubricated. Extra long bearing shall be provided for suction and discharge bowls. The hardness of bush bearing shall be less by at least 50 BHN than that of shaft.

2.13 Column Pipe Assembly:

Column pipes shall be of M.S. Fabricated heavy weight, flanged type each in 2 m length or less so that after complete erection of the pump/s the bottom of strainer shall be as per the CPHEEO Manual and length of strainer shall be adjusted accordingly. The total length of column assembly, bowl assembly, bell mouth and strainer shall be decided by the contractor based on the data collected after detail survey. The column assembly length (including column pipes, bowl, assembly, bell mouth and strainer) shall be adjusted considering, the pump floor, levels. A matching piece shall be provided if required. The stiffeners shall be provided to all pipe flanges. The discharge head/ tee and column pipe dia shall be same. The discharge head tee incorporates full diameter elbow.

2.14 Line Shaft:

The shafts shall be of solid circular section, prepared from stainless steel machined and ground thoroughly and coupled with muff couplings. The shaft sections shall be provided with noncorrosive and abrasion resisting wearing surfaces particularly at the location of each guide bearing.

Length of line shaft shall not be more than 2 m. each.

2.15 Line Shaft Bearing:

These shall be designed to be water lubricated by external clear forced water, and shall be placed in bearing holders located in position at the joint of columns. Line shaft bearing shall be of cut less hard rubber designed for efficient water lubrication. The line shaft protection tubes shall be provided for holding line shaft bearings. The line shaft protection tubes shall be of heavy duty seamless tubes to withstand all mechanical and hydraulic forces exerted on it, with an allowance for corrosion and erosion. Composite design of line shaft materials and diameter and bearing centre shall ensure that the entire rotating assembly is brought from standstill to full speed without any vibrations and shaft deflection and to ensure that first critical speed is not within 80% to 120% of full speed.

2.16 Discharge Head & Motor Stool:

The discharge head shall be fabricated from M.S. and shall incorporate mounting flange for motor stool for solid shaft motor, stuffing box with renewable gland packing and tapping for pressure gauge mounting etc. The discharge head shall be of robust construction and shall be designed to support entire load of pump assembly, water column and motor etc. and shall withstand all static and dynamic, torsion loads, hydraulic thrust imposed during operation from shut off to stipulated operating conditions and thrust due to change in direction of flow, without any vibrations. The delivery nozzle shall be above ground.

Discharge head with sole pads will not be accepted. The discharge head shall be installed on sole plate with ISMB frame and entire load of motor and pump shall be on the lower floor. Drain arrangement for gland leakage water shall be provided at bottom of discharge head with G.I. pipe. The base of the discharge head shall be sufficient to properly support the pump. The power shall be transmitted from motor to vertical shafting through a flexible coupling. Both halves of the coupling shall be machined all over, securely keyed to their

respective shafts. The pins shall be of stainless steels. The arrangement of two halves shall be suitable to check alignment and parallelism.

A self aligning thrust bearing shall be housed in the head gear adequately designed to accommodate entire weight of rotating parts and hydraulic through and shall be suitable for reserved rotation up to at least 150% normal forward speed. Bearing shall be designed for 40,000 hours life. The bearing shall be of oil lubricated type and shall be provided with oil level gauges and suitably positioned temperature probes. Two sets of adjustable contacts shall be provided one for an alarm and other for tripping the pump motor. This shall be connected to scanner panel so that digital temperature can be read out with alarm and tripping.

Motor stool shall be provided for mounting the electric motor. The motor stool shall accommodate the pump thrust bearing and pump motor coupling. The motor stool shall be robust construction and of fabricated mild steel and adequately sized with opening to work on the flexible coupling. Height of pump supporting girder/ channel, discharge head and motor stool shall be adjusted to have motor base at or marginally above panel floor level.

The pump shall be provided with non reversible ratchet to prevent them from rotation in reverse direction. Pressure gauge to each pump and manifold pipe shall be provided. Pressure gauge shall be 150 mm dial size and least count shall be 0.05, each pressure gauge shall be fitted with restrictor nozzle of brass and G.I. Pipe and U tube. Pressure gauge on manifold shall also be provided. All pressure gauges shall be installed in pump house on wall with necessary G.I. pipe connections from manifold to pump house. The pressure gauges shall be installed at suitable height so that the reading can be taken accurately.

2.17 Sole Plate:

The M.S. sole plate arrangement shall be provided under the discharge head for precise horizontal and vertical alignment.. It shall be independent of base plate integral with the discharge head. The contact surfaces of the sole plate arrangement as under shall be machined for precise leveling and shall ensure vibration free operation of the pump.

Corner plates and sole frame Sole frame and sole plate Sole plate and discharge head.

All joints between machined contact surfaces shall be with nut bolts/ tapped studs/ bolts. The opening in the sole-plate/frame shall be of adequate size to pass the bowl assembly etc. very easily. M.S. base frame shall be anchored in the floor ensuring complete rigidity. Entire structural fabrication and foundation arrangement shall be designed and submitted for approval. M.S. plates shall be grouted on pump supporting R.C.C. beams provided in civil structure. The fixing of M.S. plates on the R.C.C. beams and subsequent anchoring of M.S. sole frame in proper level shall be the responsibility of contractor with all related works.

2.18 Automatic Air Release Arrangement:

An automatic air release valve of min 50 mm size shall be provided, to remove the air from column pipe during starting of the pump

NOTE: All accessories required for proper and safe operation, dismantling and erection and pump shall be supplied with heavy duty clamps for column and line shafts, one pair for each pump.

2.19 Forced Water Lubrication and Cooling System

The forced water lubrication system for transmission bearings and supply of cooling water to pump thrust bearing shall be provided. The river water shall be taken in a sump, from where it shall be passed through pressure filter, by booster pump. The filtered water shall be free of solids. The degree of filtration shall be 50 microns. There shall be standby booster pump. A suitable 10000 liters over head tank shall be provided to supply lubrication water to pumps, in case failure of Forced water lubrication system. The system flow and pressure requirements should be as pump manufacturer's recommendations

2.20

MATERIALS OF CONSTRUCTION FOR V.T. PUMPS/Booster Pumps

Sl. No.	Description	Material
1.	Bell mouth, pump bowls, suction casing and discharge nozzle	Ni-C.I. conforming to IS 210 grade 20
2.	Impellers for V.T. pumps & Booster pumps	Stainless Steel CD4 M Cu – BHN.220 – 270 with anti abrasive
3.	Impeller shafts for V.T. pumps & Booster pumps	Stainless Steel AISI 410
4.	Column Pipes	Mild steel IS 2062 EFW/ ERW pipes.
5.	Line Shaft Protection tubes	Seamless M.S.
6.	Flexible coupling	Forged steel conforming to IS 3495
7.	Wearing rings for V.T. pumps and Booster pumps	Stainless steel as appropriate
8.	Column Flanges	Mild steel IS 2062
9.	Nut bolts and washers upto bottom of discharge head	Stainless steel AISI ST 304/316
10.	Line shaft	Stainless steel AISI – 410
11.	Line shaft coupling	Stainless steel AISI – 410
12.	Pump shaft bearing	Cut lass Rubber
13.	Discharge head	C.I. conforming to IS 210 or mild steel fabricated IS 2062
14.	BOWL bearings	Ni-CI confirming IS 210 or Mild Steel fabricated IS 2062
15.	Strainer	Gun Metal/ Stainless steel AISI304
16.	Casing of Booster Pumps	Ni-CI or galvanized steel
17.	Pressure Filters	C.I. conforming to I.S. 210 grade 20i Body and Flanges - M.S. fabricated ii Filter media - Graded sand

2.21 MECHANICAL FILTER ELEMENT

Design duty	-	To be decided by pump manufacturer
Degree of filtration	-	50 Micron
End connections	-	Flanged
Fluid	-	Water
Viscosity	-	1 cp
Flow Rate	-	Adequate with sufficient margin
Design Pressure	-	Adequate
Pressure Drop	-	0.2 Kg/cm.sq. (Clean condition)
Hydro test pressure	-	1.5 times of design pressure
Applicable Standard	-	I.S. 2825
Filter media	-	Strainer tube

2.22 PUMP STARTING / CLOSING LOGIC AND INTERLOCKS (The data is given for proper design of control system)**LOGIC OF PUMP STARTING**

After single push button command, following operations will take place in sequence.

- a. After starting of sump cleaning pumps, dewatering pump should be run for 20 minutes. (De watering pump is required to run before starting of first pump motor, then after direct second pump can be started.)
- b. Forced water lubrication system / pre lubrication starts after stopping dewatering pump.
- c. After a time delay the main pump motors will start and capacitor cubicle circuit will be 'ON'
- d. The pumps will be started in sequence, at an interval such that the subsequent pump starts after the previous pump has attained full speed.

LOGIC OF PUMP CLOSING

- i. The main pump motors will stop and Capacitors cubicles circuit will be OFF.
- ii. Forced water lubrication and cooling system will be closed..(Force water lubrication system and cooling system is common for all pumps in the pumping station, so it will get closed when all pumps are switched off)

INTERLOCKS

- i. Each V.T. pumps will not start if lubrication system and cooling hasnot started functioningand developed required pressure/ flow.
- ii. Control and monitoring of pump set

- iii. All stators of motors shall incorporate three manually closed (NC) thermal high temperature sensors. Should the high temperature occur; the thermal switches shall open, stop the motor and activate the alarm
- iv. Thermal switches shall be provided for motor bearings and pump thrust bearing. Should high temperature occur, there will be Audio visual alarm.
- v. Vibration monitors shall be provided at motor, should any abnormality occur, there will be audio visual alarm.

Note: The above controls are in addition to the regular protections such as O/L, low voltage, SP, Reverse Rotation, low water level, motor not picking up speed in predetermined time etc.

2.23 Drawings / Data to be Submitted

The pump manufacturer shall submit the following performance curves and Data along with his technical offer as minimum

- i Pump Discharge v/s Total Head Curve
- ii Pump Discharge v/s Pump Power Input Curve
- iii Pump Discharge v/s Motor Power Input Curve at 50 Hz.
- iv Pump Discharge v/s Pump efficiency Curve Pump Discharge v/s NPSHR
- v. Family Performance Curve

2.24 NPSHR

- i) Pump Discharge v/s Overall Efficiency Curve
- ii) Motor efficiency at Full Load
- iii) Motor efficiency at Rated Duty Point
- iv) Motor Power factor at Full Load
- v) Motor Power factor at Rated Duty Point
- vi) No Load Current of Motor
- vii) Motor Current at duty Point
- viii) GA drawing for the pump offered with foundation details.
- ix) Weight of Pump set and required minimum crane capacity.
- x) Weight of component/assembly weighing maximum during assembling and dismantling
- xi) Performance Parameters

The pump manufacturer has to declare the performance parameters separately as Guaranteed Performance Parameters. These shall include Discharge, Head, Pump Efficiency and Overall Efficiency.

2.25 TESTING :

All the pumps shall be subject to factory test in presence of Engineer-in- Charge or his representative and third party appointed for the purpose.

The contractor shall arrange all required test equipment duly calibrated, Field performance test shall be witnessed by authorities for initial condition.

2.26 Testing at Manufacturer's Shop

All the pump sets shall be tested and approved for their complete performance at manufacturer's work before dispatch as per ISO 9906, Grade 2.

The testing shall be done with the job motor at rated voltage, frequency and speed.

The performance of the pump shall be tested at manufacturer's work before dispatch. Following parameters shall be checked during pump performance testing.

- i) Head
- ii) Discharge
- iii) Power input to the motor
- iv) Voltage
- v) Current
- vi) Frequency
- vii) Bearing Temperature (wherever temperature sensors for the bearings are provided)
- viii) Noise

A) FACTORY TEST:

Review of raw materials test certificates and quality control procedure.

1) Hydrostatic Test:

Following items shall be tested at hydrostatic pressure equal to twice duty head or 1.5 times shut off head of bowl assembly whichever is higher as per IS: 5120.

- (a) Bowl assembly
- (b) Discharge head / tee
- (c) 20% quantity of column pipes.

2) Performance Test:

The test shall generally be carried out as per IS 9137. Class pumps acceptable test for pumps class-C. The test shall be carried out at full speed, full load at manufacturers work.

The test shall cover minimum 6 points, i.e.,

- (a) Duty point
- (b) 2 points above duty point
- (c) 2 points below duty point
- (d) Shut off head
- (e) Power consumption at all above points
- (f) Zero reading confirmation for V. notch.

The test shall be carried out only by the job motor which will be supplied under this contract. The test at reduced speed and reduced load will not be acceptable.

Strip Inspection:

All the pumps after completion of its performance test and as selected by the Engineer or Inspector at random will be offered for strip inspection and dimensional checking. The manufacturer/ contactor shall submit all required dimensional drawings of strip inspection.

Minimum points as under shall be checked.

Condition of all components particularly bushes, bearings and wearing rings to examine undue rubbing, wear etc.

Hardness of cut less rubber bearing

Dynamic balancing of

- (a) Impellers
- (b) Flexible coupling

Clearance and tolerances between

- (a) Wearing rings
- (b) Impeller shaft and bearings
- (c) Impeller shaft and key
- (d) Shaft and flexible coupling
- (e) Key and keyway on shaft at (d)

2.27 NUMBER OF PUMPS TO BE TESTED

- 1) ALL pumps must be tested by manufacturers with lab motor for performance test and certificates to be furnished to owner
- 2) Hydro test for all pumps to be carried out for all pumps/components by pump manufacturer and certificates shall be furnished for approval

- 3) The material test certificates shall be furnished by manufacturer for all critical components
- 4) One pump of each type shall be tested with job motor and shall be witnessed by client's representative. It includes performance test, hydro test, strip test, verification of material test certificates and balancing certificates. If identical pumps are provided in other pump houses the owner will decide the actual number of tests to be witnessed
- 5) The actual number of witness tests will be decided by client after proposal are received and before order is finalised
- 6) The contractor shall intimate the time of inspection/tests at works sufficiently advance so that the tests may be witnessed by the employer.
- 7) The witnessing of tests shall, however, not relieve the contractor of his responsibilities to fully meet the requirements of the specifications and guarantees.
- 8) Test reports shall be supplied to the employer. No shipment/dispatch of any portion of the equipment shall be made till the test certificates for the tests conducted at the factory are approved by the employer in writing.

B) FIELD PERFORMANCE TEST:

The test shall be carried out as per IS: 9137 code of acceptance test of pump Class-C, in general and as started below in particular.

The purpose of the field test is not to ensure whether pump performance as regards parameter i.e. H.Q. & power etc. within acceptance limit as per IS: 9137. The purpose is to ensure that the pump performance is generally acceptable or otherwise. Final acceptance shall be as per following criteria.

- i) As regards H-Q characteristic for acceptance it shall be checked whether motor is not getting overloaded within the specified head range.
- ii) Flow measurement shall be taken by the flow meter to be provided by contractor. Calibration certificate from approved Govt laboratory shall be submitted.
- iii) The head shall be measure with calibrated pressure gauge of accuracy 1% or better. At least 3 pressure gauges shall be got calibrated from two different institutions with prior approval of the Engineer- in-charge. The calibration shall be point to point and not mere for percentage error. The gauge shall be fitted at suitable place from the discharge nozzle. It may be noted that pressure gauge shall be installed at least 2 times diameter away from discharge nozzle and delivery valve be placed at least four times diameter away from discharge nozzle. Such conditions shall be simulated at site condition and no allowance for this deficiency shall be considered. The decision of Engineer-in- Charge shall be final.
- iv) The input power to motor shall be measured by 2 wattmeter method. The watt meters shall be of Laboratory grade having accuracy of min. 0.5% and these should be digital type.
- v) The speed shall be measured by non contact tachometer with digital display calibrated. The field test shall be taken with entire head range in such a manner that

it would cover at least 6 points (i.e. duty point, 2 above duty point, 2 below duty point and shut off). The guarantee for head and discharge shall be deemed to be fulfilled as per clause.

- vi) To check starting current of pump & motor to ensure that starting current is as per tender requirement.
- vii) monitor Power factor of the pump motor on load to confirm PF correction is up to 0.95 as per tender requirement
- viii) Sound level and vibration level measurement as per IS or manufacture recommended parameter.

The field performance test at site is absolutely essential as above (i) to (viii) and the manufacturer shall also be asked to attend the same.

3.0 SPECIAL TOOLS, SLINGS, CONSUMABLES ETC.

3.1 All necessary special tools and devices such as lifting devices erection and maintenance c. shall be included in the offer. The contractor shall submit a list of the above special tools, slings etc. in the tender. Any special reamers and bracing equipment for all works to be done in field/site shall be provided by the contractor.

3.2 Oil for the first filling of the pump lubrication system etc. shall be included in the offer. The quantity and technical particulars/brand of the oil to be used for lubrication of the motor bearings shall also be specified in the bid.

4.0 SPARES

Spare parts for the pumps and other equipment's is to be supplied by the contractor. All spare parts furnished shall be interchangeable with and of the same materials and workmanship as the corresponding parts of the equipment.

5.0 Paint & Finish

All external and internal parts shall be finished and painted with epoxy paint to produce a neat and durable surface which would prevent rusting and corrosion. The contractor shall mention the shade and code number of paint to be used. The equipment shall be thoroughly degreased, and sharp edges and scales removed and treated with one coat of primer and two coats of enamel paint.

Material Test Certificate of the various pump components shall be furnished by contractor

Annexure – I**TECHNICAL DATA SHEET**

Sl. No.	Parameter	UOM	Value
PUMP PERFORMANCE			
1	Manufacturer	-	
2	Type of Pump	-	
3	Model	-	
4	Rated Discharge	m ³ /hr	
5	Rated Head	m	
6	Pump Efficiency at Duty Point	%	
7	Overall Efficiency at Duty Point	%	
8	BkW	kW	
9	Shut-off Head	m	
10	Maximum Discharge	m ³ /hr	
11	Head at Maximum Discharge	m	
12	Maximum Input to the Pump over Entire Operating Range	kW	
13	Pump Input at Shut-off	kW	
14	Pump Input at Maximum Discharge	kW	
15	NPSHR at Duty Point	m	
16	NPSHR at Maximum Discharge		
17	Minimum Submergence required for Safe Operation	mm	
18	Maximum permissible Liquid temperature	°C	
19	Speed	rpm	
20	No. of stages	-	
21	Max out side dia. Of bowl	mm	

Annexure II

Sl. No.	Parameter	OFFERED BY BIDDER
MATERIAL OF CONSTRUCTION		
1	Pump Casing	
2	Impeller	
3	Gland packing	
4	Shaft	
5	Motor casing	
6	Column pipe	
7	Discharge Elbow	
8	Line shaft bearing	
9	Shaft protection tube	
10	Fasteners	
11	Foundation / Grouting Fasteners	
CONSTRUCTION OF PUMPSET		
12	Type of Pump Casing	
13	Type of Impeller	
14	Type of Thrust Bearing	
15	Installation Arrangement -Delivery nozzle above pump floor	
16	Seal Arrangement	
17	Motor Cooling Arrangement	
18	Type of lubrication for thrust bearing	
19	Type of lubrication for shaft bearing	

Note : Lubrication for line shaft bearing is external forced water lubrication which is mandatory for all the pumps.

Annexure – III**DECLARATION ON THE PRODUCT OFFERED**

Sl. No.	Description	Declaration		Remarks
		Yes	No	
1	Pump manufacturer.			
2	Impeller balanced dynamically			
3	Sealing with gland packing			
4	Line shaft lubrication Arrangement / Design as per Specifications			
5	Interlocks for lubrication system provided.			
6	Cooling of the Thrust bearing provided			.
7	Wearing ring provided for impeller			
8	Bearings are provided as per specifications			.
9	Installation accessories exactly as per specifications			
10	Motor is Squirrel Cage induction type HT/LT as per specs			
11	Temperature sensor for COOLING WATER OUTLET OF THRUST BEARING LOCATED IN PUMP			
12	Gland Leakage out let piping provided			
13	All the performance characteristics as per clause enclosed.			
14	Testing Facility at Rated Voltage, rated Frequency and rated speed available at manufacturer's work.			
15	All motors can be tested for Routine and Type tests at manufacturer's works.			

6. GENERAL TECHNICAL REQUIREMENTS – MECHANICAL EQUIPMENT

Submerged Centrifugal Pump Set:

Technical Specifications of Wet Installed, Submerged Centrifugal Pump sets **Technical Specifications of Wet Installed, Submerged Centrifugal Pump sets.**

1. The pump set shall be of Compact Unitary construction. The pump casing shall be of high efficiency, bowl or volute Casing type with the Impeller mounted directly onto the Extended Solid Motor Shaft (*without any couplings*).
2. The pump set should be Single / two Stage type i.e. it should have only One / two impeller(S) & one / two Casing – Two stages shall not be allowed (except for heads > 90m). Pump Casing shall be high efficiency, Centrifugal Volute type.
3. The pumps are to be installed directly into the water body (*Canal / Sump / River or unscreened Jack well*), so it may suck up lot of silt, clay, pebbles & vegetation. Hence it should be reliable & robust.

6.1. INSTALLATION

- 6.1.1. Submerged Centrifugal Pump is preferable where available head is more than 12m. The pumps should always be suitable for Vertical or Horizontal; Permanent or Portable Installation & be interchangeable between these modes throughout their working life time (*by suitable use of base frames/ auto coupling systems*) .
- 6.1.2 The detailed scope of supply & mode of installation shall be as per the specific tender datasheets or as per instructions of the Engineer-in-Charge.

6.2 Possible Installation Arrangements.

6.2.1 Vertical Permanent; i.e. Auto Coupling System.

- a) The pump set should be coupled to the rising mains by an Automatic Coupling System within built integrally cast bend. The automatic coupling system should have a pedestal (which is bolted on to sump bottom by pre grouted foundation bolts) which is permanently bolted on to the rising mains with Guide pipe Arrangement.
- b) Auto coupling 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.

7.0 PUMP AND DESIGN

7.1 Speed

- 7.1.1 To achieve best efficiency, reasonable cost & yet long life, the speed of the Pump set should be such that the Specific Speed (N_s) of the pumps (*calculated as per for Single Stage, Single Suction Impeller pumps assuming duty point as the best efficiency point*); should not exceed:

- 58 for up to DN 100,
- 70 for pumps up to DN 200,
- 87 for pumps up to DN 300,
- 106 for pumps up to DN 400,
- 116 for pumps up to DN 500 &
- 125 for larger pumps.

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

- 7.1.2 In addition to 7.1.1; Motors > 113 kW &/or with Pump's duty point flow rate > 100 Lps shall be limited to not more than 1450rpm.
- 7.2 The pump shall be capable of developing the required total head at rated capacity for its continuous operation. Pumps of particular category shall be identical and shall be suitable for parallel operation.
- 7.3 The head capacity (H-Q) 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.
- 7.4. The Impeller shall be of high efficiency Multi Channel Enclosed type (*except for Specific Speeds 90 where Semi Open Impellers shall be allowable*).

7.5 SUCTION STRAINER

- 7.5.1 The pump is fitted directly with a Suction Bell mouth to which is compulsorily fitted a Heavy duty Strainer (*to avoid pick up of gravel, pebbles, vegetation, etc.*)
- 7.5.2 Sizing of the Suction Strainer should be as per the Larger of the two :
- 7.5.2.1 At the duty point flow, the Suction Velocity (at Strainer Holes), should never exceed 3.0m/s.
- 7.5.2.2 At the duty point flow, the total cumulative Suction Area of all the Strainer Holes should always be 2.0 times the Impeller's Suction Eye Area.
- 7.5.3 However Large & Slow Speed pumps (*with Solid Handling Ability 75mm & of Speeds 1000 rpm*) may be offered without Suction Strainer.
- 7.5.4 The pump's minimum thickness of suction strainer & maximum hole size of suction strainer should be as per below mentioned chart.

Table 1: Design of Impeller & Strainer		
Pump Delivery Size	Min Thickness of Suction Strainer	Max. Permissible Hole Size of Suction Strainer
DN 25, DN 32 & DN 40	2 mm	Not more than 4mm
DN50 & DN65		Not more than 6mm
DN80		Not more than 8mm
DN100		Not more than 10mm
DN125	3mm	Not more than 12mm
DN150		Not more than 14mm
DN 200	5mm	Not more than 21mm
DN 250		Not more than 30mm
DN 300 & DN 350		Not more than 40mm
DN 400 & above	7mm	Not more than 50mm

- 7.5.5 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.
- 7.5.6 Complete Performance Curve, Data Sheets, GA drawings showing Installation Sizes shall be submitted along with the Technical Bid.
- 7.5.7 Pump having less than minimum guaranteed efficiency i.e. 84% are not acceptable. |

8.(SUBMERGED) INDUCTION MOTOR END DESIGN

8.1 The motor shall be of Squirrel Cage, Induction type, Resin Filled yet capable of Water Immersion up to 20mwc for S1 duty with IP-68 Protection – Motors with Oil or Water filled windings shall not be allowed. It shall comply to IS9283 (2013).

8.2 **Rated Voltage for L.V Motor : 415 Volt, 50 Hz (-5% to +3%)**

8.3 Its winding should be of Class “H” insulation * (*withstanding winding hot spot temperature of up to 185°C.*) while the nominal temp rise of winding hotspot should not exceed that of class “B” .i.e 130 C

8.4 It should be wound using Dual Coated, Super Enamelled; Copper wire with high temperature index as per I.S. 4800 Part-13. PVC / Poly propylene – poly ethylene insulation for winding wires shall not be allowed.

8.5 Motor’s Insulation should be Vacuum Varnish Impregnated & Oven Baked to ensure a Moisture Impervious & Mechanically Robust insulation. Dip or Pour type Air Dry Varnishing shall not be allowed.

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

8.5.1 Motor rating shall be below 200 Kw as per IS-325 and rated for 415 Volts.

8.5.2 115% of the power input to the pump at duty point at a speed corresponding to the frequency of 50 Hz.

8.5.3 105% of the maximum power input while operating solo or in parallel within maximum and minimum system resistances corresponding to the speed at 50Hz.

8.6 MOTOR COOLING:

8.6.1 The pumps are to be installed horizontally, the motor can be cooled just by water immersion i.e. no jacketing is required.

8.7 MOTOR PROTECTION

8.7.1 Thermal Overload Protectors (*Bi Metallic Over Load sensors*) should be embedded in each phase of the stator winding to detect overheating & trip the motor from the control panel in the event of the temperature exceeding the safe operating limit (*above 130°C*).

8.7.2. To detect primary Mechanical Seal’s Leakage a Moisture Sensor shall be provided in intermediately Oil Chamber (*& not in the Motor casing or else where*)

– this shall detect water mixing in oil by mode of increased leakage current from the moisture sensor.

8.8 CABLES

8.8.1 A watertight Cable Junction Box sealed from the motor shall be provided for the motor power and signaling cables.

8.8.2 The cable shall be brought directly out of the submerged motor without joints, and shall be of sufficient length, minimum 10 m to be terminated in an IP 67 junction box outside adjacent to the wet well & above the HFL.

They shall be sized in accordance with the electricity utility regulations and BS 7671.

- 8.8.3 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.

9. SHAFT & BEARINGS

- 9.1 The Solid Shaft shall be supported by heavy duty Ball or Roller bearings with a minimum **L10** life of 75,000 hours in accordance with BS 5512
- 9.2 The bearings should be Permanently Greased with Premium Quality, High Temperature, Long Life Grease - the bearing should be of Metric Series & not Imperial ones.
- 9.3 Oil Lubricated bearings shall not be allowed.
- 9.4 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.

10. STUFFING BOX / OIL CHAMBER

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

11. ENERGY COST LOADING :

- 11.1.1. Applicable

12. TESTING

- 12.1 The pump sets shall be tested at the in accordance of ISO 9906 or IS 9137 or IS 5120 (*Tolerance Class 2*); with or without VFD
- 12.2 In case of MNC pump manufacturer not having adequate testing facility within reasonable distance (i.e. decided by the area of operation of the TPI); the pumps should be tested at the Alternative Facilities & Internal Test Certificates shall be submitted for review to the TPI. The customer may demand Field Testing of such (*unwitnessed*) pumps within 30 days of installation which the contractor/ manufacturer is bound to offer at no extra cost.
- 12.3. Pump testing should be carried out preferably with VFD; incase the pump sets are to be used with VFD then the testing has to be conducted Compulsorily with VFD (*to ascertain compatibility with VFD*)

Table 2 : Materials of Construction		
Motor Casing, Oil Chamber & other parts	Cast Iron (FG 260 as per IS 210 or GG25 or EN-JL1040)	
Motor Cooling Jacket(if applicable)	SS 202 or 304	
Mechanical Seals	Faces : - Primary (Inboard) : Silicon Carbide v/s Silicon Carbide or Tungsten Carbide v/s Tungsten Carbide - Secondary (Outboard) :Carbon v/s Cast Chrome Molybdenum Steel or Silicon Carbide or Tungsten Carbide	
	Elastomers: - All “O” rings of Viton only & Bellows of either Viton OR Nitrile	
Fasteners	Stainless Steel or Hot Dip Galvanised BHT Alloy Steel	
Pump (Bowl/Volute) Casing		
	a)Pumps with Head ratings > 40m b)Pump with Head ratings<40m.	a)Ductile Cast Iron or Cast Steel(SG 400/12 or EN-JS1050 or GGG 40 or WCB) b) Cast Iron (FG 260 as per IS 210 or GG25 or EN-JL1040)
Suction Bell mouth & miscellaneous pump parts	Cast Iron (FG 260 as per IS 210 or GG25 or EN-JL1040)	
Impeller & Wearing Rings (Casing & Impeller)	Cast Austenitic Stainless Steel (SS 316 or CF 8M or 1.4406) or Bronze	
Pump-Motor Shaft	Stainless Steel (SS 410 or SS 430 or 1.4021 or 1.4460)* * Larger Motors (i.e. 200kW) may be supplied with High Carbon Alloy Steel Shaft (EN 8 or others) protected with SS 316 Shaft Sleeves	
Suction Strainer	Stainless steel AISI304.	
Portable Stand (if applicable)	MS (C15) Fabricated with Epoxy Coating	

DATA SHEET FOR DRY MOTOR, WET INSTALLED SUBMERGED CENTRIFUGAL PUMP SETS

1.	Application	Submerged Centrifugal pump is used for Water Intake/ & mounted in Sump / Canal Horizontally depending upon the site conditions
2.	Type of motor	Squirrel cage induction type with IP68 enclosure
3.	Name of Pumping Station	-----
4.	Rated Flow	-----
5.	Rated Head	-----
6.	Speed (as dictated by 5.1)	-----
7.	Rated kW (Suitable for pump as per previously outlined margin norms)	-----
8.	No. of units.	-----
9.	Supply system fault level	50 KA for 1 Sec(LV)/25 KA for 3 Secs(HV)
10.	Supply neutral	Solidly-earthed
11.	Rated voltage/	415 V
12.	No. of Phases & frequency	3 Phase & 50 Hz.
13.	Supply condition	Clause-4 of the System Conditions(design parameters)
14.	Duty condition as per IS 325 or equivalent	S 1 suitable for constant operation
15.	Method of starting	Micro Processor Soft Starter OR FCMA soft starter
16.	Starting torque & Pull Out Torque	Sufficient enough to start the pump with delivery valve open and when other pumps are running. Sufficient to bring the motor to normal speed in minimum time
17.	Class of Insulation & temp. rise by thermometer	Class "H" but Temperature rise restricted to that of class "B" i.e. 75°C
18.	Ambient temperature	45° C
19.	a) Type of Cooling b) Degree of protection	Surface cooled by circulation of water through jacket shell. IP 68
20.	Cable details	3 ¼ Cores (minimum ¼ cores required as <u>Earth</u>)

21.	Shaft orientation. Horizontal / Vertical	Pump set should be suitable for Any position– i.e. Vertical or Horizontal or Inclined
22.	Type of bearings	Ball / Roller / Thrust Anti Friction type
23.	Bi Metallic Thermal Over Load Sensor for Winding required ?	Yes, one in each phase; for trip, alarming and indicating set to trip @ 130 °C
24.	Bearing Over Temperature Detectors	Required for motors > 113kW By Bi Metallic Overload Thermal Switches set to Trip @ 95°C
25.	Winding connections	6 Terminals
26.	Standards to be followed	IS 325, 8225, 4889, 4772, 4029, 4691, IS-8034, IS-9283 and other relevant Indian Standard or equivalent BSS. Testing as per ISO 9906 or IS 9137 or IS 5120
27.	P.I Value of Motor	P.I Value should not be less than 2.

Technical Data Sheet of Submerged Centrifugal Pump sets
(To be submitted along with the bid documents)

Sl. No	Description	Particulars
1	Make of Pump set	
2	Model	
3	Design Capacity	m ³ /hr
4	Total Head	Mwc
5	Shut Off Head	
6	Rated Speed & Supply Frequency	
7	No of Stages	
8	No of Casing	
9	Pump Efficiency @ duty point	
10	bkW @ duty point	
11	Maximum Pump Input throughout the Curve	
12	Rated Motor Efficiency	
13	Over All Pumpset Efficiency @ duty point	
14	Motor Input @ Duty Point	
15	Motor Rating	kW
16	Class of Insulation of Motor	
17	Fill of Motor	Air / Oil / Water
18	Type of Bearings & its rated L10 life	
19	Type of Lubrication & its rated Life	

20	Cable Size & MoC	Power Cables	$\text{mm}^2 \times \text{Cores} \times \text{Runs}$ $\text{mm}^2 \times \text{Cores} \times$
		Control Cables Conduct or	$\text{mm}^2 \times \text{Cores} \times \text{Runs}$ Al / Cu
21	Pump's Suction & Delivery Nozzle size	mm & mm	
22	Suction Strainer Provided	Yes / No	
23	MoC of Motor Rotor Shaft		
24	MoC of Pump Casing		
25	MoC of Impeller		
26	MoC of Impeller's Wearing Ring		
27	MoC of Casing's Wearing Ring		
28	Weight of Pump set	Kg	

13.0 TECHNICAL SPECIFICATION OF H.T MOTORS FOR VT PUMPS

- 13.1 The specification covers the design, manufacture, testing at manufactures works, supply, delivery, storage at site; erection, testing and commissioning of Squirrel cage induction motors complete with instrumentation controls and safety devices, equipment for the cooling water system, lubricating system oil, water piping with valves, fitting and other accessories at each pumping station as detailed in the Schedule of Requirements and as described in the various sub sections of the specifications. The scope of supply shall include spares for 15 years of operation of the pumping station, special tools and testing devices, all parts accessories etc. which are essential for construction, operation and maintenance of all the motors even though these are nor individually or specifically stated or enumerated. Corresponding components of all the motors and associated equipment and spares shall be of the same material, dimensions and finish and shall be interchangeable.
- 13.2 The motor shall perfectly match in respect of speed, runaway speed, moment of inertia, overload capacities, couplings and any other requirement with that of pump.

13.3 Standards

Sl. No.	Standard	Description
1.	IS 325	Squirrel cage induction motors
2.	IS 4691	Type of enclosures
3.	IS 900	Code of practice for installation and maintenance of induction motors
4.	IS 6362	Method of cooling
5.	IS 4029	Testing of induction motors
6.	IS 2223	Dimensions of flange mounted as induction motors
7.	IS 2253	Designations for types of construction and mounting arrangements of rotating electrical machines.
8.	IS 2254	Designations of vertical shaft motors for pumps
9.	IS:4722	Rotating electrical machines
10.	IS:4728:1975	Terminal marking and direction of rotation for rotating electrical machinery.
11.	IS:6362:1995	Designation of methods of cooling for rotating electrical machines.
12.	IS:7816:1975	Guide for testing insulation resistance of rotating machines.
13.	IS:12065:1987	Permissible limits of noise level for rotating electrical machines.
14.	IS:12075:1987	Mechanical vibrations of rotating electrical machines
15.	IS:4889:1968	Method of determination of efficiency of rotating electrical machines.
16.	IS:12802:1989	Temperature rise measurement of rotating electrical machines.
17.	IS:12824:1989	Types of duty and classes of rating for rotating electrical machines.

13.4 Technical Parameters

1.	Motor Rating	As per the requirement of Pump.
2.	Type of motors	Totally enclosed CACA .
3.	Motor duty	Continuous, S1
4.	Supply voltage & frequency conditions	Voltage : 6.6 k.v +10% to -10% Frequency : 50 Hz +3% to -5% Any Combination of above
5.	Insulation class	Class F and temperature rise as per class B
6.	Starting Method	Soft Starter
7.	Cable termination details	Al conductor, XLPE insulated, armoured 6.6 kV (UE) grade cable. Cable termination box protection class IP 55.
8.	Space heater	230 V space heater
9.	Bearing temperature sensing	Required
10.	Winding temp. sensing	6 Nos. required for each motor
11.	Earthing conductor	GI strip as per the sizes specified

13.5 Design Criteria**Rating & Temperature rise**

- a) All motors shall be of continuous rated type
- b) The motors shall be designed for maximum ambient temperature of 50 deg. C; with the temperature rise of the stator winding by resistance method over the ambient air temperature not exceeding 70 deg. C for both class B and class F insulation.
- c) Air cooled motors shall be designed
- d) In case of continuous operation at extreme supply voltage variation limits, the temperature rise limits as specified above shall not exceed by more than 10deg. C for motors of output up to and including 200KW.±10%
- e) Each motor shall be assigned a maximum continuous rating (MCR) corresponding to this temperature rise.
- f) Wherever the basis for motors ratings are not specified in the corresponding mechanical specification sections, maximum continuous motor ratings shall be at least ten (10) percent above the maximum load demand of the driven equipment under entire operating range as specified elsewhere including voltage and frequency variation.

13.6 Supply Conditions

- a. The rated supply voltage, voltage & frequency variations in the supply are mentioned elsewhere. Motors shall be capable of delivering its maximum continuous rating with supply variations. The motor can start, run and operate satisfactorily under the extreme voltage conditions at site.
- b. All motors shall be so designed that the maximum inrush currents, and locked rotor and pull out torques developed by them at highest voltage and frequency limits do not endanger the motor and the driven equipment.
- c. Induction motors shall be designed to be capable of withstanding the voltage and torque stresses developed due to the difference between the motor residual voltage and incoming supply voltage equal to 150% of the rated motor voltage during changeover of buses.

13.7 Torque requirements

- a. The accelerating torque at any speed with the lowest starting voltage shall be at least ten (10) percent of rated full load torque of the motor.
- b. The pull out torque at rated voltage shall not be less than 205 percent of the full load torque.

13.8 No. of starts

Continuous duty motors shall be suitable for two starts in succession and three equally spread starts in an hour under the specified conditions of load, torque and inertia, with the motor initially at its normal running temperature.

13.9 Starting time

- a) For motors with starting time up to 20 seconds at minimum permissible voltage during starting, the locked rotor withstand time under hot condition at highest voltage limit shall be at least 2.5 seconds more than starting time.
- b) For motors with starting time more than 20 seconds but not exceeding 45 seconds at minimum permissible voltage during starting, the locked rotor withstand time under hot condition at highest voltage limit shall be at least 5 seconds more than the starting time.
- c) For motors with starting time more than 45 seconds at minimum permissible starting voltage, the locked rotor withstand time under hot conditions at highest voltage limit shall be more than the starting time by at least 10% of the starting time.

13.10 Control

All HT motors shall be suitable for control through circuit breaker specified in HT panel specifications.

13.11 Enclosure and Method of Cooling

The motors shall be of totally enclosed closed air circuit, air cooled machine mounted heat exchanger (CACA).

13.12 Vibration Level & Noise Level

The vibrations as measured at motor bearings shall be within the limits specified in IS: 12075/BS: 4999 Part -142. The shall also be capable of withstanding the vibration produced by the driven equipment. Noise levels shall comply with IS:12065.

13.13 Constructional Features**13.13.1 General**

- a) Motor and its components (such as stator, rotors, end shields, terminal boxes, bearings and heat exchangers) shall be designed to be readily interchangeable as integral units for the same design and rating.
- b) All nonmetallic components used shall be of resistant to flame propagation.
- c) All enclosures shall be designed to provide an effective sealing between the primary and secondary air circuits. All totally enclosed type of motors shall have suitable means of breathing
- d) The cooling fans shall be capable of being connected for rotation in either direction and due care for cooling etc.,.
- e) All heavy parts of the motors shall be provided with necessary arrangements such as lifting lugs/eye bolts for lifting or handling during erection or overhaul.
- f) All motor rotors shall be dynamically balanced. Rotors shall be so designed as to keep the combined critical speeds with the driven equipment away from the running speed by at least 20%.
- g) Space heaters shall be provided on motors to maintain the windings in a dry condition during periods of standstill. The heaters shall be suitable for use on a 240 volts, 50 Hz A.C supply.

13.13.2 Winding and Insulation

- a) Winding insulation shall be and class F for HT motors. It shall be of proven high quality and reliability.
- b) For HT motors the insulation system of stator winding shall be of the epoxy type.
- c) The slot and overhang insulation of windings of HT shall also be based essentially on mica. Windings of HT shall be provided with stress control and corona protection. The anti corona protection shall be adequately earthed and be resistant to damage due to abrasion or vibration.
- d) All windings insulation shall be non-hygroscopic, oil-resistant to flame propagation. All windings shall be impregnated and suitably processed to effectively seal them to prevent deterioration from adverse environmental conditions at site.

- e) Stator coils and rotor bars shall be tight fit in their slots. Any stator slot packing used for winding of HT motors shall comprise of material impregnated with a conducting medium and shall be compatible with the system of stress control.
- f) All winding overhangs and leads shall be adequately supported, braced and blocked.
- g) Case winding and all joints shall be designed to give an adequate safety factor on the fatigue due to thermal and mechanical stresses, taking into account the specified starting and running conditions. All electrical joints and connections shall be of brazed or welded construction.
- h) All HV motors shall be capable of withstanding a 1.2/50 micro second surge test voltage as per relevant standard.
- i) All HV motors coils shall be capable of withstanding high frequency over voltage test as per relevant standard.

The high frequency range shall be mutually agreed upon. Each coil of motor shall be subject to the above specified voltage wave before making the final connections between coils.

- j) Each coil of the HV motor shall be capable of withstanding the surges with a wave shape of 0.3/3 micro second to check the inter turn insulation withstand capability against switching surges as per relevant standard.

k) Temperature Detectors

At least six nos. of simplex or duplex platinum resistance type embedded temperature detectors, evenly distributed around the stator, shall be provided for all HT motors. These shall be located at locations where high temperatures are expected during operation. Resistance of the temperature detector at zero deg. C shall be one hundred (100) ohms. Temperature detector and detector lead insulation class shall be the same as stator winding insulation class. Detector leads, external to the slot shall be provided with a protective covering. These RTDS shall be wired to PLC controls for monitoring temperature rise.

13.13.3 Bearings

- a) Bearings shall be of anti friction type. Vertical motors shall have rolling type guide and thrust bearing.
- b) Flow of shaft currents through bearing shall be positively blocked. In the case of pedestal mounted bearings, both bearing shall be insulated, and an earth bonding link shall be provided at the driving end. The link shall be removable for insulation testing. Where the bearings are mounted directly in the motor end frames, the non drive end bearing shall be permanently insulated. It shall be possible to carry out maintenance without damaging

the insulation. All oil and water pipes, direct driven oil pumps etc. shall be insulated where necessary to prevent flow or any shaft current.

- c) The bearings shall be designed to prevent ingress of dust and water shall be sealed against leakage of lubricant along the shaft. Sump-lubricating bearing shall be fitted with two oil rings, or other approved device running in oil bath of adequate capacity.
- d) Temperature of lubricating oil as it leaves the bearing shall be not exceed 71 deg C.
- e) All HT motors bearing shall be provided with dial type thermometer with adjustable alarm contacts to monitor bearing temperature. Resistance temperature detector (RTD) shall also be provided, one (1) no. for each bearing. RTD shall be of duplex 3 wire type having 100 ohms resistance at zero degree centigrade.
- f) Bearing shall comply with the relevant Indian or International Standards. The bearings housing shall be correctly packed with lithium based grease at the time of assembly. Construction shall be such that the bearings can be dismantled without risk of damage.
- g) Lubrication shall be possible without removal of the guarding. All grease nipples, nipples, oil cups and dip sticks shall be readily accessible.

13.13.4 Heat Exchangers

Suitable heat exchanger shall be provided for CACA motors. The special requirement of ventilation shall be provided considering site conditions and motor requirement, under various operating conditions

13.13.5 Terminal Boxes and Associated Fittings

- i) Separate terminal boxes having IP 55 degree of protection shall be provided for stator leads, RTD leads & space heaters,
- ii) The cable boxes and terminations shall be designed to enable easy disconnection and replacement of cables. Leads from terminals to the windings shall be adequately sized and braced to withstand the heating and forces produced by maximum fault current. For single core cables, gland plates shall be of non-magnetic material.
- iii) Terminals shall be suitable for receiving aluminum/copper conductor XLPE insulated cables. Motor shall be supplied with compression type tinned brass cable glands and Crimping type tinned copper lugs (conform to DIN 46329) for the termination of cable. The neutral terminal block should be *phase segregated type*.
- iv) A suitable provision of releasing the pressure developed during faults shall be made. Terminal boxes shall be suitable for top and bottom entry of cables.

- v) The distance between gland plate and the power terminal studs for HT motors shall not be less than 500 mm.
- vi) HT motors Power terminal box as well as neutral terminal box shall have a phase separated construction. Motor terminal box shall be capable of being turned through 180deg.

13.13.6 Earthing Terminals

Two independent earthing points shall be provided in accordance with IS : 3043, on opposite sides of the motor for bolted connection.

13.13.7 Rating Plate

In addition to the requirements as called for GTC of Volume –II and relevant IS, the rating plating plate shall indicate the following:

- a) Maximum continuous rating in KV and corresponding temperature rise, as applicable for cooling medium temperature specified in clause in 3.1
- b) Bearing identification numbers (in case of ball/roller bearing and recommended lubricant.)

13.13.8 Paint & Finish

- a) All external parts shall be finished and painted to produce a neat and durable surface which would prevent rusting and corrosion. The equipment shall be thoroughly degreased, and sharp edges and scales removed and treated with one coat of primer and two coats of enamel paint shade no 692 as per IS :5. Motor fans shall also be painted.
- b) All fasteners used in the construction of the equipment shall be either of corrosion resistant material or heavy cadmium plate. Current carrying fasteners shall be either of stainless steel or high tensile brass or copper.

13.14 OUTPUT AND EFFICIENCY GUARANTEE

13.14.1 Output Guarantees

The motor shall be guaranteed to be capable of giving its rated and maximum outputs without exceeding the temp. rise as defined in clause 3.0

13.14.2 Efficiency Guarantees

The efficiency of the motor shall be guaranteed when delivering 100% of rated output at rated terminal voltages and for temp. limits of the windings specified above. The efficiency shall be determined according to IEC publication NO.34-2.

13.15 SPECIAL TOOLS, SLINGS, CONSUMABLES ETC.

All necessary special tools and devices such as lifting devices for stator, rotor, rotor pole and shaft, pedestal for stator/rotor etc. required for erection and maintenance of the motor, etc. the tender.

Any special reamers and bracing equipment for all works to be done in field/site s hall be provided by the contractor.

Oil for the first filling of the motor lubrication system etc. shall be included in the offer. The quantity and technical particulars/brand of the oil to be used for lubrication of the motor bearings shall also be specified in the bid.

13.16 SPARES

Spare parts for the motors and other equipments to be supplied by the motor contractor including excitation equipment, voltage regulator and unit control boards. All spare parts furnished shall be interchangeable with and of the same materials and workmanship as the corresponding parts of the equipment.

13.17 TESTING DEVICES AND INSTRUMENTS FOR TESTING DURING ASSEMBLY/ERECTION AT SITE AND FOR ACCEPTANCE TESTS

All devices and instruments required for site testing of the motor and other associated equipment shall be provided by the contractor.

Similarly all instruments and devices required for the field acceptance tests for fulfillment of efficiency, output and temperature rise guarantees shall be provided by the contractor on returnable Basis.

A detailed list of the above devices and instruments shall be furnished with the Bid,

13.17.1 TESTS

General

The tests on the motors and associated auxiliary equipments shall be carried out in accordance with the detailed schedule to be approved by the employer.

- i. During manufacture, all necessary inspections and tests shall be made to the satisfaction of the employer so as to ensure the quality of materials, workmanship and adequacy of design and test reports/data shall be furnished for approval of employer.
- ii. On completion of erection work at site, all equipments shall be tested to the satisfaction of the employer to demonstrate that the plant complies in every way with the specification that all guarantees have been met with and that equipment is suitable for commercial operation.
- iii. The contractor shall intimate the time of inspection/tests at works sufficiently in advance so that the tests may be witnessed by the employer. The witnessing of tests shall, however, not relieve the contractor of his responsibilities to fully meet the requirements of the specifications and guarantees.
- iv. Test reports shall be supplied to the employer. No shipment/dispatch of any portion of the equipment shall be made till the test certificates for the tests conducted at the factory are approved by the employer in writing.

Routine Tests

Following routine tests/checks on major components and accessories shall be carried out at works on each motor.

- i. HV Test on stator coils and stator sections.
- ii. Static flux test on unwound stator frame and core assembly.
- iii. Trial build up of rotor rim.
- iv. Shaft assembly.
- v. Calibration of over speed devices.
- vi. Insulation, resistance tests for stator and rotor windings, bearings & embedded temperature detectors.
- vii. Tests on excitation & regulation equipment.
 - a) Measurement of resistances.
 - b) Measurement of insulation resistances.
 - c) Visual inspection & wiring check.
 - d) Functional checks of electronic modules.
- viii. Additional tests, if any, required for judging the performance of motor and its auxiliaries.

Type Tests

The following type tests on the first completely assembled motor (of individual rating) and associated auxiliaries shall be carried out at work :

- 1) Temperature rise test.
- 2) Dielectric Tests
- 3) Excess current tests.
- 4) Efficiency tests
- 5) Line charging capacity.
- 6) Bearing currents.
- 7) Determination of characteristics.
- 8) Measurement of DC resistance of armature and field winding.
- 9) Moment of inertia of rotating parts (GD^2)
- 10) Short circuit ratios
- 11) Runaway speed test
- 12) Phase sequence test
- 13) Test on static excitation and regulation equipments.
 - i) Open circuit saturation curve

- ii) Heat run to determine the maximum temp rise at rated and maximum output .
- iii) Excess current test at rated full load.
- iv) Adjustment and checking of overload computation
- v) Test to determine speed of response.
- vi) Tests to determine ceiling voltage.

14) In addition to above, tests shall be carried out on C.Ts, and all other auxiliaries.

Tests at site

The following tests shall be carried out at site:

- 1 Measurement of stator winding resistance and rotor winding resistance.
- 2 Measurement of stator and rotor winding insulation resistance.
- 3 Alignment of motor rotor and pump shaft.
- 4 PI value of motor (PI value should not be less than 2)
- 5 Automatic start and stop test.
- 6 Quick and emergency stop test.
- 7 Checking and commissioning of various other auxiliary equipments as per relevant standards.
- 8 Checking/testing of various other auxiliary equipments.

Acceptance Tests

The following acceptance tests at site shall be conducted by the contractor.

- i) Vibration Tests
- ii) Bearing Temperature Tests
- iii) Noise

However, the employer reserves the right to call on any third party to made field tests to determine whether any of the motor purchased under this meets the specification guarantees of efficiency, temperature rise, output etc. in such case the contractor shall cooperate and shall assume full responsibility for the operation and safety of their equipments during these tests.

DRAWING AND DATA

The following drawing and data shall be submitted with the tender.

- 1 . The general arrangement and overall dimensions of motor showing position of main and neural leads, important elevations etc.

- 2 . Drawing showing thrust bearing and guide bearing assemblies etc,
- 3 . Drawing showing arrangement of air coolers, air ducts etc.
- 4 . Diagram of lubricating system, braking/jacking system.
- 5 . Physical and schematic drawings of excitation system, automatic voltage regulator equipment, field discharge equipment and descriptive literature.
- 6 . Graphs showing predicted characteristics of the Motor.
- 7 . General layout drawing showing overall dimensions and layout and relative position of all auxiliaries, ducts, spaces for cables and piping, cooling water system etc.

SCHEDULE OF REQUIREMENTS

Vertical shaft induction motors complete with stator, rotor, and shaft having conventional type bearings in accordance with the specification. Each motor will be complete and equipped as follows (as per motor manufacturer's design):-

- i) Anti-condensation heaters for the stator winding.
- ii) Forced / Hydrostatic lubricating system complete with necessary pipe work, valves, filter, pump set etc. for lubrication of the bearings.
- iii) Plug in type oil coolers for the bearings.
- iv) 1 set. Sole plates, foundation bolts, bolts, dowels etc. required for proper erection, leveling, alignment etc. of motor.
- v) 1 set. Platform, stairs, walkways, handrails etc. for access to the bearings, slip-rings etc.

1 Set Common equipment

Equipment & devices common for all the motor for each Pumping Station:

- i) Set of spares for 15 years operation for all the motors & associated auxiliaries.
- ii) Set of special tools, slings & erection devices, consumables etc.
- iii) Set of testing devices & instruments.
- iv) Equipment for field acceptance tests (on-returnable basis.)

All other items as covered in the specifications or required for completeness of the above equipments.

13.18 Guaranteed Technical specifications/Data

The contractor may furnish all the data related to guaranteed technical specifications and relevant data

13.19 Erection

The work of erection of motors and its alignments with the pump including laying of foundations, grouting, Doweling and painting etc. shall be done by the Contractor at his own cost as per General and Misc. specifications' mentioned.

13.20 Emergency Stop Switches

Emergency stop switches near the motors should be provided for switching off the motors in case of emergency.

13.21 Testing

One motor of each rating shall be type tested and all motors shall be routine tested at the supplier's works in the presence of engineer in charge or his representative. In addition to the above, shop tests and site tests should also be conducted on motors. The Schedule for Part-I, Part-II, Part - III and Part - IV for each of above tests i.e. type tests, routine tests, shop tests, and site tests follow as below.

Type Tests On Motors - Part – I

- i. No load running of motor and reading of voltage, current, power input and speed.
- ii. Reduced voltage running up test at no load to check the ability of motor to run upto full speed on no load in each directions of rotation with $1/\sqrt{3}$ of rated line voltage applied to the stator terminal.
- iii. Locked rotor readings of voltage, current, power input, and values and torque of motors. **(Note : This test may please be made at a reduced voltage.)**
- iv. Full load reading of voltage, current power input and slip.
- v. Temperature rise test.
- vi. Momentary over load test.
- vii. Insulation resistance test (both before and after the high voltage test)
- viii. Vibration test.
- ix. High voltage test.
- x. Test to determine losses & efficiencies.

Routine Test On Motors - Part - II

- i. Insulation resistance test.
- ii. High voltage test.
- iii. No. load running of motor and reading of current in the three phases and voltage.

- iv. Locked rotor reading of voltage, current and power input at a suitable reduced voltage.
- v. Reduced voltage running up test at No load to check the ability of the motor to run upto full speed on NO load, in each direction of rotation, with $1/\sqrt{3}$ of the rated Line voltage applied to the stator terminals.

Shop Tests On Motors - Part - III

- i. Line out of motor and pump shafts including and fixing of coupling bolts and checking of bearing faces.
- ii. Over run test.
- iii. Vibration test.
- iv. Motor frame dimensional check and general appearance check.
- v. General appearance of main shaft and dimension of the same.
- vi. Insulation resistance, dielectric and coil resistance tests of poles.
- vii. Dimensional check and general appearance check after assembly of complete motor and assembly of pump with motor.
- viii. Efficiency test.
- ix. Measurement of air gap length.
- x. High voltages test.
- xi. Tests to determine losses and efficiency.
- xii. Heat run test to determine the temperature rise of various parts including windings, bearings etc. of the motor when the machine is in operation continuously at the rated and over load output.
- xiii. Dielectric test of motor windings.

Site Tests On Motors- Part - IV

- i. Measurement of resistance of windings.
- ii. Insulation resistance test (Before & after H.V. test)
- iii. High voltage test.
- iv. Measurement of air gap.
- v. No load test.
- vi. Over-run test

The motor and pump is to run continuously for 72 hours at full load and temperature of various parts including winding, bearing etc. are to be observed. This test is to be carried out on each pump separately and measurement of discharge at rated head is to be measured.

- i. Losses and efficiency of pump set are to be carried out on any two motors selected by the Engineer.

- ii. Measurement of insulation resistance of windings.
- iii. Alignment of motor and pump shafts.
- iv. Vibration test.

14.0 TECHNICAL SPECIFICATION OF L.T MOTORS FOR VT PUMPS

- 14.1 The specification covers the design, manufacture, testing at manufactures works, supply, delivery, storage at site; erection, testing and commissioning of Squirrel cage induction motors complete with instrumentation controls and safety devices, equipment , lubricating system oil, The scope of supply shall include spares for 5 years of operation of the pumping station, special tools and testing devices, all parts accessories etc. which are essential for construction, operation and maintenance of all the motors even though these are nor individually or specifically stated or enumerated. Corresponding components of all the motors and associated equipment and spares shall be of the same material, dimensions and finish and shall be interchangeable.
- 14.2 The motor shall perfectly match in respect of speed, runaway speed, moment of inertia overload capacities, couplings and any other requirement with that of pumpMotor shall be designed for utimate requirement of head and flow.

Standards

Sl. No.	Standard	Description
1.	IS 325	Squirrel cage induction motors
2.	IS 4691	Type of enclosures
3.	IS 900	Code of practice for installation and maintenance of induction motors
4.	IS 6362	Method of cooling
5.	IS 4029	Testing of induction motors
6.	IS 2223	Dimensions of flange mounted as induction motors
7.	IS 2253	Designations for types of construction and mounting arrangements of rotating electrical machines.

8.	IS 2254	Designations of vertical shaft motors for pumps
9.	IS:4722	Rotating electrical machines
10.	IS:4728:1975	Terminal marking and direction of rotation for rotating electrical machinery.
11.	IS:6362:1995	Designation of methods of cooling for rotating electrical machines.
12.	IS:7816:1975	Guide for testing insulation resistance of rotating machines.
13.	IS:12065:1987	Permissible limits of noise level for rotating electrical machines.
14.	IS:12075:1987	Mechanical vibrations of rotating electrical machines
15.	IS:4889:1968	Method of determination of efficiency of rotating electrical machines.
16.	IS:12802:1989	Temperature rise measurement of rotating electrical machines.
17.	IS:12824:1989	Types of duty and classes of rating for rotating electrical machines.

Technical Parameters

1.	Motor Rating	As per the requirement of Pump.
2.	Type of motors	TEFC
3.	Motor duty	Continuous, S1
4.	Supply voltage & frequency conditions	Voltage : 0.415 kV +10% to -10% Frequency : 50 Hz +3% to -5% Any Combination of above
5.	Insulation class	Class F and temperature rise as per class B
6.	Starting Method	Star Delta upto 50 kW Soft Starter for Above 50 kW
7.	Cable termination details	Al conductor, XLPE / PVC insulated, armored 1.1 kV grade cable. Cable termination box protection class IP 55.
8.	Space heater	230 V space heater

9.	Bearing temperature sensing	Required
10.	Winding temp. sensing	6 Nos. required for each motor
11.	Earthing conductor	GI strip as per the sizes specified
12.	Efficiency class motor	IE-2(Minimum)

14.3 Design Criteria

14.3.1 Rating & Temperature rise

- a) All motors shall be of continuous rated type
- b) The motors shall be designed for maximum ambient temperature of 50 deg. C; with the temperature rise of the stator winding by resistance method over the ambient air temperature no exceeding 70 deg. C for both class B and class F insulation.
- c) In case of continuous operation at extreme supply voltage variation limits, the temperature rise limits as specified above shall not exceed by more than 10° C for motors of output upto and including 200 KW.±10% .
- d) Each motor shall be assigned a maximum continuous rating (MCR) corresponding to this temperature rise.
- e) Wherever the basis for motors ratings are not specified in the corresponding mechanical specification sections, maximum continuous motor ratings shall be at least ten (10) percent above the maximum load demand of the driven equipment under entire operating range as specified elsewhere including voltage and frequency variation.
- f) The rated supply voltage, voltage & frequency variations in the supply are mentioned elsewhere. Motors shall be capable of delivering its maximum continuous rating with supply variations. The motor can start, run and operate satisfactorily under the extreme voltage conditions at site.
- g) All motors shall be so designed that the maximum inrush currents, and locked rotor and pull out torques developed by them at highest voltage and frequency limits do not endanger the motor and the driven equipment.
- h) Induction motors shall be designed to be capable of withstanding the voltage and torque stresses developed due to the difference between the motor residual voltage and incoming supply voltage equal to 150% of the rated motor voltage during changeover of buses.

14.3.2 Torque requirements

- a. The accelerating torque at any speed with the lowest starting voltage shall be at least ten (10) percent of rated full load torque of the motor.

- b. The pull out torque at rated voltage shall not be less than 205 percent of the full load torque.

14.3.3 No. of starts

Continuous duty motors shall be suitable for two starts in succession and three equally spread starts in an hour under the specified conditions of load, torque and inertia, with the motor initially at its normal running temperature.

14.3.4 Starting Current

The ratio of starting Current/rated current (MCR corresponding to the specified temperature rises) shall not exceed 6.

14.3.5 Starting time

- a. For motors with starting time upto 20 seconds at minimum permissible voltage during starting, the locked rotor withstand time under hot condition at highest voltage limit shall be at least 2.5 seconds more than starting time.
- b. For motors with starting time more than 20 seconds but not exceeding 45 seconds at minimum permissible voltage during starting, the locked rotor withstand time under hot condition at highest voltage limit shall be at least 5 seconds more than the starting time.
- c. For motors with starting time more than 45 seconds at minimum permissible starting voltage, the locked rotor withstand time under hot conditions at highest voltage limit shall be more than the starting time by at least 10% of the starting time.

14.3.6 Control

All the motors shall be suitable for control through circuit breaker / MCCB as specified.

14.3.7 Enclosure and Method of Cooling

The motors shall be of totally enclosed Fan Cooled, (TEFC).

14.3.8 Vibration Level & Noise Level

The vibrations as measured at motor bearings shall be within the limits specified in IS: 12075/BS: 4999 Part - 142. The shall also be capable of withstanding the vibration produced by the driven equipment. Noise levels shall comply with IS:12065.

14.3.9 Constructional Features

- a) Motor and its components (such as stator, rotors, end shields, terminal boxes, bearings and heat exchangers) shall be designed to be readily interchangeable as integral units for the same design and rating.
- b) All nonmetallic components used shall be of resistant to flame propagation.
- c) All enclosures shall be designed to provide an effective sealing between the primary and secondary air circuits. All totally enclosed type of motors shall have suitable

means of breathing and of drainage to prevent accumulation of from condensation. Drain holes diameter shall not exceed 6mm.

- d) The cooling fans shall be capable of being connected for rotation in either direction or due care for cooling etc. Specially where identical motors are to be provided for opposite direction of rotation, such as for a pair of conveyor without replacing or removal of fans or any other parts.
- e) Motors shall preferably be capable of being connected for rotation in either direction with due care for cooling etc., specially where identical motors are to be provided for opposite direction of rotation, such as for a pair of conveyor without replacing or removal of fans or any other parts.
- f) All heavy parts of the motors shall be provided with necessary arrangement: such as lifting lugs/eye bolts for lifting or handing during erection or overhaul.
- g) All motor rotors shall be dynamically balanced. Rotors shall be so designed as to keep the combined critical speeds with the driven equipment away from the running speed by at least 20%.
- h) Space heaters

Internal electric heaters shall be provided on motors rated above 30 KW. To maintain the windings in a dry condition during periods of standstill. The heaters shall be suitable for use on 240 volts, 50Hz a.c. supply.

- j) Temperature Detectors

At least six nos. of simplex or duplex platinum resistance type embedded temperature detectors, evenly distributed around the stator, shall be provided for all HT motors. These shall be located at locations where high temperatures are expected during operation. Resistance of the temperature detector at zero deg. C shall be one hundred (100) ohms. Temperature detector and detector lead insulation class shall be the same as stator winding insulation class. Detector leads, external to the slot shall be provided with a protective covering. These RTDS shall be wired to PLC controls for monitoring temperature rise.

14.3.10 Winding and insulation

- a) Winding insulation shall be of class B or better for LT AC motors. It shall be of proven high quality and reliability.
- b) All windings insulation shall be non-hygroscopic, oil-resistant and resistant to flame propagation. All windings shall be impregnated and suitably processed to effectively seal them to prevent deterioration from adverse environmental conditions at site.
- c) All winding overhangs and leads shall be adequately supported, braced and blocked.
- d) Cage windings and all joints shall be designed to give an adequate safety factor on the fatigue due to thermal and mechanical stresses, taking into account the

specified starting and running conditions. All electrical joints and connections shall be of brazed or welded construction.

14.3.11 Bearings

- a) Bearings shall be of roller type, except where motor speed and shaft loading dictate otherwise. Vertical motors shall normally have rolling type guide and thrust bearings. The latter may however be of Kingsbury tilting pad type where heavy axial loads are to be supported.
- b) Temperature of lubricating oil as it leaves the bearing shall be not exceed 71 deg C.
- c) Bearing shall comply with the relevant Indian or International Standards. The bearings housing shall be correctly packed with lithium based grease at the time of assembly. Construction shall be such that the bearings can be dismantled without risk of damage.

14.3.12 Terminal Boxes and Associated Fittings

- i) The cable boxes and terminations shall be designed to enable easy disconnection and replacement of cables. Leads from terminals to the windings shall be adequately sized and braced to withstand the heating and forces produced by maximum fault current.
- II) Terminals shall be suitable for receiving aluminum conductor XLPE/PVC insulated cables. Motor shall be supplied with compression type tinned brass cable glands and Crimping type tinned copper lugs for the termination of cable. The termination lugs shall conform to DIN 46329.
- III) Clearance between the lugs/bare live parts of different phases and between lugs/bare live parts and earth shall be as per relevant standard. The terminal boxes shall be capable of withstanding a system fault level. A suitable provision of releasing the pressure developed during faults shall be made. Terminal boxes shall be suitable for top and bottom entry of cables.
- IV) LT motor terminal box shall be capable of being turned through 360 deg in step of 90 deg.

14.3.13 Earthing Terminals

Two independent earthing points shall be provided in accordance with IS:3043, on opposite sides of the motor for bolted connection.

14.3.14 Rating Plate

In addition to the requirements as called for in relevant IS, the rating plating plate shall indicate the following:

- a) Maximum continuous rating in KW and corresponding temperature rise, as applicable for cooling medium temperature as specified.

- b) Bearing identification numbers (in case of ball/roller bearing and recommended lubricant.)

14.3.15 Paint & Finish

- a) All external parts shall be finished and painted to produce a neat and durable surface which would prevent rusting and corrosion. The equipment shall be thoroughly degreased, and sharp edges and scales removed and treated with one coat of primer and two coats of enamel paint shade no 631 as per IS:5 for indoor motors and shade 632 as per IS:5 for outdoor motor. Motor fans shall also be painted to withstand corrosion.
- b) All fasteners used in the construction of the equipment shall be either of corrosion resistant material or heavy cadmium plate. Current carrying fasteners shall be either of stainless steel or high tensile brass or copper.

14.3.16 TESTS

- a) All motors shall be subjected to routine tests. For all LT motors, type test report of the tests conducted in identical motors within last five years from the date of Latter of Intent shall be furnished. However for motors not type tested in the last five years, type tests need to be performed without any extra cost.
- b) The tests shall be carried out as per applicable standards including all special tests. The list of routine tests and type tests are given below.

Routine Test

- a) Visual Check
 - i) Marking on rating plates
 - ii) Appearance and painting
 - iii) Location and details of terminal boxes and accessories
 - iv) Check for phase sequence and terminal markings
- b) Dimensional Check
- c) Measurement of resistance of windings space heater
- d) No load test
- e) Locked rotor test (For al the ratings of motors as per IS:4029)
- f) Reduced voltage running test at no load
- g) Over speed test
- h) Vibration measurement at rated speed and rated voltage
- i) Degree of protection test for IP54 & IP55 enclosure

Type Test

The following type tests on the first completely assembled motor (of individual rating) and associated auxiliaries shall be carried out at work

- a) All the tests as listed under routine tests
- b) Measurement of Noise at no load.
- c) Momentary overload test
- d) Full load test
- e) Pull out torque measurement
- f) Degree of protection tests for the enclosure followed by IR, HV and no load run test.
- g) Fault level withstand test for terminal box.
- h) Measurement of No load starting time.

When tests to determine the breakaway starting current of cage induction motors are taken at reduced voltage, due allowance shall be made for the effect of saturation and the estimated value of breakaway starting current at rated voltage shall be given on all test certificates.

COMMISSIONING CHECKS Commissioning checks should be carried out as per IS:900 and other relevant standards.

MOTOR PERFORMANCE			
1	Model	-	
2	Rated Output	kW	
3	Rated Voltage	Volts / KV	
4	Rated Current	Amps	
5	Rated Frequency		
6	Rated Power Factor At full Load At Duty Point At 75% Load At 25 % Load	-	

7	Rated Speed	rpm	
8	Efficiency At full Load At Duty Point At 75% Load At 25 % Load	%	
9	Permissible Voltage variation		
10	DOL Starting Current	Amps	
11	Maximum Ambient Temperature for Continuous Operation	°C	
13	Power Factor at Starting	-	
14	Maximum Temperature Rise at Full Load	°C	

15.0 DRAINAGE PUMPS

15.1 The pumps shall be designed for duties of 30 cubic meter/hr . TWO pumps are provided in each sump pump.

The pump set shall be single stage, submersible type, mono block, volute type driven by squirrel cage induction motor. The motor shall be an integral part of the pump set. It shall be a totally sealed unit suitable for completely as well as partially submerged condition. The pump shall operate continuously (S1 duty) even if the water level in the sump is low (motor portion not in submerged condition). The pump shall be suitable for reverse rotation and shall not have any adverse effect on the operation of mechanical seal or any other component.

Pump Casing

The pump casing shall be Gray Cast Iron as per ASTM – A 48 no. 35 B / EN 1561-GJL-250 or FG 260 as per IS 210 The pump casing shall be pressure tested at pressure twice the duty point pressure or 1.5 times the shut-off pressure, whichever is maximum. However, the minimum pressure shall be 10 kg/cm².

Impeller

It shall be made of high chrome stainless steel grade CD4MCu as per ASTM A 351 or equivalent having hardness 220-270 BHN or more

Fasteners

All fasteners exposed fasteners exposed to pumping media shall be of stainless steel grade AISI 304 / AISI 316 / Grade A2 of ISO 3506 or better.

Sealing

Each pump shall be provided with a tandem bi-directional mechanical shaft seal system consisting of two totally independent mechanical seal assemblies. The seal shall operate in a buffer fluid that lubricates and cools the seal.

Motor Cooling System

Motors shall be designed to be cooled by the surrounding pumping media.

Wear Ring

A wear ring system shall be used to provide efficient sealing between the volute and suction inlet of the impeller

The impeller wearing rings shall be of stainless steel, heat-shrink fitted on to the suction inlet of impeller.

Bearing

The pumps shall be provided with one support roller bearing and one two row angular contact ball bearing as main bearing.

Shaft

It shall be made of ASTM / AISI 431.

Suction Strainer

Each pump shall be supplied with a suitable stainless steel strainer at the suction of the pump set to keep the coarse solids away from the pump set.

Installation Accessories

For permanent type installation, the pump shall be automatically and firmly connected to the floor/base. For transportable type of installation a suitable stand / base frame type of arrangement shall be provided in such a way that in no case the pump will tilt.

Each pump set shall be provided with the suitable length of stainless steel lifting chain.

Motor

The motor shall be dry type squirrel cage induction motor suitable for the offered pump set. The rating of the motor shall be the required power over the entire pump operating range. Also, the motor shall be suitable for minimum 8 starts per hour.

Construction

It shall be submersible type with degree of protection IP 68. The motor shall be designed for operation up to 40°C ambient.

Operating Voltage and Frequency

The motors shall be suitable for operation on 415 V, 3 phase, 50 Hz Junction Box.

Protections

All stators shall incorporate three normally closed (NC) thermal switches in series to monitor the temperature of each phase winding. Should high temperature occur, the thermal switches shall open, stop the motor and activate alarm.. Control and Monitoring

Performance Parameters

The pump manufacturer has to declare the performance parameters separately as Guaranteed Performance Parameters. These shall include Discharge, Head, Pump Efficiency and Overall Efficiency

SECTION V -B

ELECTRICAL WORKS OF THE PUMPING STATION

Index

9.0 ELECTRICAL WORKS OF THE PUMPING STATION	7
9.1 DESIGN CRITERIA FOR ELECTRICAL EQUIPMENT	7
9.1.1 INTRODUCTION	7
9.1.2 GENERAL POWER DISTRIBUTION SCHEME	7
9.1.2.1 LOAD REQUIREMENT	7
9.1.3 POWER SUPPLY SCHEME	7
9.1.3.1 6.6 kV MAIN PUMP MOTORS	7
9.1.3.2 0.43 kV MAIN PUMP MOTORS	7
9.1.4 PROTECTIONS	8
9.1.4.1 33 kV INCOMER	8
9.1.4.2 POWER TRANSFORMERS	8
DISTRIBUTION/ AUX TRANSFORMERS:	9
9.1.4.3 MOTORS	9
9.1.5 METERING	9
9.1.6 SWITCHGEAR	10
9.1.7 H.V. MOTORS(200 KW & ABOVE)	10
9.1.8 CABLES	11
9.1.9 D.C. POWER SUPPLY	11
9.1.10 SAFETY EARTHING & LIGHTNING PROTECTION	12
9.1.11 POWER FACTOR IMPROVEMENT	13
9.1.14 OUTLET MANAGEMENT SYSTEM WITH CLOUD BASED CONTROL SYSTEM	17
1. INTRODUCTION:	17
9.2.1 GENERAL	20
9.2.2 SCOPE OF WORK	20
9.2.3 QUALITY ASSURANCE, TESTING & INSPECTION	20
9.3 SOFT STARTER	22
9.3.1 SCOPE	22
9.3.2 TECHNICAL PARAMETERS	22

9.3.3 OTHER CONSIDERATIONS	22
9.3.4 TESTING:	24
9.4.4.1 SHOP TEST	24
9.4.4.2 SITE TEST:	24
9.4 HT INDOOR SWITCHGEAR	25
9.4.1 SCOPE	25
9.4.2 STANDARDS	25
9.4.3 OTHER REQUIREMENTS	26
1.1 MAIN PANEL SHALL BE SHEET STEEL DUST & VERMIN PROOF INDOOR FLOOR MOUNTING TYPE H.T. PANEL WITH BUS BARS, SUITABLE FOR SYSTEM VOLTAGE AND DUTIES SPECIFIED FOR EACH STAGE COMPLETELY ASSEMBLED, WIRED, TESTED AND PAINTED WITH RUST PROOF PAINT CONFORMING TO RELEVANT I.S. THE PANEL SHALL COMPRISE OF FOLLOWING INCOMING BREAKERS. THE DEGREE OF PROTECTION SHOULD BE IP-52. PANEL SHOULD HAVE VALID TYPE TESTS INCLUDING TYPE TEST FOR BOUGHT OUT ITEMS.	26
9.4.4 INCOMING BREAKER SHALL CONSIST OF FOLLOWING.	26
9.4.5 OUTGOING FEEDERS FOR MOTORS	27
9.4.6 OUTGOING FEEDERS FOR CAPACITORS	27
9.4.7 OUTGOING FEEDERS FOR AUXILIARY TRANSFORMER	27
9.4.8 BUS COUPLER BREAKER SHALL CONSIST OF FOLLOWING.	28
9.4.9 ANNUNCIATION	28
9.4.10 DETAILED TECHNICAL SPECIFICATIONS	28
9.4.10.1 VACUUM CIRCUIT BREAKERS.	28
9.4.10.2 BUS BARS AND SUPPORTS	30
9.4.10.3 WIRING	30
9.4.10.4 PANELS	30
9.4.11 TECHNICAL PARAMETERS	30
9.4.12 NAME PLATE	31
9.4.13 TESTS	32
9.4.13.1 TESTING	32
9.5 HT / LT CAPACITORS	32
9.5.1 SCOPE	32
9.5.2 STANDARDS	33

SECTION – V	PUMPS & ELECTRO – MECHANICAL WORKS	ELECTRO-MECHANICAL WORK
9.5.3	OTHER CONSIDERATIONS	33
9.5.4	TECHNICAL PARAMETERS	34
TESTING		34
9.6	METAL ENCLOSED LT SWITCHGEAR	35
9.6.1	SCOPE	35
9.6.2	STANDARDS	35
9.6.3	OTHER CONSIDERATIONS	36
9.6.4	BRIEF SPECIFICATION FOR ACB & MCCB	36
9.6.4.1	AIR CIRCUIT BREAKER	36
9.6.4.2	MOULDED CASE CIRCUIT BREAKER	36
9.6.5	AN INCOMING FEEDER OF SUITABLE AMP. RATING COMPRISING OF	37
9.6.6	OUTGOING FEEDERS	37
9.6.7	TECHNICAL PARAMETERS	38
9.6.8	TESTING	39
9.6.9	SELECTION CHART FOR STARTERS	39
9.6.9.1	SELECTION CHART FOR DOL STARTERS	39
9.6.9.2	SELECTION CHART FOR STAR –DELTA STARTERS	41
9.7	LT BUS DUCT	42
9.7.1	SCOPE	42
9.7.2	STANDARDS	42
9.7.3	OTHER CONSIDERATIONS	42
9.7.4	TECHNICAL PARAMETERS	42
9.7.5	TESTING	43
9.8	HT CABLES	44
9.8.1	SCOPE	44
9.8.2	STANDARDS	44
9.8.3	OTHER CONSIDERATIONS	44
TECHNICAL PARAMETERS		44
9.8.4	CONDUCTOR	44

SECTION – V	PUMPS & ELECTRO – MECHANICAL WORKS	ELECTRO-MECHANICAL WORK
9.8.5 INSULATION		45
9.8.6 SHIELDING:		45
9.8.7 OUTER SHEATH		45
9.8.8 TESTING		45
9.9 LT CABLES		45
9.9.1 STANDARDS		45
9.9.2 OTHER CONSIDERATIONS		45
TECHNICAL PARAMETERS		46
9.9.3 TESTING		46
9.10 CABLING SYSTEM		47
9.10.1 INSTALLATION		48
9.10.2 TERMINATION		49
9.10.3 TESTING OF CABLES		50
9.11 EARTHING AND LIGHTNING PROTECTION		50
9.11.1 INTENT OF SPECIFICATION.		50
9.11.2 CODES AND STANDARDS		50
9.11.3 GENERAL TECHNICAL REQUIREMENT		51
9.11.4 INSTALLATION		51
9.11.4.1 GENERAL INSTRUCTIONS		51
9.11.5 EARTHING SYSTEM		52
9.11.5.1 THE VARIOUS SIZES OF EARTHING CONDUCTORS FOR VARIOUS APPLICATION SHALL BE AS BELOW		52
9.11.6 LIGHTING PROTECTION SYSTEM		54
9.11.7 TESTS		55
9.11.8 COMMISSIONING :		55
9.12 LIGHTING SYSTEM :LED LIGHTS SUGGESTED AS PER APPLICABLE CODE.		56
9.12.1 APPLICABLE STANDARDS		56
9.12.1 LIGHTING SYSTEM DESCRIPTION		58
9.12.2.1 NORMAL AC LIGHTING SYSTEM		58

SECTION – V	PUMPS & ELECTRO – MECHANICAL WORKS	ELECTRO-MECHANICAL WORK
9.12.2.2 DESIGN PHILOSOPHY		58
9.12.2.3 FANS & REGULATORS		58
9.12.2.4 SWITCH BOX		58
9.12.2.5 JUNCTION BOXES		58
9.12.2.6 CONDUITS, FITTINGS & ACCESSORIES		58
9.12.2.7 PULL-OUT BOXES		59
9.12.2.8 LIGHTING WIRES		59
9.12.3 LIGHTING LEVELS		59
9.12.4 GENERAL REQUIREMENTS		60
9.12.5 TESTING		61
9.13 D.C. BATTERY AND BATTERY CHARGER		61
9.13.1 BATTERY		61
9.13.1.1 INTENT OF SPECIFICATION		61
9.13.1.2 CODES AND STANDARDS		61
9.13.1.3 GENERAL TECHNICAL REQUIREMENTS		62
9.13.1.5 MANUFACTURER’S IDENTIFICATION SYSTEM		63
9.13.1.6 ACCESSORIES		63
9.13.1.7 TESTS		64
9.13.1.8 TECHNICAL PARAMETERS		66
9.13.2.1 INTENT OF SPECIFICATION		67
9.13.2.2 CODES AND STANDARDS		67
9.13.2.3.1 GENERAL TECHNICAL REQUIREMENTS		68
9.13.2.4 PRINTED CIRCUIT BOARDS(PCB)		69
9.13.2.5 CONTACTORS		69
9.13.2.6 THERMAL OVERLOAD RELAY		69
9.13.2.7 RECTIFIER-TRANSFORMERS AND CHOKES		69
9.13.2.8 RECTIFIER ASSEMBLY		70
9.13.2.9 INSTRUMENTS		70
9.13.2.10 AIR BREAK SWITCHES		70
9.13.2.11 CONTROL AND SELECTOR SWITCHES		70
9.13.2.12 FUSES		70

SECTION – V	PUMPS & ELECTRO – MECHANICAL WORKS	ELECTRO-MECHANICAL WORK
9.13.2.13	INDICATING LAMPS	70
9.13.2.14	BLOCKING DIODE	71
9.13.2.15	ANNUNCIATION SYSTEM	71
9.13.2.16	NAME PLATES AND MARKING	71
9.13.2.17	CONSTRUCTION	71
9.13.2.18	WIRING	72
9.13.2.19	PAINTING	73
9.13.2.20	TESTS	73
9.13.2.21	COMMISSIONING	76
9.13.2.22	TECHNICAL PARAMETERS	77
9.14	TECHNICAL SPECIFICATIONS FOR INSTALLATION, TESTING AND COMMISSIONING OF	77
	ELECTRO-MECHANICAL EQUIPMENTS AND SYSTEMS	77
9.14.1	SCOPE	77
9.14.2	EXTENT AND ITEMS OF WORKS	77
9.14.3	LIST OF MAJOR EQUIPMENTS TO BE ERECTED.	78
9.14.4	STANDARDS	79
9.14.5	DRAWING	79
9.14.6	TEMPORARY POWER & LIGHTING	80
9.14.7	STORAGE AND PROTECTION OF THE WORKS	80
9.14.8	EQUIPMENT INSTALLATION AND COMMISSIONING	81
9.14.9	EQUIPMENT SPECIFICATIONS AND INFORMATION	82
9.14.10	GROUNDING OF EQUIPMENT	83
9.14.11	INSPECTION AND TESTS	83
9.14.12	INITIAL OPERATION, COMMISSIONING AND COMMERCIAL OPERATION	84
9.14.13	TRAINING OF ENGINEER'S STAFF	85
9.14.14	ERECTION AND COMMISSIONING SCHEDULE	85
9.14.15	SCHEDULE OF CONSTRUCTION EQUIPMENT AND EXPERIENCE	85
9.15	MISCELLANEOUS	85
9.15.1	CABLE GLANDS AND LUGS	85

9.15.2 CABLE TRAYS	85
9.15.3 LOCAL PUSH-BUTTON (PB) STATIONS	85
9.15.4 LIGHTING PANEL	85
9.15.5 STREET LIGHT POLE	86
9.15.6 RUBBER MAT	86
9.15.7 FIRE EXTINGUISHER	86
 9.16 DATA SHEETS TO BE FILLED BY CONTRACTOR – ELECTRICAL	 87
9.16.1 TECHNICAL PARTICULARS	87
9.16.2 HT SWITCHGEAR	87
9.16.3 SOFT STARTER	89
9.16.4 L.T. SWITCHGEAR	90
9.16.5 BATTERY	91
9.16.6 BATTERY CHARGER CUM DCDB	92
9.16.7 L.T. CABLES	92
9.16.8 H.T. CABLES	92
9.16.9 MISCELLANEOUS	92
 9.17 LIST OF ELECTRIACAL DRAWINGS	 93
9.17.1 HT CAPACITORS	93
DRAWING AND DOCUMENTS REQUIRED	93
9.17.2 6.6 kV INDOOR SWITCHGEAR	93
DRAWING AND DOCUMENTS REQUIRED	93
9.17.3 METAL ENCLOSED LT SWITCHGEAR	93
DRAWING AND DOCUMENTS REQUIRED	93
9.17.4 BATTERY AND CHARGER CUM DCDB	93
DRAWING AND DOCUMENTS REQUIRED	93
9.17.5 MOTORS	93
DRAWING AND DOCUMENTS REQUIRED	93
9.17.6 LT CAPACITORS	94
DRAWING AND DOCUMENTS REQUIRED	94

9.0 ELECTRICAL WORKS OF THE PUMPING STATION**9.1 DESIGN CRITERIA FOR ELECTRICAL EQUIPMENT****9.1.1 Introduction**

The 'Design Criteria' of electrical equipment covers the equipment for **Mega Lift Irrigation Project**.

9.1.2 General Power Distribution Scheme**9.1.2.1 Load Requirement**

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

a. Load Factor

I. Main motor	:	0.9
II. Auxiliary load valve motors, etc	:	0.9
III. Lighting load	:	1.0

b. Diversity Factor

i. Main motor	:	1.0
ii. Auxiliary load, motors etc	:	1.5
iii. Lighting load	:	1.20
iv. Power Factor of H.V. Motors	:	As per Manufacturers Catalogue
c. Efficiency of H.V. Motors (GTP)	:	As per Manufacturers Data Sheet
d. Power Factor of L.V. Motors	:	- do –
e. Efficiency of L.V. Motors	:	- do –
f. Efficiency of Distribution transformer	:	- do-

(Note: Combined efficiency of Pump & Motor will not be less than 0.8)

9.1.3 Power Supply Scheme

The source of power supply to pumping stations will be through dedicated 33 kV overhead lines from identified EHT Grid Substations and/ or connectivity with 33 KV DISCOM networks in an integrated manner.

9.1.3.1 6.6 kV main Pump motors

Power supply shall be met from MSDSS having at least two 33K.V/6.9 K.V transformers of suitable ratings in pool concept model that shall supply to single or more schemes. It will have a station transformer of 33/.433 KV of suitable rating. Sizing of power transformers shall be based on logic mentioned at clause 6.0 of section-VII-A.

9.1.3.2 0.43 kV main Pump motors

Power supply shall be from DSS (6.6 K.V/0.433 K.V or 33 K.V/0.433 K.V) as case may be, having at least two TRFs of suitable ratings. Distribution transformer shall be sized based on logic mentioned at clause 6.0, section-VII-A. Further short circuit capability of DSS should be adequate to meet the

starting impact of largest motor.

33 kV system	:	25 KA for 3 sec or as per the fault level calculations to be submitted by the bidder (whichever is higher).
6.6 kV system	:	25 KA for 3 sec or as per the fault level calculations to be submitted by the successful (whichever is higher).
0.433kV system	:	50 KA for 1 sec or fault level calculations to be submitted by the bidder (whichever is higher).

a. While the power for main HT pump motors is supplied at 6.6 kV, for other auxiliary loads such as Desilting Pumps, Butterfly Valves, Dewatering Pumps, exhaust fans, lighting etc. shall be supplied at 415 V (3 phase, 4 wire) through station Auxiliary transformer.

b. Power factor correction capacitors shall be provided and their capacity shall be adequate to correct the power factor of motors up to 0.95 at full load. “Design & economic location of reactive power control” in 6.6 KV system whether group compensation at 6.6 KV bus and/or at individual 6.6 KV motor end, is a technology platform to be decided on studies at detailed engineering stage.

c. Suitable metering facility shall be provided for monitoring purposes.

d. Wherever the 33/0.433 kV transformer rating is above 1000 kVA bus duct should be used.

9.1.4 Protections

ALL the Protective relays including IDMT over current & earth fault, REF, motor protection relays shall be numeric type only. Protection scheme for system connectivity shall comply with **Odisha Grid Code** issued by OERC.

9.1.4.1 33 kV Incomer

- i. Inverse time phase over current relays
- ii. Inverse time earth fault relay.
- iii. Instantaneous over current relays
- iv. Instantaneous earth fault relay

9.1.4.2 Power Transformers

H.V. side (33KV)

- i. Transformer Buchholz/gas pressure/Oil Surge relay with alarm and trip contacts as applicable on Transformer capacity & shall comply with relevant ISS.
- ii. Winding & Oil temperature indicators with alarm and trip contacts

- iii. Dropout Fuse/ breaker, based on transformer capacity.

L.V. side (6.9 KV)

- i. Inverse time phase over current relays
- ii. Inverse time earth fault relay.
- iii. Instantaneous over current relays
- iv. Instantaneous earth fault relay
- v. Restricted earth fault relay (will trip 33 kV Breaker).
- vi. Stand by earth fault relay (will trip 33 kV Breaker).

Distribution/ Aux Transformers:

H.V. Side (33 KV or 6.6 KV)

- i. Transformer Buchholz/gas pressure/Oil Surge relay with alarm and trip contacts as applicable on Transformer capacity & shall comply with relevant ISS.
- ii. Winding & Oil temperature indicators with alarm and trip contacts
- iii. Dropout Fuse/ breaker, based on transformer capacity.

L.V. side (430 V)

430 V L.V. incomer shall be provided with MCCB . All the other feeders will be provided with MCCB's / MCB's. Unless otherwise specified the SFUs / FSUs are not to be provided.

9.1.4.3 Motors**Motors (Main Pump Motors)**

Comprehensive motor protection relay consist of,

- i. Thermal overload protection for trip.
- ii. Locked rotor protection for trip.
- iii. Short circuit protection in all the three phases.
- iv. Instantaneous unbalance single phasing protection.
- v. Earth fault relay connected to core balance C.T. for trip in case of fault in Capacitors.
- vi. Temperature monitoring by RTD elements embedded in stator windings and bearing temperature indicators provided on both the bearing (with separate temperature scanner).

9.1.5 Metering

The following metering shall be provided.

a. Incomers (6.9 kV)

- i. Ammeters with selector switch

- ii. Voltmeter with selector switch (In PT cubicle)
- iii. Frequency meter. .

b. Main Transformers (33 KV Side)

- i. Ammeters with selector switch
- ii. Voltmeter

c. Motor Feeders:

- i. Ammeter in all the three phases
- ii. Multifunction Meter with RS 485 port.

d. L.T. Incomer

- i. Ammeter in all the three phases
- ii. Voltmeter with selector switch

9.1.6 Switchgear

M.V. Switchgear (6.6 kV, indoor)

M.V. 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 IP4X for indoor installation.

M.V. indoor switchgear circuit breakers shall be suitable for 110V D.C. control power supply.

a) L.V. Switchgear (indoor)

- i. *415 V Power control centers, power distribution boards etc. shall be of fixed, compartmentalized Single front construction, excepting circuit breaker modules which shall be of draw out type and single front construction.*
- ii. *The degree of protection for switchgear shall be IP 4X.*

9.1.7 H.V. Motors(200 KW & above)

- a. Main Pump Induction motors shall be suitable for 6.6 kV three Ph, 47.5 - 52.5 Hz supply.
- b. H.V. motors shall be closed air circuit air cooled (CACA) type. Temperature rise for air cooled motors shall be limited to 70° by resistance method for both class B and F insulation.
- c. At least six resistance type temp. detectors for the stator winding, each having D.C. resistance of 100 Ohms at 0° C, embedded in the stator winding at locations where highest temperatures may be expected shall be provided for H.V. pump motors.
- d. H.V. pump motors, bearings shall be provided with dial type thermometers having two separate NO contacts, for alarm / tripping of the motor.
- e. Each motor shall be provided with start/stop facility near the motor as well as on the panel, however, no power isolation near motor is envisaged.

9.1.8 Cables

The H.V. Power supply from main sub-station to the equipment shall be done by using aluminium conductor, XLPE insulated, PVC sheathed and armoured type. The L.V power cables shall be aluminium/ copper conductor, XLPE insulated, and armoured type. The control cables shall be copper conductor only, minimum 2.5 sq.mm PVC insulated. PVC sheathed and armoured type. The cable above 4 sq.mm. should be of Aluminum Conductor.

- a. Cable shall be flame retardant, low smoke (FRLS) type as per relevant IS/IEC. All HV power cable sizes shall be based on continuous current carrying capacity (with due consideration to de-rating factors), permissible starting (limiting to 15% drop) & running voltage drop (limiting to 5% drop) and short circuit rating of the system (25 KA as per technical specification). Cable size shall be calculated on fault clearing time of 0.5 second (breaker opening time).
- b. For L.V. incomers and L.V. outgoing Motor feeders, the fault clearing time shall be 0.5 second but the cable will be selected for short time rating of 1 sec.
Minimum and maximum size of cable shall be as per IS: 1554.
- c. 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.
- e. Motor starting & permissible voltage dips:-
 - Voltage dip on starting of largest LT motor shall be limited to 15% of nominal voltage at the motor terminal.
 - Maximum allowable voltage drop in any feeder under steady state condition shall be maintained:-
 - Total voltage drop during running: - 6%
 - LTSS to Motor:- 6%
 - LTSS to MCC:- 2%
 - MCC to Motor:- 4%
- f. The Bidder shall submit computer based software studies for selection of size for HT & LT Power cable.

9.1.9 D.C. Power Supply

- a. A set of maintenance free rechargeable sealed lead acid batteries of adequate A.H. capacity shall be provided for control of H.V. switchgear in pumping stations as well as 2 hours of emergency lighting in main operating area and shall comply with relevant CEA General Guide lines for Substations & Switchyard and Relevant CEA Regulations.
- b. Batteries shall be provided with float cum boost battery charger incorporating indicating lamps and annunciations.
- c. A sectionalized DCDB with incomers shall be provided.

9.1.10 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 shall be Galvanised steel to prevent atmospheric corrosion. The minimum rate of corrosion of steel used for earthing conductor shall be considered as 0.12 mm per year while determining the conductor size.
- d. The maximum values of the earth fault current for the design of the earthing system shall be considered as below:
 - i. 33 kV system : 25 kA or as per Substation specifications.
 - ii. 6.6 kV system : 25kA
 - iii. 415 V system : 50 KA
- e. Fault clearing time for sizing the earthing conductor shall be taken as three (3) seconds.
- f. Maximum allowable temperature rise for steel welded joints will be taken as 500°C and ambient temperature as 50 °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 interconnectors of maximum size conductor.
- i. In outdoor sub-station 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 min. 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. Earth mat design shall be submitted at the design stage.
- j. Main earthing conductors inside the building will be planned such that various equipment is connected to earthing system in most economical and reliable manner.
- k. 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.

- l. Minimum adequate spacing between rod/pipe electrodes shall be provided.
- m. The detail earthing calculation furnishing the step potential (V_s) and the touch potential (V_t) for outdoor switchyard should be carried out during detailed engineering by successful bidder.

9.1.11 Power Factor Improvement

- a. Capacitors for motor shall be provided with manual switching across motor terminals to improve power factor up to 0.95.

9.1.12 Safety Clearances

Clearances in electrical rooms shall be:-

S.N	Clearance	Min. Distance (in mm)
1	Back clearance	1200
2	Front clearance between draw out/ semi draw out panel boards	2500
3	Between two panel boards installed in a row	1000
4	Between front of panel to the wall of the room	2000
5	Between the wall and end of the switchgear/ MCC	1000
6	Back to back clearance	1500
7	Back to front clearance	2000

Note: In any other cases, the layout shall confirm to provide clearances as per CEA (Measures relating to safety and Electric Supply) Regulations, 2010.

9.1.13 Automation System

Each scheme shall have automation system that shall provide advanced visualization and system control for quality & reliability. ***The outlet management system (OMS) Central control unit & SCADA has to be provided in PLC room of pump house***

1. General Philosophy:

Adequate and appropriate automation shall be designed and engineered using state-of-art and field proven technology to facilitate monitoring, control and all other functions associated with operation of pumping unit through user-friendly human-machine interface (HMI).

The automation system shall be designed with geographical & functional distribution of hardware in a multi-level hierarchy, viz. Level-0, Level-1 etc as applicable, to meet specific

site requirements for monitoring, control, visualization & optimization of all major drives in the scheme unit.

The automation system shall be structured in general, considering the following hierarchical levels:

- Level-0: This level is also called field level. It is functionally responsible for generation, transmission & conversion of signal for input to the higher level equipments as well as signal based activation for the final control/ operation. Primary sensing elements, proximity switches, converters, microprocessors based intelligent system etc, are in domain of this level.
- Level-1: This level, also called supervisory level, is functionally responsible for supervision of the individual process equipment & function, control, visualization and regulation, guidance & optimization and control of process parameters to the desired level of perfection based on signals generated from field level.

This level is also responsible for processing of signals for generating compatible control commands to control the process parameters by activation of the final control elements. This level is realized based on controllers & systems, input systems, data based units, data communication, visualization system (HMI stations) and interface units for connectivity to the other levels of automation system. In addition to routine MIS functions, advanced process optimization functions comprising special control algorithms, mathematical computations etc. will be able to permit distribution of control and data acquisition functions throughout the entire pumping stations (Scheme).

The Level-1 automation shall basically comprise:

- A programmable Logic Controller (PLC) based automation system.

Modes of operation shall be:

A. Local: Local control Station (LCS) shall be provided for all motors/ drives & shall have required numbers of push buttons for operation of drives. HV motors shall be provided with hard-wired interlocking in MCC. However for fail safe operation, potential free contact of push button from LCS and a potential free contact of field safety sensor shall be hard wired to MCC for safety reason. Drive cannot be started if the selector switch is in OFF position.

B. Remote: In remote mode, the equipment can be started from control room only. This mode is further divided into following three modes:

- Operator mode.
- Auto mode.
- Computer mode

Once the remote mode of operation is selected, then from HIM with the help of Key board/ mouse/soft keys above three modes of operation can be selected.

2. Applicable Standards:

IPSS: 2-07-015-88	Modular programmable logic controllers.
IPSS: 2-07-016-88	Specification for panels.
IPSS: 2-07-030-88	Guidelines for application software documentation.
IPSS: 2-07-036-93	Guide for supply of computer hardware manuals.
IS: 10118 (Part 1 to 4)- 1982	Code of practice for selection, installation and maintenance of switchgear and control gear.
IS: 13947 (Part 1,5)- 1993	LV switchgear & control gear.
IS: 12021-1987	Specification for control transformer for exceeding 1000 Volt AC.
IS: 8623 (Part 1)- 1993	Specification for low voltage switchgear & control gear assemblies.
IEC 1131-2	Specification for Programmable Controllers.

Automation shall cover all specified aspects in the Bid document Section V-A (Technical Specification for Pumps & Electro-Mechanical works), Section V-B (Electrical works of the pumping Station). If any part, whole of specific aspect of equipment is not being covered under the above standards; the bidder shall specifically bring out such aspects to DoWR.

Otherwise, the successful tenderer shall be liable to abide by the specific requirement of the purchaser at detailing stage without any additional cost to the Purchaser.

3. Basic Parameters:

I. Memory

Type memory CMOS/ Ram (Min.16 MB) with Ni/Cd or Li backup battery
for a min. Period of 24 hours.

Memory size for user Ensure that 50% spare space will be available. It shall
be programmer possible to add memory incrementally
if required later.

II. Processing Unit: The CPU will be 32/64 bit microprocessor. It will be modular construction and be plug-in type. It will be able to perform logic processing, timing counting, latching, comparing, retrieve, storage and arithmetic functions.

III. Minimum speed acceptable is 8 Mbps.

IV. HMI:

Each drive can be controlled through HMI. Hence HMI shall be capable of following

- Displaying status information of all drives/ system etc.
- Command execution for start/stop, setting of parameters for the system
- Report generation
- Data logging
- Dynamic graph display of mimic System overview
- Real time/ history trending etc,
- Event logging of commands, parameters change etc executed from HMI.

V. Communication: Each motor controller unit shall communicate on the communication bus (Device net/ Mode bus/ Profibus) with PLC directly or through data concentrator or any equivalent module/ converter.

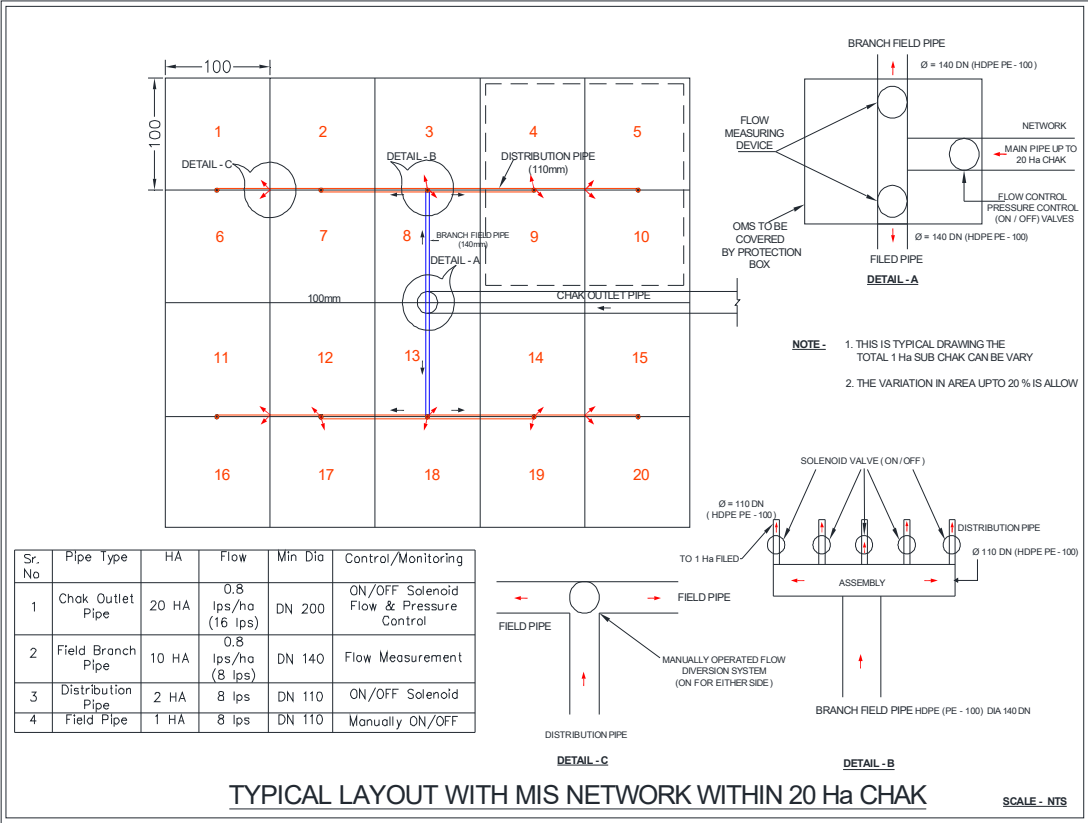
The communication protocol (bus) for MCC and package PLC shall be same for ease of communication.

9.1.14 Outlet management system with cloud based control system**1. Introduction:****OUTLET MANAGEMENT SYSTEM (OMS) WITH ROTATION MANAGEMENT SYSTEM(RMS)**

Outlet Management System (OMS) should be provided at every approximate 20 Ha chak outlet and should be capable of measure, monitor and control the flow and pressure remotely from control centre. The distribution of water beyond outlet management system shall be carried by providing rotation management system capable to control approximate 2 Ha. by providing automatic ON/OFF valve suitable of 6 lps for ON/OFF as per need remotely from control centre. Further manual ON/OFF valve to be provided for every 1 Ha. The outlet management system and rotational management system should be provided with protective enclosure which shall not interfere in radio based communication and is to be approved by CE, Megalift.

All air valves on Rising main/Pressure main/Distribution system shall be provided in protective enclosure and shall have remote pressure monitoring system with vandalism alert system.

The pumping system SCADA shall be capable of synchronizing with Cloud based control system used for outlet management system and rotational management system, Air valve monitoring system for smooth working of entire water distribution network. The radio frequency based RTU should be on license free band.



Filtration System**Primary Filtration System**

The Primary Filtration system shall be at pumping station with multiple location at rising main or pressure main or branch distribution. The system shall be Online Automatic screen Filter with self-cleaning mechanism of 200 micron suitable for Project total flow rate along with isolation butterfly valve and manifold etc. completed (Primary Filter) as per relevant Indian or International standard and as directed by Engineer-in-Charge.

- 1) Minimum Flow Rate: 0.6 LPS/Ha
- 2) Filtration Degree: 200 Micron
- 3) Self Cleaning Mechanism: Activated by Differential Pressure in the System.
- 4) No of Units- equals to number of Pumps or as per design requirement.

The automated filter unit should consist of heavy-duty automatic filters with self-cleaning mechanism and should be capable to a filter design discharge of pump. It should have capability to work for 22 hours continuously per day without any obstruction due to cleaning operation. It should be installed on the delivery side of Pump after the Pump Control Valve.

9.2. GENERAL REQUIREMENTS – ELECTRICAL EQUIPMENT

9.2.1 General

It is not the intent to specify herein all the details pertaining to the design, drawing, selection of equipment/materials, procurement, manufacture, installation, testing & commissioning, however, the same shall be of high standard of engineering and shall comply with all currently applicable standards, regulations & safety codes.

9.2.2 Scope of Work

The scope of this specification covers establishment of Electrical System of Pump House to receive Power supply and distribute to Pumps.

The scope shall include, Design, engineering, manufacture, testing, and supply on FOR destination site basis, including transportation & insurance, storage, erection, testing and commissioning of the following equipment/items, complete in all respects:

- 33/6.9 kV , 33 / 0.43 kV & 6.6/.43 Power/ Distribution Transformers
- 33 KV outdoor switch gear & indoor Control panel
- 6.6 kV Indoor Switchgear and control panels
- Soft starters
- Battery, Battery charger & DCDB.
- 415 V PMCC, ACDB
- 6.6 kV Power Cables and terminations
- LT power cables and control cables.
- Marshalling kiosks/ junction boxes.
- Illumination system including lighting panels, poles, lighting fixtures & accessories.
- Equipment Earthing & lightning protection for Substation/ Pumping stations through earth mate of adequate design.
- Cable trays, supports, clamps & accessories
- Cable glands and lugs for all the cables.
- Miscellaneous items like Danger boards & other sign boards, rubber mats, Fire buckets, etc.

9.2.3 Quality Assurance, Testing & Inspection

All materials, components and equipment covered under this specification shall be procured, manufactured, erected, tested, and commissioned at all the stages, as per approved Quality Plan & from approved vendor.

All tests shall be conducted as per relevant IS/IEC/IEEE standards and shall be performed in the presence of Owner's representative, if so desired by the Owner. The contractor shall give at least 15 days advance notice from the date when the tests are to be carried out.

Equipment offered shall be of type tested and proven type. Type test certificates for test conducted earlier on similar rating shall be furnished. Routine tests shall be carried out for all the equipment as per applicable standards.

Copies of certified reports of all tests carried out at the works shall be furnished. The equipment shall be dispatched from works, only after receipt of Owner's written approval of the test reports and issuance of Material Dispatch Clearance Certificate (MDCC).

Routine tests & Acceptance tests shall be conducted for all the equipment in accordance with the agreed quality plan and as per the latest version of applicable IS for all the equipment. The charges for carrying out all the routine tests shall be deemed to be included in the bid price.

The general QA requirement is attached; the vendor is advised to go through the same before submitting the bid.

9.3 Soft Starter

9.3.1 Scope

It is a unitized equipment of proven design with valid type tests for both reactor & soft starter panel (short circuit & temperature rise test) from the approved soft starter manufacturer. The specification covers the design, manufacture, testing at manufactures works, supply, delivery, storage at site; erection, testing and commissioning of Soft Starters complete with instrumentation controls and safety devices. The scope of supply shall include spares for 5 years of operation of the pumping station, special tools and testing devices, all parts accessories etc. which are essential for construction, operation and maintenance of the switchgear even though these are nor individually or specifically stated or enumerated. Corresponding components of the Switchgear and associated equipment and spares shall be of the same material, dimensions and finish and shall be interchangeable. **The motor soft starter design shall be as per the IS 5553 [part 3] / IEC 60289/076 working on the principle ‘series Reactor for current limiting of 3 Phase motor ‘**

9.3.2 Technical Parameters

1.	Rating	Suitable to Motor rating
2.	Connection	Neutral Side / Line Side As per Manufacturers recommendations for HT Motors Line Side for LT Motors
3.	TP bus bar details	High Conductivity Aluminium grade E91E for TP bus bar. Copper bus bar can be proposed.
4.	Max. Temp. of bus bar	40°C over ambient
5.	Bypass Device	Vacuum Contactor / breaker for HT and Contactor / Breaker for LT
6.	CT details	Cast resin, bar primary type, 1 A CT
7.	Winding (in case of non electronics Soft Starter)	Class of Insulation H & Temp. Rise restricted to insulation Class B
8.	Core (Starter)	Sil iron

9.3.3 Other Considerations

1. The Soft Starter for Pump motor will be of proven type and shall be installed on Line or Neutral side of H. T. Motor and on line side of LT motor.
2. The Soft starter shall be designed for Supply Voltage Variation of +10% to -10%& Frequency variation $\pm 5 \%$.
3. The Soft Starter shall be rated corresponding to the Motor Power & shall be capable of Operating satisfactorily with the Motor under the various loading & starting condition of the Motor over the entire Operating Range. The Soft Starter rating offered shall not be less than the rated KW of the Motor.

4. The Soft Starter shall reduce the starting current of the motor at least to 60% of the direct line starting current of the motor. The Soft Starter shall have a facility to further reduce the current if the motor & pump torque speed curved permit so. Calculation for reactance / impedance required to limit starting current shall be submitted accordingly it shall be measured during factory inspection.
5. The Soft starter shall control the starting torque in such a manner so as to effect smooth starting of the Motor Drive is achieved.

Further line current reduction should be [if required] achieved by the use of dynamic compensator. *For further system current reduction a dynamic compensator [as per IS 13925] can be used to reduce the current up to 1.5 X FLC. Separate dynamic compensator for each motor shall be provided.* **USE OF LOW VOLTAGE CAPACITORS FOR MEDIUM VOLTAGE / HIGH VOLTAGE SOFT STARTERS IS NOT ALLOWED.**

MEDIUM VOLTAGE / HIGH VOLTAGE SOFT STARTERS SHOULD NOT HAVE ANY LOW VOLTAGE POWER DEVICES AS A PART OF KEY COMPONENT OTHER THAN CONTROL SWITCHGEAR.

6. The Soft Starter shall be provided with suitably rated ammeter to indicate the motor current during starting.
7. The Soft Starter shall be so rated as to allow at least three starts equally spaced per hour or one hot start.
8. The control supply to the Soft Starter shall be 110 V.D.C
9. The Soft Starter shall be housed in a sheet steel enclosure of thickness not less than 14 gauge and painted with corrosion resistive paint such as epoxy or Polyurethane. The Soft Starter Panel shall have an integral 300 mm high-fabricated pedestal to prevent water ingress.
10. Soft Starter unit shall have anti – condensation heater, complete with switch and thermostat. The heater shall have interlocking in such a way that it is switched 'OFF' when motor is in run mode.
11. Soft Starter shall have a built in facility for run mode bypass so that the incoming voltage to the motor is equal to the supply voltage.
12. The Soft starter shall be provided with specially programmed and calibrated PLC to control the starting process of motor through soft starter. PLC should monitor the complete starting process for errors, healthiness, and operational sequence of soft starter.
13. PLC should provide current based close loop starting process and should not work on timer based open loop control.
14. PLC should be equipped with enough digital and analog ports to control the complete soft starting process and continues monitoring.
15. The minimum but not limited to parameters to be monitored by PLC are :

- interlock fail with external device
- door open
- over temperature
- number of starts and consecutive start limit
- bypass device fail
- long starting time
- premature current fault
- number of starts and time for life cycle of soft starter
- energy saving calculations and performance curve plotting etc.

16. The interface for soft starter should be through capacitive touch screen HMI of IP 65 Grade of 5.7" or higher size with at least 16 shade colour display or better.

17. The HMI should be capable of displaying all errors, warnings, status messages with accept and reset facility.

18. The HMI should be capable of plotting the starting performance curves along with energy saving calculations with minimum 200 previous start histories.

19. complete PLC configuration should be possible through HMI

20. The Soft Starter shall have suitable hour meter and operation counter for counting motor running hours & counting no. of start–stop operations of the motor.

9.3.4 Testing:

9.4.4.1 Shop Test

- Physical inspection for dimensional check.
- Control circuit operation check
- Insulation resistance test before and after high voltage test.
- High voltage test.
- Temperature rise test for bypass device at rated motor current.
- Starting Current measurement

9.4.4.2 Site Test:

- Insulation resistance test.
- Control circuit operation test.
- Test to demonstrate achievement of starting current as per specifications.

9.4 HT Indoor Switchgear

9.4.1 Scope

The specification covers the design, manufacture, testing at manufactures works, supply, delivery, storage at site; erection, testing and commissioning of 6.6 kV Switchgear complete with instrumentation controls and safety devices. The scope of supply shall include spares for 5 years of operation of the pumping station, special tools and testing devices, all parts accessories etc. which are essential for construction, operation and maintenance of the switchgear even though these are nor individually or specifically stated or enumerated. Corresponding components of the Switchgear and associated equipment and spares shall be of the same material, dimensions and finish and shall be interchangeable.

9.4.2 Standards

Sl. No.	Standard	Description
1.	IS 9920/9921	AC Disconnectors
2.	IS 13118	General requirements for CB for voltages above 1000V.
3.	IS 3427	Metal enclosed Sw Gr & Cont. Gr (for V > 1 kV & < 11 kV).
4.	IS 2516	Circuit breaker
5.	IS 2147	Degree of protection
6.	IS 1248	Electrical Indicating Instruments.
7.	IS 722	Integrating AC electric meters.
8.	IS 2705	Current transformers.
9.	IS 3156	Voltage transformers.
10.	IS 9046	AC contactors of voltages above 1 kV, up to and including 11 kV.
11.	IS 5621	Insulators
12.	IS 3231	Electric Relays
13.	IS 8686	Specification for static relays
14.	IS 5082	Wrought aluminium and alloy bars, tubes, rods for Electrical purpose.
15.	IS 9385	HV fuses
16.	IS 10118	Installation and maintenance of switchgear.
17.	IS 9431	Indoor post insulators of organic material
18.	IS 11353	Guide for uniform system of marking terminals
19.	IEC-TC-73 WG-4	Metal oxide surge arresters

Sl. No.	Standard	Description
20.	IS 375	Marking and arrangement for switchgear bus bars main connections and auxiliary wiring.
21.	IS 5621	Insulators

9.4.3 Other requirements

1.1 Main panel shall be sheet steel dust & vermin proof indoor floor mounting type H.T. panel with bus bars, suitable for system voltage and duties specified for each stage completely assembled, wired, tested and painted with rust proof paint conforming to relevant I.S. The panel shall comprise of following incoming breakers. The degree of protection should be IP-52. Panel should have valid type tests including type test for bought out items.

9.4.4 Incoming breaker shall consist of following.

1. 6.6 kV 3 phase, 50 Hz draw out type Vacuum circuit breaker with A.C. motor charged spring closing mechanism and facility for remote operation.
2. 3 Nos. Three core current transformers of ratio rated $\frac{V}{I}$ 1/1/1A one core for metering Class-I accuracy, 15 VA burden, Second core for protection class - 5P-10, 15 VA burden and Third core of class PS.
3. 3 Nos. single phases, double core potential transformers to be star/star connected with ratio. $\frac{V}{V}$ 6.6 kV / $\sqrt{3}$ / (110V/ $\sqrt{3}$). Core 1 will be Class - I accuracy and 100 VA burden and other for protection class 3P.
4. Trip, neutral, close, circuit breaker control switch.
5. Indication lamps for ON/ off/ Auto Trip Spring Charged indication, rated for 110 Volts D.C.
6. White indication lamp for trip circuit healthy indication suitable for 110 Volts D.C. and with Trip Circuit Supervision Relay
7. 96 sq. mm. ammeter of suitable scale with 3 ways and ON/OFF selector switch.
8. 96 sq.mm. Voltmeter of suitable scale with 3 ways and ON/OFF selector switch.
9. Multi Function Meter with accuracy class 1.0 with RS 485 port to communicate the data to Automation system.
10. High speed tripping relay.
11. A Triple pole inverse definite minimum time lag (IDMTL) relay (Numeric Type) with two element for over current protection and other element for earth fault protection with common instantaneous setting.
12. PT Fuse Failure Relay
13. Cable termination arrangement with cable end box suitable for terminating XLPE cable coming from transformer.
14. Auxiliary relays, A.C. and D.C. fuses etc. as required.
15. Remote/Local selector switch (3 Position), with locking arrangement.
16. Space heater with interlocks to ensure that space heater is ON. When breaker is open and OFF when breaker is closed. Internal lighting should be provided in the panels.
17. Frequency indicator having range of 45 Hz to 60 Hz.
18. Counter showing No. of tripping made by breaker.

9.4.5 Outgoing Feeders for Motors

Each feeder to have the following -

1. 6.6 kV 3 phase, 50 Hz draw out type Vacuum circuit breaker with A.C. motor charged spring closing mechanism and facility for remote operation.
2. 3 Nos. double core current transformers of ratio rated $\frac{1}{1A}$ one core for metering Class-I accuracy, 15 VA burden and other core for protection class - 5P-20, 15 VA burden.
3. Trip, neutral close circuit breaker control switches with time lag arrangement.
4. Indicating lamps for circuit breaker On/Off/Auto Trip/Spring Charged
5. Indication for trip circuit healthy indication suitable for 110 volts D.C. and with Trip Circuit Supervision Relay
6. Indication rated for 110 volts D.C.
7. Indication for Soft Starter RUN / BYPASS mode.
8. Butterfly valve operation switches OPEN/CLOSE with indication lamps, indicating valve positions of Fully open and Fully close.
9. 96 sq.mm. Ammeter shall be with suitable scale with 3 ways ON/OFF selector switch.
10. High speed tripping relays.
11. Numeric comprehensive Motor Protection relay.
12. Disconnecting links for disconnection of cable of capacitors.
13. Cable termination arrangement with cable end box suitable for terminating cables (for motor and for capacitor)
14. Remote/Local selector switch (3 Position), with locking arrangement.
15. Auxiliary relays terminals A.C. and D.C. fuses etc. as required.
16. Hour meter one for each motor panel and spare panel operating on 230/ 110/ V.A.C/ D.C. Supply.

9.4.6 Outgoing Feeders for Capacitors

Each feeder to have the following -

1. 6.6 kV 3 phase, 50 Hz draw out type Vacuum circuit breaker with A.C. motor charged spring closing mechanism and facility for remote operation.
2. 3 Nos. double core current transformers of ratio rated $\frac{1}{1A}$ one core for metering Class-I accuracy, 15 VA burden and other core for protection class - 5P-20, 15 VA burden.
3. Trip, neutral close circuit breaker controls switch with time lag arrangement.
4. Indicating lamps for circuit breaker On/Off/Auto Trip/Spring Charged
5. Indication rated for 110 volts D.C.
6. Indication for trip circuit healthy indication suitable for 110 volts D.C. and with Trip Circuit Supervision Relay
7. High speed tripping relays.
8. A Triple pole inverse definite minimum time lag (IDMTL) relay (Numeric Type) with two elements for over current protection and other element for earth fault protection with common instantaneous setting.
9. Cable termination arrangement with cable end box suitable for terminating cables.
10. Remote/Local selector switch (3 Position), with locking arrangement.
11. Auxiliary relays terminals A.C. and D.C. fuses etc. as required.

9.4.7 Outgoing Feeders for Auxiliary Transformer

Each feeder to have the following –

12. 6.6 kV 3 phase, 50 Hz draw out type Vacuum circuit breaker with A.C. motor charged spring closing mechanism and facility for remote operation.
13. 3 Nos. double core current transformers of ratio rated **/1/1A one core for metering Class-I accuracy, 15 VA burden and other core for protection class - 5P-20, 15 VA burden.
14. Trip, neutral close circuit breaker controls switch with time lag arrangement.
15. Indicating lamps for circuit breaker On/Off/Auto Trip/Spring Charged
16. Indication rated for 110 volts D.C.
17. Indication for trip circuit healthy indication suitable for 110 volts D.C. and with Trip Circuit Supervision Relay
18. High speed tripping relays.
19. A Triple pole inverse definite minimum time lag (IDMTL) relay (Numeric Type) with two elements for over current protection and other element for earth fault protection with common instantaneous setting.
20. Cable termination arrangement with cable end box suitable for terminating cables.
21. Remote/Local selector switch (3 Position), with locking arrangement.
22. Auxiliary relays terminals A.C. and D.C. fuses etc. as required.

9.4.8 Bus Coupler breaker shall consist of following.

(Shall be applicable where there are two different sources of supply)

1. 6.6 kV 3 phase, 50 Hz draw out type Vacuum circuit breaker with A.C. motor charged spring closing mechanism and facility for remote operation.
2. Trip, neutral, close, circuit breaker control switch.
3. Indication lamps Red/Green/Amber for circuit breaker.
4. On/ Off/Spring Charged indication, rated for 110 Volts D.C.
5. White indication lamp for trip circuit healthy indication suitable for 110 Volts D.C. and with Trip Circuit Supervision Relay
6. 96 sq. mm. ammeter of suitable scale with 3 ways and ON/OFF selector switch.
7. High speed tripping relay.
8. Auxiliary relays, A.C. and D.C. fuses etc. as required.
9. Remote/Local selector switch (3 Position), with locking arrangement.
10. Space heater with interlocks to ensure that space heater is ON. When breaker is open and OFF when breaker is closed. Internal lighting should be provided in the panels.
11. Counter showing No. of trippings made by breaker.
12. Forced water lubrication pump start/stop switches with indication lamps.
13. Indication for DC Failure.

9.4.9 Annunciation

1. 1 No. buzzer suitable for operation on 110 volts D.C.
2. 1 No. Bell suitable for operation on 230 volts A.C.

9.4.10 Detailed Technical Specifications

9.4.10.1 Vacuum Circuit Breakers.

The Breaker unit shall have two main components:

- a) The trolley assembly
- b) The cradle assembly

The trolley assembly made of steel plates shall be mounted on wheels. The trolley assembly shall be provided with:

- The pole assembly
- The operating mechanism

The pole assembly component of the trolley assembly shall have;

- i. The interrupter units having vacuum not less than 10⁻⁵ Torr.
- ii. The top terminals for interrupter units, separated by fire retardant type barriers.
- iii. The contacts of the breaker shall be silver plated copper or silver plated copper-chromium.

The operating mechanism shall consist of:

- Solenoid operating mechanism
- Control devices

The solenoid mechanism operating on the electro-magnetic principle shall close or open the interrupter. The driving force of the closing electro-magnet shall be imparted to the operating shaft with a trip free link mechanism.

There shall be a heavy duty plug-in type earth contact/change over switch which shall make before the insertion of trolley assembly and break after the withdrawal of the same.

The cradle assembly made of steel plates shall be mounted on chassis and shall accommodate the trolley assembly.

The cradle assembly shall consist of:

- a) Copper terminals to receive the breaker contact.
 - b) Rails to guide the trolley assembly.
 - c) Insulated safety shutter mechanism to make the shutter operation fully automatic depending on circuit breaker position.
- a) Each Breaker shall have following accessories.
 1. Operation counters to register number of breakers operations.
 2. Mechanical operating device for manual closing and tripping of Breaker.
 3. Device for manual charging of closing spring.
 4. Mechanically operated Red 'Trip' shrouded Push button.
 - b) There should be locking facility in SERVICE, TEST and ISOLATED position.
 - c) In TEST position, the Breaker will be tested without energizing the power circuit.
 - d) It should not be possible to operate breaker unless it is fully plugged IN, TEST or fully isolated position.
 - e) Though the Breakers are to be suitable for electrical operation provision of manual charging, closing and tripping shall be made.
 - f) All Breakers of identical current ratings shall be interchangeable.

- g) Charging motor and closing coil shall operate between 85 to 110 percent of 110 volts D.C. supply and trip coil between 70 to 110 percent of 100 volts, D.C. supply suitable thermal protection shall be provided for charging motor.

9.4.10.2 Bus Bars and Supports

Bus Bars shall be of Electrolytic Aluminium and of ample in size. It shall be adequately supported on non hygroscopic, non-combustible fibre glass reinforced, plastic insulators. The Bus Bars up to incoming of breaker and also up to the outgoing terminals including all joints shall be fully insulated with heat shrinkable PVC sleeves. They shall be uniform and continuous throughout the length of Switch Board. The Bus Bars shall be extendable on both sides.

9.4.10.3 Wiring

All control wiring shall be of adequate capacity, and all outgoing circuits shall be wired up to terminal blocks, for external connections. Wires shall be properly colour coded and ferruled, to distinguish different circuits. They shall be neatly routed through PVC channel of adequate size. All control wiring shall be carried out with 1.1 kV grade, 2.5 sq.mm. PVC insulated wires.

9.4.10.4 Panels

The panel shall be indoor, free standing type, fully compartmentalised and properly ventilated. It shall be totally enclosed, dust and vermin proof. It shall be possible to extend the assembly on either side, single front/ double front, depending upon site requirements. It shall be made out of least 10 SWG sheet steel suitably reinforced to provide flat level surface, resistant to vibration, and rigid during transportation and installation. Doors and removable covers may be of 14 SWG, sheet. Breaker compartment shall have front hinged door, with lock and key.

In case of breaker panel, fixed main disconnect contacts in panel housing shall be provided with automatic safety shutters, to cover the high voltage circuit means shall be provided to operate shutters by handle or knob, on the front of the panel. Shutter operating mechanism shall be interlocked with withdrawable truck, to prevent incorrect operation.

All panel surfaces to be painted/power coated shall be first chemically treated to remove all rust, scale, and then two coats of Zinc primer shall be applied. The colour of all panels shall be light Grey to shade No. 631 of IS-5 (or as approved by Engineer in Charge) with semi-glossy finish for the exterior and brilliant white synthetic enamel, for interior. The other alternative like powder coating is also acceptable.

9.4.11 Technical parameters

a)	TP bus bar details	High Conductivity Aluminium grade E91E for TP bus bar, bare type, size shall be suitable for current rating shown on diagrams
b)	Min. Clearance	As per IS / BS standard (Min. 90 mm)
c)	Earth Bus	50 x 6 Al strip
d)	Impulse withstand voltage	As Per relevant IS
e)	Power freq. Withstand – Voltage	As Per relevant IS
f)	Short time Rating	25 kA (rms) for 3 second
g)	Max. Temp. of bus bar	70 °C

h)	Feeder details	Ratings and other details are as per diagrams
	Incoming/ outgoing Breaker	Vacuum circuit breaker Control supply 110V DC Spring charge motor 230 V AC
	Operating duty cycle	0-3 min-co-3 min-co
i)	CT details	Cast resin, bar primary type, 1 A CT CT ratio, burden and class as per SLD
j)	PT details	Cast resin, single phase, wound type, 110 V PT PT ratio, burden and class as per SLD
k)	Relays	All relays shall be Numeric Type.
l)	Selector switch details	AS for Ammeter with R, Y, B, OFF positions and VS for Voltmeter with RY, YB, BR, OFF positions
m)	Indicating Meter details	Moving iron type, 90 ° scale, for AM & VM, Suppressed scale in case of AM for motors AM dial range to suit CT primary current. VM dial range to suit PT primary voltage. Accuracy Class 1.0 For other details refer SLD.
n)	Push button details	Momentary type, 2 NO & 2 NC contacts of 10 A
o)	Indicating lamp details	LED type
p)	Control fuse details	HRC cartridge type with base & carrier. contractor to select rating.
q)	Miscellaneous details	1. CT terminals shall be provided with shorting link and earthing facility 2. Control wiring - marked with ferrule no at both ends. 3. Panel shall be provided with Thermostat controlled space heater & cubicle illumination. 4. Degree of protection - IP 4X (for indoor panel) and IP52 (for outdoor)

9.4.12 NAME PLATE

The name plates of the circuit breaker and its operating device shall have marking as:

Manufacturer

Type designation and serial number

Rated voltage

Rated frequency

Rated normal current

Short circuit withstand capacity

Rated short circuit breaking current

Rated supply voltage of closing and opening devices

Rated supply frequency of closing and opening devices

Tender Document Ref:

Operating duty

Supply voltage of auxiliary circuits

Supply frequency of auxiliary circuits

Weights

Rated operating sequence

Year of manufacture

9.4.13 Tests

The switchgear assembly & all other components, like circuit Breaker, Bus Bars, C.T. P.T. shall be tested for all Type and Routine tests, as per latest editions of relevant Indian Standard. In case, Type test reports on similar equipment are available then Engineer may waive these tests. All Routine tests as per relevant standard shall be conducted on the assembly and the various components.

All the above testing shall be carried out for routine and type functional test at manufacturers works in presence of Engineer or his representative.

9.4.13.1 Testing

H.T. Switch gear panel shall be tested for routine and type functional tests at manufacturer's works in presence of the Engineer or his representative Type test certificate shall be furnished.

i) Switchgear shall be made out of sheet steel in compartmentalized design and shall be suitable for bottom cable entry on rear Side. The main incomer shall come from outdoor switchyard be through XLPE insulated Al conductor or fire retardant cable. The horizontal bus bar chamber shall be on the top.

ii) Additional 6 Nos. of NO - NC contacts shall be provided than the required numbers.

9.5 HT / LT Capacitors

9.5.1 Scope

The specification covers the design, manufacture, testing at manufactures works, supply, delivery, storage at site; erection, testing and commissioning of 6.6 kV / 0.433 kV Capacitors with instrumentation controls and safety devices.

The capacitors are required for following

- To improve the power factor of motors (and in turn, improve the power factor of the system). This compensation may be individual/group or central based on optimal location studies of reactive compensation.
- Capacitors are provided to improve the power factor of the system when the motors are not running (as the power factor of the transformer, under no load condition, is very poor).

The scope of supply shall include spares for 5 years of operation of the pumping station, special tools and testing devices, all parts accessories etc. which are essential for construction, operation and maintenance of the capacitors even though these are nor individually or specifically stated or enumerated. Corresponding components of the capacitors and associated equipment and spares shall be of the same material, dimensions and finish and shall be interchangeable. The specification covers the design, manufacture, testing at manufactures works, supply, delivery, storage at site; erection, testing and commissioning of 6.6 kV capacitors complete with instrumentation controls and safety devices.

9.5.2 Standards

Standard	Description
IS 2834	Power factor improvement capacitors

9.5.3 Other considerations

Capacitor across each motor shall be selected to improve the power factor up to 0.95 however care shall be taken that kVAR of capacitor shall not exceed magnetising kVAR of the motor even if corrected power factor is less than 0.95.

The capacitors shall be provided in separate expanded metal housing with top completely covered with M.S. sheets. The capacitors shall be mounted on rigid framed structure. The bushings required for supporting I.S.2834 but shall also meet the requirement as per B.S.S. 1950 wherever these are applicable.

The capacitors shall be provided with earth terminals. The earth fault relay is included under H.T. panel. The one No. of CBCT to detect the earth fault required for earth fault relay shall be provided.

Each capacitor cubicle will comprise of followings.

1. Bank of capacitors of suitable KVAR rating for each motor to improve the P.F. of motor to 0.95.
2. HRC fuses suitable for operating voltage.
3. Earthing terminals.

Clarification: The capacitor cubicles will be one number to each motor.

1. HT Capacitors for power transformers shall be protected against over current by means of suitable breaker with adjustable over current Relays, which are adjusted to interrupt the circuit, when the current exceeds the permissible limits, specified in 5.3 of I.S.2834-1964. HT capacitors

for Power transformers above 3.15 MVA, shall be considered at detailed engineering stage, if client prefers so.

2. Suitable discharge device to be provided,

The size and method of connection of capacitors shall be checked with the motor manufacturers.

Contractor shall check with manufacturer regarding the provision of inductor coil.

Capacitor Value shall be worked such that the power factor will improve to 0.95 when the motor running at duty point.

The capacitors shall be provided with low loss device and reduce the voltage to 50 V within 5 minutes.

9.5.4 Technical parameters

Quantity and output	For individual motor and transformer 1 No. each,
Capacitor starting	Along with motor and on bus for transformer
Capacitor type	MPP
Rated voltage and frequency	6.6 kV or 0.433 kV, 3 phase, 50 Hz
Maximum over voltage the unit capacitor is capable of withstanding continuously	110 %

Testing

The capacitor will be tested in manufacturers works as per IS 2834-1964 in presence of the Engineer or his representative.

9.6 Metal Enclosed LT Switchgear**9.6.1 Scope**

The specification covers the design, manufacture, testing at manufactures works, supply, delivery, storage at site; erection, testing and commissioning of 0.415 kV Switchgear complete with instrumentation controls and safety devices. The scope of supply shall include spares for 5 years of operation of the pumping station, special tools and testing devices, all parts accessories etc. which are essential for construction, operation and maintenance of the switchgear even though these are nor individually or specifically stated or enumerated. Corresponding components of the Switchgear and associated equipment and spares shall be of the same material, dimensions and finish and shall be interchangeable.

9.6.2 Standards

Sl. No.	Standard	Description
1.	IS 3247	Switchgear general requirements.
2.	IS 2516	Circuit breaker
3.	IS 8623	Factory built assemblies of Sw Gr & Cont. Gr (for voltages < 650 V).
4.	IS 2147	Degree of protection of enclosure for LV switchgear and control gear.
5.	IS 1248	Electrical Indicating Instruments.
6.	IS 722	Integrating AC electric meters.
7.	IS 2705	Current transformers.
8.	IS 3156	Voltage transformers.
9.	IS 10118	Installation and maintenance of switchgear.
10.	IS 3231	Electric Relays
11.	IS 8686	Specification for static relays
12.	IS 5082	Wrought aluminium and alloy bars, tubes, rods for Electrical purpose.
13.	IS 9431	Indoor post insulators of organic material
14.	IS 5621	Insulators
15.	IS 11353	Guide for uniform system of marking terminals
16.	IS 2544	Porcelain post insulators
17.	IS 375	Marking and arrangement for switchgear busbars main connections and auxiliary wiring.

9.6.3 Other Considerations

One sheet steel, totally enclosed, dust and vermin proof L.T. panel Board, suitable for indoor floor mounting with of suitable Amp. Aluminium bus bar and neutral of half the rating for operation on 415 V 3 Phase, 50 Hz. A.C. system, completely, assembled wired, tested and painted with rust proof paint for controlling L.T. supply to different auxiliaries of pump house. *The ACB / MCCB are to be installed in the panel; switch fuse units (SFU / FSU) are not permitted.*

Each panel shall consist of following item well installed and connected to suitable size of bus bars provided in the panel.

The main incomer from the transformer shall be through a 3 1/2 C XLPE / AYFY or BUSDUCT Cable with suitable termination at the bottom of the switchgear. The horizontal bus bar chamber shall be on the top whereas vertical bus bars shall be provided in bus alley at the front.

9.6.4 Brief Specification for ACB & MCCB

9.6.4.1 Air Circuit Breaker

- Type : Manually Operated fully Draw out type
- Rated Operational Voltage : 690V
- Rated Insulation Voltage : 1000 V
- Rated Impulse Withstand Voltage : 12 kV
- All the ACBs have Microprocessor based protection Release with self diagnostic& test function. Following standard protections are available.
 1. O/L settable from 0.4.....1xIn with time delay
 2. Selective S/C from 1.....10xIn with time delay
 3. Instantaneous S/C from 1.5.....15xIn
 4. Earth Fault from 0.2.....1xIn with time delay

9.6.4.2 Moulded Case Circuit Breaker

- MCCBs are Manually Operated fixed type
- Rated Operational Voltage : 690V
- MCCBs with Microprocessor based Protection Release shall have following settings:
 - O/L :- 0.4.....1 x In with time delay
 - S/C :- 1.....10 x In with time delay
 - Inst.:- 1.5...15 x In
 - E/F:- 0.2.....1 x In; Time:- 0.1s.....0.8s

Alternatively Thermo Magnetic release with adequate setting range can be proposed

9.6.5 An Incoming Feeder of Suitable Amp. Rating Comprising of

1. Triple pole 415 Volts of L.T. ACB having 35 / 50 kA capacity and provided with thermal relay along with shunt trip, magnetic release and auxiliary contacts etc. each comprising of following items will be installed and connected to suitable size of bus provided in the panel.
2. Indication lamps Red/Green/Amber for ON/OFF and Auto trip position indications receptively.
3. Current transformers having ratio suitable Amp. and V.A. rating Class-I accuracy for metering, Class – 5P20 accuracy for protection.
4. 1-96 sq.mm. Voltmeter of suitable scale.
5. 1-Voltmeter selectors switch 3 way and ON/OFF.
6. 1-96 sq.mm. Ammeter of suitable scale.
7. 1-Ammeter selector switch 3 way ON/OFF.
8. 1-Multifunction meter with RS 485 Port.

One sheet steel, totally enclosed, dust and vermin proof L.T. panel Board, suitable for indoor floor mounting with of suitable Amp. Aluminium bus bar and neutral of half the rating for operation on 415 V 3 Phase, 50 Hz. A.C. system, completely, assembled wired, tested and painted with rust proof paint for controlling L.T. supply to different auxiliaries of pump house. Each panel shall consist of following item well installed and connected to suitable size of bus bars provided in the panel.

The main incomer from the transformer shall be through a 3 1/2 C XLPE / AYFY Cable with suitable termination at the bottom of the switchgear in case the Transformer rating is less than 1000 kVA. The horizontal bus bar chamber shall be on the top whereas vertical busbars shall be provided in bus alley at the front.

If the transformer rating is above 1000 kVA, a bus duct of adequate rating is proposed. The bus duct is to be terminated on top (preferably) or bottom suitably.

9.6.6 Outgoing feeders

- Wherever the main pump motors are of 0.415 kV, the adequate starters with protection are to be provided. The starter to be selected as follows

Upto 5 kW	- DOL Starter
Upto 50 kW	- Star Delta Starter
Above 50 kW	- Soft Starter

Please check the selection table at the end of the specifications of LT Switchgear.

Note:

THE LINE SIDE CONTACTOR OF THE SOFT STARTER SHOULD BE SELECTED OF THE RATING OF THE ***DIRECT ON LINE (DOL)***.

- D.O.L. type push button operated reversible starters for individual Butterfly Valve control through actuator with 2 No. (Normally Open) + 2 NC (Normally Closed) auxiliary contacts, Motors shall be connected on this panel duly wired through the MCCB unit. Switch for Local/ Remote control operation should also be provided. Auxiliary relays, contacts, terminals etc. as required.
- Suitable rating MCCBs and starters (wherever required) for all other LT loads
- Cable termination gland suitable for adequate capacity Armoured Power and Control cable.
- 1-Multifunction meter with RS 485 Port on each motor feeder

➤ At least three outgoing spare feeders

9.6.7 Technical parameters

1.	TPN bus bar details	High Conductivity Al grade E91E for TPN bare bus bar, size shall be suitable for current rating shown on the drawings.
2.	Min. Clearance	Phase to phase - 25 mm & Phase to earth - 20 mm
3.	Earth Bus	50 x 6 GI strip
4.	Power freq. Withstand	2.5 kV RMS, 50 Hz for one minute
5.	Short time	50 kA (rms) for 1 second
6.	Max. temp. of bus bar	70 ° C
7.	CT details	Cast resin, bar primary type, 1 A CT CT ratio, burden and class as required, but min. Burden should be 15 VA
8.	MCCB details	Suitable rating with static release, U/V & current limiting feature
9.	Selector switch details	AS for Ammeter with R, Y, B, OFF positions. VS for Voltmeter with RY, YB, BR, OFF positions
10.	Indicating Meter details	Moving iron type, 90 ° scale, for AM & VM, AM dial range to suit CT primary current. VM dial range to suit PT primary voltage. Size 96 mm ² for outgoing feeders Accuracy Class 1.0 For other details refer drawings
11.	Integrating Meter details	Multifunction meter with RS 485 Port
12.	Push button details	Momentary type, 2 NO & 2 NC contacts of 10 A at 240 V AC
13.	Indicating lamp details	7 Watts filament type with series resistance,
14.	Control fuse details	HRC cartridge type with base & carrier. Contractor to select rating.
15.	Miscellaneous details	Control Wiring shall be with stranded copper conductor, PVC insulated, 650 V grade wires of 2.5 mm ² for CT circuits and 1.5 mm ² for other circuits. Control terminals shall be of 10 A, 1100 V grade, clip on type with din rail mounting. CT terminals shall be provided with shorting link and earthing facility

		Control wiring - marked with ferrule No. at both ends. All boards shall be provided with Thermostat controlled space heater & cubicle illumination. Degree of protection – IP5X (for indoor system) & IP 52(for outdoor system)

9.6.8 Testing

The L.T. panel switch board shall be tested for routine, type and functional tests at manufacturers' works in the presence of the Engineer or his representative.

9.6.9 Selection Chart for Starters

9.6.9.1 SELECTION CHART FOR DOL STARTERS

Motor Rating 415V/3 Ph			Relay Range	Contactor	MCCB Rating
HP	kW	Current In A			
0.125	0.09	0.4	0.3-0.5	10 A	2
0.16	0.12	0.45	0.3-0.5	10 A	2
0.2	0.15	0.57	0.45-0.75	10 A	2
0.25	0.19	0.75	0.6-1	10 A	4
0.33	0.25	0.9	0.6-1	10 A	4
0.5	0.37	1.2	0.9-1.5	10 A	6
0.75	0.55	1.6	1.4-2.3	10 A	6
1	0.75	2.1	1.4-2.3	10 A	8
1.5	1.1	2.7	2-3.3	10 A	10
1.75	1.3	3	2-3.3	10 A	10
2	1.5	3.5	3-5	10 A	16
2.5	1.8	4.8	4.5-7.5	10 A	16
3	2.25	5	4.5-7.5	10 A	16
4	3	6.4	4.5-7.5	10 A	20
5	3.7	7.9	6-10	10 A	20
5.5	4	8.5	6-10	10 A	20
6	4.5	9	6-10	16 A	25
7.5	5.5	11.2	9-15	16 A	32

Motor Rating 415V/3 Ph			Relay Range	Contactor	MCCB Rating
HP	kW	Current In A			
10	7.5	14.8	9-15	25 A	32
12.5	9.3	19	14-23	25 A	50
15	11	22	14-23	25 A	63
17.5	13	24	20-33	32 A	63
20	15	29	20-33	32 A	63
25	18.6	35	30-50	45 A	80
30	22.5	40	30-50	45 A	80
35	26	47	30-50	65 A	100
40	30	55	45-75	65 A	100
45	33.5	60	45-75	65 A	100
50	37	66	45-75	80 A	125
60	45	80	66-110	95 A	160
75	55	100	66-110	110 A	160
90	67.5	120	90-150	140 A	200
100	75	135	90-150	140 A	200
110	80	139	90-150	185 A	200
125	90	165	135-225	185 A	250
150	110	200	135-225	225 A	315
175	130	230	180-300	265 A	315
197	147	260	180-300	265 A	400
200	150	275	180-300	325 A	400
215	160	280	180-300	325 A	400
225	168	300	270-450	325 A	400
245	180	320	270-450	325 A	400
270	200.55	340	270-450	325 A	500

9.6.9.2 SELECTION CHART FOR STAR –DELTA STARTERS

MOTOR		Current in A		Relay	Contactor			MCCB
HP	kW	Line	Phase		Star	Line	Delta	
1	0.75	2.1	1.21	0.9-1.5	10 A	10 A	10 A	4
1.5	1.1	2.7	1.6	1.4-2.3	10 A	10 A	10 A	6
2	1.5	3.5	2.02	1.4-2.3	10 A	10 A	10 A	6
3	2.25	5	2.88	2-3.3	10 A	10 A	10 A	8
4	3	6.4	3.7	3-5	10 A	10 A	10 A	10
5	3.75	7.9	4.6	3-5	10 A	10 A	10 A	16
6	4.5	9	5.2	4.5-7.5	10 A	10 A	10 A	16
7.5	5.5	11.2	6.5	4.5-7.5	10 A	10 A	10 A	20
10	7.5	14.8	8.54	6-10	10 A	10 A	10 A	20
12.5	9.3	19	11	9-15	16 A	16 A	16 A	32
15	11	22	12.7	9-15	16 A	16 A	16 A	32
20	15	29	16.7	14-23	16 A	25 A	25 A	40
25	18.5	35	20.2	14-23	16 A	25 A	25 A	50
30	22.5	40	23	20-33	16 A	25 A	25 A	63
35	26	47	27	20-33	25 A	32 A	32 A	63
40	30	55	31.8	30-50	25 A	32 A	32 A	63
45	33.5	60	34.6	30-50	32 A	45 A	45 A	80
50	37.5	66	38.2	30-50	32 A	45 A	45 A	80
60	45	80	46.2	30-50	45 A	65 A	65 A	100
65	48.5	87	50	45-75	45 A	65 A	65 A	100

9.7 LT Bus Duct**9.7.1 Scope**

The specification covers the design, manufacture, testing at manufactures works, supply, delivery, storage at site; erection, testing and commissioning of 0.415 kV bus duct. The scope of supply shall include spares for 5 years of operation of the pumping station, special tools and testing devices, all parts accessories etc. which are essential for construction, operation and maintenance of the switchgear even though these are nor individually or specifically stated or enumerated. Corresponding components of the bus duct and associated equipment and spares shall be of the same material, dimensions and finish and shall be interchangeable.

9.7.2 Standards

No	Standard	Description
1	IS 8623	Bus Duct
2	IS 5621	Insulators

9.7.3 Other considerations

The Transformers shall be provided with a bus duct as required. The Bus-duct supporting arrangement shall be planned such that removal of any one transformer shall be possible while other transformers remain in service.

9.7.4 Technical parameters

a)	Application	Transformer secondary to PMCC/PCC.
b)	Enclosure material and shape	Sheet steel, rectangular
c)	Type of bus duct	Non-phase segregated bus ducts
d)	Number of bus bars	3 phase & 1 neutral
e)	Rated Voltage	415V
f)	Rated Current	As per transformer rating
g)	Rated short time current & duration	35 / 50 kA(rms), 1 sec.
h)	Installation	Partly indoor & partly outdoor
i)	Maximum enclosure temperature	65 ° C
j)	Degree of protection	IP 55
k)	Painting shade	632, as per IS 5, enamel
l)	Main bus bar material	AL - Electrical Grade E 91E
m)	Number, size & material of earth bus	2 Nos., 50 x 6 mm GI strip

n)	Flexible	Copper foil with bi-metallic strip
o)	Location of flexible	At transformer end
p)	Maximum main bus bar temperature	80 ° C
q)	Enclosure support	To be provided suitably

9.7.5 Testing

All the routine test shall be carried out, as per relevant standard, in presence of Engineer in Charge or his representatives.

9.8 HT Cables

9.8.1 Scope

The specification covers the design, manufacture, type test, testing at manufactures works, supply, delivery, storage at site; laying the cable at site, testing and commissioning of 6.6 kV cables with terminations.

9.8.2 Standards

No.	Indian Standard	Description
	IS 7098	XLPE insulated electric Cables.
	IS 5831	PVC insulation and sheath of electric cables.
	IS 3975	Mild steel wires, strips and tapes for armouring of cables.
	IS8130	Aluminium conductors for insulated cables.

9.8.3 Other Considerations

The HT cable sizing shall be based on fault level of 25 KA or based on studies conducted, whichever is higher.

Technical parameters

Voltage grade	:	6.6 kV (UE) grade laid from 6.6 kV panel to 6.6 kV induction motors
Impulse level	:	Is per IS
No. of cores	:	Three core
Nominal area of conductor	:	As per the drawing and related documents
Conductor	:	Aluminium conductor complying with the requirements specified in I.S.
Type of insulation	:	Cross linked polyethylene (XLPE)
Shielding	:	Conductor shielding and insulation shielding
Armoured or Unarmoured	:	Armoured
Cables to be used in earthed or unearthed system	:	Earthed system

9.8.4 Conductor

The conductor shall be made from high electrical purity Aluminium of circular shape. Conductor construction and testing shall comply with latest I.S.

9.8.5 Insulation

High quality XLPE insulating compound of natural colour shall be used for insulation and shall be chemically crossed linked by continuous vulcanisation process. The cables shall be manufactured with dry cure system. This shall comply with latest IS.

9.8.6 Shielding:

The XLPE cables shall be provided with both conductor shielding and insulating shielding. Both conductor shielding and insulation shielding shall consist of extruded semiconductor compound. Additional insulation shall be provided with semiconductor tape and non-magnetic tape screen over the extruded insulation conductor shielding. XLPE insulation and insulation shielding shall be extruded in one operation by a special process ensuring perfect bonding of inner and outer shielding with insulation.

9.8.7 Outer Sheath

- i) A tough outer sheath of heat resisting PVC compound shall be extruded over the non-magnetic metallic part of insulation screening. This shall conform to latest I.S. The outer sheath shall be embossed with name of manufacture, voltage grade and year of manufacture after every 300/350 mm along the length of cable.
- ii) The outer sheath of the cable shall be provided with antirodent, antitermite property.
- iii) The outer sheath of the cable shall be marked with progressive length and cable at one meter interval at the time of manufacturing.
- iv) The outer sheath of the cable shall have fire retardant low smoke property (i.e. FRLS) and shall be tested for IEC 332-3 category C.

9.8.8 Testing

The capacitor will be tested in manufacturer's works as per IS 2834-1964 in presence of the Engineer or his representative.

9.9 LT Cables**9.9.1 Standards**

No.	Standard	Description
1.	IS 1554	PVC insulated electric Cables.
2.	IS 7098	XLPE insulated electric Cables.
3.	IS 8130	Conductors for insulated electric cables.
4.	IS 5831	PVC insulation and sheath of electric cables.
5.	IS 3975	Mild steel wires, strips and tapes for armouring of cables.
6.	IS 1753	Aluminium conductors for insulated cables.

9.9.2 Other Considerations

Power cable shall be of Al conductor, whereas control and lighting cables shall be of Cu conductor. The minimum size of Al conductor cable shall be 4 mm² and Cu conductor cable of 2.5 mm².

Power cable sizing shall be based on the various de-rating factors recommended by cable manufacturer, rated current, temperature rise of conductor and voltage drop.

Control cables of CTs shall be based on the VA burden of CT and relays, meters.

Technical parameters

LT Cables	PVC / XLPE insulated, taped PVC inner sheath and outer sheath 650/1100 V grade, with multi-stranded aluminium/copper conductor, armoured
Cable selection	Cable shall be selected considering following points ➤ Current rating of the load ➤ De-rating due to grouping of cables ➤ Voltage drop as specified at para9.1.8 (Cable section) ➤ De-rating factor due to ambient temperature. ➤ De-rating due to depth in case of buried cables

9.9.3 Testing

The capacitor will be tested in manufacturers works as per IS 2834-1964 in presence of the Engineer or his representative.

9.10 Cabling System

The work covers detailed engineering work for preparation of cable schedule and cable termination schedule. This will comprise of detailed study of various equipments / panel drawings, Co-ordination with manufacturers / suppliers and preparation of cable schedule giving the equipment interconnection references, preparation of cable termination schedules giving the terminals details core identification purpose etc.

Details about Engineering Work for preparation of cable termination schedules giving the terminal details core identification, purposes etc.

The cable schedule to be prepared after study of various drawings / diagrams shall contain the following details.

- I. Size of cable.
- II. Giving the identification number.
- III. Reference drawing numbers.
- IV. Equipment reference i.e. (from and equipments reference to)
- V. Purpose of interconnection, e.g. power supply alarm, annunciator, control metering trip and close inter locking etc.
- VI. Approximate lengths of cable.
- VII. In case of spare cables the terms 'spare' shall be used.

Cable termination schedule shall contain the following.

- I. Cable number.
- II. Equipment reference drawing.
- III. Equipment terminal markings for individual cores.
- IV. Apparatus reference number of equipment.
- V. Equipment reference.

The contractor shall have to prepare the cable schedule in respect of all the power and control cable involved in the pump house and associated equipment.

The 6.6 cables shall be XLPE AL conductor type armoured and 1.1 kV cable shall be XLPE/PVC insulated AL armoured conductor type.

The work of providing and installation of cables shall be started only after the quality of Cables proposed to be provided is tested and approved by the Engineer-in-charges. The rejected lot of Cables shall be removed from the site. The decision of Engineer-in-charge in this regards shall be final and binding on the tenderer.

The work of wiring and cabling will be done as per the provision of Indian Electricity Act, 1910, 1948, 1956 and rules in existence from time to time and rules presently in force, and the contractor shall

be liable for any damage or accident or loss or injury due to faulty wiring or cabling or for non-observance of rules or Act mentioned above.

9.10.1 Installation

The cables shall be laid in trenches, Cellar, trays or conduits or buried in ground as specified in the cable layout drawing. The cable trench is applicable only for MSDSS/DSS.

In case of space constraints/ restrictions, cable shall be laid in walk able cable tunnel. Underground walk able cable tunnels shall have hydro sealing to prevent water seepage.

For multi- layer installation, overhead cable bridge shall be used depending upon numbers of cable to be laid.

Cable routings given on the drawings shall be checked at site to avoid interference with structures, piping and ducting. Minor adjustments shall be made to suit the field/site conditions.

All cables shall be carefully measured and cut to the required length, leaving sufficient length for final connections to the equipment on both ends.

The Contractor shall ascertain the exact requirement of cable, for a particular feeder, by measuring at site along the actual finalized route.

Cables shall be laid in complete uncut lengths from one item of equipment to another.

Cables shall be neatly arranged in the trenches, trays in such a manner, that criss-crossing is avoided and final takeoff to the motor, switchgear is facilitated. Arrangement of cables within the trench, tray shall be the responsibility of the Contractor.

Power and control cables shall be laid on different trays in one trench. Cable shall be laid from top to bottom in order of HT on top rack followed by LT cables and other cables on lower racks.

All cables shall be identified close to their termination point by cable numbers. Cable numbers will be punched on aluminium straps, (2 mm thick), securely fastened to the cable and wrapped around it.

Underground cables shall be provided with cable markers. These cable marker posts shall be located at every 50 metres and every corner or change of direction.

All temporary ends of cables shall be protected against dust and moisture to prevent damage to the insulation. While laying cables, the ends shall be taped with PVC tape.

Cables shall be handled carefully during installation to prevent mechanical injury to the cables. Ends of cables leaving trenches shall be coiled and provided with protective cover until the final termination to the equipment is completed.

Where cables rise from trenches to motors, control stations, lighting panels etc., they shall be taken up in GI pipes (rigid, flexible) for mechanical protection up to a minimum of 600 mm above grade level. The diameter of the GI pipe shall be at least 3 times the diameter of the cable.

Cable shall be carefully pulled through conduits to prevent damage.

If pipe sleeves installed are inadequate due to a greater number of cables being laid, then additional pipe sleeves shall be laid. After the cables are installed and all testing is complete, conduit ends above grade level shall be plugged with suitable weatherproof plastic compound.

Where cables pass through foundation walls or other underground structures, the necessary ducts or openings will be provided in advance for the same.

At road crossings and other places where cables enter pipe sleeves an adequate bed of sand shall be given.

Cables installed above grade level shall be run in trays, exposed on walls, ceilings or structures and shall be run parallel to, or at right angles to, beams, walls or columns. The cables shall be so routed that they will not be subjected to heat.

Cables running along with structures will be clamped by means of GI saddles and saddle bars at a spacing of 300 mm.

Cable carrier system i.e. site fabricated ladder type cable trays and supporting steel shall be painted before laying of cables. Painting shall have two coats of red oxide and one coat of Aluminium paint.

For all outdoor buried cables a 3 metre diameter loop shall be provided at both ends before termination.

9.10.2 Termination

All LT XLPE/PVC cables shall be terminated at the equipment/panel by means of double compression type brass glands and tinned copper lugs.

All HT XLPE cables shall be terminated at the equipment/panel by means of HT cable termination kits.

Power cable cores shall be identified with red, yellow and blue PVC tapes.

In case of control cables, all cores shall be identified at both ends by their terminal numbers by means of PVC ferrules. Wire numbers shall be as per inter-connection diagrams, to be furnished to the Contractor.

The cable shall be taken through an adequate size gland inside the panel or any other electrical equipment.

Cable leads shall be terminated at the equipment terminals by means of crimped type solderless connectors.

Crimping shall be done by hand crimping/hydraulically operated tool and conducting jelly shall be applied on the conductor. Insulation of the leads should be removed immediately before the crimping.

9.10.3 Testing of cables

Before energising, the insulation resistance shall be measured from phase to phase and phase to ground.

9.11 EARTHING AND LIGHTNING PROTECTION**9.11.1 INTENT OF SPECIFICATION.**

This specification is intended to cover all the equipment of earthing and lightning protection, any item which is not specifically mentioned but required for successful and trouble free operation shall be in the scope of bidder.

9.11.2 CODES AND STANDARDS

All standards, specifications and codes of practice referred to herein shall be the latest editions including all applicable official amendments and revisions as on date of opening of bid. In case of conflict between this specification and those (IS codes, standards, etc.) referred to herein, the former shall prevail. All work shall be carried out as per the following standards and codes.

IS: 513	Cold rolled low carbon steel sheets and strips.
IS: 802 (part-1I)	Code of practice for the use of structural steel in overhead transmission line tower : Fabrication, galvanizing, inspection & packing.
IS: 808	Dimensioning of hot rolled steel Beam Column Channel and angle sections.
IS:1079	Hot rolled carbon steel sheet & Strips
IS:1367(part- I)	Technical supply conditions for threaded steel fasteners. Introduction and general Information.
IS: 1367 (Part13)	Hot dip galvanized coatings on threaded fasteners.
IS: 2062	Steel for general structural purposes.
IS :2309	Code of practice for the protection of building and allied structures against lightning .
IS: 2629	Recommended practice for hot dip galvanizing of iron & steel.
IS: 2633	Method for testing uniformity of coating on zinc coated articles
IS: 3043	Code of practice for Earthing .
IS: 6745	Methods for determination of weight of zinc coating on zinc coated iron & steel articles.
IS: 9595	Recommendation for metal-ARC welding of carbon manganese steels.
IS: 2309	Protection of Building and allied structure from lightning

Indian Electricity Act and Indian Electricity Rules:

Equipment complying with other internationally accepted standards such as IEC, BS, USA VDE etc. will also be considered if they ensure performance and constructional features equivalent or superior to standards listed above, In such a case, the contractor shall clearly indicate the standard (s) adopted, furnish a copy in English of the latest revision of the standards along with copies of all official amendments and revisions in force as on date of opening of bid and shall clearly bring out the salient features for comparison.

9.11.3 GENERAL TECHNICAL REQUIREMENT

3.1 Galvanising

1. Galvanising of steel components and accessories shall conform to IS: 2629 & IS: 2633. Additionally galvanizing shall be uniform, clean, smooth, continuous and free from acid spots. Should the galvanizing of the samples be found defective, the entire batch of steel shall have to be regularized at Contractor's cost after picking.

- 3.1.2 The amount of zinc deposit over threaded portion of bolts, nuts, screws and washers shall be as per IS: 1367 (Part 13). The removal of extra zinc on threaded portion of components shall be carefully done to ensure that the threads shall have the required zinc coating on them as specified.

2. Welding

The welding shall be carried out in accordance with IS: 9595. All welding procedure and welders qualification shall also be followed strictly in line with IS: 9595.

9.11.4 Installation

9.11.4.1 General Instructions

1. The contractor shall make his own arrangement for moving/lifting all the equipments/items into the respective buildings/erection sites.
2. Equipments/items shall be installed in a neat work manner so that it is leveled, plumbed, squared and properly aligned and oriented. Tolerance shall be as established in manufacture's drawings or as stipulated by the Employer. No equipment shall be permanently bolted down to foundation or structure until the alignment has been checked and found acceptable by the Engineer.
3. The contractor shall furnish all supervision, labour, tools equipment, rigging materials, incidental items such as bolts, wedges, anchors, concrete inserts etc. required to completely install, test adjust and fix the equipment.
4. Manufacture's drawings instructions and recommendations shall be correctly followed in handling, erecting, testing and commissioning of all items/equipments and care shall be exercised in handling to avoid distortion to stationary structures, the marring to finish, or damaging of delicate instruments or other electrical parts.
5. The contractor shall carry out all minor civil works such as welding, bolting, drilling, grouting, chipping, sealing, making openings, finishing's etc. as required for satisfactory execution of the work. All civil works associated with earthing and lightning protection are also in the Contractor's scope.

6. All care should be taken to avoid damage of galvanized/painted surfaces during installation. All damaged surface of galvanized or ungalvanized faces of steel structures, conduits, junction boxes, trays etc. shall be brushed up and shall be painted with red lead primer paint followed by two coats of aluminum paint/enamel paint to the satisfaction of Engineer.

9.11.5 Earthing System

1. Earthing system shall be in strict accordance with IS:3043 and Indian Electricity Rules/Acts/ CEA Safety Regulations, 2010 and Employer drawings.
2. The earth conductors shall be free from pitting laminations, rust. Scale and other electrical, mechanical defects. The material of the earthing conductors shall be as follows.
 - a) Conductors above ground level - Galvanized and built up trenches
 - b) Conductors buried in earth - Mild steel rod
 - c) Earth electrodes - Mild steel rod

9.11.5.1 The various sizes of earthing conductors for various application shall be as below

	Equipment	Earth conductor	
		Buried in earth	above ground level & in trenches
a)	Main earth grid 40 mm diaMs rod		50 x 10 mm GS flat
b)	6.6 KV switch gear /415V switch gear /MCC / 6.6 KV Motors		50 x 10 mm GS flat
c)	415 V Distribution board / LT Transformer		50 x 6 mm GS flat
d)	LT Motors		
	i) above 160 KW		50 x 6 mm GS flat
	ii) 25 KW to 160 KW		25 x 6 mm GS flat
	iii) 1 KW to 25 KW		25 x 3 mm GS flat
	iv) Fractional /Horse Power motor		8 SWG GI Wire
e)	Control panel and control desk		25 x 3 mm GS flat
f)	Push button station /JB		8 SWG GI Wire
g)	Earth electrodes		40 mm diaMs rod 3 mt long
h)	Columns, structure cable trays & and busducts enclosures		50 x 6 mm GS flat

- i) Crane, rails rail tracks and other 25 x 6 mm GS flat
non-current carrying metal parts

1. Metallic frame of all electrical equipment shall be earthed by two separate and distinct connections to earthing system, each of 100% capacity. Crane rails, tracks, metal pipes and' conduits shall also be effectively earthed at two points. Steel RCC columns, metallic stairs, hand rails etc. of the building housing electrical equipment shall be connected to the nearby earthing grid conductor by one earthing ensured by bonding the different sections of hand. rails and metallic stairs. Metallic sheaths, screens, and armour of single core cables shall be earthed at switchgear end only unless otherwise instructed by Employer. Every alternate post of the switch yard fence shall be connected to earthing grid by one GS flat and gates by flexible lead to the earthed post. Railway tracks within the plant area shall be bonded across fish plates and connected to earthing grid at several locations. Portable tools, appliances and welding equipment shall be earthed by flexible insulated cable.
2. Each continuous laid out lengths of cable tray shall be earthed at minimum two places by G.S flats to Employer's earthing system, the distance between earthing points shall not exceed 30 metre. Wherever earth mat is not available contractor shall do the necessary connections by driving an earth electrode in the ground.
3. Neutral connections and metallic conduits/pipes shall not be used for the equipment earthing. Lighting protection system down conductors shall not be connected to other earthing conductors above the ground level.
4. Connections between earth leads and equipment shall normally be of bolted type. Contact surface shall be thoroughly cleaned before connections. Equipment bolted connections after being tested and checked shall be painted with anti corrosive paint/compound.
5. Suitable earth risers approved by Engineer shall be provided above finished floor/ground level, if the equipment is not available at the time of laying of main earth conductor.
6. Connections between equipment earthing leads and between main earthing conductors shall be of welded type. For rust protection the welds should be treated with red lead compound and afterwards thickly coated' with bitumen compound. All welded connections shall be made by electric arc welding.
7. Resistance of the joint shall not be more than the resistance of the equivalent length of conductor.
8. Earthing conductors buried in ground shall be laid minimum 600 mm below grade level unless otherwise indicated in the drawings. Back filling material to be placed over buried conductors shall be free from stones and harmful mixtures. Back filling shall be placed in layers of 15mm.
9. Earthing conductors embedded in the concrete floor of the building shall have approximately 50mm concrete cover.
10. A minimum earth coverage of 30 mm shall be provided between earth conductor and the bottom of trench/foundation/underground pipes at crossings. Earthing conductors crossings

the road can be installed in hume pipes. Wherever earthing conductors crosses on runs at less than 300mm distance along metallic structures such as gas, water steam pipe lines, steel reinforcement in concrete, it shall be bonded to the same.

11. Earthing conductors along their run on columns, walls, etc. shall be supported by suitable welding/cheating at interval of 1000mm and 750mm respectively .
12. Earth pit shall be constructed as per approved drawings. Electrodes shall be embedded below permanent moisture level. Minimum spacing between electrodes shall be 600mm. Earth pits shall be treated with salt and charcoal if average resistance of soil is more than 20 ohm metre.
13. On completion of Installation, continuity of earth conductors and efficiency of all bound and joints shall be checked. Earth resistance at earth terminations shall be measured in presence of Employer's representatives. All equipment required for testing shall be furnished by conductor.

9.11.6 Lighting Protection System

1. Lightning protection system shall be in strict accordance with IS: 2309
2. Lightning conductor shall be of 25x6mm GS strip when used above ground level and shall be connected through test link with earth electrode/earthing system.
3. Lightning system shall be comprise of air terminations, down conductors test links earth electrode etc. as per the IS 2309.
4. Down conductors.
 - a) Down conductors shall be as short and straight as practicable and shall follow a direct path to earth. Down conductor shall not be connected to other earthing conductors above ground level.
 - b) Each down conductor shall be provided with a test link at 1000mm above ground level for testing but it shall be in accessible to interference. No connections other than the one direct to an earth electrode shall be made below a test point.
 - c) All joints in the down conductors shall be of welded type.
 - d) Down conductors shall be cleated on outer side of building wall, at 750mm interval or welded to outside building columns at 1000mm interval.
 - e) Lightning conductor on roof shall not be directly cleated on surface of roof. Supporting blocks of PCC/insulating compound shall be used for conductor fixing at an interval of 1500mm.
 - f) All metallic structures within a vicinity of two meters of the conductors shall be bonded to conductors of lightning protection system.
 - g) The lightning protection system shall not be through cables, conduits and metal enclosures of electrical equipment.

- h) Lightning conductors shall not pass through or run inside GI Conduits.
- i) Testing link shall be made of galvanized steel of size 25x6mm.

9.11.7 TESTS

Following routine test shall be carried out on all the equipments, devices & materials supplied.

a) Galvanizing Tests

The quality of galvanizing shall be inspected visually and shall be smooth, continuous, free from flux stains. In addition following tests shall be conducted ..

- a. Uniformity of coating-The coating of any article shall withstand for 1 minute dips in, standard copper sulphate solution without the formation of an adherent red spot of metallic copper upon the basic metal.
- b. The quality of cadmium/zinc plating on items with screw threads shall be inspected visually and shall free from visible defects such as unplated areas, blisters and modules.
- c. In Addition, the plating thickness shall be determined microscopically or electronically.

b) Welding

The Quality of welding shall be visually inspected, particular attention being paid to the following point.

The welded joints shall be continuous along its length on both sides and of uniform width and thickness. It should be free from blow holes.

- i) The weld metal shall be properly fused with the parent metal without undercutting.
- ii) The outside surface of the weld shall be clean. All slag shall have been removed. All welding shall be regularly checked for cracking using magnetic particle inspection or their equivalent technique.
- iii) Physical and dimensional checks for all items.

9.11.8 COMMISSIONING :

The contractor shall carry out the following commissioning tests and checks after erection at site. In addition the contractor shall carry out all other checks and tests as recommended by the Manufactures.

- a) Earth continuity checks
- b) Earth resistance of the complete system as well as sub – systems.

9.12 Lighting System :LED Lights suggested as per applicable code.**9.12.1 Applicable Standards**

IS 1913 : 1978 : General and safety requirements for luminaries

IS 2148 : 2004 : Flame proof enclosures of electrical apparatus

IS 418 : 2004 : Tungsten filament general service electric lamps

IS 1258 : 2005 : Bayonet lamp holders

IS 1534 : 1977 : Ballast for fluorescent lamps

IS 1569 : 1976 : Capacitors for use in tubular fluorescent, high pressure mercury vapour and low pressure sodium vapour

discharge lamp circuit

IS 1777 : 1978 : Industrial luminaries with metal reflectors

IS 2215 : 1983 : Starters for fluorescent lamps

IS 2418 : 1977 : Tubular fluorescent lamps for general lighting services

IS 3323 : 1980 : Bi-pin lamp holders for tubular fluorescent lamps

IS 3324 : 1982 : Holders for starters for tubular fluorescent lamps

IS 4013 : 1967 : Dust-tight electric lighting fittings

IS 6616 : 1982 : Ballasts for high pressure mercury vapour lamps

IS 8224 : 1976 : Electric Lighting fittings for Division 2 areas

IS 9900 : 1981 : High-pressure mercury vapour lamps

IS 9974 : 1981 : High pressure Sodium vapour lamps

IS 10276 : 1982 : Edison screw lamp holders

IS 10322 :Luminaries

IS 13021 : 1991 : AC Supplied Electronic Ballasts for tubular fluorescent lamps

Lighting Panels, Switch-boxes

IS 1293 : 2005 : Plugs & socket outlets of rated voltage upto and including 250volts & rated current upto and including 16 Amps

IS 2551 : 1982 : Danger notice plates

IS 13947 :Low voltage switchgear and controlgear

IS 3854 : 1997 : Switches for domestic and similar purposes

IS 6875 :Control switches (switching devices for control and auxiliary circuits including contactor relays) for voltages upto and including 1000VAC and 200V DC

IS 13703 : 1993 : Low voltage fuses for voltages not exceeding 1000V AC or 150 V DC

Conduits, Pipes and Accessories

IS 2667 : 1988 : Fittings for rigid steel conduit for electrical wiring

IS 3837 : 1976 : Accessories for rigid steel conduits for electrical wiring

IS 9537 : Conduits for electrical installations

Lighting Wires/Cables

IS 694 : 1990 : PVC insulated cables for working voltages upto and Including 1100 V

IS 3961 : 1967 : Recommended current ratings for cables.(PVC Insulated and PVC sheathed heavy duty cables and light duty cables).

IS 8130 : 1984 : Conductors for insulated electric cables and flexible cords

IS 10810 : Methods of tests for cables

Electrical Installation Practices & Miscellaneous

IS 1944 : Code of practice for lighting of public thorough fare

IS 3646 : Code of practice for interior illumination.

IS 5572 : 1994 : Classification of Hazardous areas (other than Mines) having flammable gases and Vapours for electrical installation

IS 6665 : 1972 : Code of practice for industrial lighting. National Electrical Code Indian Electricity Rules. Indian Electricity Act

IS 5 : 2004 : Colour for ready mixed paints& enamels.

IS 280 : 2006 : Mild steel wires for general engineering purposes

IS 374 : 1979 : Electric ceiling type fans & regulators

IS 732 : 1989 : Code of practice for electrical wiring installations

IS 1255 : 1983 : Code of practice for installation and maintenance of power Cables upto and including 33KV rating

IS 2062 : 1999 : Steel for general structural purposes

IS 2629 : 1985 : Recommended practice for hot-dip galvanizing of iron and steel

IS 2633 : 1986 : Methods for testing uniformity of coating of zinc coated articles

IS 2173 : 1991 : Tubular steel poles for overhead power lines

IS 3043 : 1987 : Code of practice for earthing

IS 5216 : 1982 : Guide for safety procedures and practices in electrical work

IS 5571 : 2000 : Guide for selection of electrical equipments for hazardous areas

9.12.1 Lighting System Description

9.12.2.1 Normal AC Lighting System

Normal AC lighting system will be fed from LT MCC.

Emergency lighting will be from DC battery system, which shall be provided at important locations.

9.12.2.2 Design Philosophy

- a) A comprehensive illumination system shall be provided.
- b) Street Lighting shall be automatically controlled by synchronous timer. Provision to bypass the timer shall be provided in the panel for manual control.
- c) The system shall include distribution boards, lighting panels, lighting fixtures, junction boxes, receptacles switch boards, lighting pole/masts, conduits, cables and wires, etc. The system shall cover all interior and exterior lighting such as area lighting, including Transformer yard etc. The constructional features of lighting distribution boards are given in item LT Switchgear.
- d) The illumination system shall be designed on the basis of best engineering practice and shall ensure uniform reusable, aesthetically and glare free illumination. The lighting fixtures shall be designed for minimum glare. The Illumination levels to be adopted for various areas are indicated in Table Below.

Ballasts

All HPSV lamp fixtures shall be provided with wire-wound ballasts. All fluorescent fixtures except for Class-I, Div-II fittings/ increased safety fittings (Div-II/Hazardous Area) shall be provided with electronic ballasts. All luminaries and their accessories and components shall be of type readily replaceable by available Indian makes.

9.12.2.3 Fans & Regulators

Ceiling Fans shall be suitable for operation on 240 V, 50 Hz, AC supply comprising of class F insulated copper wound single phase motor, 1200mm sweep, aerodynamically designed well balanced MS blades (3 Nos.), down rod, die cast aluminium housing, capacitor, suspension hook, canopies etc. finished in stove enameled white. Power factor of fans shall not be less than 0.9. Each fan shall cover approximately 10 m² area

9.12.2.4 Switch Box

Switch boxes shall be made of 1.6 mm thick, MS sheet with 3 mm. thick decorative, cover. Switchbox shall be hot dip galvanized

9.12.2.5 Junction Boxes

Junction box for lighting fixtures shall be deep drawn or fabricated type made of mm. 1.6mm thick CRCA Sheet. The box shall be hot dip galvanized.

9.12.2.6 Conduits, Fittings & Accessories

Conduits, Pipes and Accessories Galvanized heavy duty steel conduits for normal area and galvanized heavy-duty steel conduits with an additional epoxy coating for corrosive area shall be offered. Alternatively glass reinforced epoxy conduits with comparable compressive and impact strength with that of heavy-duty steel conduits may be offered.

a) Rigid Steel Conduits

Rigid steel conduits shall be heavy duty type, hot dip galvanized conforming to IS: 4 9537 Part-I & II shall be suitable for heavy mechanical stresses, threaded on both sides and threaded length shall be protected by zinc rich paint. Conduits shall be 4 smooth from inside and outside.

b) Flexible Steel Conduits

Flexible conduit shall be waterproof and rust proof made of heat resistant lead coated steel.

9.12.2.7 Pull-Out Boxes

Pull out boxes shall be provided at approximately 4-metre interval in a conduit run. Boxes shall be suitable for mounting on Walls, Columns, Structures, etc. Pull out boxes shall have cover with screw and shall be provided with good quality gasket lining. Pull out boxes shall be weather proof type suitable for IP: 55 degree of protection. Pull out box & its cover shall be hot dip galvanized.

9.12.2.8 Lighting Wires

Lighting wires shall be 1100 V grade, light duty PVC insulated unsheathed, stranded copper/aluminum wire for fixed wiring installation, colour of the PVC insulation of wires shall be Red, Yellow, Blue and Black for R, Y, B phases & neutral, respectively and white & grey for DC positive & DC negative circuits, respectively. Minimum size of wire shall not be less than 1.5mm² for copper and 4 mm² for aluminium. The size of the lighting wires/ cables shall be selected such that the total voltage drop from the LDB to the lighting fixture I receptacle does not exceed 3%.

Lighting fixtures shall generally be group controlled directly from lighting panel. However, in office areas, control shall be provided through switch boxes. Each switch shall control a maximum of three fluorescent fixtures.

Wiring shall run throughout in separate conduits. Wires of different phases shall run in different conduits. Wiring for lighting circuits and receptacle circuits shall be carried out in separate conduits and from separate feeders.

Lighting panels etc. shall be earthed by two separate and distinct connections with earthing system. Switch boxes, junction boxes, lighting fixtures, fans, single-phase receptacles etc. shall be earthed by means of separate earth continuity conductor. The earth continuity conductor 14 SWG GI wire shall be run along with each conduit run. Cable armours shall be connected to earthing system at both the ends.

9.12.3 Lighting Levels

Pump House Indoor Area	Average Illumination Level in Horizontal plane (in Lux)	Type of fitting	Lamps
Main Pump house area	200	High Bay anodized Aluminum reflector assembly complete with control gear Box	250/400 W HPSV Lamp
		To be supplemented with fluorescent tube lights if	2 X 40 W

Pump House Indoor Area	Average Illumination Level in Horizontal plane (in Lux)	Type of fitting	Lamps
		required.	
Service Bay	200	-do-	-do-
Control Room	300	Mirror optic	2x40 Watt fluorescent tube lights
Switchgear Room	250	Mirror optic	2x40 Watt fluorescent tube lights
Cable floors & other areas (each)	100	Industrial type vitreous enameled reflector	2x40 Watt fluorescent tube lights
W.C; galleries & Staircase	100	Industrial type fitting without reflector	1x40 Watt fluorescent tube lights
Galleries	70	Water proof Bulk head Luminaries of cast Aluminium stove enameled	60 W Incandescent lamps
Battery Room	150	Corrosion proof luminaries cast Aluminium housing with specially designed vapour proof lamp holder	2x40 Watt fluorescent tube lights

9.12.4 General Requirements

Location of lighting fixtures, switches and receptacles shall be shown on the drawing and shall be relocated if required to suit the site conditions. 5A, 3 pin, 15A, 6 pin receptacles with switches shall be provided on the light control switch boards.

LP's shall be provided with labels indicating LP number and outgoing circuit feeder numbers.

LPs shall be provided with cable gland for incoming cable and knockouts for outgoing conduit termination.

Cable and Conduit supports shall be provided at an interval of 300-400 mm for horizontal runs and 400-500 mm for vertical runs.

Cables and Conduits shall be kept, wherever possible at least 300 mm away from pipes, heating devices and other equipment.

For the purpose of calculating connected loads of various circuits, a multiplying factor of 1.25 will be made to the rated lamp voltage for lamp fixtures to take into account the losses in the control gear.

Junction boxes, pull boxes, terminal blocks, glands, conduits and accessories (elbows, tees, bends etc.) and supporting/anchoring materials shall be supplied, to make the installation complete.

In all types of cabling, due consideration shall be given to neatness and good appearance.

The work for installation, testing and commissioning of the indoor lighting shall include the mounting of fixtures with necessary materials, laying of cable/conduit, pulling of wires through conduit and external earth wire, providing all accessories for cable/conduit installation, including conduit fittings. Providing of light control switch board with switches, switch board mounted 5A, 3 pin receptacles with switches etc.

9.12.5 Testing

Lighting installation testing shall include but not be limited to the following:

- Measure the insulation resistance of each circuit without the lamps being in place. It should be not less than 1 M ohms to earth.
- Current and voltage of all the phases shall be measured at the lighting panel busbars with all the circuits switched on with lamps. If required, load shall be re-balanced on the three phases.
- Check the earth continuity for all socket outlets. A fixed relative position of the phase and neutral connections inside the socket shall be established for all sockets.

After inserting all the lamps and switching on all circuits, minimum and maximum illumination level shall be measured in the area with an approved industrial light meter.

9.13 D.C. BATTERY AND BATTERY CHARGER

9.13.1 BATTERY

9.13.1.1 INTENT OF SPECIFICATION

This specification is intended to cover the D.C. Battery with all materials and accessories required for the efficient & trouble free operation of control room. DC power supply from maintenance free rechargeable seal lead acid batteries i.e. VRLA battery would be preferred.

9.13.1.2 CODES AND STANDARDS

All standards, specifications and codes of practice, referred to herein, shall be the latest edition including all applicable official amendments and revisions as on date of opening of bid.

In case of conflict between this specification and those (IS Codes, Standards etc.) referred to herein, the former shall prevail.

All works shall be carried out as per the following standards and codes:

IS: 10918	-	Specification for vented type Ni-Cd batteries.
BS:1146	-	Specification for potassium hydroxide.
IS:1069	-	Specification for water for storage batteries. Indian Electricity Rules. Indian Electricity Acts

Equipment complying with other internationally accepted standards such as IEC, BS, VDE etc. will also be considered if they ensure performance and constructional features equivalent or superior to standards listed above. In such a case, the contractor shall clearly indicate the standard(s) adopted, furnish a copy in English of the latest revision of the standards along with copies of all official amendments of revisions in force as on date of opening of bid and shall clearly bring out the salient features for comparison.

9.13.1.3 GENERAL TECHNICAL REQUIREMENTS

9.13.1.3.1 Equipments

9.13.1.4.1 Containers

Containers shall be made of poly propylene plastic material. Containers shall be robust, heat resistance, leak proof, non absorbent, alkali resistant, nonbulging type and free from flaws such as wrinkles, cracks, bisters, pin holes etc. Electrolyte level lines shall be marked on container in case of transparent containers. In case of opaque containers level gauge shall be provided.

9.13.1.4.2 Vent Plugs

Safety Valve/Vent plugs shall be provided in each cells. They shall be anti splash type, having more than one exit hole and shall allow the gases to escape freely but shall prevent acid from coming out. The design shall be such that the water loss due to evaporation is kept to minimum. In addition the ventilator shall be easily removed for topping up the cells and of such dimensions that syringe type hydrometer can be inserted into the vent to take electrolyte samples.

9.13.1.4.3 Plates

The plate shall be designed for maximum durability during all service conditions including high rate of discharge and rapid fluctuations of load. The construction of plate shall conform to latest revisions of IS: 10918. The separators shall maintain the electrical insulation between the plates and shall allow the electrolyte to flow freely. Separators should be suitable for continuous immersion in the electrolyte without distortion.

The positive and negative terminal posts shall be clearly marked.

9.13.1.4.4 Sediment Space

Sufficient sediment space shall be provided so that cells will not have to be cleaned during normal life and prevent shorts within the cell. Contractor shall furnish the supporting facts to prove the same.

9.13.1.4.5 Cell Insulator

Each cell shall be separately supported on PVC/porcelain/hard rubber insulators fixed on to the racks with adequate clearance between adjacent cells. Minimum distance between the adjacent cell shall be more than the budge allowed for two cells in accordance with IS:1146.

9.13.1.4.6 Electrolyte

The electrolyte shall be prepared from battery grade Potassium hydroxide conforming BS:5633 and distilled water conforming to IS:1069. The cells shall be shipped dry uncharged. The electrolyte shall be supplied separately.

9.13.1.4.7 Connectors & Fasteners

Nickel coated copper connectors shall be used for connecting up adjacent cells and rows. Bolts, nuts and washers shall be effectively Nickel coated to prevent corrosion. The thickness of Nickel-coating of connectors should be not less than 0.02mm. all the terminals and cells interconnectors shall be fully insulated or have insulation shrouds. End take off connections from positive and negative poles of batteries shall be made by single core cables having stranded aluminum conductors and PVC/XLPE insulation. Necessary supports and lugs for termination of these cables on Batteries shall also be supplied by the contractor. All connectors and lugs shall be capable of continuously carrying the 30 minute discharge current of the respective. Battery and through fault short circuit current which the battery can produce and withstand for the period declared. Contractor shall furnish necessary sizing calculations to prove compliance to the same.

9.13.1.4.8 Battery Racks

Wooden racks for all the batteries shall be provided. They shall be free standing type mounted on porcelain/hard rubber/PVC pads insulators. Batteries shall preferably be located in the single tier arrangement. However, batteries shall having a complete cell weight of lower than 50kg could be located in the double tier arrangement. The batteries racks and wooden supports for cable termination shall be coated with three (3) coats of antiacid paint of approved shade. Numbering shade, Numbering tags, resistant to acid for each cell shall be attached on to the necessary rack. The bottom tier of the stand shall not be less than 150mm above the floor.

Wherever racks are transported in dismantled conditions, suitable match markings shall be provided to facilitate easy assembly.

9.13.1.5 Manufacturer's Identification System

The following information shall be indelibly marked on outside of each cell

- i) Manufacturer's name and trade mark
- ii) Country & year of manufacture
- iii) manufacturer's type designation
- iv) AH capacity at 5 hour discharge rate
- v) Serial Number

9.13.1.6 Accessories

One complete set of all accessories and devices required for maintenance and testing of batteries shall be supplied corresponding of each battery bank. Each set shall include at least the following:

i) Hydrometer	- 2 Nos.
ii) Set of hydrometer spring suitable for the vent holes in different cells.	- 2 Nos
iii) Thermometer for measuring electrolyte temp.	- 5 Nos
iv) Specific Gravity correction chart.	- 2 Nos

v)	Wall mounting type holder made of teak wood for hydrometer and thermometer.	- 2 Nos
vi)	Cell testing voltmeter (3-0-3v) conforming to IS:1248.	- 2 Nos
vii)	Alkali mixing jar.	- 2 Nos
viii)	Rubber apron.	- 2 Nos
ix)	Pair of rubber gloves	- 2 Nos
x)	Set of spanners	- 2 Nos
xi)	“No smoking” notice.	- 2 Nos
xii)	Goggles (Industrial)	- 2 Nos
xiii)	Instruction card.	- 10 Nos
xiv)	Minimum and maximum and Maximum temperature Indicator	-

One set of variable metallic resistor and shunt suitable for carrying out the discharge tests (5 Hr discharge rate) on all the batteries shall also be supplied.

ii. The following information shall be given on the instruction cards supplied with the Battery :

- a) Manufacturer’s instructions for filling and initial charging of the battery together with starting and finishing charging rate
- b) Maintenance instructions.
- c) Designation of cell in accordance with IS: 10918
- d) Storing conditions of electrolyte.

9.13.1.7 TESTS

1. All routine and acceptance tests shall be carried out as per relevant Indian Standards.
2. Type test report of the tests conducted on identical battery within last five years shall be furnished. However for Battery not type tested in last five years, type test need to be performed without any extra cost to Owner.

9.13.1.7.1 Routine Tests

All the routine tests listed below shall cover cells containers, hard wares being supplied as per the latest issue of IS:1146 and IS:1651 or 1652 (whichever is applicable)

a) Container

- i) Verification of constructional requirements.
- ii) Verification of working and packing.

- iii) High voltage tests (Cl.7.6 of IS:1146)

b) Cell and Batteries

- i) Verification of construction requirements
- ii) Verification of marking
- iii) Verification of dimensions

9.13.1.7.2 Type tests

All type listed below shall cover cells containers, hard wares of each type being supplied, as per the latest issue of IS:1146 and IS:1651 or IS:1652 (whichever is applicable depending on type of Battery being offered.)

a) Container (Rubber and Plastic containers)

- i) High voltage test
- ii) Drop ball test
- iii) Plastic yield test
- iv) Acid resistance test
- v) Hydraulic thrust endurance test

b) Cell and Batteries

The following shall be carried out in the sequence given below:-

- i) Tests for capacities for 5 hr and 30 minutes discharge rates and test for voltage during discharge.
- ii) Ampere hours and watt-hour efficiency test.
- iii) Tests for retention of charge.
- iv) Endurance tests.

Type tests shall be carried out on three cells selected randomly. Two cells shall undergo all tests except capacity and endurance tests while the other would undergo only capacity and endurance test.

9.13.1.7.3 Acceptance Tests

All acceptance tests as listed below shall be carried out at site after completion of installation.

- i) Verification of markings.
- ii) Verification of dimensions.
- iii) Tests for capacities for 5 hrs discharge rate alongwith the test for voltage during discharge.

The contractor shall arrange for all necessary equipment, including the variable resistor, tools, tackles and instruments. If a Battery fails to meet the guaranteed requirements the Owner shall have the option of asking the contractor to replace the same.

9.13.1.8 Technical Parameters

9.13.1.8.1 Battery

a)	Battery voltage	To be decided by the bidder
b)	No. of cells	As per the rating
c)	Battery Type	Stationary Nickle Cadmium. High Discharge type/ VRLA Type
d)	Capacity	200 AH or 120 AH as specified
	Hour rate to 1.0 V/Cell at 27°C in scope of work	
e)	Float voltage	1.4 V/Cell
f)	Boost voltage	1.54 V/Cell to 1.7 V/Cell

9.13.2 BATTERY CHARGER

9.13.2.1 INTENT OF SPECIFICATION

This specification shall be applicable for all chargers. These chargers shall supply power to control circuits of various equipment. Any item which is not specifically mentioned but required for successful & trouble free operation of the charger shall be in scope of bidder.

9.13.2.2 CODES AND STANDARDS

All Standards, specifications and codes of practice referred to herein shall be the latest editions including all applicable official amendments and revisions as on date of opening of bid. In case of any conflict between this specification and those (IS Codes, standards etc.) referred to herein, the former shall prevail. All work shall be carried out as per the following standards and codes.

ANSI-C		Guide of surge withstand capability tests.
IS:5		Colours for ready mix. Pains.
IS:694		PVC insulated cable for working voltages upto and including 1100V.
IS:1248		Specification for Direct acting indicating analogue electrical measuring instruments.
IS:2147		Degree of protection provided by enclosures for low voltage switchgear and control gear.
IS:2959		Contactors for voltages not exceeding 1000 V AC or 1200 V DC.
IS: 3231		Electrical relays for power system protection.
IS:3842		Electrical relays for AC System.
IS:3895		Mono-crystalline semi-conductor Rectifier Cells and Stacks.
IS:4064		Air break switches, air break disconnecter, fuse combination units for voltage not exceeding 1000 V AC or 1200 V DC.
IS:4540		Mono-crystalline semi- conductor Rectifier Assemblies and Equipment.
IS:6005		Codes of practice for phosphating of iron and steel.
IS:6619		Safety Code for Semi-conductor Rectifier Equipment.
IS:6875		Control Switches/switching devices for control and auxiliary circuits including contractor relays for voltages 1000 V AC or 1200 V DC.
IS:9000		Basic environmental testing procedures for electronic and electrical items.
IS:9224		Space. for low voltage fuses . Indian Electricity Rules. Indian Electricity Acts.

- 3.0 Equipment complying with other accepted standards such as I.E.C., B.S., V.D.E. etc., will also be considered if they ensure performance and constructional features equivalent or superior to standards listed above. In such a case, the contractor shall clearly indicate the standards(s) adopted, furnish a copy in English of the latest revision of the standards along with copies of all official amendments and revisions in force as on date of opening of bid and shall clearly bring out the salient features for comparison.

9.13.2.3.3.1 GENERAL TECHNICAL REQUIREMENTS

9.13.2.3.1 Equipment Description

1. The Battery Chargers as well as their automatic regulators shall be of static type. Battery chargers shall be capable of continuous operation at the respective rated load in Trickle mode i.e. Trickle charging the associated maintenance free rechargeable seal lead acid batteries i.e. VRLA battery while supplying the D.C. loads. The Batteries shall be trickle charged at 1.4 V to 1.42 V per cell. All chargers shall also be capable of Boost charging the associated D.C Battery at 1.54 to 1.7 volts per cell at the desired rate. The Chargers shall be designed to operate, as mentioned above, at ambient air temperature of 50 deg C.
2. Battery charges shall have a selector switch for selecting the battery charging mode i.e. whether Trickle or Boost Charging.
3. All Battery Chargers shall be provided with facility for both automatic and manual control of output voltage and current. A selector switch shall be provided for selecting the mode of output voltage/current control. Whether automatic or manual. Means shall be provided to avoid current/voltage surges of harmful magnitude/nature which may arise changeover from Auto to Manual mode or vice-versa under normal operating condition.
4. Soft start features shall be provided to build up the voltage to the set value slowly within fifteen second. The chargers shall have load limiters which shall cause when the voltage control is in automatic mode, a gradual lowering of the output voltage when the DC load current exceeds the load limiter setting of the Charger. The load limiter characteristic shall be such that any sustained overload or short circuit in DC system shall not damage the Charger shall trip on overload or external short circuit. After clearance of fault, the Charger voltage shall build automatically when working in automatic mode.
5. When on automatic control mode during Trickle charging, the Charger output shall remain within +/-1% of the set value of AC input voltage variation of +/- 10% , frequency variation of +3/-5% combined voltage and frequency (absolute sum) variation of 10% and continuous DC load variation from zero to full load Uniform and stepless adjustment of the voltage setting (in both manual & automatic mode) shall be provided on front of the charger panel covering the entire trickle charging output range specified. Stepless adjustment of the load limiter setting shall possible from 80% to 100% of the rated output current for Trickle charging mode.
6. During Boost charging, the Battery Chargers shall operate on constant current mode (When automatic regulator is in service. It shall be possible to adjust the Boost charging current continuously over range of 50 to 100% of the output current for Boost charging mode. The Charger output voltage shall automatically to on rising, when it is operating on

Boost mode, as the Battery charges up. For limiting the output voltage of the Charger, a potentiometer shall be provided on the front of the panel. Whereby it shall be possible to set the upper limit of this voltage anywhere in the output range specified for Boost charging mode. All voltage and current setting potentiometers shall be vernier type.

7. Engineering the Charger with fully charged battery connected plus 10% load shall not result in output voltage greater than 110% of the voltage setting. Time taken to stabilise, to within the specified limits in clause 3.1(e) shall be less than fifteen seconds.
8. Momentary output voltage of the Charger, with Battery, connected shall be within 94 to 106% of the voltage setting during sudden load change from 100% to 20% of full load or vice-versa. Output voltage shall return to, and remain, within the limits specified in clause 3.1 (e) in less than 2seconds after the above mentioned change.
9. The Charger manufacturer may offer an arrangement in which the voltage setting device for Trickle charging mode is also used as output voltage limit setting device for Boost charging mode, and the load limiter of Trickle charging mode is also used as Boost charging current setting device.
10. Suitable filter circuits shall be provided in all the Chargers to limit the ripple content (peak to peak) in the output voltage to 1% irrespective of the DC load, even when they are not connected to a battery.
11. The D.C system would be ungrounded and would float with respect to the ground potential when healthy. An earthfault relay would be provided in the D.C Distribution Board for remote annunciation.

9.13.2.4 Printed Circuit Boards(PCB)

PCB shall be made of glass epoxy of 1.6mm thick, fire resistant, bonded with 99.8% pure copper foil, free of wrinkles, blisters, scratches and pinholes. The contact surface of the edge connector of the PCBs shall be plated with hard gold to a minimum thickness of 5 microns. Component identification shall be printed on PCB by silk screen method. All PCBs shall be tropicalised and masked.

9.13.2.5 Contactors

All Battery chargers shall have an AC contactor on the input side. It shall be of air break type and suitable for continuous duty. The operating coil be rated for 415 Volts AC.

9.13.2.6 Thermal Overload Relay

A thermal overload relay incorporating a distinct single phasing protection (using differential movement of bimetal strips) shall also be provided for the AC input. The relay shall trip the above contactor.

9.13.2.7 Rectifier-Transformers and Chokes

The rectifier-transformers and chokes shall be dry and air cooled (AN) type. The rating of the rectifier-transformers and chokes shall correspond to the rating of the associated rectified assembly. The rectifier-transformers and chokes shall Class-B insulation with temperature rise limited to Class-A insulation value.

9.13.2.8 Rectifier Assembly

The rectifier assembly shall be full wave bridge type and designed to meet the duty as required by the respective Charger. The rectifier cells shall be provided with their own heat dissipation arrangement with natural air cooling. The rectifier shall utilize diodes/thyristors and heat sinks of extruded and anodized type for power diodes and thyristors rated to carry 200% of the load current continuously and temperature of the heat sink shall not be permitted to exceed 85°C absolute duly considering the maximum charger panel inside temperature. The contractor shall submit calculations to show what maximum junction temperature will be and what the heat sink temperature will be when operating at 200% and 100% load current continuously duly considering the maximum surrounding air temperature of 50°C outside the panel. Necessary surge protection devices and rectifier type fast acting fuses shall be provided in each arm of the rectifier connections.

9.13.2.9 Instruments

D.C. voltmeter, D.C. ammeter and A.C voltmeter in 96mm square shall be provided for all chargers. The instruments shall be flush mounted type, dust proof and moisture resistant. The instruments shall have easily accessible means for zero adjustments. The instruments shall be of 1.5 accuracy less.

9.13.2.10 Air Break Switches

All chargers shall have AC input and DC output switches of air break, single throw, load break and fault make type. The contacts of the switches shall open and close with a snap action. Switches shall be rated for 120% of the maximum continuous load, 'ON' & 'OFF' position of the switch shall be clearly indicated.

9.13.2.11 Control and Selector Switches

Control and selector switches shall be of rotary stayput type with escutcheon plates showing the functions and positions. The switches shall be of sturdy construction and suitable for mounting on panel front. Switches with shrouding for live parts and sealing of contacts against dust ingress shall be preferred. The contact ratings shall be at least the following :

i)	Make and carry continuously	-	10 Amps
ii)	Breaking current at 110V DC	-	0.5 Amps(inductive)
iii)	Breaking current at 240 V AC	-	5Amp.At 0.3 p.f

9.13.2.12 Fuses

Fuses shall be of HRC cartridge fuse link type. Fuses shall be mounted on fuse carriers which are mounted on fuse. Wherever, it is not possible to mount fuses on fuse carriers, fuses shall be directly mounted on plug in type bases. In such cases one insulated fuse pulling handle shall be supplied for each charger. Kick-off fuses (trip fuses) with alarm contacts shall be provided for all D.C fuses.

9.13.2.13 Indicating Lamps

Three (3) indicating lamps shall be provided to indicate A.C supply availability. The indicating lamps shall be of panel mounting, filament type low wattage and capable of clear status

indication under the normal room illumination. The lamps shall be provided with series resistors (non-hygroscopic) preferably built, in the lamp assembly and replaceable from front. The lamp covers shall be preferably screwed type, unbreakable and moulded from heat resistant material.

9.13.2.14 Blocking Diode

Blocking diode shall be provided in the output circuit of each Charger to prevent current flow from the D.C Battery into the Charger.

9.13.2.15 Annunciation System

Visual indications through annunciation facia shall be provided in all chargers for the followings:

- i) A.C Supply failure.
- ii) Rectifier fuse failure
- iii) Surge circuit fuse failure
- iv) Filter fuse failure
- v) Load limiter operated
- vi) Charger trip
- vii) Battery in boost

9.13.2.16 Name Plates and Marking

The name plates shall be made of non-rusting metal/3 ply Lamicoid and shall have black background with white engraved letters and secured by screws. These shall be provided near top edge on the front as well as rear sides of Charger. Name plates with full and clear inscriptions shall also be provided on and inside of the panels for identification of the various equipments.

9.13.2.17 Construction

The Chargers shall be indoor, floor mounted, self supporting sheet metal enclosed cubicle type. The contractor shall supply all necessary bade frames, anchor bolts and hardware. The Charger shall be fabricated using cold rooled sheet steel not less than 2.0mm. and shall have folded type of construction. The panel frame shall be fabricated using cold rolled sheet steel of thickness not less then 2.0mm. Removable undrilled gland plates of at least 3.0mm sheet steel and lugs for all cables shall be supplied by the Contractor. The lugs for cables shall be made of electrolytic copper with tin coat. The Charger shall be tropicalised and vermin proof. Ventilation luvors shall be backed with fine brass wire mesh. All doors and covers shall be fitted with synthetic rubber gaskets. The Charges shall have hinged double leaf doors provided on front and/ or backside of adequate access to the Charger internals. All the Charger cubicle doors shall be properly earthed. The degree of protection of Charger enclosure shall be atleast IP-52 per IS: 2147.

1. All indicating instruments, control & Selector switches and indicating lamps shall be mounted on the front side of the Charger. Design of panels shall be based on the following dimensions.

a)	Overall height	-	Maximum 2350 mm
b)	Operating handles (highest and lowest positions reached by operator's hand), protective relays instruments and mechanical indicators	-	Maximum 1800mm minimum 350 mm
c)	Doors and panel handles and locks	-	Maximum 1800mm Minimum 300 mm

2. Electronic equipments shall be of modular design consisting of plug in modules in standard 19 inches metallic racks with metallic card guides. The cards should be provided with proper handles. Card to card wiring should be preferably through a mother board Unplanned Jumpering and track. Modifications are not permitted. Mechanical interlocks to prevent wrong insertion of cards should be provided. Each card shall have its junction and test points identified. Maintenance aids such as extension printed wiring boards and jumper leads shall be provided.

3. For locking Trickle/Boost selector switches in the trickle position only. This would be used for having key mechanical interlock between Trickle/Boost selector switch and isolator in D.C distribution board.

4. The Charger enclosure door locking requirements shall be met by the application of padlocks. Padlocking arrangement shall allow ready insertion of the padlock shackle but shall not permit excessive movement of the locked parts with the padlock in position.

9.13.2.18 Wiring

Each charger shall be furnished completely wired up to power cables lugs and terminals blocks ready for external connection. The power wiring shall be carried out with 1.1 KV grade PVC insulated cables conforming to IS: 1554 (Part-II). The control wiring shall be 1.1 KV grade PVC insulated stranded copper conductor, of 2.5 sq.mm conforming to IS: 694 Control wiring terminating at electronic cards shall not be less than 1.0 sq.mm Control terminals shall be suitable for two wires with 2.5 sq.mm stranded copper conductors. All terminals shall be numbered for ease of connections and identification. At least 20% spare terminals shall be provided for circuits.

1. Power and Control wiring panels shall be kept separate. Any terminals or metal work which remains alive at greater than 115V when panel door is opened shall be fully protected by shrouding.
2. An air clearance of at least ten (10) mm shall be maintained throughout all circuit, except low voltage electronic circuits, right up to the terminal lugs. Whenever this clearance is not available, the live parts shall be insulated or shrouded.

9.13.2.19 Painting

All sheet steel work shall be pretreated in tanks, in accordance with IS:6005. Degreasing shall be done by alkaline cleaning. Rust and scale shall be removed by pickling with acid. After pickling the parts shall be washed in running water. Then these shall be rinsed in slightly alkaline hot water and dried. The phosphate coating shall be 'Class-C' as specified in IS: 6005. Welding shall not be done after phosphating. The phosphate surfaces shall be rinsed and passivated prior to application of staved lead oxide primer coating after primer application, two coats of finishing synthetic enamel paint of shade-622(smoke grey) of IS: 5 shall be applied, unless required otherwise by the Owner. The inside of the Charges shall be glossy white. Each coat of finishing synthetic enamel paint shall be properly stoved. The paint thickness shall not be less than fifty (50) microns. Finished parts shall be coated by the peelable compound by spraying method to protect the finished surfaces from scratches, grease and dirt during testing, transportation handling and erection. All hardware shall be nickel chromium plated.

9.13.2.20 TESTS

The routine tests shall be carried out on Battery Chargers as per relevant latest Indian Standards. The type test report of the tests conducted on identical Battery charger within last five years from the date of Letter of Award shall be furnished. However, if the type test are not conducted in last five years, the type tests need to be performed without any extra cost to Owner.

9.13.2.20.1 Type Tests

Following type test shall be carried out on each rating and type of Battery Charger.

- a) Complete physical examination
- b)
 - i) Temperature rise at full load.
 - ii) Temperature rise of rectifier assembly at 200% of full load.
- c) Insulation resistance test.
- d) High Voltage (power frequency) test on power and control circuits except low voltage electronic circuits.
- e) Ripple content test at
 - i) No load
 - ii) Half load
 - iii) Full load
- a) Automatic voltage regulator operation test at specified A.C. supply variations at.
 - i) No load
 - ii) Half load

- iii) Full load
 - a) Load limiter operation test
 - b) Efficiency and power factor measurement
 - c) Input and output surge withstand capability test Surge Voltage as per ANSIC37.90 a shall be applied not less than 2 sec. at the following points of the Charger operating at 50° at full load.
- i) Across each A.C input phase
- ii) Across A.C input line to ground
- iii) Across D.C output terminals.
- iv) Across each D.C output terminal to ground

The charger shall not exhibit any component damage and there shall be no change in performance as per cluse 4.02.00 (f) and (g).

9.13.2.20.2 3.7.01 Environmental Test

Steady state performance tests {Clause 4.02.00(f) and (g)} shall be carried out before and after each of the following tests.

- i) Sock Test

The electronic modules shall be subjected to continuous operation for minimum period of 72 hours. During last 48 hours, the ambient temperature shall be maintained at 50° C. The 48 hours test period shall be divided into four equal 12 hour segments. The input voltage during each 12 hours shall be nominal voltage for 11 hours followed by 110% of nominal voltage for 30 minutes followed by 90% of nominal voltage of 30 minutes.

- ii) Degree of protection test

9.13.2.20.3 Routine Tests

3.8.01 Following routine test shall be carried out in all Rectifier-transformers.

- a) Temperature rise test
- b) Insulation resistance test.
- c) High voltage (power frequency)test.

3.8.02 Following routine tests shall be carried out on all Battery Chargers.

- a) Complete physical examination.

- b) Temperature rise test at full load.
- c) Insulation resistance test
- d) High, voltage (power frequency) test.
- e) Ripple content test at
 - i) No load
 - ii) Half load
 - iii) Full load
- f) Automatic voltage regulator operation test at specified A.C supply variations at
 - i) No load
 - ii) Half load
 - iii) Full load
- g) Load limiter operation test
- h) Checking of proper operation of annunciation system
- i) Dynamic response test'

Overshoot/Undershoot in output voltage of the Chargers as a result of sudden change in load from 100% to 20% to 100% shall be measured.
- j) Burn in Test-shall be carried out on at electrical modules as panels with module as routine test. During the test panel/module shall be subjected to ambient temperature to 50°C for 48 hours in energized condition, the temperature rise inside the cubicle shall not exceed 10° C during the test.
- k) Degree of protection test-the charger shall be checked for gasketing arrangement as per drawing.

9.13.2.20.4 Following routine tests shall be carried out on Annunciation system:

- a) Annunciation Assembly & modules shall be functionally test as per EEUA-45D.
- b) Burn in test shall be carried out as per Cl.4.03.00
- c) The Contractor shall furnish for inspection, the type and routine tests certificates for the following components whenever required by the Owner's approval.

a)	Relays
b)	Instrument
c)	SCR
d)	Diodes
e)	Chokes and transformer
f)	Annunciator

9.13.2.21 COMMISSIONING

The Contractor shall carryout the following commissioning tests and checks after erection of the equipment at site.

a)	Complete physical examination
b)	Checking of proper operation of annunciation system
c)	Temperature rise test at full load.
d)	Insulation resistance test
e)	Automatic voltage regulator operation
f)	Load limiter operation
g)	Dynamic response test Overshoot/ undershoot in output voltage of the Chargers as a result of suddent change in load from 100% to 20% and 100% shall be measured with the Batteries connected/disconnected. Output voltage of the Charger connected with Battery shall be within 94% to 106% of the voltage setting in above conditions and shall return to and remain, within the limits specified in clause 3.01.00(e) in less than 2 seconds.

1. If Charger fails to meet the specified requirements, the Contractor shall replace the same with appropriate charger without affecting the commissioning schedule, and without any extra cost the Owner.
2. Above test and checks shall be carried out in the presence of the Engineer, it desired by the Engineer, for which the Contractor shall give atleast 20 days advance notice.

3. Guaranteed Technical specification/Data

The contractor may furnish all data related to guaranteed technical specifications and relevant data as per details mentioned in Appendix EM1 data sheet E-5.

9.13.2.22 TECHNICAL PARAMENTS

a)	D.C output ratings		
	i)	System	110V
	ii)	Trickle Charging Mode	
		- Voltage range	90V-130V
		- Rated current	15A
	iii)	Boost Charging Mode	
		- Voltage range	115-150V
		- Rated current	15A
b)	A.C input		
	i)	Voltage	415,±10%(3 phase 4)
	ii)	Frequency	50 Hz +3% to (-)5%

9.14 TECHNICAL SPECIFICATIONS FOR INSTALLATION, TESTING AND COMMISSIONING OF ELECTRO-MECHANICAL EQUIPMENTS AND SYSTEMS

9.14.1 SCOPE

This specification covers complete mechanical, hydraulic and electrical installation including labour, materials, tools, instruments, services, storage during erection, unpacking, grouting, cabling etc. and also testing, commissioning and putting into commercial operation of all pumping units driven by electric motors along with all the electrical and mechanical equipment and systems.

9.14.2 EXTENT AND ITEMS OF WORKS

1. Places of Erection

The installation works, covered by the present specification is distributed principally in the pumping station and shall include the all the equipment and Cubicles covered in this specification.

2. The installation work also includes laying of power and control cables for inter-connecting power and control circuits.

3. Items of works

The contractor shall provide skilled, semi-skilled and unskilled labour, all necessary services, construction tools, derricks, cables and slings, rigging skids, blocking, scaffoldings, welding machines, equipments for heating, stress relieving equipment, instruments, appliances, materials and supplies required for handling, storage during erection, erection and testing etc., that may be required to accomplish the work under this contract, unless otherwise provided for. Adequacy of such equipments will be subject to final approval by the Engineer.

- 2.4 The materials to be furnished by the contractor shall include but not be limited to the following:
- a) All consumable material and devices
 - b) All joining materials like gaskets, round rubber, gland-packing etc.
 - c) Cable identification tags, wire identification ferrules, HT & L T insulating tapes, Bitumen tapes, solder etc.
4. The work to be performed by the contractor shall include but not be limited to the following services as required for the complete installation and placing the equipment in commercial operation:
- a) Indenting of equipment and materials (the equipment shall be received by the contractor from his stores and transported into the erection bay).
 - b) Providing adequate, mechanical and weather proof protection for the equipment and materials (see also clause 7).
 - c) Providing temporary power and lighting facilities inclusive of all materials, required for the installation work (see also clause 6)
 - d) Handling and assembling equipment and materials (as given in clause 3) including erection, leveling aligning, grouting, fixing, cabling, wiring, piping, welding, purifying and filling oil and lubricants, connecting, start up and initial
 - e) Checking of all systems and components of equipments, pre-commissioning and commissioning test, bringing into initial operation and commissioning.
 - f) According for all material/ equipment and returning all the unused items to the Engineer.
 - g) Painting of all non-galvanized steel parts and painting for phase, circuit, voltage and equipment identification of different circuits, switches, piping etc.
 - h) All incidental and auxiliary works as may be necessary for the satisfactory and successful completion of the work in accordance with the specification, standards and manufacture's / consultants instructions.
5. All the works shall be carried out to the satisfaction of the Engineer. The contractor shall be responsible for the correctness, alignment and positioning of the work according to the drawings and manufacture's /supplier's instruction, base lines and bench marks.
6. The contractor shall be completely responsible for all the works covered under the scope of this specification notwithstanding that they may have assisted by the Engineer in doing so.

9.14.3 LIST OF MAJOR EQUIPMENTS TO BE ERECTED.

The list of major equipment which are required to be installed within the scope of this specification is given below. The list does not cover all the equipments and materials required to be installed and required for the proper functioning of the generating station. The list should not be considered as defining the equipment or limiting the extent work.

- i) Vertical Turbine pumps
- ii) Fire fighting equipment for each pump house.
- iii) Cooling water equipment for each pump house.
- iv) One number E.O.T crane, as specified for each pump house.
- v) Control and protecting equipment for each pump house.
- vi) Two numbers, 3 phase transformers (with appropriate voltage grade 33/6.6 KV, 6.6/.415 KV, 33/.415 KV and proper capacity) in each new pump house to meet the prime drive load and other auxiliary LT load.
- vii) 6.6 KV switchgear etc, including associated civil works.
- viii) 415 Volts , LTAC Switchgear for each pump house.
- ix) A Set of battery, set of charging equipment and one D.C distribution board for each new pump house.
- x) Automation system (PLC networking) for individual Mega- Lift scheme.
- xi) Illumination board and fitting and wiring of various luminaries and fixtures for each pump house.
- xii) Laying of ground mat in the each pump house.
- xiii) Installation of internal communication system.
- xiv) Air cabling and wiring connecting different equipment installed in the each pump house. Erection of all embedment required for laying of cable racks, ventilation and air conditioning ducts, various piping etc
- xv) All pipes and fitting.

9.14.4 STANDARDS

The procedure followed and precautions taken and the equipments/ materials used in the installation work shall conform to the relevant Indian or Internal Standards and also to the following wherever applicable.

1. Indian Electricity Rules, 1956
2. Indian Boiler Regulations and all other applicable statutory rules and regulations.
3. Indian Factories Act
4. Indian Explosives Act
5. National Electrical Code-Standards of the National Board of Fire Underwrites (USA)

9.14.5 DRAWING

1. A list of drawings enclosed with specifications are given in a separate volume. These are only specification drawings and are not to be used for construction. These are enclosed to facilitate understanding of the project scheme, general pump house layout and the

equipments involved, etc, and for estimating the nature and extent work involved. The list of drawings and equipment / materials shown are liable to be revised for additions, corrections and to include additional drawings.

2. Construction drawings shall prepared by the contractor on the basis of manufacture's /suppliers drawings The contractor shall carry out the installation work according to such drawings and instruction books issued for construction by various manufactures.
3. The drawings, diagrams and manufacturer's instruction shall be read together. Disagreements and inconsistencies, if any, shall be brought to the notice of the Engineer whose decision shall be final.
4. During the progress of the work, the contractor shall maintain and mark a complete set of the latest design, drawings issued for construction, in which all deviations from the drawings in the actual execution shall be clearly marked as " as built" conditions,. Upon completion of all works, the contractor shall furnish the Engineer with a set of "as built " drawings.

9.14.6 TEMPORARY POWER & LIGHTING

1. All temporary lighting and power facilities required for the installation work shall be furnished and installed by the contractor. These temporary installations shall include cables, outlets and conduits supports, insulators fuses, switches and other required materials.
2. The contractor will have to take construction power from area DISCOM
3. Engineer cannot guarantee uninterrupted supply of electric power and no claim for compensation for any failure or short supply shall be entertained by the Engineer nor shall any extension of time be entertained on this account.
4. The materials used for temporary facilities shall not be reused in any permanent installation. The contractor shall remove all temporary facilities from the plant premises, after the same have served the purpose.

9.14.7 STORAGE AND PROTECTION OF THE WORKS

1. The contractor shall used care and diligence to ensure that all works, equipments, material furnished, handled, stored and/or installed by him are at all times thoroughly protected from the weather and from any damage. Necessary labour, tarpaulins, boards, boxes, frames, canvas, polythene sheets and other materials and any temporary light, heat or cooling facilities, fire protection or protection from insects required to keep the materials/equipment in first class condition shall be furnished and installed by the contractor.
2. The contractor will be responsible for the receipt, storage and protection of material and/or equipment as received at site on behalf of the employer for installation by the contractor. The equipment shall be suitably insured during transit, storage, erection, testing and commissioning so that all risks of the employer are fully covered.
3. The contractor shall provide watch and ward storekeepers, etc. to safeguard the materials, tools, construction aids and equipment while in the contractor's care, custody or

control during the performance of work and till its taking over by the employer.

9.14.8 EQUIPMENT INSTALLATION AND COMMISSIONING

1. The contractor shall check, clean all dirt and rust, install, connect, test and place in commercial operation all plan/ machinery, equipments included in this specification, in accordance with the detailed Instructions/drawings of the manufactures/suppliers or as directed by the Engineer. All works shall be performed by qualified, trained and experienced personnel, licensed where required *in* the various trades.
2. Extreme care shall be taken in handling equipment in position and moving it into place. Any damage to the equipment or T&P belonging to the contractor or employer shall be reported to the Engineer. Installation of the damaged equipment shall not proceed until the Engineer has had an opportunity to assess the extent of damage and decide on the procedure to be adopted. The contractor shall repair or replace at his expense, any equipment damaged by him during the progress of work. Such repairs or replacements shall be subject to the Engineer's approval.
3. All equipments shall be installed and secured in place in a workman like manner so that it is level and true, properly aligned and oriented. Tolerances shall be as per manufacturer's drawings/instructions or. as specified by the. Engineer No equipment shall be permanently bolted down to foundation or structure until the alignment has been checked and found acceptable by Engineer.
4. Contractor shall make his own arrangement for hoisting and handling the equipment. The contractor may suitably plan the sequence of erection of equipment so that the crane is Installed and commissioned by him prior to erection of the pumping unit.
5. The erection and installation of the equipment shall be subject to the supervision of the Engineer or his representative. The contractor shall also arrange for the service of the erection supervisor of the manufacture at his own expense wherever it is felt essential. The contractor shall comply with the instructions of the Engineer/erection supervisor regarding the procedure, method and quality of work and shall execute the work to their satisfaction. The detailed action schedule, including the number, specialization and duration of stage of all supervisory erection and commissioning personnel of various supplier shall be finalized by the contractor and shall be subject to the approval of the employer.
6. It shall be the responsibility of the contractor to provide and depute the required number of first class welders, welding rods, welding sets for all types of welding work. at his cost. All welders shall be certified welders who shall be got tested and approval by the Engineer at site. All arrangements in regard to the tests for approval of the welders, at site, will have to be made by the contractors, at his cost. Details of welding tests and acceptance standards shall be laid out by the Engineer in consultation with the erection supervisors of the manufacturer and will be binding on the contractor.
7. The contractor shall provide concrete foundations, furnishing and placing of reinforcement and concreting as and when necessary. The contractor shall also be responsible for setting the anchor bolts and foundation bolts correctly and in position. The contractor shall also carry out grouting to the satisfaction of the employer.

8. A service bay is provided in the each pump house for facilitating unloading and assembly of equipment.

9.14.9 EQUIPMENT SPECIFICATIONS AND INFORMATION

1. The technical specifications of various equipment and systems to be erected are given in various sections. The drawings as listed in a separate volume indicating the general arrangement and layout of different items at various levels in the each pump house are enclosed. The weights and dimensions of various items of heavy equipment may be indicated in the offer by the contractor.
 - a. The contractor shall familiarize himself with the constructional features of all Electrical & Mechanical plant & equipments as applicable for scheme. The erection schedule shall need to be adhered to and the contractor shall quote accordingly. Any deviation from this shall be clearly brought and in the tender along with reasons for such deviations. The employer reserves the right to reject, any bid deviating from the schedule as envisaged without assigning any reason.
2. The contractor shall review the location of equipment/various panels and give his recommendations regarding their location which could be more suitable from the point of view of erection, operation and maintenance.
3. Cables, Racks, Trays & Accessories
 - a. The power and control cables for the aforementioned equipment to be erected shall be on cable racks, in build up trenches on cable trays and supports in conduits and ducts or bars on walls, ceiling etc. which shall be got approved from the engineer.
 - b. The contractor's scope of work include laying, fixing, joining, bending and terminating of power/control cables pertaining to the pumping units and its auxiliary equipment such as unit control and automation boards, motor terminals etc. All the control and power equipment as well as auxiliary transformer and H.T. switch gear to be erected in the switchyard. Permanent cable trenches for laying cables underground, the excavation and back fitting of trenches and permanent reinstatement are included in the scope of work of this contract.
 - c. Standard cable grips and reels shall be used for cable pulling and care shall be taken to avoid damage to cable end seal and cable insulation or stressing cable beyond manufacturer's recommendations in pulling.
 - d. All the cable termination shall be made according to the relevant drawings in a neat workman like and approved manner. Cables shall be provided with non-corrosive type identification tags at the ends and at suitable intervals in long runs. At the control cable terminations, each core shall also be provided with ferrules designating the wire number or any other identifications mark as given in the schedule. The cable cores or any. Other identification mark as given in the schedule. The cable cores or wires which are not used for making connections shall be sharply cut without exposing any conductor. All identification tags, wire ferrules etc. required shall be provided by the contractor. Metal sheath of the cable shall be

bounded to the earth system of station.

- e. All power cables shall be megger tested before connecting or jointing. After jointing all LV cables shall be megger tested and HV cables appropriately pressure tested before commissioning. All the cable cores shall be tested for continuity, insulation resistance to earth and between conductor. The contractor shall furnish all testing kit and instruments required for field testing including high voltage testing kit.

9.14.10 GROUNDING OF EQUIPMENT

All electrical equipments required to be grounded shall be connected to the grounding bus as per relevant drawings/instructions of Engineer.

9.14.11 INSPECTION AND TESTS

1. Upon completion of the various phases of the work, or at convenient times during the progress of the work, equipment and wiring installed by the contractor shall be checked, tested and got inspected. Any defects pointed out by the Engineer/Government Inspector shall be corrected by the contractor at no additional cost.
2. All checking and testing procedures shall be performed by competent and experienced personnel employed by the contractor in the presence of all as directed by the Engineer.
3. All equipments and instruments required to conduct the tests shall be provided by the contractor.
4. The contractor shall provide all labour, materials, tools and instruments and supervision and shall be responsible for conducting pre-commissioning tests on all equipments as per relevant standards. In cases, where the services of the commissioning engineer of the manufacturer/supplier of the equipment is availed, the tests shall be performed under the overall supervision of the said commissioning engineer.
5. The checks and tests to be made shall include but not be limited to the following:-
 - i) All routine and pre-commissioning tests and any other special test required to be conducted at site on other motors, pumps, associated equipment as specified and as agreed to between the contractor and the engineer as per recommendations of supplier of various equipments.
 - ii) All routine and pre-commissioning tests and any other special tests required to be conducted at site on each and every equipment as per the relevant standards and manufacturer's instructions and recommendations.
 - iii) Visual checks for correctness of all wire and cable connections, including internal wiring of control panels, switch gear, transformers and all other equipment.
 - iv) Visual checks for correctness of all pipings and checks for any leakages of air water oil etc. as the case may be. Continuity checks for all control and power cables including each conductor of multiconductor cables.

- vi) Insulation resistance tests of, *all* power and control cables, motors, panels, switchgear gear, instrument transformers etc.
 - vii) Polarity checks of all instrument transformers.
 - viii) Lead resistance measurements of current transformer circuits.
 - xi) The primary and secondary injection tests for CTs and relays.
 - xi) Checks for adjustment and characteristic of all control and protective relays in accordance with manufacturer's instructions.
- Setting and calibration of relays
- xii) Check all equipment for proper mechanical adjustment and freedom of operation.
 - xiii) Check electrical operation of all remotely operated equipment.
 - xiv) Energize all control, protection, alarm and supervision circuits and check each circuit for correct functional operation including all interlock devices.
 - xv) Check all meters for proper rotation and correct measurement under load conditions. Checks to detect excessive vibration of equipment and foundations, misalignment etc.
 - xvii) All other tests as specified under various sections. Different relevant standards and codes of practice but not mentioned here.

During the course of all tests, contractor shall keep a complete record of all tests done and measurements taken and also record all adjustments, alternations and repairs made to the equipment. After completion of the tests, contractor shall furnish three copies of all such records complete to the engineer duly signed.

9.14.12 INITIAL OPERATION, COMMISSIONING AND COMMERCIAL OPERATION

1. Before putting the units in operation, all equipment shall be thoroughly cleaned and then inspected in the presence of the Engineer-in-charge for correctness and completeness of installation . and acceptability for operation
2. The procedure to be followed for completion tests, trial run and period of initial operation shall be as per standard and as agreed to between the contractor and engineer prior to the tests being carried out. Sufficient notice 'should be given by the contractor about readiness for performing the trial run and initial operation.
3. When the contractor and engineer as satisfied that the equipment is operating properly, tests report sheets, in the form as approved by the engineer shall be compiled for each piece of equipment. Five copies of each report shall be submitted to the Engineer.
4. Immediately .after the trial run, an overall inspection of the station shall be made to detect any signs of mal-functioning of any part of the equipment or of any auxiliary system.
5. Approval in writing will be given by the employer/engineer after he is entirely satisfied regarding the correct and proper functioning of all equipments auxiliaries, services etc. for putting the pumping units into initial operation.

9.14.13 TRAINING OF ENGINEER'S STAFF

The contractor shall provide the necessary facilities for training the project staff for the erection, testing and commissioning of the equipment including in these specifications. The training shall commence immediately after the award of the contract and shall continue till all the plant and equipment is erected, tested and commissioned. These trainees will be deputed to operate and maintain the machinery subsequently.

9.14.14 ERECTION AND COMMISSIONING SCHEDULE

The contractor shall furnish along with the tender a detailed erection and commissioning target given in these specification.

9.14.15 SCHEDULE OF CONSTRUCTION EQUIPMENT AND EXPERIENCE

The tender shall indicate the list of construction equipment which will be brought by him to the site for carrying out various constructions and testing activities

9.15 Miscellaneous**9.15.1 Cable glands and lugs**

All cable glands shall be made out of brass and shall be of double compression type.

All cable lugs shall be of tinned copper, crimping type.

9.15.2 Cable trays

Cable carrier system shall comprise of site fabricated ladder type cable trays made out of structural steel and painted with two coats of red oxide primer and a final coat of enamel paint. The construction of the cable trays shall be as per the site requirement. An alternate cable carrier system may be considered made of Hot Dip Galvanised Iron.

9.15.3 Local Push-button (PB) Stations

Construction	Outdoor type weatherproof
Main pump motor	On-off with de-interlock switch and ammeter
Other motors	On-off
Valve motors	Forward-reverse-stop

9.15.4 Lighting Panel

The panels shall be of 14 gauge sheet metal construction. Panels shall be equipped with phase and neutral busbars of adequate capacity and miniature circuit breakers. The incomer shall be of ELMCB and outgoing circuits shall have only MCBs. Miniature circuit breakers shall be mounted in such a way that operating levers project outside the front bakelite cover plates. A hinged door to cover the operating knobs shall be provided. Synthetic rubber gasketing shall be provided between box and cover. The board shall be provided with detachable top and bottom plates with 25 mm knockouts. All metal surfaces shall be cleaned free of rust, given a coat of red oxide primer and finished with two coats of synthetic enamel paint of shade 631 as per IS 5. A 415V danger board and engraved nameplate shall be fixed on the panel. The lighting panels shall be marked with the voltage and No. of phases of the supply.

9.15.5 Street Light Pole

Coat of bituminous preservatives to be applied before concreting to the embedded portion of the pole. Two coats of red oxide primer shall be applied followed by two coats of aluminium paints to the portion above ground of pole and mounting bracket, sleeves etc.

10 m long swage steel tubular pole conforming to IS 2713 with 1.8 m buried in ground with weather proof junction box fixed at 1500 mm above the ground containing one 6A, DP 10kA 'B' series MCB and a connector strip to loop in loop out cable, with wiring by 3 runs of 6 mm² PVC insulated cables from the weather proof box to the top of the pole up to the luminaires.

9.15.6 Rubber mat

1 M wide 11 kV grade and 1.1 kV grade rubber mat shall be provided in front of the 6.6 kV and 415 V panels. This mat shall cover the full length of the panel.

9.15.7 Fire Extinguisher

Min. 7.5 kg carbon di oxide extinguishers shall be provided in electrical panel rooms. These cylinders shall be located on wall at easily accessible locations.

Fire bucket stand with 4 numbers round bottom fire bucket shall be provided out side the transformer room.

9.16 Data Sheets to be filled by Contractor – Electrical**9.16.1 Technical Particulars**

The contractor shall complete the various tables given under this schedule to give the technical particulars of the equipment proposed by him.

If any additional particulars are necessary or the particulars are given in some other form the same may be enclosed separately.

The contractor shall give all the particulars. The tender, may be considered as non-responsive, if important particulars are not submitted.

9.16.2 HT Switchgear

1	General Particulars a) Name of Panel manufacturer b) Construction compartmentalised or non-compartmentalised c) Sheet metal thickness d) Degree of protection	
2	Dimensions of the Board Length (mm) x Width (mm) x Depth (mm)	
3	i) Material of busbars ii) Busbar size Phase Neutral iii) Ground Bus (Material & size)	
4	Vacuum Circuit Breaker a) Make b) Type	
5	Protection relays a) Make b) Type	
6	Control Wiring a) Size b) Type c) Insulation d) Voltage grade	
7	Control Terminals a) Make b) Type c) Voltage Grade	

	d) Current rating e) Minimum 10 % spare terminal furnished	
8	Push Buttons a) Make b) Type c) No. & Rating of Contacts	
9	Indicating Lamps a) Make b) Type c) Rating	
10	Integrating Meters a) Make b) Type c) Accuracy Class d) VA Burden	
11	Current Transformers a) Make b) Type c) Core Details (Current ratio, VA Burden, Accuracy, RCT and VK) Core 1: Core 2: Core 3:	
12	Potential Transformers a) Make b) Type c) Core Details (Voltage ratio, VA Burden, and Accuracy) Core 1: Core 2:	
13	Terminal Blocks a) Make b) Type c) Current rating d) Voltage Grade e) Suitable for 2 Nos. Cu 2.5.mm ² wire	
14	H.T. Capacitors a) Make b) Type	

	c) kVAR Rating/Unit x No. of Units	

9.16.3 Soft Starter

1	General Particulars a) Name of Panel manufacturer b) Sheet metal thickness c) Degree of protection	
2	Dimensions of the Board Length (mm) x Width (mm) x Depth (mm)	
3	i) Material of busbars ii) Busbar size Phase Neutral iii) Ground Bus (Material & size)	
4	Bypass contactor / breaker a) Make b) Type c) rating	
5	Protection relays a) Make b) Type	
6	Control Wiring a) Size b) Type c) Insulation d) Voltage grade	
7	Control Terminals a) Make b) Type c) Voltage Grade d) Current rating e) Minimum 10 % spare terminal furnished	
8	Push Buttons a) Make b) Type c) No. & Rating of Contacts	
9	Indicating Lamps a) Make	

	b) Type c) Rating	
10	Integrating Meters a) Make b) Type c) Accuracy Class d) VA Burden	
11	Current Transformers a) Make b) Type c) Core Details (Current ratio, VA Burden, Accuracy, RCT and VK) Core 1: Core 2: Core 3:	
12	Potential Transformers a) Make b) Type c) Core Details (Voltage ratio, VA Burden, and Accuracy) Core 1: Core 2:	
13	Terminal Blocks a) Make b) Type c) Current rating d) Voltage Grade e) Suitable for 2 Nos. Cu 2.5.mm ² wire	

9.16.4 L.T. Switchgear

1	General Particulars Name of Manufacturer Sheet metal thickness	
2	Air Circuit Breaker a) Make b) Type	
3	Moulded case Circuit Breaker	

	a) Make b) Type	
4	Selector Switch a) Make b) Type	
5	Push Buttons a) Make b) Type	
6	Indicating Lamps a) Make b) Type	
7	Integrating Meters a) Make b) Type	
8	Current Transformers a) Make b) Type	
9	L.T. Capacitors a) Make b) Type	

9.16.5 Battery

1	Battery Capacity at 27° C at 10 hour rate Initial Rated End of life	
2	Type of positive plates	

3	No. of positive plates/cell	
4	No. of cells required to give rated D.C. voltage No. of spare cells	
5	Expected life of battery	

9.16.6 Battery Charger cum DCDB

1	Manufacturer's Name	
2	Type - Float Charger/Boost Charger/Float cum boost charger	
3	Rating i) Input voltage ii) Output voltage iii) Rated output	

9.16.7 L.T. Cables

Name of Manufacturer	
1. LT Power cable	
2. Control / Lighting cable	

9.16.8 H.T. Cables

1.	Name of Manufacturer	
2.	Type	
3.	No. of cores	
4.	Size	

9.16.9 Miscellaneous

1	Cable glands make and type	
2	Cable Lugs make and type	
3	Type of wires lighting Make Voltage grade	
4	Outdoor Cabling:- Cable route marker RCC block type prov. Cable protection covers RCC tiles prov.	Yes/No Yes/No

5	Lighting Fixture – Makes	
6	ACSR conductor size	
7	Clamp for ACSR conductor –	
	a) make	
	b) type	

9.17 LIST OF ELECTRICAL DRAWINGS

9.17.1 HT Capacitors

Drawing and documents required

- GA drawing of the capacitor unit, bank
- Instruction manual for installation, operation and maintenance for capacitor

9.17.2 6.6 kV Indoor Switchgear

Drawing and documents required

- GA drawing of 33 kV panel with foundation details
- Single line diagram for HV panels
- Schematic diagrams for various modules
- Instruction manual for installation, operation and maintenance of various components of switchgear

9.17.3 Metal Enclosed LT Switchgear

Drawing and documents required

- GA drawing of each panel with foundation details
- Single line diagram for each panels
- Schematic diagrams for various modules
- GA drawing of the bus duct including supporting structure If required
- Instruction manuals - installation, operation and maintenance of switchgear

9.17.4 Battery and Charger cum DCDB

Drawing and documents required

- GA drawing of the battery and the charger cubicle
- Schematic diagram for battery and charger cum DCDB
- Instruction manual for installation, operation and maintenance for battery and charger

9.17.5 Motors

Drawing and documents required

- GA drawing of the each motor showing dimensional details and terminal box details
- Motor selection details

- Motor Characteristics
- Instruction manual for installation, operation and maintenance for motors

9.17.6 LT Capacitors

Drawing and documents required

- GA drawing of the capacitor unit, bank
- Instruction manual for installation, operation and maintenance for capacitor

SECTION V - C
MECHANICAL WORKS

SECTION – V
MECHANICAL WORKS

C O N T E N T

Sl. No.	Name	Page No.
1	13.0 CRANE & HOISTS	2
2	14.0 VENTILATION & AIR CONDITIONING SYSTEM	7

VOLUME –II**Section-V****TECHNICAL SPECIFICATION FOR MECHANICAL WORKS****INTRODUCTION****13.0 CRANES AND HOISTS**

Each pump house will be provided EOT cranes as per specification. The capacity and other designs will be carried out by EPC contractor.

14.0 VENTILATION AND AIR CONDITIONING SYSTEM

General guidelines are specified in this section. The air conditioning may be required for control rooms. The ventilation is required for pump house and electrical room, if AC is not provided

13.0 CRANES AND HOISTS**13.1 SCOPE**

Specification covers the design, manufacture, shop assembly, shop testing, dispatch, erection, testing at site and commissioning of 1 no. Electrically operated overhead Traveling crane (EOT) for the pumping stations.

13.2 EOT CRANE FOR PUMP HOUSE

The crane shall be provided with a main hoist of capacity capable of safely handling the motor rotor with shaft or any other heaviest assembly of the pump house. The capacity shall not be less than 25% above the weight of the heaviest item envisaged to be lifted during erection and maintenance. The crane shall be with an auxiliary hoist of suitable capacity and shall be complete with motors for all motions of the crane and the hoists, control gears, power and control cables, runway rails, runway conductors with mounting brackets, collectors, insulators etc. The wire rope should be galvanized and construction to be IWRC type.

The pump house crane shall be pendent operated. The power shall be supplied from a single electrical power supply point at a suitable location on the operation floor of pump house.

13.3 STANDARDS

All equipments under this specification shall comply fully except as otherwise specified in this specification with the requirements of latest edition of relevant Indian Standard specifications and in their absence with British Standard Specification or with any other internationally accepted standards

The relevant Indian Standards are as follows \

IS: 807 -	Code of Practice for design, manufacture, erection and testing (Structural portion) of crane and hoists.
IS: 3177 -	Code of Practice for electric over head traveling cranes and gantry cranes other than steel works cranes.
IS: 800 -	Code of Practice for General Construction in steel.
IS: 2266 -	Steel wire rope for general engineering purposes.
IS: 5749 -	Forged Ram shorn hooks.
IS: 3815 -	Points h00ks with shank for general engineering purpose.
IS: 2062 -	Weld able structural steel.
IS: 325 -	Three phase induction motors.

13.4 TECHNICAL REQUIREMENTS

The crane shall be electrically driven single trolley, double girder/over head traveling type.

Power will be supplied from the conductors (bus bars) mounted at. convenient height along the length of the pump house.

The crane span, lift of main and auxiliary hooks shall be provided to suit the requirements. Other requirements are indicated below:

- i) Crane rail - CR- 60 along with embedment
- ii) Safety Factors of - As per Clause 7.4 IS 3177 Mechanical components
- iii) Factor of safety of sling - 6

- iv) Brakes for hoisting - Elector-magnetic and Thruster
 - v) Brake for other motion - Elector-magnetic
 - vi) Class of mechanism - M 5
 - vii) Nearest position of main hook - ≤ 800 mm
to centre line of gantry rail upstream side
 - viii) Nearest position of main hook - ≤ 1600 mm
to centre line of gantry rail down stream side
- The manufacturer may improve upon the hook limits specified to suit requirements. Minimum clearance to (400 mm) shall be made available between the extreme points of crane and side wall and 500 mm between the top of the crane and the overhead observation.

13.5 INCHING OPERATION

Inching operation for all motions shall be provided for achieving slow operation of the crane for the purpose of erection, lowering, centering, alignment etc. This shall be 10% of normal speed.

- 13.5.1 The crane shall be complete with trolley and truck, wheel & axles. Drive mechanisms, Hoisting Drums, Brakes, Creep Speed Arrangement, Lifting tackles, Buffers' Electric Motors, Controls, Switch Board and cabling, horns, warning lights, limit switches etc. Any item not mentioned herein but required to make the system complete for the satisfactory performance of the crane shall also be included.
- 13.5.2 Mechanical and Electrical equipment of each crane shall be of simple robust design, easy for correction adjustment, readily accessible for maintenance and elegant in appearance. All steel used in the crane shall be tested to requirements.
- 13.5.3 The lifting tackle shall consist of a safety type lower pulley block, hook, necessary sheave and flexible steel wire ropes. The lower sheaves and ropes shall be of adequate design and size to handle the specified loads. The hooks shall be of forged steel. The main hook shall be of Ram shorn type conforming to IS: 5749 (latest edition) and the auxiliary hook shall be of shank type conforming to IS: 3815 (latest edition). The factor of safety for the rope shall not be less than six (6). The sheaves shall be of heavy duty with deep flanges made of cast steel and shall be properly grooved to fit the rope and adequately guarded.
- 13.5.4 Each crane shall be equipped with motors of ample capacity for the duties and speeds specified conforming to IS: 325-1970. The motor shall also meet the requirements as specified in IS: 3177 (latest edition) rated capacity of each motor shall be such that its full load torque shall not be exceeded in giving the specified performance of the crane. The rating of the main hoist motor (slip ring induction) shall be one hour and ratings of all other motors shall be half an hour. All motors shall be suitable for operations at 415V, 50 cycles, 3 phase, 3 wire system.
Each crane shall have a permanent inscription in English on each side, readily visible from the ground level, stating the safe working loads in tones for both the hooks, year of manufacture, crane serial number and manufacturer's name.
Power conductor system (Down Shop Lead); Contractor shall provide a proven insulated (PVC Covered) mobile conduction and current collector system complete with all installation, accessories and special tool and tackles.

13.6 TESTS**Shop Tests**

- 13.6.1 Shop tests shall include all tests to be carried out at supplier's work, works of his sub-supplier and at works where raw materials supplied for manufacture of equipment is produced. The supplier shall carry out a comprehensive inspection and testing programme during manufacturer at the works. All the test certificates and reports shall be submitted to Owner for approval Owner's representative shall be given full accesses to all tests. The manufacturer shall inform the Owner of the testing well in advance so that it so desired Owner's representative can witness the test.
- 13.6.2 All electrical and mechanical equipment shall be tested in accordance with the appropriate Indian Standards or British Standards and such other tests as may be required by statutory regulations shall be carried out at either the crane manufacturer's or equipment manufacturer's Works. Test certificates giving the necessary test figures shall be furnished to the Purchaser. All test certificates must be endorsed with sufficient information to identify 'the material or equipment which the certificate refer, and must carry on top right hand corner the identification of the owner and the Contract. Material used for the manufacture of crane hoists shall be of tested quality and suitably identified.
- 13.6.3 The EOT crane shall be completely assembled at shop including wirings and fittings shall be tested at "No Load" on hoisting and cross travel motions
- 13.6.4 Electrical hoist, shall be assembled at shop and tested for capacity, proof load, lift, functional check as per requirement of respective code & approved specs.
- 13.6.5 All electrical equipments offered shall be of type-tested quality. Necessary type test reports shall be furnished before fabrication is started. In case the type test has not been carried out earlier on equipments, the same shall be carried out without any commercial implication to Owner/Consultant.
- 13.6.6 Control cabinet shall be subjected to the following test.
- (a) Mechanical operation test
 - (b) High voltage test (2KV for 1 minute)
 - (c) Electrical control interlock .and sequential test
 - (d) Verification of wiring as per approved schematic
- 13.6.7 Following tests shall be carried out on all solid-state equipment
- (a) Surge withstand capability test (Refer ANSI publication C39.9a - 1994 or latest)
 - (b) Bum in and elevated temperature test.
 - (c) Insulation test as applicable
- 13.6.8 Routine test and Acceptance test shall be carried out on all associated equipment as per relevant standards. Certified copies of all type and routine test certificates shall be submitted for the purchaser's approval before the dispatch of the control cabinet.
- 13.6.9 Girders (web, top and bottom, carriage, Crab, Gear box and rope drum:
- a) The plate materials shall be tested for chemical & mechanical properties.
 - b) The plates above 25mm thick shall be ultrasonically tested.

- c) Heat treatment as applicable
- 13.6.10 Forgings (Wheels, gears, pinions, shafts, axles, coupling hooks and hook trunion).
 - a) Chemical and mechanical testing. For mechanical testing one sample, per sample, per heat treatment cycle shall be taken. Integral test pieces shall be identified for testing.
 - b) Ultrasonic testing (For gears and pinion blanks before teeth cutting).
 - c) D.P. testing
 - d) Heat treatment
 - e) Hardness test
- 13.6.11 Welding
 - a) All the welding processes and welders shall be qualified as per ASME Sec. IX and only qualified welders shall be employed for all the welding works. All the welding procedure specification as per ASME Sec-IX shall be furnished to Owner to review.
 - b) For welded steel drums, all circumferential welds shall be 100% radiographed and all butt weld joints on structural members subject to "tensile stress shall also be 100% radiographed, 25% of other butt weld joints shall be radiographed at random.
- 13.6.12 Hook
 - a) Chemical, mechanical (Tensile, proof load etc.)
 - b) U.T
 - c) D.P.T. before and after proof load testing
- 13.6.13 Steel castings (pulley sheaves, brake drums etc.)
 - a) Chemical and Hardness and mechanical specification.
 - b) Ultrasonic examination.
- 13.6.14 Wire ropes

Wire ropes shall be tested as per relevant standard.

13.7 TESTS AT SITE

- (i) Insulation Tests

After erection but before the crane is connected to supply, the insulation of electrical equipment shall be tested by a suitable instrument and any defects revealed shall be rectified, as specified in relevant Indian or British Standards.
- (ii) The basic parameters like crane clearances shall be verified. The height of the lift also shall be measured.
- (iii) Tests of operation

After the supply has been connected, and before the complete crane installation is put into commercial service, tests shall be carried out as specified in IS: 3177 (latest edition).
- (iv) Deflection tests

The deflection test shall be carried with the safe working load at rest and with the trolley in a central position as specified in IS: 3177 (latest edition).

 - (i) No deviation in the specification should be anticipated by the Supplier without, the prior consent of Owner/Consultant.

13.7.1 Contractor should submit test certificates as required by statutory authorities.

13.8 Guaranteed Technical specifications! Data

The Contractor may furnish all the data related to guaranteed technical specifications and relevant data

13.9 LIST OF MANDATORY SPARES FOR CRANES AT EACH PUMPING STATION EOT

Crane for Pump House

i)	Set of all bearings	2 sets
iii)	Oil seals	2 sets for each type
iv)	Brake springs	2 sets for each type
v)	All limit switches	2 sets for each type
vi)	Timers and relays	2 sets for each type

14.0 VENTILATION & AIR CONDITIONING SYSTEM**14.1 VENTILATION SYSTEM**

Ventilation System is to be incorporated for ventilation of Pump House, Auxiliary Building and for all other Mechanical areas (where Air Conditioning is not provided) excluding Control Room and Office

15.2 Axial Flow Fans

These fans shall have cast aluminum impeller with blades of aerofoil design. The fan casing shall be of heavy gauge sheet steel construction. Necessary rain protection cowl, inlet and outlet cones; bird protection screen, dampers etc. shall be provided.

For supply fans, coarse filters and fine filters shall be provided. The fans coming in gaseous areas shall be suitably painted. All other accessories like supporting structure etc. as required shall be provided.

14.2 Centrifugal Fans

These fans shall have scroll fabricated out of heavy gauge steel sheet. The impeller shall have die formed backward curved blades and shall have non-overloading characteristics. The fan bearings shall be ball or roller of the self-aligning type. The fans shall be belt driven. Necessary accessories like fan belt protection screen, vibration isolation damper, base plate etc., shall be provided.

14.3 Roof Ventilators

Roof Ventilators shall be located in the pump house.

The impeller shall be of axial flow type, cast in one piece and casing shall be heavy gauge construction. The head shall be provided to protect from rain and other contingencies. All accessories, steel supports as required will be provided.

14.4 Motors

All the motors provided shall have output 10% higher than the equipment power required (including that of drive in any) and shall be suitable for operation 50°C ambient.

14.5 AIR CONDITIONING SYSTEM

The control room and office area in each pumping station shall be air-conditioned. Separate chiller units shall be provided for the control room & for office area.

14.6 Air Conditioning System Design conditions

- a) For design conditions, refer enclosed data sheet
- b) All Air Conditions equipment shall be provided with 100% standby equipment.
All load calculations shall have to be got approved by OWNER.
- c) Split/Packaged .Air Conditioners
Either split type or Package type Air conditioner shall be use. The split /package air conditioners shall consist of the following:
 - i) Casing
 - ii) Compressor
 - iii) Condenser
 - iv) Air Handling Fan
 - v) Cooling Coil
 - vi) Humidifier
 - vii) Filters
 - viii) Piping, valves etc
 - ix) Controls, Instruments, MCC cum control panel.

- d) The diffusers, grills etc. as required shall be provided.
- e) The cabinet casing housing shall be manufactured from 1.6 mm thick sheet steel and shall be given two coats of rust preventive paint. The casing shall be lined with 25 mm thick insulation.
- f) The condenser shall be either air cooled or water cooled shall & tube type.
- g) The air handling fan shall be axial/centrifugal type with forward curved blade and shall be complete with drive etc.
Pre-filters shall be of metallic Synthetic construction and after filters shall be micro-vee type.
- h) Cooling coil shall be DX type and shall be made of seamless copper tubes.

14.7 Specification of Insulation -- 'Material

	Code	Thermal Conductivity mw/cm°C	Density Kg/m ³
Resin bonded mineral wool/glass Wool/ equivalent	IS :8183	0.49 at 50°C	At least 24
Mineral wool pipe section (min. Gr. 2)	IS :9842	0.43 at 50°C	At least 81
Expanded Polystyrene	IS 4671	0.37 at 50°C	At least 15

14.8 Type

Sl. No	Surface	Insulation Material	Insulation Form	Thickness (mm)
1.	Supply air & Resin Return air duct for air system	Resin bonded Mineral wool (15:8183)	Roll	25
2.	Refrigerant Piping	Expanded Polystyrene OR Mineral wool	Pipe section	75
3.	AHU drain pipe	Expanded Polystyrene OR Mineral wool	Pipe section	25
4.	AHU drain pan, coil section and tank section	Expanded Polystyrene OR Mineral wool	Slab	25
5.	Expansion tank with pipe	Expanded Polystyrene OR Mineral wool	Slabs / Pipe section	50

14.9 List of Applicable Standards

15:660	Safety Code for Mechanical Refrigeration
ANSI-B, 9.1 ARI:520	Safety Code for Mechanical refrigeration
IS: 520	Standard for positive Displacement Refrigeration Compressor and Condensing Units
IS : 5222	Code of practice and measurement for testing refrigerant compressors

IS:4501	Shell and Tube type heat Exchange
ASHRAE 22-72	Method of Testing for rating water cooled refrigerant condensers
IS : 4503	Shell and tube type heat exchanger
ANSI-B-31.5	Refrigeration Piping
IS :650	Safety code for air conditioning
ASHRAE -3	Methods of Testing for Rating forced circulation air cooling and air heating coils.
IS: 659	Safety Code for Air-Conditioning
IS : 1520	Horizontal Centrifugal pumps for clear, cold, fresh water.
IS : 5120	Technical Requirement for Rotodynamic special purpose pumps.
IS: 655	Specification for Metal Air Duct
IS 277	Specification for Galvanized Steel sheet
IS: 7375	Specification for Wrought Aluminum and aluminum sheet and strip.
IS : 3583	Specification for Electrical axial flow fans
IS:2312	Propeller type A/C Ventilation fans
IS : 2831	Methods of test for air filters used in air conditioning and general ventilation.
IS :277	Galvanized steel sheets
IS : 1239	Mild steel tubes and tubulars
IS : 3069	Glossary of terms, Symbols and units relating to thermal materials
IS : 4671	Expanded Polystyrene for Thermal insulation.
IS : 8183	Bonded mineral wool
IS : 4849	Centrifugal fans

14.10 Guaranteed Technical specifications Data

The contractor may furnish all the data related to guaranteed technical specifications and relevant data.

- i) The ambient design condition to be considered shall be
 Temperature = $24.4 \text{ deg. C} \pm 1.1 \text{ deg. C}$ for all areas other than control equipment room etc.
 and $22 \text{ deg C} \pm 1.1 \text{ deg C}$ for the control room.
 as mentioned in the site data.
- ii) The number of fresh air changes per hour shall be 21.5 (min) or $0.45 \text{ m}^3 / \text{min}$ per person.
 Whichever is higher.
 - (B) Ventilation System
 - i) General areas - 10
 - ii) Battery room - 15
 - iii) However, in areas producing lot of heat, the temperature should be the criteria
- iii) The internal design conditions to be maintained are as follows:
 The number of air changes per hour in mechanically ventilated areas shall be as follows.
 Temperature rise above design ambient should be maximum 3°C . The criteria which give higher number of air changes shall be selected.

SECTION-VI

PART - A **PIPE LINE WORKS**

INDEX

SL. NO.	PARTICULARS	PAGE NO.
1	A. R.C.C HUME PIPES	2
2	B. M.S. PIPE LINE	4
3	C. PSC PIPELINE	41
4	D. HDPE PIPELINE	45
5	E. DI PIPELINE	57
6	F. GRP PIPELINE	68

SECTION – VI
PART – A
PIPELINE WORKS
GENERAL

TYPE OF PIPES TO BE PROVIDED FOR DIFFERENT COMPONENTS OF MEGALIFT SYSTEM.

Sl. No.	Components of the Mega lift System	Type of pipes to be provided
1	Intake pipes	RCC NP4 Hume pipes
2	<u>Rising Main/Pressure Main</u>	
	a. Diameter up to 1000 mm.	a. Ductile Iron Pipe as per detailed specification.
	b. Diameter more than 1000mm)	b. M.S pipe as per detailed specification.
3	<u>Distribution network</u>	
	a. Below 300mm dia.	a. HDPE pipe as per detailed specification.
	b. 300mm to 800mm dia.	b. D.I pipe as per detailed specification.
	c. Above 800 mm to 1000 mm dia.	c. GRP/PSC/D.I. pipe as per detailed specification.
	d. More than 1000mm	d. MS pipe as per detailed specifications.

A. R.C.C Hume Pipes

1.0 GENERAL

R.C.C Hume Pipes of non pressure type NP₄ shall be used as water conductors from intake to the sump well of Pump Houses.

1.1 SCOPE

Scope of the work includes procurement of NP₄R.C.C Hume pipes of adequate size from reputed manufacturers having accreditation from B.I.S transportation from factory to the site, unloading & laying of the pipes on the prepared bed fixing in position & filling up the trenches as per specification

2.0 SPECIFICATION

Schedule – 3: Reinforced Concrete, Medium duty, Non-pressure Pipes, Class: NP₃, with ends of the pipes suitable for flush joints conforming to IS: 458/2003 (Fourth Revision) with up-to-date amendment.

Nominal Diameter of Pipes in mm.

80, 100, 150, 200, 225, 250, 300, 350, 400, 450, 450, 500, 600, 700, 800, 900, 1000, 1100, 1200, 1400, 1600 & 1800.

2.1. Dimensions, Design & Strength requirements of Reinforced Concrete Pipes of Class NP₄ shall be as per the Table 3 of IS: 458/2003 (Fourth Revision) with up-to-date amendment.

3.0 INSPECTION & TESTING:

As per prevailing practice, the following Review of Reports shall be carried out.

Review of Reports:

The following Reports shall be submitted to the Inspecting Officer at the time of Inspection for review:

During manufacturing, Compressive Strength Tests shall be conducted by the manufacturers on 150 mm Concrete Cubes in accordance with the relevant requirements of IS: 456/2000 with up-to-date amendment and IS: 516/1959 (Reaffirmed 1999) with up-to-date amendment, as stipulated in clause 5.5.3 of IS: 458/2003 (Fourth Revision) with up-to-date amendment. The manufacturer shall submit the results of Compressive Strength Tests of Concrete Cubes made from the Concrete used for the pipes. Alternatively, if the manufacturers do not have the facilities for Compressive Strength Test on Concrete Cubes, they shall get the Test done at CSIDC laboratory at least once in a month and submit the report to the Inspecting Officer for review.

1. Manufacturer shall submit his own Certificate for materials of construction used in the pipes.
2. Manufacturer shall submit Test Certificate for the Steel used for Reinforcement.
3. Manufacture's Test Report of Rubber Rings shall be submitted for review (in case of Pipes with Socket & Spigot ends).
4. Manufacture's having E.P.M rate contracts shall have to provide the certification from E.P.M authorities.

4.0 TESTS:

All required tests shall be conducted as per procedure & methods according to IS: 458-2003 & IS: 784-1978.

As per prevailing practice, the following Tests/Checking shall be carried out.

1. Visual examination,
2. Permeability Test and
3. Three Edge Bearing Test to produce 0.25 mm crack.
4. Any other Tests that are mentioned in IS: 458/2003 (Fourth Revision) with up-to-date amendment shall be carried out if desired by the Consignee.

NOTE:

1. The tolerances on Pipes shall be as per clause 8.2 & tolerances on Collar shall be as per Table No. 21 of IS: 458/2003 (Fourth Revision) with up-to-date amendment.
2. Workmanship & Finish of the Pipes & Collars shall be as per Clause 9 of IS: 458/2003 (Fourth Revision) with up-to-date amendment.
3. The length in which the pipes are to be supplied shall be as per the mutual agreement between the purchaser and the supplier. However, the recommended length above 300 mm Nominal Diameter is 2.5 meters.
4. Curing of the pipes shall be done as per the Clause 7.4 of IS: 458/2003 (Fourth Revision) with up-to-date amendment.
5. Rubber Ring chords used in the Pipe joints shall conform Type 2 of IS: 5382/1985 with up-to-date amendment.

6. The following information shall be clearly marked on the each Finished Pipe.
 - a. Size of Pipe,
 - b. Class of Pipe, and
 - c. Name of manufacture.
7. The supplier shall guarantee the Pipes and Collars for a period of 12 months from the date of receipt of the materials by the consignee.

5.0 **Transportation:-**

Pipes shall be transported from factory to work site mostly by trucks or trailers. Loading & unloading must be done by mobile cranes or Hydra Cranes & lowered carefully to the bed of carrier trucks with such cushioning material sand or pebbles or Murom as available. The sides of the pipes shall be prevented from rolling & dashing with each other during transportation by suitable wooden wedges fixed securely to the bed of transport vehicle. Similarly while unloading from vehicles at work site due care shall be taken to lower the Pipes to a level surface slowly so as to avoid any jerk or impact. Protection against rolling & dashing against other pipes or hard materials like rock out crops etc., by sand bags of adequate numbers on both sides.

6.0 **Laying of pipes in position, filling of trenches.**

Laying of pipes will be done inside trenches excavated for the pipes by moveable cranes (Hydra Cranes). Tackles for lifting should be carefully placed so that the pipes are lifted in a horizontal manner & don't tilt or slip during shifting & lowering. Pipes are to be placed on the prepared & compacted bed as far as in a straight line & completely horizontal bedding slowly without any jerk or impact. After lowering a few pipes end to end, they should be carefully aligned and the end faces brought closer so as to form a flush joint. After due checking of levels & the alignment by competent authority, filling up of the sides of the trench should start with selected excavated materials, layer by layer & manually compacted till desired top level is reached.

7.0 **Provision for manholes**

Suitable manholes for cleaning shall be provided 50m apart.

- P.S- Contractors may also adopt other systems like RCC barrels of suitable size for the conductor system of raw water to pump houses. Specification of RCC provided in section-III will be followed.

B. M.S PIPE LINE

1.0 **DETAILED TECHNICAL SPECIFICATIONS OF M.S. PIPELINE**

1.1. **APPLICABLE CODES & SPECIFICATIONS (M.S. PIPES)**

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

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

1. IS : 2062 Steel for general structural purposes.
2. IS : 814 Covered Electrodes for manual Metal Arc Welding of carbon and C-Mn steel.

3. BS EN 499 Welding Consumables covered Electrodes for Manual Metal Arc Welding of Non Alloy and Fine Grain Steel. Classification
4. AWS : A-5.1 Specification for Mild Steel Covered Arc Welding Electrodes.
5. IS : 3613 Acceptance Tests for Wire Flux combinations for Submerged – Arc Welding.
6. AWS : A-5.17 Specification for Bare Mild Steel Electrodes and Fluxes for Submerged Arc Welding.
7. IS : 1377 - Technical Supply Conditions for Threaded Fasteners
8. IS : 1367 Technical Supply Conditions for Threaded Fasteners (Parts 1 to 3).
9. IS : 2074 Ready Mixed Paint, Red Oxide Zinc Chrome and Priming.
10. IS : 102 Ready Mixed Paint, Brushing, Red Lead, non setting Priming.
11. IS : 816 Code of practice for use of Metal Arc Welding for General Construction in mild steel.
12. IS : 4353 Submerged Arc Welding of Mild Steel & Low Alloy Steels – Recommendations.
13. IS : 817 Code of practice for Training and Testing of Metal Arc Welders.
14. IS : 1182 Recommended practice for Radiographic examination of Fusion -Welded Butt Joints in steel plants
15. IS : 2595 Code of Practice for Radiographic Testing.
16. IS : 3658 Code of Practice for Liquid Penetrant Flaw Detection
17. IS : 5334 Code of practice for Magnetic Particle Flaw Detection of welds.
18. ASTM E 94 Guide for Radiographic Testing
19. ASTM E 709 Guide for Magnetic Particle Examination.
20. ASTM E 165 Test Method for Liquid Penetrant Examination.
21. IS : 3600 Methods of Testing Fusion Welded Joints and weld metal in Steel (Parts 1 to 9)
22. IS : 4853 Recommended Practice for Radiographic Inspection of Fusion Welded Butt Joints in Steel Pipes.
23. IS : 3589 Seamless or Electrically welded steel pipes for Water Gas And Sewage (168.3 to 2540 Outside Diameter)
24. IS : 6631 Steel pipes for Hydraulic Purposes
25. IS : 7343 Code of practice for ultrasonic Testing of Ferrous Welded Pipes And Tubular Products
26. IS : 2598 Safety Code for Industrial Radiographic Practice
27. IS : 5822 Code of Practice for Laying of Electrically Welded steel pipes For water supply
28. IS : 1608 Mechanical testing of Metals.
29. IS : 9595 Metal Arc welding of Carbon and Carbon-Manganese Steels.
30. IS : 2825 Code of unfired Pressure Vessels
31. IS : 5504 Code for Spiral Arc Welded pipes
32. I.S. 10748 Requirement of weldable hot rolled carbon steel strip in coils.

1.2. MATERIALS**1.2.1 Steel Plates / H. R. Coil**

The steel used for pipes, fittings, specials and stiffeners shall be of mild steel conforming to IS: 2062, grade B Fe 410 or H. R. coil conforming to IS: 10748 grade III or equivalent ISO. The dimension of HR coils shall conform IS: 2062. The quality of steel, chemical composition and tensile strength of the steel plates shall be as specified in IS: 3589 for steel of grade Fe 410. Positive tolerance as per IS: 3589 shall be allowed for plate thickness, but no negative tolerance shall be allowed.

Steel plates should confirm to IS: 1730, Dimensions for Steel Plates, Sheets, Strips and Flats for General Engineer-in-Charge Purpose. The test certificate for the plates shall be issued by Plate Manufacturer.

1.3. Minimum thickness of the MS pipe line:

The thickness of the plate for the manufacturing of the MS rising main shall be governed by the economic sizing of the pipes analysed in line with the guidelines of CPHEEO manual and BIS Standards. However less than 8 mm thickness of pipe shall not be acceptable.

1.4. Welding Consumables

Welding consumables Such as electrodes, filler rods and wires shall conform to IS: 814, IS: 3613, IS: 6419 and IS: 7280.

1.5. Standard Length of pipes

The MS pipes shall be manufactured in lengths of 10 to 13m with beveled ends. Length of each pipe shall be measured at diametrically opposite four places and average of the four measured lengths shall be considered for measurements of pipe length.

1.6. Welding process

The pipes shall be manufactured by shop welding from steel plates only by qualified welders, butt welded either spirally or longitudinally by automatic submerged arc welding process using at least two runs, one of which shall be on the inner side of the pipes. Welding shall be so done that there will be through fusion and complete penetration and shall be free from cracks, oxides, and slag inclusion and gas pockets. Longitudinally welded pipes shall have circumferential weld at not less than 1.5 m centre to centre. Longitudinal weld shall be staggered. Minimum distance between spiral welds should be 1.5 m. The contractor shall certify that the welding of pipes has been done by qualified welders and welding operators.

1.7. Deviation in Length

Finished pipe length shall not deviate from straightness by more than 0.2 percent of the total length.

1.8. Straightness of Pipes

Finished pipes shall not deviate from straightness by more than 0.2% of the total length checking for straightness shall be carried out using as taut string or wire from end to end along the side of the pipe to measure, the greatest deviation. Pipe ends shall be at right angle to the axis within 1°.

1.9. Radiographic / Ultrasonic test

Three percent of all seams of pipes, welded in the fabrication shop, shall be radiographed at the end of pipe (as per IS: 4853) to render visible inspection of any internal defects such as blow holes, slag, inclusion of cracks. If any defects are detected, the metal at the location shall be gouged out and re-welded. In addition to the radiography of the joints, 100 percent testing by ultrasonic equipment (as per IS: 4260) shall also be done for welding tests. Any defects found out shall be rectified free of cost. Welds found deficient in quality shall be removed by gouging or melting and remade as per specifications. Chipping or cutting the weld shall not extend to the base metal. Gouging of defective welds should be done carefully by experienced welders so that no damage to the original plate base metal occurs.

1.10. Hydraulic Test at Works

Each pipe shall be hydraulically tested at manufacturer's works before applying any coating / lining.

1.11. Allowable tolerance

- Allowable tolerance for outside diameter shall be $\pm 0.75\%$ of the specified diameter.
- Allowable tolerance for ovality shall not be more than 1% of the specified diameter.
- Negative tolerance for plate thickness shall not be allowed.

1.12. Sampling and testing

Sampling and conformity criteria for various tests shall be as given in IS: 4711. The test samples shall be cut from pipes in the final condition of supply. Tests for tensile strength, percentage elongation, guided bend test, shall be carried out and the test values shall be in conformity with those specified in IS: 4711.

1.13. Destructive Test

The destructive test of pipe joints on the field shall be carried out as per IS 3600. It will be one for every rising main and for every two km of manufactured length.

1.14. Third party inspection

The pipes ready in the manufacturer's work yard shall be inspected and tested before dispatch, by the employer and or inspecting agency appointed by the employer. All the tests including hydraulic test shall be carried out on specified number of samples from each lot as specified in IS: 4711, in presence of the inspecting agency. The protective coating as per specification shall be applied to the pipes only after the inspecting agency is satisfied regarding the test results,

which shall be in conformity with the limits specified in IS: 4711. The contractor shall produce the test certificate issued by the inspecting agency.

1.15. Application of Red oxide

The pipes cleared by the inspecting agency shall be provided with one shop coat of red oxide as per relevant IS, externally, prior to despatch.

2.0 Manufacture, Supply, Laying and Jointing of MS specials

2.1. Fabrication of specials and appurtenances

Specials such as bends, tapers, and tees shall conform to IS: 7322. Specials shall be fabricated by cutting plates / HR coils of required thickness to the required shape, obtained by developing the form of specials on ground. Abutting profiles shall be obtained using templates, which guide the cutting torches as to obtain a uniform cut. No hand cutting shall be permitted. Specifications for using and testing of the plates, electrodes, welding process, etc shall be the same as for the MS pipes. Plain ends shall have beveled edges. Specials shall be manufactured as per the standard drawings enclosed in the tender documents. Stiffeners shall be provided wherever necessary.

2.2. Requirement

Specials as specified below may be required. Slight variation may be possible as per the site conditions.

- Horizontal and vertical bends
- Air valve tees
- Washout valve tees
- Access manhole tees with blank flange
- Eccentric reducers (tapers)
- Steel strap ring and bearing plates at chairs proposed for the above ground pipeline.
- Stiffener rings for pipes and specials as required and as directed by the Engineer-in-Charge.
- Blank flanges etc.

2.3. Bends, tees and tapers

The testing of these specials is not envisaged at the fabrication stage. These shall be subjected to test when the completed pipeline is tested hydraulically. In view of this, the contractor shall fabricate these specials with due care so that there is no failure of any welded joint during testing of the completed pipeline, which will invite dewatering the main, repairing and retesting.

2.4. Eccentric tapers (Reducers)

The tapers shall be fabricated in one or more pieces as may be necessary according to their lengths and plate sizes available. Stiffener rings shall be provided as necessary and as directed by the Engineer-in-Charge. The tapers shall be eccentric with bottom portion straight and top reducing as shown on drawing.

2.5. Stiffener rings

Stiffener rings shall be provided for the pumping main on each side of air valves, washout valves, on line valves and access manholes to strengthen the pipe at provided openings.

2.6. Bearing plates and steel strap rings

Bearing plates, equal in width of chairs and thickness as shown on approved drawings shall be provided on the chair / pedestal supports below roller bearings as shown on drawing. Steel straps of size and thickness as shown on drawings shall be provided and fixed for pipe anchorage with the chair supports. The straps shall be welded to MS angle on either end and anchored with the chair concrete by providing MS bolt as shown on drawing.

2.7. Gas Cutting For Ms Pipes

Cutting of the pipe for providing tees for air valves, washout valves, preparation of manhole openings, etc becomes necessary. The edges of the specials are required to be cut to match with the pipe edge for proper jointing and welding. Plate cutting operations at such places are performed with the use of gas cutting.

3.0 PROCEDUREFOR RECEIVING STEEL PIPES**3.1. General**

To ensure that the work of erecting pipes is not held up at any stage and place, the Contractor shall maintain an adequate stock of standard specials, flange rings, plug plates, manhole covers, etc. and short length of smaller diameter pipelines, etc. at site in his field stores, in consultation with the Engineer. Wherever possible, the Contractor shall arrange one full month's requirement of pipes, specials, etc. stacked along the alignment.

3.2. Stacking of pipes, etc. and Inspection

The Contractor shall keep in each section a responsible representative to take delivery of the pipes, specials and appurtenances, etc. transported from the fabricating stockyard or received from any other work site to the site of laying and to stack along the route on timber skids. Padding shall be provided between coated pipes and timber skids to avoid damage to the coating. Suitable gaps in the pipes stacked shall be left at intervals to permit access from one side to the other. The pipes, specials, appurtenances so received on site shall be jointly inspected and defects recorded, if any, such as protrusions, grooves, dents, notches, damage to the internal coating etc. shall be pointed out immediately to the Engineer at the site and in the acknowledgement challans. Such defects shall be rectified or repaired to the satisfaction of the Engineer entirely at the Contractor's risk and cost.

3.3. Handling of Pipes, Specials, Appurtenances, etc.

It is essential to avoid damage to the pipes, fittings and specials, etc. or their coatings at all stages during handling. The pipes and specials shall be handled in such a manner as not to distort their circularity or cause any damage to their surface treatment. Pipes shall not be thrown down from the trucks nor shall they be dragged or rolled along hard surfaces. Slings of canvas or equally non-abrasive materials of suitable width of special attachment shaped to fit the pipe ends shall be used to lift and lower coated pipes to prevent damage to the coating. Great care shall be taken in handling the pipe right from the first operation of manufacture until they are laid and jointed. The Contractor will provide temporary props in order to prevent any sagging of the pipes while they are stacked in their yard and while transporting to the site of delivery, i.e. laying. The props shall be retained until the pipes are laid. If at any time these props are found to be dislodged or disturbed, the Contractor shall immediately reinstate them in such a way that the true shape of the pipe shell or specials is maintained to the satisfaction of the Engineer. No defective or damaged pipe or special shall be allowed to be used in the work without rectification to the satisfaction of the Engineer. Any damage to the coating shall be repaired by the Contractor at his own cost to the satisfaction of the Engineer.

3.4. Dents

Whenever any dent, i.e. a significant alteration of the curvature of the pipe shell is noticed, the depth of the dent shall be measured between the lowest point of the dent and the pipe shell curvature line. All dents exceeding 2 percent of the outer diameter of the pipe shall be removed by cutting out a cylindrical portion of the pipe and replacing the same by an undamaged piece of the pipe. The Engineer may permit insert patching if the diameter of the patch is less than 25 percent of the nominal diameter of the pipe. Repairs by hammering with or without heating shall not be permitted. Any damage to the coating shall also be carefully examined and rectified.

3.5. Marking

The component parts of the pipes shall be carefully marked for identification in the field. The marking shall be on the side, which will be the inside of the pipe after bending. The marking operation shall be conducted with full size rulers and templates. Only blunt nose punches should be used. The plates used for fabrication of pipes shall be laid out in such a way that when the shells are completed one set of original identification markings for the material will be plainly visible. In case these markings are unavoidably cut out, they shall be accurately transferred by the Contractor to a location where these markings will be visible on the completed work. After hydraulic tests on the specials and other items, the number of the shell in the line as it will be erected and the direction of flow shall be stamped in a prominent manner on each piece.

A register shall be maintained in suitable proforma giving the following information for each shell tested:

- (a.) Serial No.
- (b.) Shell No.
- (c.) Date of test
- (d.) Thickness and specification of steel
- (e.) Weight of shell tested
- (f.) Maximum test pressure
- (g.) Details of test performance
- (h.) Details of radiographic examination of welds
- (i.) Name of Engineer's representative witnessing tests

A copy of these details shall be furnished to the owner at free of cost.

4.0 SPECIFICATION FOR LIQUID EPOXY COATING SYSTEMS FOR INTERIOR COATING OF STEEL WATER PIPELINES:

Providing & applying internal lining / painting / coating to MS pipe with solvent free food grade epoxy having dry film thickness of 406 microns including scrapping the surface of the pipe.

4.1 General

Buried steel pipeline shall be coated internally, with a single coat two part solvent free high build liquid epoxy lining as per AWWA C210-07 suitable for potable water application and shall be approved by NSF International Standard NSF/ANSI-61 2004 or by water regulations advisory scheme (WRAS), UK or Central Food Research Institute, Mysore as per standards BS 6920 UK. Protective lining shall consist of a coating system consisting of 100% solids epoxy comprising of resin & hardener mixed in a proportion as recommended by the manufacturer. The mixed epoxy shall be applied to abrasive blasted steel surface in the coating plant using plural hot airless spray machine with extended boom to apply the lining to a smooth finish without any drip or sag. The epoxy shall also be capable of application by brush at field joint locations and repair of damages to the spray applied epoxy.

The Contractor shall perform all work in accordance with these specifications and the latest pipeline coating practices, and shall complete the work in all respects to the full satisfaction of the Owner / Owner's Representative. The entire coating operation starting from cleaning and surface preparation till coating shall be performed under the supervision of skilled personnel who are well conversant with the work. Pipes which have been cleaned and primed, or cleaned, primed and coated, without having been inspected and approved shall be rejected.

This specification is not intended to be all inclusive and the use of guidelines set forth here does not relieve the Contractor of his responsibility for the quality and performance of the applied coating system, and to supply coating material capable of performing its intended service.

All steel special sections, connections fittings and field joints to be used for underground steel pipeline shall be internally coated with same liquid epoxy.

4.2 Reference Standards

The following standards (latest revision) referenced below are a part of this specification.

In case of conflict between this specification and the referenced standards, this specification shall apply

- (a) ANSI/AWWA C210 - Standard for Liquid Epoxy Coating Systems for the Interior & Exterior of Steel Water Pipelines.
- (b) NSF/ANSI 61 – Standard for Drinking Water System Components- Health Effects.
- (c) ANSI /ASTM D149 - Standard Test Method for Dielectric Breakdown Voltage and Dielectric Strength of Solid Electrical Insulating Materials at Commercial Power Frequencies.
- (d) ANSI/ASTM D3359 - Standard Test Method for Measuring Adhesion by Tape Test.
- (e) ANSI/ASTM D3363 - Standard Test Method for Film Hardness by Pencil Test.
- (f) ANSI/ASTM D4417 - Standard Test Method for Field Measurement of Surface Profile of Blast Cleaned Steel.
- (g) ANSI/ASTM D4541 - Standard Test Method for Pull-Off Strength of Coatings Using Portable Adhesion Testers.
- (h) ANSI/ASTM D2240 – Standard Test Method for Rubber Property – Durometer Hardness
- (i) ANSI/ASTM D5000 - Standard Test Method for Abrasion Resistance of Organic Coatings by the Taber Abraser
- (j) SSPC-PA 2 - Measurement of Dry Paint Thickness with Magnetic Gauges
- (k) SSPC-SP 1 - Solvent Cleaning
- (l) SSPC-SP 6/NACE No. 3 - Commercial Blast Cleaning
- (m) IS 16676:2017 Specification for solvent less liquid epoxy system for application on the interior and exterior surface of steel water pipeline.

4.3 Internal Lining System

The internal epoxy lining shall consist of chemically cured resin (epoxy) & hardener (curing agent), mixed in the ratio as recommended by the manufacturer and applied to a dry film thickness (DFT) of minimum 406µ.

Table-1 Physical properties of the internal lining shall be as follows.

Property	Requirement	Test Method / Reference
Long term contact with potable water	No effects for human consumption as certified by NSF International	NSF / ANSI -61
Thickness (applied min)	406 μ	SSPC-PA 2
Thickness deviation (min)	- 0 / + 200 μ	SSPC-PA 2
Dielectric strength (min)	450 V/mil (15 V/ μ m)	ASTM D149
Hardness Shore D	85 (min)	ASTM D2240
Adhesion to Steel (min)	800 psi	ASTM D4541
Tabor Abrasion	1560 cycles / mil	ASTM D4060
Compressive strength	70 MPa	ASTM C109

4.3.1 Coating Application for bends, joints etc.**General**

For internals of bends, short section of pipes, tees, fittings etc., internal epoxy will be manually spray applied either in the coating plant or in the field using suitable two component airless plural spray machine.

Internal field joint coating shall be brush applied.

The internal epoxy lining shall be applied only on blasted steel surface.

4.3.2 Pipe preparation**Metal surface condition**

Internal surface of the pipe shall be free from mud, mill scale, mill lacquer, wax, oil, grease, or any other foreign material. Before blast cleaning, surfaces shall be inspected and pre-cleaned according to SSPC-SP 1 to remove oil, grease, and loosely adhering deposits. Visible oil and grease spots shall be removed using a solvent. Only solvents that do not leave a residue shall be used. Preheating to remove oil, grease, and mill scale may be used provided that all pipe is preheated in a uniform manner to avoid distortion.

After drying and removing all loose adhering foreign materials, the pipe surface shall be cleaned by blasting with grit or steel shots to achieve a surface preparation at least equal to that specified in SSPC: SP6/NACE3. The blast anchor pattern or profile depth shall be 2 mil to 3 mils (50 μ m to 75 μ m) measured in accordance with ASTM D-4417.

For consistent surface finish, a stabilized working mix shall be maintained in abrasive recycling blasting machines by frequent small additions of new grit, shot

infrequent large editions shall be avoided. The abrasive working mix, abrasive recycling blasting machines shall be maintained clean of contaminants by continuous effective operation of blasting machine scalping and air-wash separators.

The cleaned interior pipe surface shall be inspected for adequate surface preparation. Surface imperfections, such as slivers, scabs, burrs, weld spatter, and gouges, shall be removed by hand filing or grinding if necessary to prevent holidays.

Blast-cleaned pipe surfaces shall be protected from conditions of high humidity, rainfall, or surface moisture. No pipe shall be allowed to flash rust before coating. To ensure a dry pipe surface at the time of liquid epoxy application, the minimum steel substrate temperature shall be 10°C and at least 3°C above the dew point.

4.3.3 Application temperature

The temperature of the mixed coating material and of the pipe at the time of application shall be not lower than 10°C. Preheating of the coating material by using in line heaters to heat the coating material may be used to facilitate the application. Heating shall conform to the recommendations of the epoxy coating manufacturer.

4.3.4 Application of epoxy

The epoxy shall be applied directly to the abrasive roughened steel surface pipe using a hot plural component airless spray equipment, with all necessary ancillary equipment like spraying boom etc, in accordance with the epoxy coating manufacturer's recommendations. Pipe will be rotated at a suitable speed and the boom of the spray machine carrying the spray gun will travel inside the pipe at a pre-determined speed to ensure that thickness of minimum 406 microns is achieved in one single spray application.

4.3.5 Curing

After application of epoxy, curing of the epoxy shall be natural air convection. Typical dry time of the epoxy at ambient temperature of 25-40°C shall be between one hour to three hours. Shore D hardness of the epoxy after 10 hours shall be > 65.

Internal coating cutback on either side of the pipe shall be 75 mm +/- 25 mm.

4.3.6 Field Joints

After the main pipes have been welded in the trench, internal epoxy coating shall be applied on the inside of the pipeline at the girth welds using brush application. Internal epoxy for field joint coating shall be supplied by the same manufacturer and shall be NSF approved. The epoxy shall be supplied in small cans of appropriate size required per joint with applicator pad. The internal surface of the field joint shall be inspected and weld spatter or slag shall be removed by grinding.

The internal surface shall then be manually blasted to remove rust / contamination etc. The resin & hardener will be mixed and the coating applied to a minimum thickness of 406 μ . The internal field joint coating shall overlap the factory applied main line internal coating by 50mm on either side.

4.4 Material acceptance, inspection and testing

4.4.1 Material acceptance

Proposed internal epoxy lining materials shall be approved by the Owner / Owner's representative. Test certificate from independent third party test laboratory shall be submitted conforming compliance to the physical properties as listed in Table I. No deviation to the physical properties shall be acceptable.

When the material is supplied, acceptance of the material shall be based on submission of certificate of conformance of the internal epoxy to this specification along with manufacturing acceptance test certificates for various lots as per manufacturer's quality assurance and quality control requirements.

4.4.2 Coating application inspection

The entire internal lining operation by the Contractor will be supervised by qualified experts from the manufacturer. The CV of the manufacturer's expert shall be approved by the Owner / Owner's representative. All coating work will be done in the presence of the Owner / Owner's representative.

4.4.3 Thickness

Thickness of the coating system shall be checked in accordance with SSPC-PA 2. Thickness shall be in accordance with the values given in the Table I and shall be checked at a frequency specified by the Owner / Owner's representative.

4.4.4 Pull Off Adhesion

The pull off adhesion of the internal epoxy lining to steel shall be checked in accordance with ASTM D-4541. The average value below the limits stated in the Table I shall constitute a failure of the system to meet the adhesion requirement. The pull off adhesion test shall be conducted at a frequency specified by the Owner / Owner's representative.

4.4.5 Field procedures

At all times during construction of the pipeline, the Contractor shall use caution to prevent damage to the internal lining on the inside of the pipe. No metal tools or heavy objects shall be permitted to unnecessarily contact the finished coating. Workmen shall not be permitted to walk on the internal coating except when necessary. In these cases, they shall wear shoes with rubber or composition soles and heels or other suitable footwear that will not damage the coating. Any damage to the pipe or the protective coating from any cause during the installation of the pipeline shall be repaired.

4.4.6 Coating repair in field

All defects visually or electrically discovered either at the coating plant or in the field shall be repaired by applying the same liquid epoxy coating using brush. The minimum over-lap at the damaged area shall be 100 mm all around. The repaired area shall be tested with a holiday detector as per specifications after the repair is completed. The thickness of the coating at the repair area shall be minimum 406μ.

4.5 Epoxy Painting for Internal Surface of Pipes and Specials

The epoxy coating shall be solvent-less, liquid epoxy coating of at least 406 microns thickness, for the interior surface of steel pipe lines & conforming to IS 3589: 2001. Epoxy paint to be used for this work shall be suitable to local environmental conditions / ambient conditions.

4.5.1 General

All steel pipes and fittings outside the pumping station shall be internally lined with a spray applied solvent free epoxy approved for contact with potable water under the United Kingdom Water Regulations Advisory Scheme authorized for use under Regulation 31 (4)(a) of the water supply (Water Quality) Regulations 2000 for contact with potable water. The applicable specifications for the coating system shall be suitable to potable water at elevated ambient / air temperature tested as per BS – 6920. AWWA C210 is referred standard for coating application as per Sec. 4.4. Surface preparation application condition, post treatment of coated surface to be as per manufacturer's specifications.

Paint – NSF standard 61 – NACE RP – 01 – 75. paint should be suitable for long time storing or potable water in the pipeline.

4.5.2 Materials & Workmanship

The coating system shall be factory lined and the lining shall be suitable for application in an environment with black bulb temperature up to 85 deg C.

All steel pipes shall be lined at the factory. Pipes welded on site shall be lined on site to the same standards as for pipes.

Pipe ends – coating shall be held back in from the ends of pipe sections to be jointed by field welding.

Detailed proposals of the lining method, materials and apparatus to be used for both factory and site application shall be submitted to and approved by the Engineer before work starts. Storage and application shall be accordance with recommendations of the coating manufacturer, but as a minimum:

- a) A visual examination of the surface to be coated shall be carried out and any slivers or similar deposits removed.
- b) Prior to blasting all oil and grease shall be removed from the surface to be coated.

- c) Preparation of steel surfaces for both factory and site application shall be to a minimum of Sa 2 ½ in accordance with BS 7079/ ISO 8501-1:2007 specifications /or as per client specifications and roughness should 50-75 micron.
- d) The surface to be coated shall be dry, clean and free from foreign material and coating shall take place before any surface rusting and at least within 4 hours of blasting.
- e) Surface preparation and coating shall not be carried out when the relative humidity exceeds 85% or when the surface to be coated is less than 3 deg C above the dew point.
- f) The coating shall have a minimum mean dry film thickness of 406 microns.
- g) Coatings shall be used within the pot life specified by the manufacturer.
- h) The materials to be used for the work of each batch, test certificate shall be reviewed.
- i) Paint shall be applied by brush / air less or conventional spray method.

Pipe linings shall be inspected on site and damaged, defective or otherwise unsatisfactory linings may be condemned. All defective areas shall be made good to the satisfaction of the Engineer.

4.6 Inspection and Testing:

It will be detailed in the contractor's Quality Plan and will be undertaken as minimum to the following:

- a) Visual Inspection of blasted profile on every pipe to be coated.
- b) Visual inspection of finished coating on every pipe.
- c) Measurement of coating thickness at four points on each pipe.
- d) The completed pipe shall be subjected to holiday detection tests which shall be carried out to the satisfaction of the Engineer. The applied voltage shall be hose appropriate to the coating under test as recommended by the coating material manufacturer.
- e) The adhesion test as per clause no. 5.1.6 of AWWA-C-210.07 shall be carried out on one pipe per lot of every 10 pipes. Two parallel knife cuts about 100 mm long and 20 mm apart shall be made through the coating. If necessary, the test knife may be heated to make the cut. The painted surface between two cuts shall be lifted off the pipe with a stiff blade. If the paint film does not pill-off, more than the width of the cut, the bond shall be deemed to be satisfactory. If the width of the peel exceeds the width of the cut, two additional tests shall be made on the same pipe at two different locations. The painted surface shall be accepted if both the tests are satisfactory. If the results of either of the tests are un-satisfactory, the painting work of pipeline shall be rejected. Adhesion test shall be performed on 1 pipe out of 10 pipes. If the adhesion test fails for one pipe, then this test shall be performed on all the remaining 9 pipes of that particular lot.
- f) Prior to acceptance and application of the material, the Epoxy coating material shall be submitted by the contractor & shall be tested in an independent third party / vendor's test laboratory designated by the

purchaser, in presence of client / consultant and the results shall be in accordance with the specified standards. The frequency of the test shall be minimum 1 sample in every 10000 liters or per batch of the coating material. Tests like: Specific Gravity, Hardness (shore – D), Adhesion to steel, Tabor abrasion, pull-off adhesion tests, will be carried out.

- g) Rejection: If the sample of coating material does not comply with the standard, the coating material represented by such a sample shall be rejected.
- h) The pull-off adhesion of the internal epoxy lining to steel shall be checked in accordance with the ASTM D – 4541.
- i) All holidays visually or electrically discovered either at the coating plant or in the field shall be repaired by applying the same liquid epoxy coating using the brush. The minimum over-lap at the damaged area shall be 100 mm all around. The repaired area shall be tested with a holiday detector as per specification after the repair is completed. The thickness of the coating at the repair area shall be minimum 406 micron.

4.7 Preservation, Marking and Shipping Preservation

4.7.1 Preservation

The bare ends of each pipe shall be painted outside with a removable varnish as temporary corrosion protection during transportation.

Bevel protectors of a type to be approved by the Engineer shall protect the bare ends of each pipe.

4.7.2 Marking

In addition to the marking required by API 5L, the specification MO1 “Steel Pipes for Main lines and other applicable project specifications, the Pipe Coating Contractor’s unique coating number shall be marked to the internal surface or the pipe with synthetic resin paint.

Further marking details like colour coding etc. shall be agreed upon with the Engineer.

The marking shall have at least a distance of 150 mm to the pipe end.

4.7.3 Shipping

Shipping and Loading preparation shall be in accordance with API Specification 5L or otherwise stated in the contract documents.

The pipe coating Contractor shall submit detailed loading, stacking- and shipping procedures for approval by the Engineer.

4.8 Documentation

4.8.1 Pre-Production Documentation

The Pipe Coating Contractor shall submit the following documents to the Engineer for approval prior to commencing production:

- a) The manufacturer’s trade name and data sheets for all proposed coating materials. This includes cleaning and abrasive blasting consumables.

- b) Procedure for identifying or maintaining the identification of each coated item.
- c) Handling procedure.
- d) Stacking procedure.
- e) Materials control and traceability procedure for the batches of coating materials.
- f) Materials control and traceability procedure (pipe and coating materials).
- g) Procedure for steel surface preparation including materials, cleaning, inspection, verification of cleanliness and surface profile.
- h) Coating application procedures.
- i) The results of the batch tests for batches to be used for pre-qualification tests.
- j) Details of testing methods including instrument types and copies or current calibration certificates.
- k) Details of inspection methods for bare and coated pipe.
- l) Full test results from the coating Procedure Qualification Test (PQT).
- m) Repair procedure and results or tests on demonstration of repairs.
- n) Project specific Quality Plan. Work shall not commence until these procedures have been reviewed and approved by the Engineer.

The selection of proposed coating materials shall be subject to Engineer's approval

4.9 Production Records

A daily log containing the following data shall be maintained and be available for inspection by the Engineer during and/or after production. Data shall be recorded against the pipe unique identification number.

- a) Bare pipe inspection data
- b) Ambient temperature (every 4 hours)
- c) Humidity (every 4 hours)
- d) Coating progress (no. of items coated. Including item serial numbers)
- e) Blast pipe surface amplitude
- e) Tests for cleanliness of blast surface
- f) Test for cleanliness or blast medium
- g) Film thickness measurements
- h) Average, maximum and minimum coating thickness during each shift
- i) Details of any coating repairs
- j) The unique identification number of all items that are stripped for recoating – 'RP'
- k) Pipe coating test results

This log shall be available to the Engineer throughout all coating operations.

4.10 Release Documentation

The Pipe Supplier and/or Pipe Coating Contractor shall submit to the Engineer the following documentation in hard copy and softcopy (format to be agreed upon with the Engineer) with each batch of pipes released:

- a) Mill certificates for line pipe
- b) Unique pipe identification numbers
- c) Unique coating identification number (if different)
- d) Pipe length
- e) Length of the coated portion of each pipe and total coated lengths of all pipes.
- f) Reductions in length due to use in tests, damage or repairs, recorded against pipe unique identification number
- g) Date of coating
- h) Batch numbers of coating materials used

This shall be followed within two weeks by the following:

- a) Manufacturer's certificates for each batch of coating materials
- b) Certification / calibration certificates for all testing and coating equipment
- c) Inspection and test records, results, and other documentation of all materials and coating tests

All reports shall be signed by the Pipe Coating Contractor to signify compliance with the requirements of this specification.

The finished epoxy lining surface shall be able to deliver a guaranteed ' C_r ' value of (1) one in modified Hazen-William's formula for estimating pipe friction loss. The arrangement for ' C_r ' value testing is to be arranged by the contractor.

5 700 MICRON POLYURETHANE EXTERNAL COATING

5.1 Scope

Technical specification governs requirements for material, equipment, application, inspection, repair and handling aspects associated with the external coating.

5.2 External coating:

External surface of the pipe and specials to be painted with one coat of two part chemically cured polyurethane primer of min 30 micron dry film thickness followed by one of two coats of two part **solventfree polyurethane** provide a high build coating of dry film thickness of 700 micron including primer coat. Polyurethane coating should have good resistance to ultraviolet degradation along with corrosion resistance. PU coating should provide hard yet flexible, with very low water absorption with outstanding adhesion as well as impact and abrasion resistance.

Solventless PU system is to be used eliminating solvent health hazards.

External coating should be carried out at site by Paint Manufacturer as during transportation coating will get damaged.

5.3 General Requirement:

- I) The work shall conform to the following documents / specifications (latest revision or as specified)
 - a) SSPC SP 10 / NACE 2 / Sa2¹/₂ Near white Blast Cleaning .
 - b) SSPC PA 2 Measurement of dry film Coating Thickness With magnetic gauges
 - c) ASTM D 4541 Method for pull off strength using portable Adhesion Tester.
 - d) NACE RP 0274 – 2004 High – Voltage Electrical Inspection of Pipeline Coatings.
 - e) NACE SP 0188 - 2006 Discontinuity (Holiday) Testing of New Protective Coatings on Conductive Substrates.
 - f) NACE RP 0169 – 2002 Control of External Corrosion on Underground or Submerged Metallic Piping Systems.
 - g) AWWAC 210 - 2007 Liquid – Epoxy Coating Systems for the Interior and Exterior of Steel Water Pipelines.
 - h) IS 3589: 2001 Annexure B Steel Pipes for Water and Sewage Specification.
 - i) AWWA C222 – 2000 Polyurethane Coating for the Interior and Exterior of Steel Water Pipe and Fittings.
 - j) IS 13213 : 2000 Polyurethane Full Gloss Enamel (Two Pack)
 - k) IS 10221 : 2008 Coating and wrapping of underground Mild steel pipelines
 - l) BIS DOC : CHD 20 (1938) P Solventless Liquid Epoxy System for interior & exterior of Steel Water Pipeline.
 - m) IS 16719:2018 Specification for Polyurethane coating for interior and exterior of steel pipe and fittings.
- II) The steel surface preparation prior to actual commencement of coating shall conform to SSPC SP 10 / NACE 2 / Sa2¹/₂ (near white metal) with sand blasting.
- III) The EPC contactor shall submit a detailed written description in the form of a manual covering coating equipment, procedures, materials inspection test, and repair etc. to the Owner for approval.
- IV) The contractor shall also provide copies of test reports from NABL approved laboratory (like National Test House, Kolkata) evidencing that materials (paints / primer) shall conform to the technical specification.

- V) The contractor shall also provide certificates from coating manufacturer quoting batch numbers, date of manufacture and shelf life etc. The contractor shall provide Manufacturing Quality Plan (MQP) and field Field Quality Plan (FQP) before supply of material and starting of work.
- VI) The coating shall be applied either by coating / paint manufacturer or by their authorized applicator. If done by applicator, then the same has to be approved by the CE, Megalift. The authorized applicator should have been trained by and certified by manufacturer and shall possesses the necessary specialized equipment, trained crew and experience in spraying epoxy coating.
- VII) Applied coating shall be tested for dry film thickness, holiday (electrical inspection for continuity) and adhesion as per relevant standard such as SSPC PA 2, NACE RP 0274 and ASTM 4541.
- VIII) The material may be heated if necessary and applied by airless spray / plural component spray system with minimum wastage.

5.4 COATING PROCEDURE AND APPLICATION

5.4.1 Surface Preparation:

Pipe shall be blast cleaned by sand. The cleanliness achieved prior to application shall be in accordance with the requirement of SSPC SP 10 / NACE 2 / Sa2¹/₂ of ISO 8501 (near white metal)

- a) The blast pattern or profile depth shall be 40 to 100 micron and shall be measured by dial micrometer.
- b) Before sand blasting is started or during blasting or coating, temperature of the pipe surface should be more than 3° C above dew point temperature. Blast cleaned surface should be primed within 4 hours and shall be protected from rainfall or surface moisture and shall not be allowed to flash rust. If the rust occurs, the surface again to be prepared by sand blasting or wire brushing.

5.4.2 Application of PU Coating

- a) PU Coating shall be applied when the pipe surface temperature at least 30 C above dew point temperature (when R.H. is more than 85 %)
- b) Material preparation and application shall be done as per manufacturer recommendation and shall be applied by plural component machine.

5.4.3 TEST REQUIREMENTS:

5.4.3.1 Measurement of dry film thickness

Measurement of dry film thickness of coating: coating thickness shall be in the range of ± 20% and as per SSPC PA 2.

- (i) **Apparatus/ Instrument:** The instrument used for dry film thickness may be Type 1 pull of gauges or Type 2 electronic gauges.

(ii) Procedures

- a) No. of measurements. For 100 Square feet (9.29 Square meters) five (5) spots per test area (each spot is 3.8 cm.) in diameter. Three gauge readings per spot (average becomes the spot measurement).
- b) If the structure is less than 300 Square feet, each 100 square feet should be measured.
- c) If the structure is between 300 and 1000 Sq. ft. select 3 random 100 square feet test areas and measure.
- d) For structure exceeding 1000 square feet, select 3 random 100 square feet testing areas for the first 1000 Sq. ft. and select 1 random 100 Square feet testing area for each additional 1000 Square feet.
- e) Coating thickness Tolerance: Individual reading taken to get a representative measurement for the spot are unrestricted (usually low or high readings are discarded). Spot measurements (the average of 3 gauge readings) must be within 80 % of the minimum thickness and 120 % of the maximum thickness. Area measurement must be within specified range.

5.4.3.2 Electrical Inspection (Holiday) Test:

- a) All the coated/ Lined pipes shall be tested with an approved high voltage holiday detector preferably equipped with an audio visual signalling device to indicate any faults, holes, breaks or conductive particles in the protective coating.
- b) The applied output voltage of holiday detector shall have a spark discharge of thickness equal to at least twice the thickness of the coating to assure adequate inspection voltage and compensate for any variation in coating thickness. The electrode shall be passed over the coated surface at approximately half the spark discharge distance from the coated surface only one time at the rate of approximately 10 to 20m/min. The edge effect shall be ignored. Excessive voltage shall be avoided as it tends to induce holiday in the coated surface thereby giving erroneous readings.
- c) While selecting test voltages, consideration should be given to the tolerance on coating thickness and voltage should be selected on the basis of maximum coating thickness likely to be encountered during testing of a particular pipe.

- d) The testing voltage shall be calculated by using following formula (as per NACE 0274:2004)
- e) Testing Voltage $V=7900_{-T} \pm 10$ percent where T is the average coating thickness in mm.
- f) Any audio visual sound or spark leads to indicate pinhole, break or conductive particle.

5.4.3.3 Adhesive Pull off Test:

After holiday the coated surface is subjected to adhesion pull off test as per ASTM D 4541

- a) Apparatus/ Instrument: Adhesion tester consists of three basic components: A hand wheel, a black column containing a dragging indicator pin and scale in the middle and a base containing three legs and a pulling “jaw” at the bottom and also dollies.
- b) Prepare the test surface: Once test area is selected, test area shall be free of grease, oil, dirt, water. The area should be flat surfaces and large enough to accommodate the specified number of replicate test.
- c) Prepare Dolly (Test Pull Stub): The dolly is a round, two sided aluminium fixture. Both sides of the dolly looks same, however, one side sloped on top surface while flat on bottom surface. As the surface of the dolly is polished aluminium, roughen the same using a coarse sand paper.
- d) Select an adhesive : Use araldite, a 100 % solid epoxy adhesive. This adhesive requires at least 24 hours at room temperature to cure.
- e) Attach the dolly to the surface.
 - (a) Using a wooden stick, apply an even layer of adhesive to the entire contact surface area of the dolly.
 - (b) Carefully remove the excessive adhesive by using a cotton swab. Allow the adhesive to fully cure before performing the adhesion test.
 - (c) Attach the dolly to the coated surface and gently push downward to displace any excessive adhesive.
 - (d) Push the dolly inward against the surface, then apply tape across the head of the dolly.
- f) Determine whether scoring is required.
- g) Perform the Adhesion Test.

- (a) Attach the adhesion tester to the dolly by rotating the hand wheel counter clockwise to lower the jaw of the device.
- (b) Slide the jaw completely under the head of the dolly. Position the three legs of the instruments so that they are sitting flat on the coated surface.
- (c) Slide the dragging indicator pin on the black column to zero by pushing it downward.
- (d) Firmly hold the base of the instrument in one hand and rotate the hand wheel clock wise to raise the jaw of the device that is attached to the head of the dolly. The dragging indicator pin will move upward on the black column as the force is increased and will hold the reading. Apply the tension using a moderate speed. Continue to increase the tension on the head of the dolly until (a) the minimum PSI/Mpa/Kg.cm² required by project specification is exceeded and the test is discontinued (b) the maximum PSI/Mpa/Kg/cm² of adhesion tester has been achieved and dolly is still attached (c) the force applied by the adhesion tester causes the dolly to dislodge.
- (e) Read the scale and record the adhesion value.
- h) The black column near the middle of the adhesion tester contains two scales and a dragging indicator pin in between. Right scale is PSI and left scale is MPa. The dragging indicator Pin will hold the reading until push back to zero. When achieve the end point of test, read the scale across the bottom of the dragging pin.

5.4.4 Coating Repair

Defecting Coating: Coating shall be repaired in accordance with the following subsections.

Surface Preparation: Accessible areas of pipe requiring coating repairs shall be cleaned to remove debris and damaged coating using surface grinders or other means. The adjacent coating shall be feathered by sanding, grinding or other method. Accumulated debris shall be removed by blowing with contaminant free air or wiping with clean rags.

Areas not accessible for coating repair such as interior surface of small Diameter pipe shall be reprocessed and recoated.

Coating Application: The coating system shall be applied to the prepared areas in accordance with procedure.

Repair Inspection: Repaired portion shall be electrically inspected using a holiday detector.

5.4.5 Welded Field Joints

Preparation : The weld Joints shall be cleaned so as to be free from mud, oil, grease, welding flux, weld spatter and other foreign contaminants. The cleaned metal surfaces of the weld joint shall then be abraded using

rotary abrading pads or emery paper. The adjacent liquid Epoxy / PU coating shall be feathered by abrading the coating surface for a distance of 25 mm.

Electrical Inspection: After curing the coating system applied to the welding joints shall be holiday tested. Any holidays is indicated by the detector shall be marked with chalk to identify the area of repair

6 LOWERING, LAYING & JOINTING OF PIPE

6.1 General

Unless specified otherwise, the pipeline shall be buried with minimum cover of 1.2 m at top, as shown on drawings. No material shall be erected unless it has been previously passed by the Engineer.

Erection of fabricated shells shall be carried out by the Contractor who shall equip himself, at his cost, with all necessary tools, machinery, labour etc. required for the purpose.

6.2 Welding

Except for routine welding of joints, no other work shall be done in the absence of Contractor's engineer, either during the daytime or at night.

Chipping shall not be kept in arrears for more than 15 joints.

Saddle pieces shall be fixed in position after checking bolts holes, by means of templates. These works shall be done together with the pipe laying work, if pipeline is to be laid above ground in unavoidable circumstances.

6.3 Temperature

The components of the pipeline such as base plates, top plates and pedestals have been so designed that the centers of the plates and pedestals shall coincide at the Mean Temperature (30°).

For this reason, all works such as fixing flanges, base plate etc. in true alignment, and incorrect position and tack welding pipes shall be done at the mean temperature. For ascertaining the temperature, the Contractor shall provide mercury cups and fix them to the pipe shell from outside and shall also provide thermometers of the required type and range. No extra payment shall be made for this.

6.4 Saddle Supports

Unless otherwise specified pipeline shall be underground. However at unavoidable reaches it shall be on R.C.C. saddles spaced at about 7 m centre to centre. The material and construction of R.C.C./Steel structures such as saddles, anchor blocks, crossings etc. associated with the work of pipe line shall conform with the relevant I.S. codes, good engineering practice and as directed by the Engineer. The pipes to

be laid on saddle supports shall be erected at mean temperature. Saddle supports shall either be sliding type or fixed type. For both the types of supports a 10mm thick double plate shall be welded to the part circumference of the pipeline that will make contact with the saddle and another similar plate shall also be embedded in the concrete saddle with necessary arrangement to facilitate welding it to the double plate welded to the pipe, in case of fixed support. In case of sliding support, the pipe shall be allowed to slide freely over the plate embedded in the saddle. Alternatively to achieve fixity, the pipe shall be anchored by providing suitable anchor block. The rate for laying the pipe on saddle support shall include for laying, aligning, tack welding, provision of rigging screws with screw eyes etc., complete.

In addition to above, the pipe shall be held in position on saddles with two numbers 50mm x 8mm thick holding down traps fixed to the saddles with holding down bolts and nuts which shall be paid separately under relevant item of bill of quantities.

6.5 Erection of Shells

The erection shall be true to position, lines and grade as shown in the drawings or as modified by the Engineer. The Contractor shall provide at his cost necessary saddles, pads, spider etc., all necessary instruments and other materials and labour required for proper erection of shells in position and for the Engineer in checking the correctness of the erection.

Alignment of sections at edges to be butt welded shall be such that the maximum offset is not greater than the values given below:

Thickness 't' (mm)	Offset in Longitudinal joints (mm)	Offset in Girth joints (mm)
Upto 12	0.25 t	0.25 t
12 to 20	3 mm	0.25 t
20 to 40	3 mm	5 mm
40 to 50	3 mm	1/8 t
Over 50	Lesser of 0.0625 t or 10 mm	Lesser of 0.125 t or 20 mm

The best of welders as selected from their work in the Contractor's workshop shall be selected for in-situ welding of the shells. The relevant provision under welding such as qualification standard for welding procedures, tests on welder's work and removal of defects etc., shall also apply to in-situ welding.

6.6 General Sequence of Operations

Before commencing the work of pipe laying, the Contractor shall study the L-section of the pipeline for the section concerned. He shall also study the details of laying i.e. underground or aboveground. The underground pipeline shall be laid on sand cushioning/bedding as shown on the drawing. The difference in depth due to uneven excavations shall be made up by sand cushioning.

Pipe laying shall generally start from the fixity points on either side, the expansion joints if required for pipeline aboveground being provided last. Fixing points are at all anchor blocks. Where such blocks are not required for long lengths, fixity shall be achieved by fixing the pipeline to the special type of R.C.C. or steel saddles as directed. The distance between successive fixity points shall not exceed 300 m.

Anchor blocks shall be constructed before commencing the pipe laying work in any section. The construction of the blocks shall be carried out in 3 stages: in the first stage the lower part upto 150 mm below the invert of the pipeline including concrete chairs to support it shall be constructed; in the second stage the pipeline on this part of the block shall be laid; and lastly, the remaining block around and over the pipeline shall be constructed.

The fixity saddles and ordinary saddles if the pipeline is aboveground shall be cast at least 3 weeks before the pipeline is laid on them. After all saddles between successive fixity points have been cast, a line plan showing the actual position thereof shall be prepared, after taking levels and measuring distances. In case of any errors in casting the pedestals, corrections shall be applied. The pipe laying work shall then start from the fixity points and shall proceed towards the expansion joints. The method of jointing the pipes and erecting them on previously cast R.C.C. saddles shall be determined by the Contractor depending upon the type of plant equipment and personnel available with them.

The pipe strakes shall be assembled in position on the saddles either by the cranes, portable gantries, shear legs or any other equipment approved by the Engineer. Normally, not more than two pipes shall be aligned, tacked and kept in position on temporary supports. The Contractor shall not proceed with further work, until the circumferential joints of these pipes are fully welded. During assembly, the pipeline shall be supported on wooden sleepers and wedges, with the free end of the pipeline held in position by slings to avoid deflection due to temperature variations during the day. In general, the assembly of pipe strakes and one run of welding shall be done during the day time while full welding including the external gouging and sealing runs shall be done after 5 p.m. or so. The Contractor shall maintain the continuity of the work by adding two more pipes on the second day in a similar manner, after full welding of the previous joints is completed during the night. While this new work is being done, the Contractor shall proceed with the work of providing permanent supports for the pipeline assembled and welded previously.

6.7 Fixing Expansion Joint

The work of laying pipeline in aboveground, laying starts from the fixity points and proceeds towards the expansion joints. It shall be continued until the gap between the pipe ends is less than the lengths of the expansion joint plus pipe strake length. At this stage, the exact gap between the pipe ends shall be measured at mean temperature of that locality. Let it be 'X'. Similarly, the exact length of the pipe strake and the expansion joint bought at site shall be measured at the same

temperature let these be 'Y' and 'Z' respectively. Normally, the length of the expansion joint ('Z') is standard.

(a) Case when 'Y' plus 'Z' is more than 'X' or equal to 'X' (i.e. fixing of expansion joint without strip)

At mean temperature the exact gap between pipes shall be measured. Free ends of pipes shall be brought in a correct line and level; lateral movement, if any, shall be corrected. Then the gap between the free ends shall be made equal to the exact length of the expansion joint by cutting one of the pipe ends. Choice of the end to be cut must be made from the point of view of bringing the expansion joint to a central position.

The expansion joints are normally supplied without packing. The normal length of the expansion joint shall be reduced by about 100 mm by cutting the inside locks and inserting the inner strake by means of turnbuckles. At mean temperature this expansion joint shall be inserted inside the gap (care being taken to keep the *Volume* – tapered portion on the down-stream side), and both ends shall be tack welded to the pipe ends, after pulling the expansion joint. (Tacks of these two joints shall be of longer length, approximately 100 mm long).

Welding of these two joints of the expansion joints shall be started only after it is ascertained by taking observations that the expansion joint is functioning properly.

The procedure to be followed for taking observations is given in Clause 8.5 (c).

(b) Case when 'Y' plus 'Z' is less than 'X' (i.e. fixing of expansion joints with strap)

The expansion joint shall be laid in locked position. Before laying the pipes adjacent to the expansion joint, the exact gap between the pipes shall be calculated by taking measurements of the first pipe (upstream of the expansion joint), and the second pipe (downstream of the expansion joint) at Mean Temperature.

If the gap is less than 100 mm, the second pipe shall be cut to make the desired gap of at least 100 mm. If the gap is more than 200 mm, suitable distance piece of not less than 700 mm shall be inserted after cutting necessary length of the first pipe. The second pipe shall then be laid in position. Then a strap of length equal to three times the gap length shall be welded to the pipe, overlapping the second pipe by the gap length. The other end of the strap shall be kept free.

At mean temperature the other end of the strap shall be tacked to the first pipe, after checking of the line and level. Simultaneously, all the locks of the expansion joint shall be removed and chipped off properly.

Welding of the joints between the strap and the first pipe shall be started only after observations are over and it is ascertained that the expansion joint is functioning properly.

(c) Observations

Before fixing the expansion joint, two mercury cups - one on the left and the other on the right side - shall be fixed on the pipe near the upstream side of the expansion joint.

Immediately after the expansion joint in case (a) above or the strap in case (b) above is tack welded, observations for total expansion or contraction shall be started and continued for 48 hours round the clock. Similarly, the central and end fixity pedestals shall be kept constantly under observation.

The expansion and contraction shall be measured by making a temporary marking on the inner strake (on the upstream side) and measuring the distance between this mark and the edge of the gland of the expansion joint.

The observations shall be recorded in the following proforma;

Reading No.	Time	Shell temp on upstream side	Shell temp on downstream side	Atmospheric temperature	Dist between edge of gland and marking
1	2	3	4	5	6

In case the pipeline is laid in trenches as shown on the drawing, after welding and field testing, the trench shall be filled with selected material upto 300 mm above pipes. This backfill shall be provided in layers not more than 150 mm, with a density more than 95% of the standard proctor density. Samples shall be tested as directed by the Engineer. Remaining depth of trenches shall be filled with ground backfill material.

7 SPECIALS**7.1 General**

Specials, such as tees, Y-pieces, bends (single or composite), tapers, etc. shall necessarily be in steel and shall be manufactured as per standards and tested and laid in the same manner as the pipes. Small branches, single piece bends, etc. may be fabricated at site, care being taken to ensure that the fabricated fittings have at least the same strength as the pipeline to which they are to be jointed.

7.2 Bends

- (a) Bends shall be fabricated taking into account the vertical and horizontal angles for each case.
- (b) The bends shall have welded joints and the upstream and downstream ends of each bend shall have a straight piece of variable lengths as required.
- (c) Bends shall be designed with deflection angle of maximum 10 deg. Between segments.
- (d) When the point of intersection of a horizontal angle coincides with that of a vertical angle, or when these points can be made to coincide, a single combined or compound bend shall be used, designed to accommodate both the angles. The combined bend should have a pipe angle equal to the developed angle, arrived at from appropriate formula.
- (e) All joints in bends shall be thermally stress relieved as specified.
- (f) Details of thrust collars anchor bolts, holding down straps, saddle plates should be furnished together with full specifications in Contractor's fabrication drawing.

7.3 Manholes

- (a) Manholes of 600 mm diameter shall be provided at locations generally 2.5 km apart, with additional manholes at both the sides of butterfly valves. Manholes in the pipeline shall be placed in suitable position in the top quadrant.
- (b) The Contractor shall fabricate different parts of manhole in conformity with relevant IS Specification, well established practices and as directed by the Engineer.
- (c) The manhole shall be provided with MS blank flange on top. The required MS nut, bolts & rubber packing shall be fixed of standard quality for fixing of flange.

7.4 Closing or Make up sections

Closing or make up sections shall be furnished at appropriate locations on the line to permit field adjustments in pipeline length to compensate for shrinkage in field welded joints, differences between actual and theoretical lengths and discrepancies in measurements.

7.5 Heads

Test heads may be ellipsoidal, standard dished as per ASME code or hemispherical heads. They shall be welded in the shop and removed after the test. Allowance should be made in the length of the pipe section receiving the test head for the welding and removal of the head and preparation of the plate edges for the final weld after testing.

No separate payment will be made for such test heads.

7.6 Walkways, Stairs, Ladders, Hand Rails etc.

Walkways, stairs, rungs, ladders, hand rails, etc. shall be provided as shown in the drawings and/or as directed by the Engineer. They shall conform to well established design and construction for each accessory concerned.

7.7 Flanges

Flanges shall be provided at the end of pipes or special where, butterfly, air valve, scour valve, sluice valves, blank flanges, tapers, etc. have to be introduced. The flanges received from the manufacturers will have necessary boltholes drilled. The Contractor shall assemble the flanges in the exact position by marginal cutting, if necessary, so as to get the desired position of the valves, etc. either vertical or horizontal and shall then fully weld the flanges from both sides in such a way that no part of the welding protrudes beyond the face of the flanges. In case the welding protrudes beyond the flanges and if the Engineer orders that such protrusions shall be removed, the Contractor shall file or chip them off. If required and when ordered by the Engineer, the Contractor shall provide and weld gusset stiffeners, as directed on site. The drilling pattern shall be matching with the drilling pattern of flanges of valves.

7.8 Blank Flanges

Blank flanges shall be provided at all ends left unattended for the temporary closure of work and also for commissioning a section of the pipeline or for testing the pipeline laid. For temporary closures, non-pressure blank flanges consisting of mild steel plates, tack welded at the pipe ends may be used. For pipes subjected to pressures, the blank flanges or domes suitably designed as per Engineer's requirements shall be provided.

7.9 Stiffener Rings

The Contractor shall provide stiffener rings wherever required by design. The Contractor shall weld the same to the pipes with one circumferential run on each side. All fillet welds shall have a throat thickness of not less than 0.7 times the width of welding.

8 FIELD HYDRAULIC TEST

After each section of the pipeline has been completed, it shall be tested for water tightness before being covered. The contractor shall at his own cost fill up water in pipeline & give necessary hydraulic test section by section & the pipeline shall stand the pressure which shall exceed the working pressure by (a) 50% of the highest pressure in the section (b) 30 M whichever is less without showing any leakage or sweating anywhere in the pipe joints, specials, valves, etc. If any defect is found, the contractor shall make good the same at his own cost.

Any leaking joint shall be made good & above test pressure is to be lowered gradually after satisfactory test is over.

The hydraulic test shall be given again if considered necessary by the Executive Engineer

or his representative to show that no further leakages or sweating is there. The contractor shall have to make necessary arrangements for water testing as well as plugging the opened pipe, etc. as directed without claiming any extra cost.

It the contractor does not able to manage section wise hydraulic test, hydraulic test shall be observed as below:

After completion of entire pipeline work and commissioning of pump sets (i.e. the project is ready for commission), the entire pipeline shall be hydro tested.

The contractor shall have to take the permission for drawal of water for field-testing of pipe. The cost of hydraulic testing of the installation by providing necessary testing equipments, creating and maintaining pressure and the necessary bulk heads and their fixtures and their subsequent removal and restoring the installation to working stream shall be included in the rate for laying and testing of the pipe. Water charges and electricity charges for field hydraulic testing shall be borne by the contractor.

The pressure test shall be conducted in dry weather to observe whether any leakage takes place or not. For field hydraulic test water will pass through entire pipe line with a working pressure of maximum working pumps for a period of seven days continuously after attaining the required pressure and water reaches at the outlet of transmission main. A leakage equivalent to 0.267 litre per mm of pipe dia. per kilometre of pipeline per day for testing at working pressure applied is permissible. Any leakage beyond that specified herein above shall be rectified to the satisfaction of the Engineer.

Water shall not spout, ooze or sweat either through joints-welded or bolted or the body of the pipe. If any leakage noticed shall be repaired by the Contractor, which shall include coating and repairing of the damaged portion. Repairs and replacements and further testing including the cost of the plates and other raw materials shall be carried out by the Contractor at his own cost. If any leakages are observed during the defects liability period due to defective workmanship or material supplied by the Contractor, he shall repair the same to the entire satisfaction of the Employer, at his own cost.

After completion of field hydraulic test as specified above and if no leakage is found in the entire pipeline / joints and all welded portion, then this may be considered as field hydraulic test and after commissioning of the pipeline system, amount retained at the rate of 3% can be released. (Maximum number of working pumps will work continuously to achieve required pressure specified in the tender).

Till the contractor gives satisfactory field hydraulic test & commissioning of the pipeline an amount at the rate of 3% of testing commissioning as per Price Schedule shall be withheld.

9 PROGRESS IN LAYING

The Contractor shall submit along with the tender his detailed bar chart for manufacturing and laying of the pipeline. While preparing his bar chart, the Contractor shall plan his activities such that the laying of pipes shall closely follow

the manufacturing schedule and no pipes shall remain stacked in factory or at site for a period more than one month.

It is mandatory that he shall submit an approach note on how he will carry out this Work within the contractual period and on the compatible resources in terms of construction equipment and other facilities that he shall utilize to complete the tendered Work.

9.1 Lowering and Jointing

The pipe shall be lowered into the trenches by removing only one or two struts at a time. It shall be seen that no part of the shoring is disturbed or damaged and, if necessary, additional temporary struts may be fixed during the lowering operations. It shall also be necessary to see that the gunite coating of pipe is not damaged in any way during the lowering and assembling. After the pipe is lowered into the trench, it shall be laid in correct line and level by using the leveling instruments, sight rails, theodolite, etc. Care shall be taken to see that the longitudinal joints of two consecutive pipes at each circumferential joints are staggered by 90°. While assembling the pipes, the ends shall have to be brought close enough to leave a uniform gap not exceeding 4mm. If necessary, a marginal cut may be taken to ensure a close fit of the pipe faces. For this purpose, only experienced cutters who can make uniform and straight cuts, shall be permitted to cut the faces of the pipes. No extra payment shall be made for such marginal cutting. There shall be no lateral displacement between the pipe faces to be joined. If necessary, spiders from inside and tightening rings from outside shall be used to bring the two ends in perfect contact and alignment. It may also be necessary to use jacks for this purpose. In no case shall hammering or longitudinal slitting be permitted. When the pipe is properly assembled and checked for correct line and level, it shall be firmly supported on wooden beams and wedges and tack welded. Some portion of the trench may be refilled at this stage so as to prevent the pipeline from losing its alignment. The tack welded circumferential joints shall then be welded fully. Only experienced welders, who shall be tested from time to time shall be permitted to carry out the welding work.

On completion of the pipe jointing and external protection, the trench and the welding pits shall be cleaned of guniting rebound. The welding shall be filled and compacted in 150mm layers with the bedding material.

Backfilling shall be carried out as detailed here under.

Providing Steel Props inside the Pipeline (Dia. 1200 mm and above)

It is necessary that the roundness of the pipes is maintained circular. To achieve the same, steel adjustable screw type props of screw or similar approved make consisting of minimum six (three on each side) legs shall be fixed inside the pipe. The deflection of the pipe should be limited to 1% of the average diameter. In no case shall the limit be exceeded, even under the full load, in case of pipes laid underground. The design and drawings of the props that the Contractor intends to

use should be got approved by the Engineer before starting the work. While laying the pipes underground, the Contractor shall provide this propping arrangement from inside to maintain circularity. These props shall be fixed vertically and at intervals of not more than 1.8 metres or as directed by the Engineer. In case the Engineer finds it necessary, they will have to be fixed in any position. The props should be kept in position at least for three days after the encasing of the pipe in that section is completed or till refilling is done to the full height of fill over the pipe in case the pipes are not encased. The props shall be removed only after obtaining permission from the Engineer. The height of earth fill over the pipe top shall normally be such as to avoid floatation under submerged conditions and to have a minimum earth cushion of about 1.00 metres over the pipe whichever is greater. It is also necessary that, in case of buried pipe, adequate side supports from the backfilled materials is developed to keep the diametrical deflection within the specified limits.

Backfilling of the excavated trenches, particularly below the pipe and along the sides shall, therefore, have to be done with proper care and compaction as desired. No extra payment will be made for the above work.

9.1.1 Precautions against Floatation

When the pipeline laid underground or above ground in a long narrow cutting gets submerged in water collected in the trench of cutting it is subjected to an uplift pressure due to buoyancy and is likely to float if completely or partly empty. In the design of pipelines, provision is to be made to safeguard against floatation providing sufficient overburden or by providing sufficient dead weight by means of blocks, etc. Factor of safety for calculations for check against floating shall be taken as 1.2.

In the case of works extending over one or more monsoon seasons, however, special care and precautions are necessary during the progress of work on this account. The Contractor shall close down pipe laying operations well in time for the monsoon. The work of providing blocks, refilling the earth to the required level, compacting the same, etc. shall always be done as soon as the pipeline in the cutting has been laid.

The Contractor shall see that the water shall not be allowed to accumulate in open trenches. Where work is in an incomplete stage, precautionary work, such as blank-flanging in the open ends of the pipeline and filling the pipeline with water etc. shall be taken up as directed by the Engineer.

Such works shall be to the Contractor's account and no separate payment shall be made for the same. The Contractor's rate for pipe laying shall be deemed to include such precautionary measures against floatation.

Protection of the pipeline against floatation during the Contract Period shall be the responsibility of the Contractor. Should any section of the pipeline float due to his

negligence, etc. the entire cost of laying it again to the correct line and level shall be to his account.

Electric and telephone line, cable and pole if required to be shifted, necessary charges for shifting to be paid to respective authorities shall initially be paid by the contractor to the concern department and the same will be reimbursed by GOVT. to contractor on producing receipt of challan of concern department.

L - section of route is tentative. Contractor has to prepare a fresh Longitudinal Section before starting the work, showing all service lines coming across or parallel.

Alignment of pipeline may required to be changed on same route due to any obstructs or service lines. No extra payment made to contractor.

Manhole chamber and all other structure required to be constructed on road are to be Designed for “AA” class loading and same shall be got approved from Engineer-in-charge.

All necessary actions required for diversion of the traffic on State high way, or any other routes are to arranged by the contractor at his own cost as per the requirement of the traffic rules.

During the execution of work any damage occurred to the private / Govt. property is to be reimbursed by the contractor to the owner.

Asphalt cutting for pipeline excavation included in the scope of work and the debris of asphalt cutting shall have to be carted and dumped at the place shown by the Engineer in charge so that GOVT. can sort it out and reuse the same in other work. The contractor has to bring the road to its original position without any extra cost.

10 ADDITIONAL REQUIREMENT FOR PIPE TO BE LAID BY PUSHING METHOD

For insertion of casing pipe boring shall be carried out by auger type boring device with cutting head to drill a horizontal bore. The hole drilled shall be of suitable size to accommodate casing pipe. The casing pipe shall be inserted along with boring to keep the formation supported to prevent any settlement. The casing pipe shall be installed with even bearing throughout its length. The work will be done under the supervision of canal authority as per restrictions & precautions as may be stipulated by the canal authority.

The casing pipe will be minimum 1.2 m below the canal bed level & 0.9 m below the natural G.L. The length of casing pipe shall be upto the boundary of canal bank. Casing pipe shall be provided with minimum 50 mm dia GI pipe of 2 m height above G.L. with screen at top. Rates are inclusive of bottom & side rollers of suitable size to be provided inside casing pipe at 4 m interval to facilitate insertion of carrier pipe of required dia. The ends of casing pipe shall be suitably sealed.

The casing pipe is to be provided with epoxy treatment as below on outer face of the pipe before lowering.

Zinc Rich Epoxy Primer

Description	Two pack zinc rich consisting of –
Base	Fine Zinc Dust Ground in Epoxy Resin Solution, supplied in paste form
Catalyst	Abduct type- the non volatile portion of the material (mixed) should consist of 92 % Zinc Dust & 8-10% Epoxy Resin & curing agent
Shade	Grey
Characteristics	The paint shall provide a complete rust inhibitive barrier coating of high mechanical & abrasion resistance. The film shall be compatible for fusion & spot weld.
Pot-life	4-6 hours
Mixing Ratio	The proportion of mixing of base & hardener should be as specified by the Manufacturer by weight & volume. The mixed primer shall conform to the specifications detailed.
Viscosity of ready mixed paint	15-22 in Fort Cup No. 4 at 30°C
Drying time	i. Dust free – 10-15 minutes ii. Chamber curing – 24-28 hours
Thickness	4 mils (406 microns)

11 BACK FILLING OF TRENCHES

On completion of the pipe laying operations in any section, for a length of about 100m and while further work is still in progress, refilling of trenches shall be started by the Contractor with a view of restricting the length of open trenches. Pipe laying shall closely follow the progress of Trench Excavation and the Contractor shall not permit unreasonably excessive lengths of trench excavation to remain open while awaiting testing of the pipeline. If the Engineer considers that the Contractor is not complying with any of the foregoing requirements, he may prohibit further trench excavation until he is satisfied with the progress of laying and testing of pipes and refilling of trenches. If the excavated earth is unsuitable for backfilling, The selected earth is to be brought from outside within 3 km. distance. The selected soil brought from outside shall only be used for filling trenches from bottom of pipe to 50 cm. on above top of pipe including on both sides of the trench. Only soft earth of good quality free from stones and free from boulders, roots, vegetation etc., shall be utilised after the lumps are broken for refilling in trench. Filling shall be done in layers not exceeding 150mm and compacted to 85 percent of the maximum dry density as per part VII of IS:2720. Care shall be taken during backfilling, not to injure or disturb the pipes, joints or coating. Filling shall be carried out simultaneously on both sides of the pipes so that unequal pressure does not occur. Walking or working on the completed pipeline unless the trench has been filled to height of at least 30 cm over the top of the pipe except as may be necessary for tamping etc., during backfilling work.

The remaining portion of the trench may be filled in with a mixture of hard and soft material free from boulders and clods of earth larger than 150 mm in size if sufficient quantity of good earth and murrum are not available. Filling in shall be done in layers not exceeding 225 mm in thickness accompanied by adequate watering, ramming etc. Water contents of the soil shall be as near the optimum moisture content as possible. The trench shall be refilled so as to build up to the original ground level, keeping due allowance for subsequent settlement likely to take place. No extra payment will be made for material brought from outside.

To prevent buckling of pipe shell diameters 1200 mm and above, pipes shall be strutted from inside while the work of refilling is in progress, for which no separate payment shall be made.

Strutting shall be done by means of strong spiders having at least 6 arms which shall be sufficiently stiff to resist all deformation. Spiders shall be provided at a maximum interval of 4 m.

The Engineer shall, at all times, have powers to decide which portion of the excavated materials shall be for filling and in which portion of the site and in what manner it shall be so used.

If any material remains as surplus it shall be disposed off as directed by the Engineer, which includes loading, unloading, transporting and spreading as directed within a distance of 15 km. If the Contractor fails to remove the earth from site within 7 days after the period specified in a written notice, the Engineer may arrange to carry out such work at the Contractor's risk and cost or may impose such fine for such omission as he may deem fit. Particular care shall be taken to keep the trench dry during the entire refilling operation.

If suitable material for refilling is not available from excavation the Contractor shall bring earth, murrum of approved quality as directed by the Engineer. No extra payment will be made for material brought from outside.

No mechanical plant other than approved compacting equipment shall run over or operate within the trench until backfilling has reached its final level or the approval of the Engineer has been obtained.

Subsidence in filling in : Should any subsidence take place either in the filling of the trenches or near about it during the maintenance period of 12 months from the completion of the Contract Works, the Contractor shall make good the same at his own cost or the Engineer may without notice to the Contractor, make good the same in any way and with any material that he may think proper, at the expense of the Contractor. The Engineer may also, if he anticipates occurrence of any subsidence, employ persons to give him timely notice of the necessity of making good the same, and the expenses on this account shall be charged to the Contractor.

12 SAND BEDDING

The sand bedding of minimum 150 mm thickness & level shall be provided below pipe, prior to laying the pipe in trenches. It shall be compacted with a light hand rammer. Any reduction in thickness due to compaction shall be made up by adding sand during ramming. For the purpose of the bedding under this item only screened fine sand of grain size not larger than 2 mm shall be used. The sand shall be clean, uncoated & free from clay lumps, injurious amounts of dust, soft particles, organic matter, loam or other deleterious substances.

If the sand supplied is unclean, it shall be washed. In no case shall sand containing more than 3.5% by dry volume or 5% by wet volume of clay, loam or silt be accepted. Tests specified for determining silt in sand & organic impurities as described in IS : 383 shall apply. Sieved & washed sand shall be stored on the works in such a manner as to prevent intrusion of any foreign matter, including coarser particles of sand or any clay or metal or chips. Tests as indicated above shall be performed if called for by the Engineer at the expense of the contractor.

During the work of providing sand bedding and laying the pipeline over it, loose material from the sides or edges of the trench shall be prevented from falling inside the trench, by providing shoring and taking other measures

13 PIPELINE MARKERS

13.1 Intent

This specification covers the minimum requirements for supply, fabrication and erection of pipeline markers to be installed at various locations along the pipe route.

Following two (2) types of pipeline markers are proposed for the transmission mains.

(i) Pipeline Warning Signs

(ii) Kilometre Markers

The pipeline markers shall be installed, as far as possible, at locations where no hindrance to the regular use of the land or to the traffic is caused.

13.2 General

13.2.1 DISTANCE INDICATORS AND MARKINGS

The Contractor shall supply and fix indicators at all points of change of direction, at all valves and at every one kilometre intervals along the buried pipe line. Indicators shall consist of 10 cm x 10 cm pre-cast concrete posts 1.25 metre long, set 0.75 metre into the ground and painted white above ground level. The description shall be written in blue at one face of the pre-cast post.

In case of the pipeline laid above ground details such as chainage, Invert levels of pipe, appurtenance number, pedestal / saddle number, culvert number, anchor / thrust block. number etc., shall be suitably marked either on the pipeline or the supporting structure etc., in distinct colour. The Contractor / Contractor shall include the cost of this in his rates for the other items.

13.2.2 Pipeline Warning Sign

Pipeline warning signs shall be generally installed at the following crossings: Roads (excepting cart roads & kuchha roads), Rivers, Nallahs.

Pipeline warning sign will indicate existence of the buried pipeline at the crossing and display the name address of the client, name of the project and telephone number (for contact in case of emergency).

For the rest of the crossings as mentioned above, the warning signs shall be generally installed at a distance of 50 M on the upstream side only.

The warning sign shall be located 500 mm to the left of the pipe outside diameter, viewing in the direction of flow and shall face the item being crossed (i.e. road, river, rail track etc).

13.2.3 Kilometer Markers

Kilometer markers shall be installed along the pipe route at every one Kilometer interval.

Markers will display the distance (in full kilometer) from the upstream pumping station (in case of rising mains) or upstream reservoir (in case of gravity mains) and name of the client. Kilometer markers shall be located 500 mm to the left of the pipe centreline viewing in the direction of flow.

13.2.4 Scheme of Painting

The underground steel structure except that embedded in concrete shall be painted with coal tar epoxy of minimum 300 micron DFT. For over ground steel structure, one coat of primer & two coats of colour paint shall be applied.

Colour scheme to be adopted for the markers shall be subject to Employer's approval.

Following colour scheme is proposed for reference:

Warning Sign

- i. All letters shall be painted black except for the word "Warning" which shall be painted red. Background colour shall be yellow.
- ii. Post shall be painted with 250 mm wide alternate bands of black & white paint.
- iii. All above ground steel structure shall be painted yellow.

Kilometer Markers

- i. All above points for warning sign shall be equally applicable for Kilometer markers also.
- ii. Figures shall be stenciled on both sides of the post.

13.2.5 Language

Pipeline warning sign plates & kilometer markers shall be prepared in regional language in line with guideline for providing information as above & shall be approved by the client.

14 ANCHORING OF PIPELINE

For anchorage, RCC thrust blocks in M-20 shall be provided at each bend, tee, taper, end piece to prevent undue movements of the pipeline under pressure. They shall be constructed as per the as per design approved by Engineer considering the highest operation or testing pressure of the pipes, the safe bearing pressure of the surrounding soil and the friction coefficient of the soil.

15 ENCASING PIPELINE

Encasing of pipeline with M-20 shall be done wherever adequate cover on pipeline is not available as per site condition.

16 ROU / ROW

To lay pipeline as per requirement for which required permissions are to be obtained by the contractor. The standing crop, other damages compensations, etc. are to be borne by the contractor to the farmers. Only statutory charges paid by the contractor will be borne by the department including compensation for ROU in land as per Government rules. Additional expenses over & above are included in scope of the tender.

The contractor will have to submit consent & NOC of each farmer & authority before entering into the land / property / crossing & restoration after completion of work respectively. In any case if any claim or disability during construction and O & M arises due to negligence of the bidder, the same shall be recovered from the contractor.

17 Plain and Reinforced Cement Concrete**17.1 General**

Plain concrete is proposed as levelling course below RCC walls of valve chambers and chairs provided for above ground pipeline and reinforced concrete with mix M 20 grade is proposed for MS pipeline thrust blocks, chair / saddle supports, anchor blocks and pipe encasing at road crossings.

Reinforced concrete chambers shall be constructed for air valves, washout valves and on line butterfly valves as per the standard chamber drawings approved. The RCC walls shall have 200 mm thickness and top slab shall have 150 mm thickness. 600 mm x 600 mm size S.F.R.C. cover shall be provided over access opening in the top slab. Puddle flanges, shall be provided in the middle of chamber wall / walls for proper anchorage of the specials to resist the thrust due to water pressure. For detailed specification of concrete refer Section-III Concrete Works.

C. PSC PIPELINE**18 SPECIFICATION FOR PRE-STRESSED CONCRETE PIPES (INCLUDING FITTINGS)****18.1 Scope of work**

- a. **Providing ISI standard pre-stressed concrete pipe of** appropriate class & dia including cost of all material & labour required cost of all taxes,

inspection charges, transportation charges, unloading & stacking etc. complete.

- b. Lowering, laying & jointing in proper grade alignment pre-stressed cement concrete pipes with rubber ring joint including cost of conveyance to site of work all level involved giving hydraulic testing.
- c. Whenever manufacturer is separate & contractor for lowering, laying, jointing & testing in separate the contractor shall enter into an agreement of P.S.C. pipe manufacturer for satisfactory manufacturing, transporting, lowering, laying & jointing & testing of pipes.

18.2 Manufacture of Pipes

- a. All pre-stressed pipes and jointing materials shall strictly conform to IS:784 – 2001-2nd revision & amendment-2003, IS: 733, IS:1343 (Latest edition and amendments thereto).
- b. Cement used for manufacturing shall conform to IS:12269-1976 (53 grade ordinary Portland cement), IS: 8112 (43 grade ordinary Portland cement), IS:1489-Portland pozzolana cement, IS:455-Portland slag cement.
- c. Aggregates used shall conform to IS:383 -1970.
- d. Concrete mix and strength
The mix shall conform to the required laid down for design mix concrete vide IS:1343 latest edition and quality control shall be exercised in accordance with IS:456-2000. The strength requirement will be as specified at clause 8.1.2 of IS:784 latest revision.
- e. Steel to be used
The wires conforming to IS: 1785/Part-I and IS: 1785/Part-II (1967) shall be used for pre-stressed reinforcement of pipe.
- f. Dimension and tolerance of all pipes shall be thoroughly checked for and shall adhere to clause 4 and 9 of IS: 784 latest revised editions.
- g. The contractor shall design the pipes and suitable to withstand specific hydrostatic test pressure. The pipes shall withstand all the tests stipulated in IS:784 (latest revised). The contractor shall submit the design to Engineer-in-Charge and after approval for the design; he shall start the manufacturing of pipes.
- h. Blow out resistance of joint assembly shall be designed for the most unfavourable combinations of joint deflection and tolerance of pipe ends
- i. Necessary precautions against chemical attacks and corrosion shall be taken in manufacturing these pipes. Aspect should be studied if treatment is required that will be paid extra.
- j. The pipe shall be cured by immersing them in water or by automatic sprinkler system for a period of not less than 7 days as per IS 764-1978 the concrete core and that of the cover shall be done in two separate operations.
- k. The pipe manufactured at factory shall be stacked properly. The marking on each pipe shall conform to IS: 784. In addition to this the detail shall be boldly painted with good quality long lasting oil paint.
 - i. The Serial Number of pipe (from inside as well as from outside of the pipe both near the socket and spigot ends).
 - ii. Test pressure in Kg/sq.cm.

- I. The programme of inspection and testing shall be fixed by mutual discussions. The pipes will be tested by the owner or by the third party inspecting agency engaged by the owner.

18.3 Rubber Rings

- a. Rubber gasket shall comply with IS 5382-1969. The manufacturer of pipes shall test each gasket by stretching it to 33-1/3 percent in excess of its original length.
- b. Every ring shall be visually checked particularly at joint.
- c. Gaskets shall be clearly labelled in bundle to indicate type of joints and its test certificate.
- d. The contractor shall procure adequate number of rings required for the work irrespective of number of pipes.

18.4 Carting of Pipes

- a. Pipes manufactured at factory to be carried to site of work either directly or stacked suitably excluding cost of taxes nearby the work site
- b. All pipes shall be loaded in trucks by mechanical crane and unloaded at site by mechanical crane only. No loading of pipes on type will be allowed in any case. Stacking, lowering of pipes by chain pulley block with tripod will be allowed.
- c. Extreme care shall be taken while handling the pipes, damage during transit and handling shall be the contractor's account and will not be payable. Damaged pipe shall be rejected outright. The discretion of Executive Engineer in this behalf shall be final and binding on the contractor.
- d. Payment of excise entry tax, octroi tax and all other taxes shall be the responsibility of contractor.

18.5 Lowering, Laying, Jointing And Testing of P.S.C. Pipe Line

- a. All pipes shall be thoroughly inspected before laying, damaged pipe if any shall not be used and shall be removed from the site immediately.
- b. Murum sand bedding shall be done as directed by Engineer-in-Charge. The consolidation of bottom shall be done with ramming
- c. Lowering, laying and jointing of pipes, the provision in IS:783 shall be strictly followed. Laying shall not be started till the bedding is approved by Engineer-in-Charge.
- d. Pipes shall be lowered in trench very carefully with mechanical appliances such as crane, chain pulley block with tripod arrangements etc. only.
- e. The pipes shall be laid true to line and alignment with specified grades.
- f. The trench shall be kept free of water till the jointing material is properly set
- g. Whenever there are chances of rain water entering, into trenches, care shall be taken to prevent pipe line from floating during construction. The contractor shall suggest the position, number and size of concrete blocks in C.C.M-10 to avoid the floating of pipes and seek approval of the Engineer-in-Charge, and

shall provide sufficient number of C.C. blocks before onset of monsoon. The contractor should note that even in case after due care, pipes are lifted up or disturbed to uplift, the contractor will have to rectify the defect, including replacement of pipes wherever required entirely at his own cost.

- h. Line should be laid on gradient flatter than 1 in 12 if due to some special reasons it is not possible to do so, then contractor shall point out the same and shall suggest the anchor block as per IS 783-1985. Table 3 and shall contract the same approval of the Engineer-in-Charge.
- i. Unless otherwise specifically required the joints of pipes and fittings shall be of semi-flexible spigot and socket type, so manufactured that when fitted with the correct rubber ring the joint shall be self centering and flexible. A rubber rings of adequate strength shall be placed on the spigot which shall be forced into socket of the pipe previously laid This shall compress the rubber ring as it rolls into the annular space forced between spigot at socket and forms a flexible and water tight joint. Jointing includes jointing pre-stressed concrete pipes to pipes and P.S.C. pipes to M.S. specials. Before jointing it should be checked that joint and ring are smooth and clean. The ring should be well stretched and tension is uniform along entire circumstances. Ring should give positive seal under all circumstances of tolerance in dimensions. After Jointing is completed, it should be checked that rubber ring is properly placed in position etc. For this purpose feeder gauge (simple metal strips of 15 mm width and 0.5 mm thickness) may be used and record of checking of joint should be kept. If ring is not in proper position then pipe must be pulled out.
- j. The contractor should note that the laying work shall be taken up only after adequate number of M.S. bends and other specials are fabricated and brought at site and no gap left by contractor for want of providing M.S. machine ends barrel pipes etc. will not be paid by the Board to the contractor and such length of M.S. gaps works will be paid at rate of P.S.C. pipe of relevant class of pipes in which position the gap.

18.6 Hydraulic Testing

After laying the pipe line shall be tested for the 1.5 times of working pressure of that location in the respective sections or as per design criteria which is minimum. The line shall be filled completely with water and kept for a week. The pressure shall then be increased gradually to full test pressure required in that section; this pressure shall be maintained at least for 24 hours.

Hydraulic test pressure test at site should be as per Para 5.4.3.2 of Govt. of India. Manual on W.S.&T and Para 15.5 of IS: 783-1985 and site test pressure will be as mentioned in the design criteria. If the sectional length of pipe line fails in this hydraulic testing, contractor has to locate the leakage and to remove them and reset that sectional length. No section will be acceptable unless it is water tight.

18.7 Providing And Caulking Tarred Yarn in Annular Space of The Joint

After right joint is done and pipe line is tested the annular space in between spigot and socket shall be Ailed with spun yarn dipped in bitumen or any suitable means and shall be property caulked No extra payment for this shall be made and cost shall deemed to be included in the rate quoted in Schedule 'B' for providing and laying of P.S.C. pipes.

P.S- Specifications as laid down in IS: 784-2001 2nd revision and subsequent amendments shall be explicitly followed in all aspects of provision of P.S concrete pipes.

D. HDPE PIPELINE**19 Supply, laying and jointing of High Density Polyethylene (HDPE) Pipes & Fittings.****19.1 Scope**

This specification covers the requirements for successfully designing, manufacturing, supplying, laying, jointing and testing at works and site of High Density Polyethylene Pipes used for water supply. Use of HDPE Pipes shall be Pressure Class of minimum PN 6 or above. The minimum outer dia for network up to 20 Ha chak shall be DN 200. The minimum outer dia of the pipe beyond 20 Ha chak shall not be less than DN 110.

19.2 Applicable Codes

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

Others Codes not specifically mentioned here but pertaining to the use of HDPE pipes form part of these Specifications.

19.3 Designation

Pipes shall be designated as per IS 4984, according to the grade of material, followed by pressure rating and nominal diameter, for example, PE 100 PN 10 DN 200 indicates a pipe pertaining to material grade 100 having a pressure rating 1.0 MPa and outside nominal diameter 200 mm.

19.4 Colour

The colour of the pipe shall be black.

19.5 Materials

The material used for the manufacturer of pipes should not constitute toxicity hazard, should not support microbial growth, should not give rise to unpleasant

taste or odour, cloudiness or discoloration of water. Pipe manufacturers shall obtain a certificate to this effect from the manufacturers of raw material by any internationally reputed organization as per the satisfaction of the Engineer-in-Charge in charge.

Code No.	Title/Specification
IS 4984	High Density Polyethylene Pipes for Water Supply
IS 2530	Methods of test for polyethylene moulding materials and polyethylene compounds GRP Pipes, Joints and Fittings for use for Potable Water Supply
IS 5382	Rubber sealing rings for gas mains, water mains and sewers
IS 4905	Methods for random sampling
IS 7328	High density polyethylene materials for moulding and extrusion
IS 7634	Laying & Jointing of Polyethylene (PE) Pipes
IS 9845	Method of analysis for the determination of specific and/or overall migration of constituents of plastics material and articles intended to come into contact with foodstuffs
IS 10141	Positive list of constituents of polyethylene in contact with food stuffs, Pharmaceuticals and drinking water.
IS 10146	Polyethylene for its safe use in contact with foodstuff, Pharmaceuticals and drinking water.

19.6 Raw Material

- Raw material used to manufacture the HDPE pipes shall be 100% virgin PE 100, compounded or Natural black PE resin confirming to IS: 4984, IS: 7328 and ISO: 4427. For this a certification has to be given by the resin manufacturer as per clause 3.2.3 of IS: 4984. The resin proposed to be used for manufacturing of the pipes should also comply with the following norms as per ISO 9080
- The resin should have been certified by an independent laboratory of international repute for having passed 10,000 hour long term hydrostatic strength (LTHS) test extrapolated to 50 years to show that the resin has a minimum MRS of over 10MPa. Internal certificate of any resin manufacturer will not be acceptable.
- Certificate for having passed the Rapid crack propagation test -S4 as per ISO 13477 or FSRC as per ISO 13478 preferably certified by a Reputed International laboratory. High density Polyethylene (HDPE) used for the manufacture of pipes shall conform to designation PEEAA-45-T-003 of IS 7328. HDPE conforming to designation PEEAA-45-T-012 of IS 7328 may also be used with the exception that melt flow rate (MFR) shall not exceed 1.10 g/10 min. In addition the material shall also conform to clause 5.6.2 of IS 7328.
- The specified base density shall be between 940 kg/ m³ and 958 kg/ m³ (both inclusive) when determined at 27°C according to procedure prescribed in IS 7328 The value of the density shall also not differ from the nominal value by more than 3 kg/ m³ as per 5.2.1.1 of IS 7328. The MFR of the material shall be between 0.20 and 1.10 (both inclusive) when tested at 190°C with nominal load of 5 kgf as determined by method prescribed in IS 2530. The MFR of the

material shall also be within ± 20 percent of the value declared by the manufacturer.

- e) The resin shall be compounded with carbon black. The carbon black content in the material shall be within $2.5 \pm 0.5\%$ and the dispersion of carbon black shall be satisfactory when tested as per IS 2530.

19.7 Anti-oxidant

The percentage of anti-oxidant used shall not be more than 0.3 percent by mass of finished resin. The anti-oxidant used shall be physiologically harm less and shall be selected from the list given in IS 10141

19.8 Reworked Material

No addition of Reworked/ Recycled Material from the manufacturer's own rework material resulting from the manufacture of pipes is permissible and the vendor is required to use only 100% virgin resin compound.

19.9 Maximum Quality of Pipe

The outside diameter of pipes, tolerance on the same and Quality of pipe shall be as given in table 2 of IS 4984. Quality shall be measured as the difference between maximum outside diameter and minimum outside diameter measured at the same cross section of the pipe, at 300 mm away from the cut end. For pipes to be coiled the Quality shall be measured prior to coiling. For coiled pipes, however, re-rounding of pipes shall be carried out prior to the measurement of Quality.

19.10 Detectability

HDPE Pipes should be detectable when buried underground, by providing a copper wire of 1.20mm $\pm$ 0.2 mm $\varnothing$, co extruded or firmly secured by self adhesive tapes along the entire length of the pipes duly ISI marked or any other equivalent method enabling measurement/detectability from the top of ground including supply of 3 sets of such instrument.

Copper wire shall have PE (Polyethylene) insulation, if laid separately and secured by self adhesive tapes on the Pipe. The insulation shall be free from voids and shall be strong enough to withstand mechanical and thermal stress of underground buried conditions. The thickness of the PE insulation shall not be less than 1.25 mm or more, if specified in the relevant BIS standards.

Manufacturer of PE insulated copper wire shall perform Type, routine and acceptance tests strictly as per applicable BIS standard specifications. The Contractor will get copies of such tests certificates, approved from the Engineer-in-Charge, before dispatch.

The Engineer-in-charge reserves the right to witness all tests and the Contractor shall provide all facilities, to the Engineer-in-Charge in this regard and shall inform sufficiently in advance to enable the Engineer-in-Charge to depute his

representative to witness the same HDPE pipes should preferably to with co-extruded copper wire.

19.11 Length of Straight Pipe

The length of straight pipe used shall be more than 6 m or as agreed by Engineer-in-Charge in charge. Short lengths of 3 meter (minimum) up to a maximum of 10% of the total supply may be permitted.

19.12 Coiling

The pipes supplied in coils shall be coiled on drums of minimum diameter of 25 times the nominal diameter of the pipe ensuring that kinking of pipe is prevented. Pipe beyond 110mm dia shall be supplied in straight length not less than 6m.

19.13 Workmanship / Appearance

Pipes shall be free from all defect including indentations, delaminating, bubbles, pinholes, cracks, pits, blisters, foreign inclusions that due to their nature degree or extent detrimentally affect the strength and serviceability of the pipe. The pipe shall be as uniform as commercially practicable in colour opacity, density and other physical properties as per relevant IS Code or equivalent International Code. The inside surface of each pipe shall be free of scouring, cavities, bulges, dents, ridges and other defects that result in a variation of inside diameter from that obtained on adjacent unaffected portions of the surface. The pipe ends shall be cut clearly and square to the axis of the pipe. IS 4984 :1995 will be followed for visual appearance.

19.14 Handling, Transportation Storage and Lowering of pipes

During handling, transportation, storage and lowering, all sections shall be handled by such means and in such a manner that no distortion or damage is done to the section or to the pipes as a whole.

The following procedures should be followed so as to eliminate potential damage to pipes and fittings and to maintain maximum safety during unloading, lifting and lowering.

- Pipes must not be stored or transported where they are exposed to heat sources likely to exceed 60°C.
- Pipes shall be stored such that they are not in contact with direct sunlight, lubricating or hydraulic oils, petrol, solvents and other aggressive materials.
- Scores or scratches to a depth of greater than 10% or more of wall thickness are not permissible; any pipes having such defects should be strictly rejected.
- PE pipes should not be subjected to rough handling during loading and unloading operations. Rollers shall be used to move, drag the pipes across any surface.
- Only polyester webbing slings should be used to lift heavy PE (>315mm) pipes by crane. Under no circumstances, chains, wire ropes and hooks be used on PE pipes.

- Pipes shall not be dropped to avoid impact or bump. If any time during handling or during installation, any damage, such as gouge, crack or fracture occurs, the pipe shall be repaired if so permitted by the competent authority before installation.
- During coiling care should be taken to maintain the coil diameter at or above the specified minimum to prevent kinks. Coiling shall be done when the pipe attains the ambient temperature from the extruder. In uncoiling or recoiling care should be taken that sharp objects do not scour the pipe.
- When releasing coils, it must be remembered that the coil is under tension and must be released in a controlled manner. The end of the coil should be retained at all times, then the straps released steadily, one at a time. If the coil has bands at different layers of the coil, then they should be released sequentially starting from the outer layers. The amount of the energy locked up in the coil will depend on the size of the pipe, the SDR of the pipe, and the size of the coil.
- Straight lengths should be stored on horizontal racks giving continuous support to prevent the pipe taking on a permanent set.
- Bare coils shall be wrapped with hessian cloth for long distance (> 300Kms) transportation. The truck used for transportation of the PE pipes shall be exclusively used of PE pipes only with no other material loaded – especially no metallic, glass and wooden items. The truck shall not have sharp edges that can damage the Pipe.
- Pipes manufactured at factory are to be carried to the site of work directly or stacked suitably and neatly along the alignment/road side/elsewhere near by the work site or as directed by the Engineer-in-Charge.
- Damages during transit, handling, storage will be to the Contractor's account and replacement for such pipes has to be made by the Contractor without any extra cost as directed by the Engineer-in-Charge.

19.15 Lowering, Laying of Pipes

- Each pipe shall be thoroughly checked for any damages before laying and only the pipes which are approved by the Engineer-in-Charge shall be laid.
- As the HDPE pipe is flexible and hence smaller deflection can be avoided by bending the pipe while laying. The cold bending should be such that the minimum radius of curvature should not be less than 25 times the outer diameter of pipe. Cold bending shall be allowed at apex having deflection angle up to 10 Degree.
- For apex having deflection angle more than 10 Degree the pre fabricated bends or bend at site by hot bending shall be allowed subject to requirement of Anchor Block.
- While installing the pipes in trenches, the bed of the trench should be level and free from sharp edged stones. In most cases, the bedding is not required, as long as the sharp and protruding stones are removed, by sieving the dug earth, before using the same as backfill material. While laying in rocky areas suitable bed of sand or gravel should be provided. The fill to about 10 to 15 cm above the pipe should be fine sand or screened excavated

material. Where hard rock is met with, bed concrete M15, 15 cm or 20cm thick sand bed as approved by the Engineer-in-Charge may be provided.

- As PE pipes are flexible, long lengths of fusion-jointed pipes having joints made above ground can be rolled or snaked into narrow trenches. Such trenches can be excavated by narrow buckets.
- During the pipe laying of continuous fusion jointed systems, due care and allowance should be made for the movements likely to occur due to the thermal expansion/contraction of the material. This effect is most pronounced at end connections to fixed positions (such as valves etc) and at branch connections. Care should be taken in fixing by finishing the connections at a time the length of the pipe is minimal (lower temperature times of the day.)
- For summer time installations with two fixed connection points, a slightly longer length of PE pipe may be required to compensate for contraction of the pipe in the cooler trench bottom.
- The final tie-in connections should be deferred until the thermal stability of the pipeline is achieved.
- The flexibility of polyethylene pipes allows the pipe to be cold bend. The fusion jointed PE pipe is also flexible as the plain Pipe. Thus the total system enables directional changes within the trench without recourse to the provision of special bends or anchor blocks. However, the pipe should not be cold bend to a radius less than 25 times the OD of the pipe.
- The Installation of flanged fittings such as connections to sluice/air/gate valves and hydrant tees etc., requires the use of stub ends (collars/flange adaptors complete with backing rings and gaskets. Care should be taken when tightening these flanges to provide even and balance torque.
- Provision should be made at all heavy fittings installation points for supports (such as anchoring of the flange in the soil) for the flange joint to avoid the transfer of valve wheel turning torque on to the PE flange joint.
- PE pipe is lighter than water. Hence care should be taken for normal installations where there could be a possibility of flooding of the trench thus the trench shall be kept free of water till the jointing has been properly done
- When flooded, some soils may lose cohesiveness, which may allow the PE pipe to float out of the ground. Several design checks are necessary to see if groundwater flotation may be a concern. Obviously, if the pipeline typically runs full or nearly full of liquid, or if groundwater is always below the pipe, flotation may not be a significant concern.
- However, weights by way of concrete blocks (anchors) are to be provided so that the PE pipe does not float when suddenly the trench is flooded and the soil surrounding the pipe is washed away. Thus site conditions study is necessary to ensure the avoidance of flotation.
- Pipe embedment backfill shall be stone-free excavated material placed and compacted to the 95% maximum dry density.
- When pipe crosses the road, suitable protective measures shall be taken. For unsurfaced road crossing, the pipe shall be encased by M20 CC and for

carpet road the pipe crossing shall be with casing pipe of NP4 having sufficient larger dia.

- While crosses the drain minimum soil cover of 1 to 1.5 mt as per drain capacity shall be provided. The pipe shall be encased by M20 CC. with necessary protection of rubble pitching or launching type protective measures.

19.16 Jointing of Pipes

The pipe shall have Electro-fusion jointing system that shall provide for fluid tightness for the intended service conditions.

19.17 Bedding, Backfilling and Compaction

19.17.1 Bedding

In case of sandy strata no separate bedding is required. However the bottom face / trench bed where pipe shall be placed shall be compacted to provide a minimum compaction corresponding to 95% of maximum dry density. The pipe bedding should be placed so as to give complete contact between the bottom of the trench and the pipe.

The minimum cover over buried pipe should be 1 m.

19.17.2 Back Filling

Backfilling should be placed in layers not exceeding 15cm thickness per layer, and should be compacted to a minimum of 95% maximum dry density. The refilling should be done on both sides of pipe together & height difference in earthfill on each side should not be more to cause lateral movement of pipe.

Most coarse grained soil are acceptable. This may comprise of gravel or sand. However if the excavated earth is unsuitable for backfilling, the selected earth is to be brought from outside approved borrow area for backfilling as per IS Code.

It is very important that the pipe zone backfill material does not wash away or migrate in to the native soil. Like wise, potential migration of the native soil in to the pipe zone backfill must also be prevented.

Heavy earth moving equipment used for backfilling should not be brought until the minimum cover over the pipe is 90 cm in the case of wide tracked bulldozers or 120 cm in the case of wheeled roaders or roller compactors.

19.17.3 Compaction

Vibratory methods should be used for compaction. Compaction within distances of 15 cm to 45 cm from the pipe should be usually done with hand tampers. The backfill material should be compacted not less than 95% of maximum dry density.

19.18 Thrust Block

RCC thrust block should be suitably designed & provided at **each** bend, tee, taper, end piece and at places of reduction in cross section to take care of thrust. The eligibility for requirement of the Thrust Block has to be ascertained prior to laying”.

Further, double chamber restrained joints at 45° bends and 90° bends shall also be considered.

19.19 Fittings & Specials

All HDPE fittings/ specials shall be of minimum PN 6 or above Pressure class, fabricated in accordance with IS: 8360 (Part I & III). PE Injection moulded fittings shall be as per IS: 8008 (Part I to IX). All fittings/specials shall be fabricated or moulded at factory only. No fabrication or moulding will be allowed at site, unless specifically permitted by the Engineer-in-Charge. Fittings will be welded on to the pipes or other fittings by use of Electro- fusion process. Recommended makes for PE / PP fittings / specials are Georg- Fischer, Glynwed, Astore, Magnum and GPS.

19.20 Bends

HDPE bends shall be plain square ended conforming to IS: 8360 Part I & III Specifications. Bends shall be moulded. Combine bends for Horizontal deflection and Vertical deflection shall be avoided.

19.21 Tees

HDPE Tees shall be plain square ended conforming to IS: 8360 Part I & II Specifications. Tees may be equal tees or reduced take off tees. Tees shall be moulded.

19.22 Reducers

HDPE Reducers shall be plain square ended conforming to IS: 8008 Part I & VII Specifications. Reducer must be moulded.

19.23 Flanged HDPE Pipe Ends

HDPE Stub ends shall be square ended conforming to IS: 8008 Part I & VI Specifications. Stub ends will be welded on the pipe. Flange will be of slip on flange type as described below.

19.24 Slip-On Flanges

Slip-on flanges shall be metallic flanges covered by epoxy coating or plastic powder coating. Slip-on-flanges shall be conforming to standard mating relevant flange of valves, pipes etc. Nominal pressure rating of flanges will be PN10.

19.25 Welding Procedure

Joining between HDPE pipes and specials shall be done as per the latest IS: 7634 part II. Method of joining between the pipes to pipes and pipes to specials shall be with Electro-fusion welding using automatic or semi automatic, hydraulically operated, superior quality Electro-fusion machines which will ensure good quality fusion welding of HDPE pipes.

19.26 Site Fabrication of PE Fittings

Two or more PE specials coming at one place (like PE Tee, Reducer, Flanged end etc.,) shall be jointed at contractor's workshop and transported to the site of works

for final installation with proposed PE pipelines. In no case, jointing of three or more welds in one place, at site will be allowed.

19.27 Training

The Contractor shall provide on-site training on PE pipe laying, jointing, testing and maintenance etc., to the personnel authorized by EMPLOYER.

19.28 Manuals

Technical Manual on PE pipes including precautions to be taken during operation of the pipeline.

19.29 Flanges

All flanges employed in the project must be compatible whatever material used.

19.30 Marking

All pipes shall be marked at maximum interval of 1 m.

The marking shall indicate at least the following information.

- 1) Manufacturer's name & / or trade mark.
- 2) The dimensions (nominal outside diameter X nominal wall thickness)
- 3) The outside diameter tolerance (A or B)
- 4) The designation of pipes material (PE 100, PE 80 etc)
- 5) The nominal pressure (PN)
- 6) The production period (date or code)
- 7) The BIS standard number and ISI logo.
- 8) The word "Water" shall also be included.

Apart from online marking on pipes, pipe shall have screen printing on both end of pipes conforming to IS:4984-2016.

19.31 Packing & Transport

The pipes should be preferably transported by road from the factory and stored as per the manufacturer specifications to protect damage.

19.32 Summary of quality Tests :

1. Quality Mark: Pipe: IS 4984
2. Material: As per IS 4984. However only virgin resin is allowed, reworked material is not allowed.
3. Grade of Material: PE 100 as per IS 4984 (Certificate from raw material manufacturer is required).
4. Pressure Rating: PN-6.
5. Colour: as per IS 4984
6. Dimensions of Pipe:
Diameter: The nominal diameter (outside)
Wall thickness: As per IS 4984.
Length:
 - i. For diameter 90 mm and 110 mm : 100 meter
 - ii. For diameter more than 110 mm : minimum 6 meter. (Tolerance as per IS 4984)
7. Visual Appearance: as per IS 4984.

8. Test and sampling: as per IS 4984.
9. Special Test : Notch hydraulic Test for the HDPE pipe made from PE- 100 grade raw material as per ASTM 1474 OR ISO 13479 at manufacturers laboratory or independent laboratory and should pass the Hydraulic test as per IS:4984:1995 for a minimum 165 Hours. The test reports shall not be more than three months old.
Pipe shall convey water under variable temperature conditions ranging from 4 degree centigrade to 45 degree centigrade.
10. Jointing of pipes (pipe end): More than 110 mm diameter: Electro-fusion (Heat Fusion Process)
11. Quality Assurance:
Quality Assurance Plan shall be got approved from the employer before production start.

Note: All remaining parameters / specifications are as per respective IS.

20 Field Hydraulic testing of the pipelines

20.1 Sectional tests

After laying and jointing the pipeline shall be tested for tightness of barrels and joints, and stability of thrust blocks in sections approved by the Engineer-in-Charge in Charge. The length of the sections depends on the topographical conditions. Preferably the pipeline stretches to be tested shall be between two chambers (air valve, scour valve, bifurcation, other chamber) The length of the test section shall be from 1 Km to 2 Km and as directed by the Engineer-In-Charge.. The hydraulic testing shall have to be commenced immediately after laying and jointing of 1 km reach is completed. The design test pressure shall be as per IS.

The water required for testing shall be arranged by the contractor himself. The Contractor shall fill the pipe and compensate the leakage during testing. The Contractor shall provide and maintain all requisite facilities, instruments, etc. for the field testing of the pipelines. The testing of the pipelines generally consists in three phases:

preparation, pre-test/saturation and test, immediately following the pre-test.

Generally, the following steps are required which shall be monitored and recorded in a test protocol.

- Complete setting of the thrust blocks.
- partial backfilling and compaction to hold the pipes in position while leaving the joints exposed for leakage control
- opening of all intermediate valves (if any)
- fixing the end pieces for tests and after temporarily anchoring them against the soil (not against the preceding pipe stretch)
- at the lower end with a precision pressure gauge and the connection to the reciprocating pump for establishing the test pressure
- at the higher end with a valve for air outlet

- If the pressure gauge cannot be installed at the lowest point of the pipeline, an allowance in the test pressure to be read at the position of the gauge has to be made accordingly
- Slowly filling the pipe from the lowest point(s).
- the water for this purpose shall be reasonably clear and free of solids and suspended matter
- Complete removal of air through air valves along the line.
- Closing all air valves and scour valves.
- Slowly raising the pressure to the test pressure while inspecting the thrust blocks and the temporary anchoring.
- Keeping the pipeline under pressure for the duration of the pre-test / saturation of the lining by adding make-up water to maintain the pressure at the desired test level. Make up water to be arranged by Contractor himself at his own cost.
- Start the test by maintaining the test pressure at the desired level by adding more makeup water; record the water added carefully and the pressure in intervals of 15 minutes at the beginning and 30 minutes at the end of the test period.

The pipeline stretch will pass the test if the water added during the test period is not exceeding the admissible limits. No section of the pipe work shall be accepted by the Engineer-in-Charge in Charge until all requirements of the test have been obtained.

20.2 Hydraulic test for MS pipes and PSC pipes

20.2.1 Field test pressure

The sections of MS/PSC Raw Water Pumping main shall be tested for the pressures as worked out in detailed designed.

20.2.2 Test requirement

The quantity of water added in order to re-establish the test pressure should not exceed 0.1 litre per mm of pipe diameter per km of pipeline per day for each 30 m head of pressure applied.

All pressure testing at site should be carried out hydrostatically. The pipes shall be accepted to have passed the pressure test satisfactorily, if the quantity of water required to restore the test pressure does not exceed the amount calculated as above.

20.2.3 Failure to pass the test

All pipes or joints which are proved to be in any way defective shall be replaced or remade and re-tested as often as may be necessary until a satisfactory test shall have been obtained. Any work which fails or is proved by test to be unsatisfactory in any way shall be redone by the Contractor.

20.2.4 Back filling

Water used for testing should not be carelessly disposed off on land which would ultimately find its way to trenches.

On completion of a satisfactory test any temporary anchor blocks shall be broken out and stop ends removed. Backfilling of the pipeline shall be completed.

20.2.5 Flushing and disinfecting of pipelines

After testing and commissioning the contractor shall flush the pipes with a velocity not less than 1 m/s or as approved by the Engineer-in-Charge in Charge. Disinfection of drinking water pipelines should be done by Contractor.

21 Technical Qualifications for procurement of pipes during construction :

21.1 Pipe manufacturer : Successful bidders shall source all types of pipes and specials from reputed manufacturers. If the bidder is also manufacturing pipes, should produce documentary evidence of such production Certification of Indian Standards. Manufacturer must not have been debarred/black listed by any Government Department of India.

21.1.1 M.S.Pipe :

The Pipe manufacturer should have an annual installed production capacity of minimum 15,000 MT.

The Pipe manufacturer should have manufactured and supplied at least 200 Km. M.S. Pipe of minimum 500 mm or above dia. including at least 30 Km. M.S. Pipe of minimum 1000 mm or above dia., during past 1 year.

21.1.2 P.S.C. Pipe :

The production capacity of P.S.C pipe of diameter 800 mm to 1200mm shall be minimum 50 Km per year. The manufacturer should have also successfully supplied the above pipes for a length of 50 Km during last year.

The manufacturer should hold valid IS license under IS: 12709 consecutively for last three years to manufacture ISI marked pipes.

21.1.3 H.D.P.E. Pipe :

The Pipe manufacturer should have an annual installed production capacity of minimum 10,000 MT.

The manufacturer should hold valid IS license under IS: 4984 consecutively for last three years to manufacture ISI marked pipes.

21.1.4 D.I Pipes

The Successful Bidder shall source all Ductile Iron pipes and fittings from manufacturers having experience of supplying for at least one year and whose Ductile Iron pipes and fittings are in satisfactory performance for at least one year in Indian projects.

The D.I Pipe manufacturer should have an annual installed production capacity of minimum 15,000 MT.

The manufacturer should hold valid ISI license consecutively for last three years to manufacture ISI marked pipes.

E DUCTILE IRON(DI) PIPELINE

22 GENERAL

This specification covers the specific requirement of design, material, manufacture / fabrication, constructional features, inspection & testing, transportation, handling, laying and site testing of **Ductile Iron (DI) Pipes, Joints, fittings and specials**.

22.1 CODE AND STANDARDS

The material, design, manufacture, dimensions, tolerances, mechanical properties, internal cement mortar lining, external zinc coating along with bituminous finished layer, inspection and testing of DI water pipes shall comply with the latest Indian Standard, “IS 8329 (Centrifugally cast (spun) ductile iron pressure pipes for water, gas and sewage – specification)” or equivalent international standard unless otherwise specified elsewhere in this Technical Specification. The various referred National and International codes generally used in the design, manufacture and testing of DI pipes are as mentioned below:

Sl.No.	Code No.	Code Title
1.	IS 8329	Centrifugally cast(spun) ductile iron pressure pipes for water, gas and sewage – specification
2.	IS 9523	Ductile iron fittings for pressure pipes for water, gas and sewage – specification
3.	IS 5382	Rubber sealing rings for gas mains, water mains and sewers
4.	IS 638	Specification for Sheet Rubber Jointing and Rubber Insertion Jointing
5.	IS 12288	Code of practice for use and laying of Ductile Iron pipes
6.	IS 11606	Methods for sampling of Cast Iron pipes and fittings
7.	IS 455	Portland slag cement
8.	IS 12330	Sulphate resisting Portland cement
9.	IS 6452	Specification for high alumina cement for structural use
10.	IS 6909	Specification for super - sulphated cement
11.	IS 8112	43 grade ordinary Portland cement
12.	IS 1387	General requirements for supply of metallurgical materials
13.	IS 1500	Methods for Brinell hardness test for metallic materials
14.	IS 1608	Mechanical testing of metals - tensile testing
15.	ISO 2531	Ductile iron pipes, fittings, accessories and their joints for water applications
16.	ISO 4179	Ductile iron pipes and fittings for pressure and non pressure Pipelines -- Cement mortar lining
17.	ISO 4633	Rubber seals -- Joint rings for water supply, drainage and sewerage pipelines - Specification for materials
18.	ISO 8179	Ductile iron pipes -- External zinc based coating -- Part 1: Metallic zinc with finishing layer

Sl.No.	Code No.	Code Title
19.	ISO 8179	Ductile iron pipes -- External zinc coating -- Part 2: Zinc rich paint with finishing layer
20.	ISO 8180	Ductile iron pipelines - - Polyethylene sleeving for site application
21.	ISO 10802	Ductile iron pipelines - - Hydrostatic testing after installation
22.	ISO 10803	Design method for ductile iron pipes
23.	ISO 16132	Ductile iron pipes and fittings - - Seal coats for cement mortar linings
24.	AWWA M 41	Ductile - Iron pipe and fittings (guideline code for design, manufacturing, testing, jointing, laying & installation etc.)
25.	BSEN 545	Ductile iron pipes, fittings, accessories and their joints for water pipelines - Requirements and test methods

22.2 DUCTILE IRON (DI) PRESSURE PIPES FOR RISING MAINS & DISTRIBUTARY MAINS

22.2.1 Design Requirements

Classification

The class of DI pipes to be provided shall be as specified in the data sheet attached with this sub section. The external diameter and wall thickness of socket and spigot pipes for the specified Class shall be as per IS 8329 or equivalent international standard.

Pressure class and thickness class of pipe flanges shall be as specified in the data sheet attached with this sub section and shall conform to the requirements of IS 8329 or equivalent international standard.

Length

Socket and Spigot pipes shall be supplied in standard working lengths of 5.5m or 6m and flanged pipes in lengths of 4m / 5m / 5.5m as per requirements.

Tolerances

Tolerances on External diameter, ovality, thickness and length of pipes etc. shall conform to the provisions of IS: 8329 or equivalent international standard.

Material Requirements

The metal used for manufacturing the pipes shall be of good quality, commensurate with the mechanical requirements laid down in IS 8329 or equivalent international standard.

Manufacturing Requirements

Pipes supplied shall be centrifugally cast (spun) Ductile Iron pipes conforming to IS 8329 or equivalent international standard. The pipes shall be stripped with all precautions to avoid warping or shrinkage defects, detrimental to their good quality. The pipes shall be sound and free from surface or other defects.

External layer

The DI pipes supplied shall be provided with external protection of metallic zinc coating with finishing layer of bituminous paint as per IS 8329 or equivalent international standard.

Internal lining

The pipes shall be provided with suitable cement mortar internal lining as per IS 8329 or equivalent international standard.

Joints

Push on flexible joints shall be provided for pipe to pipe connection as per IS 8329 or equivalent. Wherever, flange joints are required e.g. at terminal points, valves, over ground and underground pipe connection etc., Welded on flanges shall be used.

Rubber gaskets

Rubber gasket used with push on flexible joints shall conform to the requirements of IS: 5382 or equivalent. Rubber gaskets for use with flanged joints shall conform to IS 638 or approved equivalent.

22.2.2DI FITTINGS & SPECIALS

General

DI Fittings should preferably be manufactured by the manufacturer of the pipes. In case they are not, it will be the responsibility of the manufacturer of the pipes to have them manufactured through a suitable manufacturer under its own supervision and have it tested at his/sub contractor's premises as per the contract. The pipe manufacturer will ensure the compatibility of the pipes and fittings by prescribed type test with its own pipe and the outsourced fittings.

The manufacturing unit should have ISO 9001 certification.

The company should have fully equipped laboratory with in-house microscope to check nodularity and to check chemical composition along with tensile, hardness & elongation by universal testing machine. The laboratory of the manufacturer should be accredited by NABL.

Since the socket design is not given in the standard the min. socket thickness of fittings at any point must not be lesser than minimum body thickness given in the standard.

22.2.3Design Requirements

Classification

The class of DI fittings to be provided shall be as specified in the data sheet attached with this sub section. The external diameter and wall thickness of fittings for Push on joints for the specified Class shall be as per IS 9523 or equivalent.

The Pressure class of flanged fittings shall be as specified in the data sheet attached with this sub section and shall conform to the requirements of IS 9523 or equivalent.

Permissible deviations on length of fittings

The permissible deviations on the length of fittings shall be as per IS: 9523 or equivalent.

Tolerances

Tolerances on external diameter, Raised face height, thickness and Flange drilling of fittings etc. shall conform to the provisions of IS: 9523 or to the provisions of international equivalent standard to which they are supplied.

22.2.4Material Requirements

The metal used for manufacturing the fittings shall conform to the appropriate grade as specified in IS 1865, in commensurate with the requirements of IS 9523 or equivalent.

22.2.5Manufacturing Requirements

The fittings shall be stripped with all precautions to avoid warping or shrinkage defects, detrimental to their good quality. The fittings shall be sound and free from surface or other defects.

Linings and Coatings for Ductile Iron Fittings

The DI Fittings are to be lined with Cement Mortar Linings with a sand cement mixture and the lining thickness should be as per Table 33 (Annex B) of IS 9523. The Coatings to DI fittings shall be similar in line with the provisions of DI pipes. All fittings must be painted with Zinc rich paint as per Annexure A of IS 9523. Bitumen being used for External coating should be approved By WRAS or similar approval authority. However, in soil conditions where soil resistivity is less than 1000 ohm-cm with or without water table, fusion bonded epoxy lined and coated DI fittings to be used in place of other type of lined and coated fittings.

Fittings with Flexible Push-on joint

Flexible joints shall be of spigot and socket “push-on” type suitable for angular deflection in any direction and capable of axial movement to compensate for thermal expansion or contraction and ground movement.

Fittings with Flanged joint

Fittings with Flanged joints will be with raised face and they shall be supplied complete with approved gaskets, hot dipped galvanized or cadmium plated bolts, nuts.

Fittings with Mechanical joint

Where Fittings with mechanical type joints are specified, proposed and approved they shall be supplied complete with approved gaskets, glands, hot dipped galvanized or cadmium plated bolts, nuts and all other necessary accessories.

Fittings with Restrained Joints

DI fittings with restrained joints shall be utilized in underground application where pipelines have to cross roads through existing ducts or in areas with restricted accessibility where the use of concrete anchor blocks is prohibited, or as directed by the Engineer-in-Charge. The CONTRACTOR shall submit with his bid with full details of the type of restrained joint he proposes to use.

Whenever in the course of work the CONTRACTOR intends to utilize restrained joints he

shall obtain prior approval from the Engineer-in-Charge.

Calculation of the number of pipe lengths with restrained joints required on both sides of the fitting shall follow the manufacturer's recommendation and shall be subject to the Engineer-in-Charge approval.

Restrained joints shall be designed in accordance with ISO 10804-1. The permissible angular deflection will be as declared by the manufacturer. The performance **Type test** of this Joint in line with ISO 10804-1/EN545 has to be established by the manufacturer by getting it witnessed by a NABCB (National Accreditation Board for Certification Bodies) or IAF (International Accreditation Forum) or EA (European Cooperation for Accreditation) accredited institution / certification agency.

Rubber ring for joints shall be of a type that will not deteriorate when stored under manufacturer's guidelines or during operation. The rubber gasket shall be of EPDM elastomer in accordance with IS:5382 suitable for water supply.

Joints between pipe and fittings

Push on flexible joints shall be provided for pipe to fitting connection as per IS 9523 or equivalent. Flange joints, wherever required, shall conform to the requirements of IS 9523 or equivalent.

Rubber gaskets

Rubber gasket used shall conform to IS:5382:1985 or as amended up to date. Other requirements of gaskets are as per clause-7 of IS 9523:2000. Rubber Gaskets to be ISI marked EPDM quality.

22.3 TYPE TESTS

The contractor / manufacturer shall carry out the type tests as listed in this specification on the pipes to be supplied under this contract. The bidder shall indicate the charges for each of these type tests separately in the relevant schedule of Section VII (Forms & Procedures) and the same shall be considered for the evaluation of the bids. The type tests charges shall be borne by the EPC contractor for the test(s) actually conducted successfully under this contract and upon certification by the Employer.

The type tests shall be carried out in presence of the Employer's representative, for which minimum 15 days notice shall be given by the contractor. The contractor shall obtain the Employer's approval for the type test procedure before conducting the type test. The type test procedure shall clearly specify the test set-up, instruments to be used, procedure, acceptance norms, recording of different parameters, interval of recording, precautions to be taken etc. for the type test(s) to be carried out.

In case the contractor / manufacturer has already conducted such specified type test(s), he may submit the type test reports to the Employer during detailed engineering for consideration of waiver of conductance of such type test(s) or otherwise as deemed fit by Employer. Such test(s) should have been either conducted at an independent laboratory or duly approved by accredited third party agency. The Employer reserves the right to waive conducting of any or all the specified type test(s) under this contract.

The type test shall be performed whenever a significant change is made in the design, material or process of manufacture or a new size or size range of the product is being supplied by the manufacturer.

The following **type tests** shall be carried out:

Joint Leak Tightness Test

- a) Tests for joints (push on flexible joints) shall be conducted as per the guidelines of ISO 2531 to establish adequate joint performance with respect to internal pressure, external pressure and vacuum pressure under both normal alignment of joints and deflected alignment of joints as dictated in ISO 2531.
- b) Tests for Leak tightness and mechanical resistance of **flanged joints** shall be conducted as per ISO 2531.

Cement Lining Smoothness Type Test

The contractor / manufacturer should have carried out Cement Lining Smoothness test to establish C value (Hazen & William's constant) of the offered DI pipe as 140. Necessary certificate for the same shall be furnished to the employer.

In case the contractor / manufacturer has not carried out the test, the same shall be carried out by the contractor / manufacturer within the scope of this contract.

Ring bend test

Ring bend test for 3% deflection with respect to external diameter of DI pipe offered shall be conducted by contractor / manufacturer to prove that internal cement mortar lining does not come off the substrate surface of Ductile Iron on random basis for each manufacturing lot.

If the contractor / manufacturer of pipes do not have the facility for this type test at his own works, the same can be arranged by him to conduct and demonstrate the test.

22.4 TRANSPORTATION AND DELIVERY OF PIPES

Bidder shall have to submit a write up for safe handling and stacking of pipes during transportation and at site. It shall conform to the requirements stated in IS: 12288 or equivalent.

All pipes fabricated in the factory and temporarily stacked in the Contractor's yard or factory shall be transported to site after shop testing & cleaning them internally. The loading in the factory shall be carried out by means of either a crane, gantry or with shear legs, so as not to cause any damage to the finished material. Similarly, while unloading and stacking, great care shall be taken to ensure that the material or lining inside is not damaged or dented.

The material being delivered at site shall be jointly inspected by the Employer and the Contractor. Defective or damaged pipe shall be rejected by Employer or in case of minor damage, the Employer may allow repair of the pipe by the Contractor to the satisfaction of the Employer as per guideline of IS 8329.

Props of proven designs shall be fixed to the pipes during transit to avoid undue sagging and consequent distortion. After the pipes are carefully stacked, props may be removed and re used for subsequent operations.

In case of transport by ship, packing shall be sea worthy so as to ensure safe delivery till site.

All the DI fittings shall be properly packed with jute cloth. Rubber rings shall be packed in polyethylene bags. Rubber rings in PE bags and nuts, bolts etc. shall be supplied in separate jute bags.

At site, pipes shall be stacked in such a way that suitable gaps shall be left in the pipes at intervals to permit access from one side to the other.

22.5 MARKING

Each Pipe shall have as cast or stamped or legibly and indelibly painted on it with the following marks:

- a) The Manufacturer's name or trademark on each pipe
- b) The nominal diameter of pipes and batch number.
- c) Class of Pipes and fittings
- d) A white ring line showing length of insertion at spigot end
- e) Standard ISI certification mark for the pipes conforming to IS or international standard mark to which they are supplied.
- f) The last two digits of the year of manufacture
- g) Any important information that the manufacturer deems fit to be inscribed on pipe.

22.6 LAYING AND JOINTING OF DI PIPES

Laying, erection and jointing of DI pipelines at field / site shall be under the direct supervision of Manufacturer (Supplier) from whom pipe is sourced / procured.

Laying Underground

Pipes shall be lowered into the trench with tackle suitable for the weight of pipes. For smaller sizes, up to 250 mm nominal bore, the pipe may be lowered by the use of ropes but for heavier pipes suitable mechanical equipment shall be used.

All construction debris shall be cleared from the inside of the pipe either before or just after a joint is made. All persons shall vacate any section of trench into which the pipe is being lowered.

The assembly for the pipes shall be made as recommended by the pipe manufacturer and using the suitable tools.

The socket and spigot ends of the pipes shall be brushed and cleaned. The chamfered surface and the end of the spigot end have to be coated with a suitable lubricant recommended by the manufacturer of the pipes. Oil, petroleum bound oils, grease or other material, which may damage the rubber gasket, shall not be used as lubricant. The rubber gasket shall be inserted into the cleaned groove of the socket. It shall be checked for correct positioning.

The two pipes shall be aligned properly in the pipe trench and the spigot end shall be pushed axially into the socket either manually or with a suitable tool specially designed for the

assembly of pipes and as recommended by the manufacturer. The spigot has to be inserted up to the insertion mark on the pipe spigot. After insertion, the correct position of the socket has to be tested with a feeler blade.

Deflection of the pipes, if any, shall be made only after they have fully been assembled. The deflection shall not exceed 75% of the values indicated by manufacturer.

On gradients of 1:15 or steeper, precautions shall be taken by anchor block to ensure that the spigot of the pipe being laid does not move into or out of the socket of the laid pipe during the jointing operations. As soon as the joint assembly has been completed, the pipe shall be held firmly in position while the trench is back filled over the barrel of the pipe. The backfill shall be well compacted.

Special provisions in trench shall be made for accommodating socket (Bell) of each pipe, as applicable so that barrel is uniformly rested on even trench bed surface, which is well compacted as recommended in codes / standards.

At the end of each working day and whenever work is interrupted for any period of time, the free ends of laid pipes shall be protected against the entry of dirt, water or other foreign matter by means of approved plugs or end caps.

Laying above ground

The following is applicable only when no additional bending moments except that those due to self weight of pipe and its content are present. If any additional moments are present, piping contractor has to suitably support the pipe in consultation with manufacturer and Employer.

a) Socket and spigot pipes

Socket (Bell) and spigot pipes shall be provided with one support (usually pedestal or steel pipe support) per pipe. The supports shall be positioned behind the socket of each pipe.

Pipes shall be fixed to the supports with mild steel straps so that axial movement due to expansion and contraction resulting from temperature fluctuations is taken up at individual joints in the pipeline. Joints shall be assembled with the spigot end withdrawn 5 to 10 mm from the bottom of the socket to accommodate thermal movements.

The designed anchorage shall be provided to resist the thrusts developed by internal pressure at bends, tees, etc.

Where a pipeline crosses a watercourse, the design and method of construction shall take into account the characteristics of the watercourse to ascertain the nature of bed, scour levels, maximum velocities, high flood levels, seasonal variation, etc., which affect the design and laying of pipeline.

b) Flanged pipes

The maximum unsupported span for flanged pipes shall not be more than 8 m. The supports shall be located at the centre of every second pipe.

The maximum unsupported span at water course shall also be not more than 8 m. The relative position of pipe joints and pipe supports shall be as per IS 12288 or equivalent.

The supports of all flanged pipe work spans shall be stable and unyielding due to movements in the pipeline.

The straps shall prevent any lateral movement or lifting of the pipelines but not restrict expansions and contractions caused by temperature fluctuations.

Cutting of pipes

The cutting of pipe, if required, for inserting valves, fittings etc. shall be done in a neat and workman like manner without damage to the pipe or lining so as to leave a smooth end at right angles to the axis of the pipe. Cutting of pipes shall be reduced to a minimum required.

Cutting has to be made with suitable tools as per IS 12288 or equivalent and according to the recommendations of the manufacturer. The spigot end has to be chamfered again at the same angle as the original chamfered end. If there is no mark for the insertion depth on the spigot ends of the (cut) pipe it shall be marked again according to the instructions of the manufacturer.

Pipeline anchorage

Pipeline shall be securely anchored at dead ends, tees, bends, tapers and valves to resist thrust arising from internal pressure. Suitable thrust blocks made of concrete shall be designed and cast- in-situ.

All specials like bends, tees etc. and appurtenances like valves etc. shall be laid in synchronization with the pipes. The Contractor has to ensure that the specials and accessories are available at site ready to be installed together with the pipes.

22.7 EXTERNAL PROTECTION

The details of soil resistivity data shall be verified by the Contractor.

The contractor shall carry out soil resistivity survey along the ROW of the pipeline using Wenner's 4 pin method in the presence of Employer's representatives.

On completion of all field work, a report incorporating resistivity (on semilog graph sheets) data shall be prepared by the contractor and submitted to the Employer.

In case of highly corrosive soil (soil resistivity less than 1000 ohm cm), polyethylene sleeving shall be provided for encasement of the pipes, fittings and joints against corrosion. This encasement shall be so designed to prevent the contact of pipe, fittings and joints with the surrounding backfill and bedding material. It shall conform to the requirements of IS 8329 & IS 12288 or equivalent international standards.

22.8 HYDRAULIC TESTING OF PIPELINES

After laying and jointing, the pipeline shall be tested for soundness and leak tightness of pipes, fittings and joints, and soundness of any construction work. The pipeline may be tested in sections.

Water and other facilities as required for such hydro testing shall be arranged by the Contractor. Each section shall be properly sealed off with special stop ends secured by adequate temporary anchors. The thrust on the stop ends shall be calculated and the

anchors designed to resist it. All permanent anchors shall be in position and, if of concrete, shall have developed adequate strength before testing begins.

Hydraulic Testing of Sections

The section under test shall be filled with water, taking care that all the air is displaced either through vents at the high points or by using a pig or a sphere.

After filling, the pipeline shall be adequately pressurized for a period of time to achieve stable conditions.

The pipeline is then pressurized up to the full test pressure as stipulated in the data sheet attached with this sub section and the section under test completely shall be closed off. The test pressure shall be maintained for a period of not less than 10 minutes to reveal any defects in the pipes, joints or anchorages. The test pressure shall be measured such as to ensure that the required test pressure is not exceeded at any point in the entire pipeline.

If the test is not satisfactory, the fault shall be found and rectified. Methods employed for finding faults shall be as per IS 12288.

Hydraulic Testing of Complete Pipeline

After all the sections have been joined together on completion of section testing, a test on the complete pipeline shall be carried out. This test shall be carried out at a pressure as specified in the data sheet attached with this subsection. During the test, the pressure at any point in the pipeline shall not exceed the pressure as specified in the data sheet attached with this subsection.

22.9 QA REQUIREMENTS FOR DI PIPES, FITTINGS AND SPECIALS

Following tests / inspections to be carried out on the finished pipes, Joints, Gaskets, DI Fittings & specials as per relevant IS/ISO standard:

1. Pipes produced are subject to following checks;
 - a. Visual Inspection for workmanship, marking, visual defect etc.
 - b. Mechanical Properties as per relevant governing Standard
 - c. Dimension
 - Inside Diameter
 - Outside Diameter
 - Wall Thickness
 - Ovality of Pipes
 - Length of Pipes
 - Straightness
 - d. Hydrostatic Leak Tightness to be carried out as per relevant standard.
 - e. Zn coating & Bituminous painting on external layer DI pipes shall be carried out as per relevant standard / Technical Specifications.
 - f. Identification – Manufacturer Logo, Nominal Diameter, Class, length indication for cutting of pipe at site, ISI certification mark, pipe no.
2. Internal lining of suitable cement mortar shall be done as per relevant standard / Technical Specifications.

3. Rubber gaskets shall confirm to the requirement of relevant standard / Technical Specifications.
4. Joints for pipe, DI Fittings & specials shall be as per relevant standard / Technical Specifications.
5. Type Tests: Please refer relevant sections of engineering portion of technical Specification.

DATA SHEET FOR DI PIPES, FITTINGS & SPECIALS

Sl. No.	Description	Units	Parameters
1.	Pipe Material		Ductile Iron (DI) pipe internally cement mortar lined and externally coated with metallic zinc & finishing layer of bituminous paint
2.	Applicable standards		IS / ISO / AWWA / BS as listed in technical specification
3.	Hazen & William's constant		140
4.	Pipe Class		K7/K9 based on approved design as per IS 8329 or equivalent
5.	Pipe Joint type		Push on flexible joints as per IS 8329
6.	Pipe Joint type at valves, pumps and other piping		Flange Joints as per IS8329 & IS 9523
7.	Welded on Flange (as applicable) Pressure Class		PN 16
8.	DI fittings class		K12 as per IS 8329 or equivalent
9.	DI fittings flange (as applicable) class		PN 16 / as per approved design
10.	Restrain mechanism at bends, specials etc.		Thrust Blocks
11.	Other Requirements		As per technical specification

F GLASSFIBER REINFORCED PLASTICS(GRP) PIPELINE**23 GENERAL**

This specification covers the specific requirement of design, material, manufacture fabrication, constructional features, inspection & testing; transportation, handling, lowering, laying, jointing, hydro testing and annual maintenance contract of Glass Fibre Reinforced Plastics (GRP) Pipes, Joints, fittings and specials. GRP pipes from mobile plants will not be allowed.

GRP pipes will not be used in the following applications:-

In rocky stretches,

In stretches where the highest water table is above the crown level of the pipe,

Where there is a chance of future excavation by other service providers within 2 m radial distance of pipeline.

24 CODE AND STANDARDS

The design, manufacture, inspection and testing of GRP water pipes shall comply with the latest Indian Standard, IS: 14402 (GRP Pipes, Joints and Fittings for use for sewerage, Industrial waste and water (other than potable) or ASTM 3517 (Standard Specification for Fiber glass (Glass Fiber Reinforced Thermosetting Resin) Pressure Pipe in the case of pressure pipes) or AWWA C 950 (Standard for fiber glass pressure pipe) & AWWA M 45 (Fiber glass Pipe design) unless otherwise specified elsewhere in this Technical Specification.

The various codes used in the design, manufacture and testing of GRP pipes are as follows:

Sl. No.	Code No.	Code Title
1.	IS 14402	GRP Pipes, Joints and Fittings for use for sewerage, Industrial waste and water (other than potable) - specification
2.	IS 12709	GRP Pipes, Joints and Fittings for use for potable water supply - specification
3.	IS 5382	Specification for Rubber sealing rings for gas mains, water mains and sewers
4.	IS 13916	Installation of GRP Piping system - code of practice
5.	IS 6746	Unsaturated polyester resin systems - specification
6.	IS 11273	Woven roving fabrics of E glass fibre
7.	IS 11320	Glass fiber rovings for the reinforcement of polyester and of epoxide resin systems
8.	IS 11551	Glass fibre chopped strand mat for the reinforcement of epoxy, phenolic and polyester resin systems

9.	IS 1367 (Part 1 to 20)	Technical supply conditions for threaded steel fasteners
10.	AWWA C950	Standard for fiber glass pressure pipe
11.	AWWA M 45	Fiber glass Pipe design
12.	ASTM C 33	Standard specification for Concrete aggregates
13.	ASTM D 638	Standard Test Method for Tensile Properties of Plastics
14.	ASTM D 695	Standard test method for compressive properties of rigid plastics
15.	ASTM D 1599	Standard Test Method for Resistance to Short-Time Hydraulic Pressure of Plastic Pipe, Tubing, and Fittings
16.	ASTM D 2105	Standard Test Method for Longitudinal Tensile Properties of Fiber glass (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe and Tube
17.	ASTM D 2290	Standard Test Method for Apparent Hoop Tensile Strength of Plastic or Reinforced Plastic Pipe by Split Disk Method
18.	ASTM D 2412	Standard Test Method for Determination of External Loading Characteristics of Plastic Pipe by Parallel-Plate Loading
19.	ASTM D 2563	Standard practice clarifying visual defects in glass reinforced plastic laminated parts
20.	ASTM D 2583	Standard Test Method for Indentation Hardness of Rigid Plastics by means of a Barcoll Impressor
21.	ASTM D 2992	Standard practice for obtaining hydrostatic or pressure design basis for Fiber glass Pipe and Fittings
22.	ASTM D 2996	Standard specification for Filament-Wound Fiber glass (Glass-Fiber-Reinforced-Thermosetting-Resin) Pipe
23.	ASTM D 3262	Standard Specification for Fiberglass (Glass-Fiber Reinforced Thermosetting Resin) Sewer Pipe, in the case of gravity sewer pipes.
24.	ASTM D 3517	Standard Specification for Fiber glass (Glass Fiber Reinforced Thermosetting Resin) Pressure Pipe
25.	ASTM D 3567	Standard practice for determining dimensions of Fiberglass (Glass Fiber Reinforced Thermosetting Resin) Pipe and Fittings
26.	ASTM D 3681	Standard Test Method for Chemical Resistance of Fiber glass (Glass-Fiber-Reinforced Thermosetting - Resin) Pipe in a Deflected Condition
27.	ASTM D 3754	Standard Specification for Fiber glass (Glass Fiber Reinforced Thermosetting Resin) Sewer and Industrial Pressure Pipe.

28.	ASTM D 3839	Standard guide for underground installation of Fiber glass Pipes.
29.	ASTM D 4161	Standard Specification for Fiber glass (Glass Fiber Reinforced Thermosetting Resin) Pipe Joints Using Flexible Elastomeric Seals
30.	ASTM D 5365	Standard Test Method for Long-Term Ring-Bending Strain of Fiber glass (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe
31.	ASTM D 5421	Standard specification for contact molded "Fibre glass" flanges.
32.	ASTM F 477	Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe
33.	BS 5480	British Standard Specification for Glass reinforced plastics (GRP) pipes, joints and fittings for use for water supply or sewerage
34.	ISO 1172	Textile-glass-reinforced plastics – Prepregs, moulding compounds and laminates -- Determination of the textile-glass and mineral-filler content – Calcination methods

25 DESIGN REQUIREMENTS**25.1 Normal Diameter**

The nominal diameter of the pipe shall be as specified in the data sheet. The inside diameters and tolerances on diameters for the specified nominal diameter shall conform to the requirements stated in IS: 14402 / AWWA C 950 / ASTM D3517.

25.2 Length

Pipes shall be supplied in nominal lengths of 6m/9m/12m as per requirements. The tolerances on nominal lengths shall be as per relevant IS / AWWA / ASTM standards to which they are supplied.

25.3 Wall Thickness

The average Wall thickness of the pipe shall not be less than the minimum wall thickness published in latest manufacturer's catalogue. However, minimum wall thickness in these published wall thicknesses of manufacturer shall conform to the tolerance limit as given in relevant IS / AWWA / ASTM standards to which GRP pipes are supplied.

Contractor shall submit design calculations as per AWWA M 45 & AWWA C 950 to establish the adequacy of pipe size, pressure class and stiffness class selected for the GRP pipes.

25.4 Pressure Class

GRP pipes shall have the pressure class as per the data sheet attached at the end of this subsection.

25.5 Stiffness Class

The pipe shall be stiff enough to meet the design requirement with particular regard to installation method, burial depths, deflection limits, buckling and vacuum requirements.

GRP pipes shall have the stiffness class as per the data sheet attached at the end of this subsection.

25.6 Hoop and Longitudinal tensile strength

GRP pipe system shall meet the minimum hoop tensile strength and minimum longitudinal tensile strength requirements specified in IS 14402 / AWWA C 950 / ASTM D3517 for the pressure class specified in the data sheet attached at the end of this subsection.

26 MATERIAL REQUIREMENTS**26.1 Resin: A thermosetting polyester resin (isophthalic resin) to be used and quality parameters shall be as per relevant IS / AWWA / ASTM standards.**

- 26.2 Glass Fiber Reinforcement: Glass fiber reinforcement shall be of commercial grade 'E' type and shall conform to IS 11273, IS11320 or IS11551 as appropriate or relevant ASTM standards.
- 26.3 Other Materials
Other materials used in the manufacturing of pipe like aggregates, fillers and additives shall be in accordance with the relevant IS I AWWA I ASTM standards.
- 27 MANUFACTURING REQUIREMENTS
The pipe shall be manufactured through Filament winding process (Continuous Filament Winding process using advancing mandrel method or Helical Filament Winding process) by winding continuous glass fibre filaments saturated with liquid resin or pre impregnated with partially cured resin (subsequent heating may be required to polymerize the resin system) onto the outside of a mandrel in a predetermined pattern under controlled tension as described in ASTM D 2996 to result in a corrosion resistant, composite structure to meet the operating conditions.
- 27.1 Wall composition
Structure of pipe shall have chemical resistant liner, reinforced structural layer and outer surface layer.
GRP Pipes (as required) shall have to be provided with UV stabilizers and flame retardants in the resin coat of outer surface layer.
- 27.2 JOINTS
The pipeline shall have a jointing system that shall provide for fluid tightness for the intended service condition.
All GRP pipes and fittings shall be joined with unrestrained sleeve couplings (Double REKA joint) or un-restrained double O' ring bell-Spigot joints. Thrust blocks are to be provided at each bends irrespective of buried as well as over ground GRP piping. For over ground piping, anchors are to be provided at reducers, branch offs, Tee-offs, expanders and terminal points of other suppliers apart from at points in straight run separated by an interval of 90 meters approx as per AWWA- M45 (for pipes up to 400mm dia.) and as per system requirements for large sizes.
Flanged Joint
Flanged joints shall be used for connecting GRP pipes with valves, pumps and other material piping etc. Flanged joints shall be used with EPDM gasket and hot dip galvanized bolts. The flanged joint is made from the same material as the pipe.
Rubber gaskets
Rubber gasket used with push-on flexible joints shall conform to the requirements of IS: 5382 I ASTM F 477.
Rubber gaskets for use with flanged joints shall conform to IS 5382 or equivalent.

TECHNICAL REQUIREMENTS**28 GRP FITTINGS & SPECIALS****28.1 General**

All GRP fittings, such as bend / elbows, ends, tees, flanges and reducers etc. shall be equal to or superior in performance to pipe of the same classifications and shall be smoothly finished internally.

Generally, all GRP fittings are to be manufactured in factory. Dimensions of the fittings shall be as per relevant standards and drawings shall be submitted to Employer for approval.

Only in exceptional circumstances, specific required fittings may be permitted (Employer's approval) to be fabricated / laminated at site under the supervision of manufacturer of pipes. However, such site fabricated / lapped fitting / branch off shall be hydro tested at pressure no less than 1.5 times the pressure class along-with the pipes.

28.2 Fittings made from straight pipe

Fittings shall be fabricated from complete pipes or portions of straight pipe complying with IS 14402 / ASTM standards as applicable for the pipe classifications. The fitting shall comply with the declared design requirement and be suitably mitred. The mitre shall be over wrapped externally and internally with liner, woven roving and/or chopped strand mat to ensure the longitudinal and circumferential tensile strength is at least equal by design to that of the pipe with which the fittings is to be used. All fittings shall have sufficient end length of pipe to accommodate over wrapped length of fitting and pipe.

28.3 Fittings made by Moulding

Moulded GRP fittings shall be made by hand lay-up, contact moulding, hot or cold press moulding or tape winding with internal liner.

29 TYPE TESTS

29.1 The contractor shall carry out the type tests as listed in this specification on the pipes to be supplied under this contract. The bidder shall indicate the charges for each of these type tests separately in the relevant schedule of Section - VII- (Forms & Procedures) and the same shall be considered for the evaluation of the bids. The type tests charges shall be paid only for the test(s) actually conducted successfully under this contract and upon certification by the Employer.

- 29.2 The type tests shall be carried out in presence of the Employer's representative, for which minimum 15 days notice shall be given by the contractor. The contractor shall obtain the Employer's approval for the type test procedure before conducting the type test. The type test procedure shall clearly specify the test set-up, instruments to be used, procedure, acceptance norms, recording of different parameters, interval of recording, precautions to be taken etc. for the type test(s) to be carried out.
- 29.3 The Long term type tests stipulated in Cl.8.05.00 below should have been conducted by the manufacturer or its technology provider on the pipes similar to those proposed to be supplied under this contract, at an independent laboratory or duly approved by accredited third party agency. Bidder shall submit these type test reports to the Employer along with the bid. The manufacturer shall however carry out the short term reconfirmation/ requalification tests as stipulated in Cl.8.05.00 below. Further, the Employer reserves the right to waive conducting of any or all type tests(short term/ reconfirmation tests) under this contract. In case such type tests are waived for any reason whatsoever, the type test charges shall not be payable to the contractor.
- 29.4 Not Used.
- 29.5 The following type tests shall be carried out:
- a) Long term hydrostatic strength I Long term hydrostatic pressure
- Manufacturer or its technology provider should have already carried out the full type testing as described in method A of IS 12709! Procedure-B of ASTM 2992, duly approved by accredited third party agency.
- Further, the manufacturer shall carry out the requalification test as described in method B of IS 12709/ reconfirmation test of ASTM 2992 on the same pressure class& stiffness class as specified for the pipes under this package.
- b) Chemical resistance of pipe in a deflected condition
- Manufacturer or its technology provider should have already carried out the full type testing as described in method A of IS 14402 I Procedure-A or Procedure-B of ASTM3681, duly approved by accredited third party agency.
- Further, the manufacturer shall carry out the requalification test as described in method B of IS 14402 I reconfirmation test of ASTM 3681 on the same pressure class & stiffness class as specified for the pipes under this package.

c) Joint testing

All joints shall meet the laboratory performance requirements of section 7 of ASTM D4161. It shall be conducted on joint prototypes of elastomeric gasket sealed couplings in accordance with section 7 of ASTM D4161 on the pipes supplied under this package.

d) Long term Stiffness - Material creep

Manufacturer or his technology provider should have already carried out the full type testing following the guidelines of ISO 10468 and analyzed according to ISO 10928, method B.

Further, the manufacturer shall carry out the reconfirmation test for 1000hrs on the same pressure class & stiffness class as specified for the pipes under this package. The test procedure for this reconfirmation test shall remain same as the Long term Stiffness test stipulated above. The acceptance criteria for this test shall be as given in Clause 11 of ASTM D 5365 or as per alternative method proposed by manufacturer subject to Employer's approval.

e) Long term Ring bending strain test

Manufacturer or his technology provider should have already carried out the full type testing using guidelines of ASTM D5365.

Further, the manufacturer shall carry out the short term reconfirmation test in accordance with ASTM D5365 on the same pressure class & stiffness class as specified for the pipes under this package.

30

MARKING

The marking on pipe shall include the following:

- a) Standard mark for the pipes conforming to IS | AWWA | ASTM standards to which they are supplied.
- b) The manufacturers name or trademark
- c) The nominal pipe diameter
- d) Class of pipe (Pressure & Stiffness)
- e) Batch no. or date of manufacture
- f) Colour bands for over ground piping

31 TRANSPORTATION AND DELIVERY OF PIPES

- 31.1 GRP pipe shall be handled, stored and transported in strict accordance to the Manufacturer's instructions. Bidder shall have to submit a write up for safe handling and stacking of pipes during transportation and at site.
- 31.2 All pipes fabricated in the factory and temporarily stacked in the Contractors yard or factory shall be transported to site after shop testing & cleaning them internally. The loading in the factory shall be carried out by means of either a crane, gantry or with shear legs, so as not to cause any damage to the finished material. Similarly, while unloading and stacking, great care shall be taken to ensure that the material is not damaged or dented.
- 31.3 The material being delivered at site shall be jointly inspected by the Employer and the Contractor. Defective or damaged pipe shall be rejected by Employer or in case of minor damage, the Employer may allow repair of the pipe by the Contractor to the satisfaction of the Employer.
- 31.4 Props of proven designs shall be fixed to the pipes during transit to avoid undue sagging and consequent distortion. After the pipes are carefully stacked, props maybe removed and re-used for subsequent operations.
- In case of transport by ship, packing shall be sea worthy so as to ensure safe delivery till site.
- 31.5 At site, pipes shall be stacked in such a way that suitable gaps shall be left in the pipes at intervals to permit access from one side to the other.

32 LOWERING, LAYING, JOINTING AND HYDRO TESTING (LLJT) OF GRP PIPES

- 32.1 Lowering, laying, jointing and hydro testing of pipe shall take place in the supervision of pipe manufacturer. Lowering and Laying shall take place only after the trench and the surface supporting the pipes have been prepared according to the sub-section IIIB - 01 (specification for Civil works of GRP pipes / DI pipes).
- 32.2 Before placing a pipe in the trench, it is necessary to clean any remains of earth, sand or mud from the inside of the socket and from the opposite end bearing the rubber ring gasket/packing. When cleaning has taken place, run a hand around inside the socket to ensure that there are no residues of hardened resin which can be removed readily with a chisel. It is also necessary to check that the groove has an even depth and has not been damaged.

32.3 For a coupling type of joint, two rubber ring gaskets shall be first fixed into the groove inside the coupling and then the coupling is fixed at the coupling area of the pipe.

32.3.1 Pipes shall be lowered in the trench with appropriate mechanical means like chain pulley block, excavators etc.

32.3.2 Place the pipe in the trench, taking care to dig a small hollow at each end so that the groove and the socket are well separated from the sand gravels in the bottom of the trench.

32.3.3 Anchor the first pipe section laid according to the method described and leave its ends free along a space enough for insertion of the next section and for checking.

Place the next pipe section in the trench and leave enough space for the operator to be free to move and to work between the two pipe sections so as to carry out the cleaning and checking operations.

32.3.4 Clean the coupling area of the joint once more with a cloth and also clean the flared portion of the lead-in using suitable lubricant.

32.3.5 Clean the groove again, take the rubber ring gasket and lubricate it by running it between the hands and checking at the same time, it being in good condition. It shall be ensured that every portion of the ring or inside of the socket must not lack lubricant as it will impair good insertion of the pipe.

32.4 For socket and spigot type of joint, pass the rubber ring under the pipe until it settles into the groove, then pull it forcibly upwards and follow the ring with the hands so that three quarters of it is positioned in the groove, then lift the ring above the upper generating line of the pipe forcibly and then release it so that it falls into the groove thus being freed of any twists.

32.4.1 Run the hands around the pipe to check that the whole of the packing is in its seating and, in the case of large diameter pipes, smear lubricant again above the inserted rubber ring gasket/packing.

32.4.2 Align and bring together the two pipe sections until rubber ring touches the flared portion of the lead-in.

When this has taken place, examine the position of the ring and above all, ensure that there are no sand or other foreign bodies present.

32.4.3 Fit the socket onto the spigot very slowly, dwelling halfway along the coupling area, and check the position of the packing visually.

32.4.4 Proceed with the joint until the socket is halted by the abutment ledge. The next pipe section shall not be fitted until the previous pipe section has been anchored with an overlay of sand.

32.4.5 Check the rubber ring gasket/packing after the joint has been coupled. This check must always be carried out and is performed with a blade of steel or of another metal having a thickness of 0.4/0.5 mm, a width of 15 mm and any length greater than 200mm, the blade being inserted into the annular space between the socket and spigot.

This check shall be conducted along the entire circumference where the packing is compressed so as to ensure that the rubber ring has a homogeneous depth and is therefore correctly positioned in its seating. If the ring is found to be seated differently at one point than other points or if there is any doubt, disconnect the joint, check the rubber ring and replace it if shows any permanent signs of faulty seating, check once more the coupling area of the joint, the flared lead-in of the socket and the groove on the spigot. When re-inserting the pipe section, take extra care to align the pipes perfectly. When uncoupling pipe sections, never use chains or steel cables in direct contact with the pipes.

Check once again the position of the ring with the blade

32.5 Checking the installed pipe - Initial diametrical deflection shall not exceed 3% of diameter. Bulges, flat areas, or other abrupt changes of pipe wall curvature are not permitted. Deflection checks shall be done when the first installed pipes have been backfilled to grade and continued periodically throughout the entire project. Laying shall not get too far ahead before verifying the installation quality.

Pipes over 3% deflection shall be replaced completely. No attempt to jack or wedge the installed over deflected pipe into a round condition shall be made to avoid damage the pipe.

32.5.1 Correcting over deflected pipe - Pipes installed with initial diametrical deflections exceeding the approved values shall be corrected to ensure the long term performance of the pipe. Damaged pipe shall be repaired or replaced as directed by the employer. Re compact/ backfill to grade and check the pipe deflections to verify they have not exceeded the values to the satisfaction of Employer.

32.6 Misalignment of the joint - When for reasons of the lay-out of the line the joint has to be misaligned (but such misalignment must remain within

the limits provided by the supplier of the pipes), such misalignment at the predetermined angle should be applied only after having inserted the pipe and the joint is thoroughly checked for its water tightness.

- 32.7 Thrust Block - RCC thrust block shall be provided at bends and at places of reduction in cross section to take care of thrust.
- 32.8 GRP pipes shall cross minor road / nallah through Hume pipes when buried GRP pipes are crossing roads & nallahs. Sand bags shall be put around GRP pipes within Hume pipe. For railway crossing and / or high way crossings of underground GRP pipes, culverts or MS encased pipe with pushing technology shall be adopted.
- 32.9 Site lapping of last joint during erection shall be done at a de-humidified condition by skilled worker to ensure correct curing.

33 Field Hydrostatic Tests

The pipeline shall be hydro tested in stretches of suitable length at 1.5 times the pressure class. Water and other facilities as required for such hydro testing shall be arranged by the Contractor.

Finally entire system shall be hydro tested at 1.5 times the pressure class of the pipe/fittings when erection is complete and pump charging has been done. The detailed Filed Hydrostatic Testing Procedure based on International standard shall be submitted to Employer for Approval.

34 ANNUAL MAINTENANCE CONTRACT (AMC) TERMS & CONDITIONS

The Contractor tie-up with the GRP pipe manufacturer, to provide Annual Maintenance Contract (AMC) for 2 years after completion of the warranty period. The following services shall be included under AMC:

- a) Round the clock monitoring of GRP pipe installation for any leakage / rupture / damage of the pipeline.
- b) Arranging all material (temporary & permanent), manpower (including skilled & unskilled labour), machineries, testing equipment, fixtures, maintenance tools & tackles consumables etc. for repair, maintenance, re-erection/ re-commissioning of any or whole portion of GRP piping system.
- c) Repairing the damaged pipes / joints, replacing the damaged part of piping/joints including fittings with new pipes / fittings, wherever necessary, making good damaged or excavated bed & trench of GRP pipe and restoring the trench bed to the original specified bed conditions.

- d) Recharging, testing and re-commissioning the entire GRP pipe installation to the satisfaction of the Employer within 24 hours of the reporting of leakage / rupture /damage of the pipeline.

DATA SHEET FOR GRP PIPES, FITTINGS AND SPECIALS

Sl. No.	Description	Units	Parameters
1.	Pipe Material		Glass fibre Reinforced Plastic Pipe
2.	Applicable standards		IS / ASTM / AWWA as listed in technical specification
3.	Design Flow	m ³ /hr	
4.	Working pressure	mWC	115 (approx.)
5.	Vacuum pressure	Kg/cm ²	-0.8
6.	Maximum service temperature	°C	36
7.	Hazen William's constant		150
8.	Pipe Nominal diameter	NB	1100-3000
9.	Pipe Length		Refer Sub-Section-IA; Scope of Supply & Services
10.	Pressure Class		PN15
11.	Stiffness Class		C
12.	Stiffness Value	KPa	248 (minimum) at 5% deflection
13.	Glass fiber reinforcement class		E
14.	Pipeline Joint type		unrestrained sleeve couplings (Double REKA joint) or unrestrained double O' ring bell-Spigot joints
15.	Pipe Joint type at valves, pumps and other piping		Flange Joints

SECTION -VI

PART-B

APPURTENANCES & MISCELLANEOUS ITEMS

Section-VI

APPURTENANCES AND MISCELLANEOUS ITEMS

SL.NO.	PARTICULARS	PAGE NO.
1	1.1 SLUICE VALVES	1
2	1.2 BUTIERFLY VALVES	3
3	1.3 KINETIC AIR VALVES	12
4	1.4 ANTI VACUUM VALVES	14
5	1.5 NON RETURN VALVES	16
6	2.0 PUMP CONTROL VALVE	17
7	3.1 M.S EXPANSION JOINT	18
8	3.2 METALLIC/RUBBER EXPANSION JOINT/DISMANTLING JOINTS	20
9	3.3 SURGE PROTECTION DEVICES	22
10	3.4 FLOW MEASUREMENT DEVICES	25
11	3.5 PIPE, VALVES, FITTINGS & AUXILIARY SYSTEMS	28

PART-II APPURTENANCES AND MISCELLANEOUS ITEMS

1.1 Sluice Valves

1.1.1 General

The sluice valves shall confirm to IS: 14846. Double flanged short body, Metal seated, Gland less (stem sealing rings) type Sluice valves with appropriate pressure rating. The material to be supplied under this sub-section shall include, but not be limited to, the following: All necessary fittings including bolts, nuts, gaskets, backing rings, counter flanges, jointing material, strainers etc. shall be supplied as required. All the Gland less (stem sealing rings) sluice valve shall be provided with ball thrust bearing and spur gear arrangement specifically for 350mm and above. Valves above 600mm shall be gland type.

1.1.2 Scope

The Gland less (stem sealing rings) sluice valves shall be with non rising stem type. The valves will be used for water supply on line installations in upright positions, with double flange, and cap or hand wheel for manual operation. The valves shall be suitable for continuous use at their PN rating within the temperature range of -10° C to 65° C.

1.1.3 Nominal pressure and dimensions

The working pressure on the valves shall be appropriate to the working conditions and approved by the Employer. The flanges and their dimensions of drilling shall be in accordance with IS: 1538 (part-1 to XXII)/IS 9523/EN 1092-2.

1.1.4 Material

The makes given are acceptable makes however the material for different component parts of sluice valve shall conform to the requirements given below:

SL. No.	Component	Material	Ref. to IS	Grade / Designation
1	Body, bonnet, dome, stool cover, Wedge, stuffing box, gland, thrust plate and cap.	S. G. iron	1865	Gr.500/7
2	Hand wheel	S. G. iron	1865	Gr.400/15
3	Stem	Stainless steel	6603	12Cr12/ 04Cr19Ni19 / 04Cr17Ni12MO2
4	Wedge nut	Leaded tin bronze	318	LTB-2
5	Body seat ring, wedge facing ring and bushes	bronze	318	LTB -2
6	Bolt	Carbon steel	1363(Part 1)	Class 4.6
7	Nut	Carbon steel	1363 (Part 3)	Class 4
8	Gasket	EPDM Rubber	11855	-
9	Stem Sealing Ring	EPDM Rubber	11855	-
10	Gear	Spheroidal graphite iron	1865	G,500/7
11	Gear housing	S.G. iron	1865	Gr.400/15
12	Pinion and pinion shaft	Wrought carbon steel	1570 (Part 3)	C55Mn75

1.1.5 Marking, Testing and Inspection

The standard marking and packing of the valves shall be done as per Clause 11 and 13 of IS: 14846. The direction of rotation for OPEN, CLOSE position shall be marked on the hand wheel and on the bonnet of the valve. Hydraulic testing of each sluice valve shall be done for close end test in accordance with IS: 14846 Annex B, to the test pressure and test duration as specified in table 5 and 6 of the IS.

All the valves shall be inspected for flaw detection test in accordance with IS: 14846, clause 10.2. The design, construction material, manufacture, inspection, performance and testing shall comply with all applicable Indian Standards and Codes. Nothing in the specification will be construed to relieve the supplier of this responsibility.

1.1.6 Manufacturer's Test certificate

The manufacture shall provide a test certificate confirming that all the valves have been tested in accordance with IS: 14846 and stating the pressures and medium used in the test.

1.1.7 Third party inspection

The inspection and testing of the sample valves from a lot will be carried out by the employer and or inspecting agency appointed by the employer, in the manufacture's workshop, before application of any paint. All the tests as required as per the IS: 14846 shall be carried out on samples from each lot (Number of samples from a lot shall be as per the relevant IS for sampling and testing), in presence of the inspecting agency. The valves shall be dispatched only after issue of the test certificate by the inspecting agency for satisfactory performance of the tested valves. The inspection charges for such tests shall be first paid by the contractor to the inspecting agency, which shall be reimbursed on production of the documentary evidence for the payment made.

1.1.8 Acceptable makes for the valves

Acceptable makes for the sluice valves shall be as per the approved vendor list. All the valves shall have the same make. Contractor should not place order with any other manufacturer for the above said item till it has been approved in writing by employer for the makes listed above.

1.1.9 Installation

The installation of the sluice valves shall be done at the locations shown on L-sections of the pumping main as washout valves and isolating valves for air valves. The job covers supply of the valves at work site with cost of all the required material and all types of taxes and duties, cost of packing, loading, transportation, unloading, stacking and installation at the specified location with cost of all jointing materials such as nuts and bolts, EPDM rubber gaskets etc. The job also covers field hydraulic testing of the valves after installation for the specified test pressure for the respective pipeline section.

1.1.10 Gate Valves

Electrically operated, Double flanged, non rising spindle for Real-time operation and control shall be installed at the inlet points of all the Minor and sub-minors off taking from rising main/ducts/ BR's.

1.2 BUTIERFLY VALVES

1.2.1 GENERAL

The Butterfly valves shall confirm to IS: 13095. Double flanged short body butterfly valves of required nominal diameter and pressure rating shall be supplied. The material to be used shall include, but not be limited to, that as shown in the table given below. All necessary fittings including bolts, nuts, gaskets, jointing material etc. shall be supplied as required. Butterfly valves of Concentric Design and Vulcanized type generally as per EN 593, BS 5155, API 609 can be also considered, for sizes upto 150mm only.

1.2.2 SCOPE

The butterfly valves shall be with disc and shaft and shall be designed to withstand the maximum pressure differential across the valve in either direction of flow. The valves shall have no visible leakage past the disc in closed position under test conditions. The shaft may be of one piece design or in two pieces separately attached to the disc. The valves will be used for water supply on line installations in upright positions with actuation. The valves shall be suitable for continuous use at their pressure rating within the temperature range of -10°C to 65°C.

1.2.3 NOMINAL PRESSURE AND DIMENSIONS

The working pressure on the valves shall be appropriate to the working conditions and approved by the Employer. The flanges and their dimensions of drilling shall be in accordance with IS: 1538 (part-1 to XXII)/IS 9523/EN 1092-2.

1.2.4 MATERIAL

The makes given are acceptable makes however the material for different component parts of butterfly valves shall conform to the requirements given below:

SI.No.	Component	Material	Ref. to IS	Grade
1	Body	Spheroidal graphite Iron / Ductile Iron	1865	Gr. 400/15
2	Disc	Spheroidal graphite Iron / Ductile Iron	1865	Gr. 400/15
3	Shaft	Stainless steel	6603	-
4	Seating ring / Seal retaining ring/ Body seat (for eccentric valves)	Integral Nickel Cromium/Stainless Steel /Ni-Cu (weld deposited)	6603	-
5	Disc Seal	EPDM Rubber	-	-
6	Shaft bearing	Bronze / brass bearing with 'O' rings/ Bronze backed Teflon	-	-
7	Internal fasteners	Stainless steel	Manufacture r's standard	Suitable for duty
8	External bolting	Carbon steel; tensile strength	-	-
9	Disc seal retainer (for eccentric valves)	Stainless steel (AISI 304/CF8)	6603	04 Cr 19 Ni 19

1.2.5 OPERATION

All valves shall be capable of being operated at a differential pressure across the disc as marked on the valves. Worm gear type of operator can be used.

Manually operated valves shall be closed by turning hand wheel in a clockwise direction when facing the hand wheel.

All gear operators shall be provided with suitable stops to prevent movement of the shaft beyond the limit corresponding to the fully closed position of the disc.

All gear operators shall be self locking type. All lever operated valves shall be capable of being locked at at-least three intermediate positions. The operating hand wheels shall be marked 'CLOSE' or 'SHUT' to indicate the direction of closure.

The operator shall be provided with arrangement to indicate disc position.

1.2.6 TESTING

All valves shall be hydraulically tested by the manufacturer before dispatch. The pressure shall be applied without any significant hydraulic shock. Testing shall be carried out before application of paint or other similar treatment.

1.2.6.1 Body test

The body ends shall be blanked. The valve disc shall be in slightly open position and the pressure equivalent to 1.5 times the maximum permissible working pressure shall be applied with water. The duration of this test shall be as in Table-3 of IS 13095

1.2.6.2 Seat test

Seat test shall be carried out in accordance with clause 17.3 of IS: 13095 for 3 minute duration.

1.2.6.3. Disc strength Test

The test shall be conducted with the body flanges in horizontal position. The test pressure shall be 1.5 times the maximum permissible pressure. With disc in closed position, hydro test pressure shall be applied to the lower face of the disc for duration as per table 3 of the IS: 13095. There shall be no damage to the valve disc or any part of the valve, or disc shall not be permanently deformed.

1.2.7 MANUFACTURER'S CERTIFICATE

The manufacture shall provide a test certificate confirming that all the valves have been tested in accordance with IS: 13095/Equivalent Standard. The manufacturer shall also provide documentary evidence of having manufactured and supplied BFV of similar design and specifications, working satisfactorily in India for minimum 5 years, through Performance Certificate.

1.2.8 THIRD PARTY INSPECTION

The inspection and testing of the sample butterfly valves shall be carried out by the employer and or inspecting agency appointed by the employer, in the manufacture's workshop before application of any paint. All the tests as required as per the IS: 13095 shall be conducted in presence of the inspecting agency on the sample valves from the lot (Number of valves to be tested from a lot shall be as per the relevant IS for sampling and testing). The valves shall be dispatched only after issue of the test certificate by the inspecting agency for satisfactory performance of the tested valves. The inspection charges for such tests shall be first paid by the contractor to the inspecting agency, which shall be reimbursed on production of the documentary evidence for the payment made.

1.2.9 MARKING

Marking shall be cast integral on the body or on a plate securely attached to the body. Marking shall be as specified under clause 21 of IS: 13095. The design, construction material, manufacture, inspection, performance and testing shall comply with all applicable Indian Standards and Codes. Nothing in the specification will be construed to relieve the supplier of this responsibility.

1.2.10 ACCEPTABLE MAKES FOR THE VALVES

Acceptable makes for the double flanged butterfly valves shall be as per the approved vendor list. All the valves shall have the same make. Contractor should not place order with any other manufacturer for the above said item till it has been recommended in writing by employer for the makes listed above.

1.2.11 INSTALLATION

The installation of the butterfly valves shall be done at the locations shown on L sections of the pumping main as inline valves. The job covers supply of the valves at work site including all type of taxes and duties, cost of packing, loading, transportation, unloading, stacking and installation at the specified location with cost of all jointing materials such as nuts and bolts, EPDM rubber gaskets etc. The job covers field hydraulic testing of the valve after installation for the specified test pressure for the respective pipeline section.

1.2.12 ACTUATORS OPERATED VALVES

- i) Actuators will be with Limit and Torque switches for either end of travel for control and interlocking purpose.
- ii) The characteristics of the actuators to be located on the valves are indicated in the actuators specification.
- iii) Should the actuator be located on the control column, all connecting accessories shall be supplied (extensions, joints, articulations etc.).
- iv) The valves 350 NB and above shall also be provided with hand wheel drive arrangement suitable for manual operation. Manual operation of valve shall be through worm and gear arrangement having totally enclosed gearing with hand wheel diameter and gear ratio designed to meet the required operating torque. It shall be designed to hold the valve disk in intermediate position between full open and full closed position without creeping or fluttering. Adjustable stops shall be provided to prevent 'OVOT travel' in either direction.
- v) Limit and torque switches shall be enclosed in water tight enclosures along with suitable space heaters.

1.2.13 MATERIALS/ DESIGN DETAILS "

Materials, design and other specific requirements of various categories of BF valves shall be as indicated below.

51. No.	Description	Requirement.
a)	Design	As per IS 13095/ BS 5155/API 609
b)	Type	Double flanged /Wafer Series
c)	Material	
	i) Body and Disc	Cast steel grade ASTM-A 276 74 d Gr. WCB

51. No.	Description	Requirement.
		or SG Iron as per IS 1865 gr.500/7, Ductile Iron GGG 40/50, ASTM A 536
	ii) Shaft	Stainless steel AISI: 431/410/Equivalent
	iii) Body Seat	Monel 60 integral/Stainless Steel
	iv) Disc Seat	EPDM/SS
51. No.	Description	Requirement.
	v) Bearing	PTFE LINED ST.ST./Bronze
	vi) Testing	AWWA-C-504/IS
	vii) Other Requirement	Tight shut off

1.2.14 SPECIFIC PERFORMANCE GUARANTEE

For the rubber seated valves, the contractor shall guarantee that in the closed position and with a disc differential pressure as specified the valves shall be water tight.

The contractor shall guarantee that the operating mechanism shall open and close the valve under the specified maximum differential pressure within the time specified.

The valve shall be suitable for frequent operation during initial commissioning operation after a long period of inactivity.

1.2.15 MARKING

The mark stated by the Employer in the Material Request shall be printed on the body, of all valves and relevant accessories (control columns and relevant connecting elements to the valve, counter flanges. valves for the auxiliary control if separately supplied. etc.).

The face of each hand wheel shall be clearly marked "Open" and "Shut" with arrows indicating the direction of rotation to which they refer. Each hand wheel shall also be fitted with a circular name plate indicating the service for which the valve is intended and valve tag number. The name plates shall be engraved in black lettering. Each spare part shall be individually marked with metal plates suitably punched for an easy identification.

1.2.16 TESTING AND INSPECTION

All valves shall be checked for correctness in respect of flange details as specified. The valves shall be tested as per the requirement of AWWA C-504 (latest version) IS . Proof of design-tested valve shall not be supplied for the project. Proof of design test as per AWWA C-504 may be conducted or certificate produced if insisted upon by the employer. For cast construction: Body and Disc shall be subjected to MPI/LPI and shaft shall be subjected to UT and LPI..

For Fabricated Construction: All Butt welds having thickness 20mm and above shall be subjected to Radiography and, stress relieving. Only qualified welders shall be used for the purpose of carrying out welding. Shaft shall be subjected to UT and LPI.

1.2.17 SITE TEST

The valves shall be tested at site for opening and closing time, valve operation etc. The valve should operate without any flutter, noise, and vibration.

**1.2.18 A. ELECTRIC MOTOR ACTUATORS FOR BUTTERFLY VALVES
DESIGN REQUIREMENTS**

Electric actuators shall essentially consist of electric motors, limit switches, hand wheel and gear trains, mechanical position indicators, internal wiring and terminal

block.

The electrical actuator assembly inclusive of drive motor and unit switches compartment shall conform to IP 67 degree of protection. Actuators shall be sized so as to. open / close the valve at the rated speed against the design differential pressure at 90% of the nominal voltage .lost motion hammer blow feature shall be provided for seating /unseating the valve when the operating torque exceeds 11 kg/m. Operators shall be designed to be self locking (i.e. maintains the stem position) upon loss of electric power supply. Motors shall be installed on the operator prior to shipment to the valve manufacturer. Actuators shall be provided with lifting lugs for handling it along with the bonnet Actuator assembly shall have all metal gear trains. Operators shall be flange mounted on the valve bonnet. Welding of operators onto bonnets is not permitted. All actuators shall be as per the approved vendor list or as approved by the employer.

1.2.19

OPERATING SPEED

All actuators shall have operating speeds as per the manufacturer's standard. However, this shall meet .operating requirement of the system. Actuator operating times (opening arid closing) shall be furnished with actuator details.

1.2.20

SERVICE CONDITIONS

The actuator shall be suitable for operation in a hot, humid and tropical atmosphere. Unless otherwise stated in the equipment specification, the ambient air temperature shall be taken as 50 dg. C, relative humidity 100% and mean sea level less than 1000 meters.

1.2.21

RATING

The actuator shall be designed for operation on a 415 V + 10%, 3-Phase 50 Hz + 5% solidly grounded system. The combined voltage & frequency variation shall be +1-10%. The control circuit voltage shall be 240/110 VA.C. or 220V D.C.

The actuator shall be rated for three successive open-close operation of the valve or 15 minutes, whichever is longer.

The normal torque rating of each drive unit shall have adequate margin and at least equal to theoretical brake torque required to drive the equipment under full load, including all losses in speed reducers and power transmission.

The drive shall take into account valve operating speeds and differential and static pressure required for the service. The contractor shall select operating speeds and design pressure to satisfy requirements of the equipment furnished and acceptable to the Employer. Motor actuator assemblies shall have all metal gear trains. Fiber gears are not acceptable.

1.2.22

PERFORMANCE

The actuator shall open and close the valve completely and make leak-tight valve close, without jamming.

The actuator shall attain full speed operation before valve load is encountered and impart an unseating blow to start the valve in motion (hammer blow effect).

The actuator shall operate the valve stem at standard stem speed and shall function against design differential pressure across the valve seat.

The motor reduction gearing shall be sufficient to lock the shaft when the motor is de energized and prevent drift from torque switch spring pressure.

The entire mechanism shall withstand any shock resulting from closing with improper setting of limit switches or from lodging of foreign matter under the valve seat.

1.2.23 SPECIFIC REQUIREMENT

Construction

The actuator shall essentially comprise of the drive motor, torque/limit switches, gear train, clutch, hand wheel, position indicator I transmitter, space heater and internal wiring. The actuator enclosure shall be totally enclosed, . dust tight, whether proof suitable for outdoor use without necessity of any canopy. All electrical equipment, accessories and wiring shall be provided with tropical finish to prevent fungus growth.

The actuator shall be designed for mounting in any position without any lubricant leakage or operating difficulty.

Motor Drive

The drive motor shall conform to sub-section E2 of this specification

The drive motor shall be three phase, 415V, squirrel cage, induction machine with class B insulation and IP-67 enclosure, totally enclosed and self ventilated and designed for high torque low inertia and reversing service suitable for operation at 50 deg. C ambient temperature

The motor shall be designed for full voltage direct on-line start, with starting current limited to 6 times full-load current

All motors shall have TEFC enclosures with space heaters to maintain the internal temperature above dew point when the motor is idle. Space heaters shall be rated for 240VAC.

The motors shall be capable of operating the valve against the maximum load on the valve disc. with drive bearings in dry and dirty condition.

Each motor shall be provided with two direct temperature sensing thermostats to prevent thermal overload.

All motors shall have O-ring seals to provide complete environmental protection when the motor is idle.

Earthing terminals shall be provided on either side of the motor.

Double shielded grease prelubricated, regreasable, antifriction bearings having a minimum life rating of 1,00,000 hours shall be furnished.

1.2.24

a.

Limit switch

Position Limit Switches

Each actuator shall have rotary drum position limit switches, two {2} for open and two (2) for close position, each with adjustable setting between fully open and fully close positions. Each rotary drum position limit switch shall have two normally closed (NC) and two normally open (NO) independent contacts. The adjusting 'mechanism for the limit switches shall be easily accessible.

b.

Torque limit switches

Each actuator shall have two torque limit switches with suitable arrangement to limit the opening / closing thrust. The torque switch, actuated by the torque' clutch when the valve is restricted during opening / closing shall stop the motor thereby

protecting the motor from overloading torque. The torque switches shall be set as near as possible to the pull out torque of the motor without damaging the valve of the operation.

Each torque switch shall have two normally open (NO) and two normally close (NC) independent contacts

The torque limit switch adjusting mechanism shall be easily accessible.

Limit switches along with all necessary electrical wiring shall be housed in a weather proof NEMA-3 enclosure and shall have gasketed cover and space heater to maintain the temperature above dew point.

Each torque / position limit switch shall have 2 NO + 2 NC potential free contacts. Contacts shall be rated to make and carry continuously 10 A at 110 V -C and 0.5A (inductive) 220 V DC.

Manual operation.

All actuators shall have mechanically independent manual drive arrangement with hand wheel and motor declutching mechanism. The manual drive shall be provided with clutch and gearing as required to limit hand wheel effort to 25 kg maximum along with suitable latch and locking arrangement to keep the hand wheel in engaged position using manual operation.

The hand wheel shall disengage automatically during motor operation.

1.2.25

Position indicator / Transmitter

All actuators shall have one (1) built-in local position indicator for 0.-10.0.% travel.

All actuators shall be provided with mechanical 3-point dial position indicators.

Rising steam valve shall

additionally have visual position indication through plastic stem covers.

Where required, valves shall be provided with continuous remote position indicators of the potentiometric type. The available voltage sources for the potentiometric position transducers are 220V DC and 240 V AC. The transducer shall be suitable for established 4-20 mA current signal. The associated wiring for the transducers shall be housed in the limit switch compartment.

Space Heater

A space heater shall be included in the limit switch compartment suitable for 240. V AC, 50. Hz supply 220. V DC.

Wiring

All electrical devices shall be wired up to and terminated in a terminal box. The internal wiring shall be of sufficient size for the power rating involved but no case less than 1.5mm copper. All wiring shall be identified at both ends with ferrules. Internal wiring diagram shall be neatly pasted on the rear side of the terminal box cover

Motor power, heater and all control wiring shall be wired at shop to suitably rated master terminal blocks located within the limit switch compartment. All internal wiring shall be of 650/1100 V grade flexible standard copper conductor cables with tropical fungicidal treatment and the insulation shall be flame resistant

The limit switch terminals should be capable of terminating two nos. 2.5 mm copper cable

Terminal boxes shall be provided with removable undrilled gland plates to terminate following sizes of cable.

- I) 1no.- 14 core 2.5² (Cu)
- II) 1no ., 10 cores - do-
- III) 1no.- 2 pair
- IV) 1no.- 10 pair
- v) 1no. - Power cable

Terminal Box

Actuator terminal box shall be suitable to receive and terminate the following cables:

- a) 1No. power cable details of this shall be intimated later.
 - b) 3 Nos. 19 C x 2.5 copper conductor PVC insulated unarmoured control cable
- Actuator terminal box shall be provided with a removable front cover plate and an undrilled detachable gland plate

1.2.26

DATA TO BE FURNISHED

Motor data sheet for each type of actuator shall be furnished along with internal wiring diagram, suggested control schematic and torque I limit switch contact development.

B) ELECTRO HYDRAULIC ACTUATORS

1.2.27

DESIGN CRITERIA

Each electro-hydraulic actuator shall be provided with its own power pack. Each actuator shall consist of a double acting cylinder, control cabinet and accessories to cater for following operational requirements.

In the closed position the valve shall be held closed by a substantial counter weight or by any other mechanical device.

Start-up sequence of pump shall initiate powered opening of butterfly valve hydraulic actuator. The actuator shall be adequately sized to open or close the valve against an unbalance. Pressure equal to pump shut-off pressure in either direction within the time period as specified. The necessary limit switches shall be provided on the valves so that at a pre-determined position, the pump circuit breaker shall be closed to start the pump.

Valve shall remain open during normal running of the pump. No disc flutter shall take place in the position nor shall there be any creep in this fully open position.

A limit switch be provided (set at about 3 deg from open position) to sense the creeping. Switch shall start the oil pump and return the valve to the fully open position.

When the valve is fully open and electric supply in the valve control system fails the butterfly valve shall remain open while the CW pump continues to deliver water.

Normal operational shut down shall enable valve to close at a slow closing rate, which shall be adjustable between 30 to 60 seconds.

In case of any fault causing pump motor trip, the corresponding butterfly valve shall start closing at a fast rate initially and thereafter at a slow rate. The emergency closing facilities shall be duplicated each with its own solenoid valve in the hydraulic circuit.

Provision for local manual operation shall be made.

The lower part to the cylinder shall have a fixed orifice especially designed to achieve a minimum valve closing time in case of failure of oil pipeline.

A locking device shall be provided so that the valve can be maintained in open/shut position during maintenance and inspection.

The hydraulic controls for each valve shall be housed in independent cabinet located on an operating floor near the valve. This shall consist of pumping unit, oil tank, and accumulator of adequate -capacity to hold the valve disc at any position and to prevent any surge including disc flutter during valve travel and to fully open position. Accumulator will also have enough capacity for 2 strokes of operation without external electric AC power. The hydraulic power pack will consist of necessary pressure switches, pressure gauges, flow regulators, solenoid valves; transformers, rectifiers etc. for DC power supply for solenoid valves contactors, relays, fuses, indicating lamps, push buttons etc. for control of solenoid valves and pumping units; throttle valve, filters, non-return valves etc. arranged in a logical circuit to meet operation requirement

All oil pipelines / flexible hoses interconnecting the control cabinet to the valve shall be in bidders scope

The electrical controls for the valve such as relays, contactors and fuses shall be housed in the common panel (local) for CW pumps or in a separate panel. Reversible starters for the valves shall however, be provided by the Employer

Each butterfly valve shall have four limit switches, each capable of being set of at any point between full open to full close position to meet desired functions. In addition, one more extra limit switch to be set at an intermediate position shall be provided, each limit switch shall have 2 NO. and 2N C contacts. Limit switch enclosure shall conform to NEMA4x standard

1.2.28 SUBMITTALS

The contractor shall submit with his offer full details of valve operating mechanism and hydraulic diagram with description.

1.2.29 TESTS AND INSPECTION

The Contractor shall furnish type test certificates from a recognized test house certifying evaluation of accuracy, reliability and repeatability.

Each valve actuator assembly shall be given a complete operation test at the valve manufacturer's shop to demonstrate that each operator is functional and all limit switches have been properly set.

Tests shall be also done for speed of travel, torque rating and calibration.

When practicable, each valve assembly shall be shop tested to open and close against the maximum differential pressure.

All the components of actuators shall be subject to tests at the works of Manufacturer as per relevant Material Specifications and Manufacturer's established practices, to ensure reliability. Details of the same shall be furnished to the Employer

Functional test on accumulators, Oil Pumps and completely assembled unit of

Actuators shall be carried out as per approved procedure and Data Sheet.

Contractor Must Conduct Proof of Design Test on the Actuators as per AINWA-C-504

1.3 Kinetic Air valves

1.3.1 General

Kinetic air valves are required with pressure rating appropriate for the working conditions and approved by the Employer, confirming to IS: 14845/AWWA C 512.

1.3.2 Scope and general design features

The air valves shall be capable of exhausting air from pipeline automatically when being filled. Air shall be released at sufficiently higher rate so that there shall be no restriction for the inflow rate. Similarly, the valves shall be capable of ventilating pipeline automatically when being emptied. The air inflow rate should be sufficiently high to avoid development of vacuum in the pipeline.

The design shall be such that, higher the rate of flow the greater the resultant down thrust, keeping the ball 'glued' to its seat until the last drop of air is expelled from the pipe system.

Each air valve shall be provided with an isolating sluice valve with flanged end connection.

The possible air velocity (inflow and outflow) must be at least 10 *m/s*.

1.3.3. Construction features

The flow of air should be as unobstructed as possible. The low pressure orifice shall be in the same axis as the main discharge / incoming air flow and must have a diameter sufficiently large. The valve body shall be designed in such a way that the turbulent air at the time of filling of pipeline shall not circulate and cause the ball to be caught in the discharging air stream and blowing the valve shut permanently. The cone angle of the low pressure (large orifice) chamber shall be such that even at a critical velocity of air escaping at 344 m / sec the total impact force on the Stainless steel ball is less than the suction force on the annular area between the ball and cone. The annulus around the low pressure ball is to be generously proportioned for discharge of air under various differential pressures. Normal range of cone angle is 450 to 600.

The orifice shall be carefully profiled to allow the requisite flow of air under varying differential pressures. It shall be in moulded synthetic rubber such that even after extended contact the, Stainless steel ball does not stick to it, when the line pressure becomes zero.

The high pressure chamber having small orifice shall be so designed that the orifice is effectively sealed in working condition. The orifice shall be profiled in such a manner that the ball is not damaged even after extended contact. There should be machined guide in the chamber which ensures that the ball travels vertically and makes contact with the nipple and seals off the orifice without fail. The orifice size shall not be less than 2.5 mm and tapering to 10 mm suitable to release accumulated air within the pipeline. High pressure orifice may be fitted from bottom side of the cover.

1.3.4 Material

The makes given are acceptable makes however the material for different components parts of the air valve shall conform to the requirements given below:

Sl.No	Component	Material	Reference to IS No.	Grade of designation
1	Body, cover, valve disc, stuffing box, valve guide, cowl, gland, cap, joint	S.G. iron / Ductile iron GGG 40/50, ASTM A 536	1865	Gr.400/ 15
2	Low Pressure seat ring and face ring	Natural rubber	11855	
3	High pressure orifice	Leaded tin bronze	318	LTB-2
4	Bolts	Carbon steel	1363	Class 4, 6
5	Nuts	Carbon steel	1363	Class 4
6	Gasket	Rubber	638	Type B
7	Float	Stainless steel/Polypropelene/ Polycarbonate	6603	04 Cr 19 Ni 19
8	Float guide	Leaded tin bronze	318	LTB-2

1.3.5 Floats

Minimum float diameters for kinetic air valves shall be as indicated in table 3 of IS 14845. The inner core of the floats shall be made from stainless steel having sufficient bearing strength and equivalent specific gravity.

1.3.6 Testing

Testing of all the air valves shall be carried out in the suppliers work shop as per IS:14845.

Following tests shall be carried for each valve.

- Function and performance test as per clause 12.4.1
- High pressure orifice test as per clause 12.4.2
- Low pressure orifice test as per clause 12.4.3
- Body test as per clause 12.4.4

The performance of the valve for the above mentioned tests shall be as specified under clause 12.1, 12.2 and 12.3 of IS 14845.

1.3.7 Manufacturer's Test certificate

The manufacture shall provide a test certificate confirming that all the air valves have been tested in accordance with the relevant standards and performance of the test results observed.

1.3.8 Third party inspection

The inspection and testing of the sample air valves shall be carried out by the employer and or inspecting agency appointed by the employer, in the manufacture's workshop before application of any paint. All the tests as required as per IS 14845 shall be conducted in presence of the inspecting agency on the sample valves from the lot (Number of valves to be tested from a lot shall be as per the relevant IS for sampling and testing). The valves shall be dispatched only after issue of the test certificate by the inspecting agency for satisfactory performance of the tested valves. The inspection charges for such tests shall be first paid by the contractor to the inspecting agency, which shall be reimbursed on production of the documentary evidence for the payment made.

1.3.9 Marking

Each valve shall be permanently marked with a plate securely fixed to the body with the information as specified under clause 15.1 of IS 14845.

The design, construction material, manufacture, inspection, performance and testing shall comply with all applicable Indian Standards and Codes. Nothing in the specification will be construed to relieve the supplier of this responsibility.

1.3.10 Acceptable makes for the valves

Acceptable makes for the kinetic double orifice air valves shall be as per the approved vendor list. All the valves shall have the same make. Contractor should not place order with any other manufacturer for the above said item till it has been approved in writing by employer for the makes listed above.

1.3.11 Installation

The installation of the air valves shall be done with isolating sluice valve. The job covers supply of the valves at the work site including all taxes and duties, cost of packing, loading, transportation, unloading, stacking and installation at the specified location with cost of all jointing materials such as nuts and bolts, EPDM rubber gaskets etc. The job covers field hydraulic testing of the valves after installation for the specified test pressure for the respective pipeline section.

1.4 Anti Vacuum Valve:**1.4.1 Scope:**

The Anti vacuum valve of 380 mm will be installed to prevent the formation of vacuum in large diameter (having of 1000 mm. and above) water mains to prevent line collapse under such conditions of flow as may result, for example, from too rapid a closure of an upstream head gate or shut down valve, a downstream burst or ordinary emptying or recharging of a pipeline.

1.4.2 Design features:

Design of the anti-vacuum valve shall automatically allow induction of large volumes of air to prevent vacuum formation; and also provide an automatic means of ventilating a line when it is being emptied of water and of exhausting air when it is being recharged.

It should be suitable to react automatically, sensitively, and positively even after long periods of inactivity, to changes of pressure within a pipe, and whenever necessary, permit air to flow in at a sufficiently high velocity, and at low enough induction pressure, to safeguard the line against collapse.

Cowled Inlet Type of the anti - vacuum valve should have an annular cowl shrouding the orifice, providing protection to the orifice and the seating. It should be suitable for air to flow through the ports provided around the periphery of the body assembly. Such application is confined to situations where no damage is likely to occur surrounding structures from sudden intakes of air.

1.4.3 Operation :

About Operation, the valve element should be in the form of the disk which is sensitively balanced by a counterpoising mechanism. The disk guide pin should be attached to a crosshead, to which is fitted at either end a cranked lever that should rock about an intermediate pivot pin and should be applicable to carry an adjustable counterweight on its outer arm. The parts should so arranged that by adjusting the position of the counterweights, the valve must be balanced at any desired points on its working travel.

Thus, when swinging freely the valve may be balanced at a partially opened position in which case, if it is closed by hand, it self-opens to the pre determined point of equilibrium, and vice- versa. Also attached to the crosshead should be an oil dashpot which should give free opening, in a downward direction, but offer resistance to closing, in an upward direction, and avoid all possibility of oscillation of the suspended.

In action, therefore, the valve should not remain at either extremity of its travel unless it is acted upon by some external force. During normal operation, the disk should be held shut by the water pressure in the pipe. If the pressure on the underside of the disk falls below that of the atmosphere, the valve should immediately open to admit air and break vacuum. With very small vacuum, say 1inch of mercury or about 0.5 psi below atmosphere, should open fully and offer a wide passage for free flow of air. On the cessation of air inflow, the valve must return to a position of slightly open, which is sufficient for the escape of air during refilling of the line. When the rising water makes contact with the underside of the disk, closure is completed: only a very small water pressure should be required to close the valve, consequently, the quantity of water overflowing through the orifice during final closure will be negligible.

1.4.4 Manufacturer's Test certificate

The manufacture shall provide a test certificate confirming that all the Anti vacuum valves have been tested in accordance with the relevant standards and performance of the test results observed.

1.4.5 Third party inspection

The inspection and testing of the sample Anti vacuum valves shall be carried out by the employer and or inspecting agency appointed by the employer, in the manufacture's workshop before application of any paint. The valves shall be dispatched only after issue of the test certificate by the inspecting agency for satisfactory performance of the tested valves. The inspection charges for such tests shall be first paid by the contractor to the inspecting agency, which shall be reimbursed on production of the documentary evidence for the payment made.

1.4.6 Marking

Each valve shall be permanently marked with a plate securely fixed to the body with the information as specified under relevant standards.

The design, construction material, manufacture, inspection, performance and testing shall comply with all applicable Indian Standards and Codes. Nothing in the specification will be construed to relieve the supplier of this responsibility.

1.4.7 Acceptable makes for the valves

Acceptable makes for the Anti vacuum valves shall be as per the approved vendor list. All the valves shall have the same make. Contractor should not place order with any other manufacturer for the above said item till has been approved in writing by employer for the makes listed above.

1.4.8 Installation

The job covers supply of the Anti vacuum valves at the work site including all taxes and duties, cost of packing, loading, transportation, unloading, stacking and installation at the specified location with cost of all jointing materials such as nuts and bolts, EPDM rubber gaskets etc. The job covers field hydraulic testing of the valves after installation for the specified test pressure for the respective pipeline section.

1.4.9 PAINTING SPECIFICATION FOR VALVES :

Final coating on internal and external surface of the Valve shall be carried out after satisfactory testing, prior to dispatch.

Before inspection : Each valve shall be cleaned and surface shall be prepared by Sand blasting to SA 2% Grade- Near white blast cleaning, and suitably protected by applying one coat of two component high build polyamide cured re-coatable zinc phosphate epoxy primer.

After inspection :One coat of two component high build polyamide crude re-coatable epoxy coating shall be applied to achieve DFT 150 micron, followed by one coat of two component aliphatic polyurethane finish to achieve DFT 80 micron. Final DFT should be minimum 250 micron.

1.5 Non-return valves

GENERAL

Each pump will be provided with one Non Return Valve in its delivery pipe. The non-return valves shall be all flanges type single door type / multi door type, (recoil or equivalent) well proven type, free acting quick opening, giving rapid non-slam closure etc. and with low head loss characteristics confirming to IS 5312. The valves shall be provided with by passes valves. The flanges shall be confirming to IS 1538-1976 / BS 4504. Valves above Ø600mm must be of multi-door design.

1.5.1 MATERIALS OF CONSTRUCTION

Body, cover, door, hinges	Ductile Iron IS 1865 Gr. 400/15 or 500/7
Hinge pins, stub pins	SS AISI 410
Suspension pins	
Disc facing	Leaded in Bronze IS 318 GR LTB2
Seating in body	Leaded in Bronze IS 318 GR LTB2
Bearing bushes, Body rings,	Leaded in Bronze IS 318 GR LTB2
Door faces	
Bolts and nuts	Stainless Steel / Carbon Steel

1.5.2 TESTING

The valves shall be subjected to seat and body test in accordance with IS 5312 at the manufacturer's works vide table below. These tests shall be carried out at manufacturer's works in presence of Engineer or his representative, before delivery. Test Certificates shall be furnished in triplicate.

Valve rating	Seat Test Pressure	Body Test Pressure
PN -0.6	6.0 Kg/cm.sq.	9.0 Kg/cm.sq
PN -1.0	10.0 Kg/cm.sq..	15.0 Kg/cm.sq.
PN -1.6	16.0 Kg/cm.sq.	24.0 Kg/cm.sq.

2.0 PUMP CONTROL VALVE

2.1 SPECIFICATION OF PUMP CONTROL VALVES

The Pump Control Valve shall open fully or shut off in response to electric signals. It shall isolate the pump from the system during pump starting and stopping, to prevent pipeline surges during Pump ON/OFF.

Valve Should be with Rapid-action piston for Fast Opening/Closing action to facilitate stable and accurate control.

Valve Should have High Kvfactor e.g. 4" valve should have KV value of 475 m3/hr,

Valve should have Low head loss at high flow rates,

Valve should be strong, lightweight and corrosion proof surfaces, which resist cavitation damage, thus increasing service life and reducing operation & maintenance cost.

Valve should have Linear flow, Low turbulence to minimize cavitation, and allow high flow velocities with low noise and vibration.

Valve should have "Soft closure" feature to prevent water hammer.

Multi-Valve modular configuration Full redundancy enabled. Individual valves can be possible to separately removed for maintenance or replacement which reduces downtime and maintenance costs & allows maintenance work to be done without halting water flow.

2.2 MATERIAL OF CONSTRUCTION :

Valve Body, : Reinforced fiber glass nylon or Polypropylene

Pistons, Bushing, Front and Rear Cups: Reinforced fiber glass nylon or Polypropylene

Main seal : NBR, VITON or EPDM rubber,

O-rings : NBR or EPDM rubber

Inlets, outlets : Stainless Steel/Reinforced Fiberglass nylon

Clamps, bolts : Stainless steel

Multi-Valve manifolds : Spheroid iron with Polyester or Epoxy coating

/Stainless Steel.

Pressure Rating : PN 16

Inspection and Testing of all equipment will be done as per the approved Quality Assurance Plan from the CE, Megalift.

Manufacture, supply and installation of MS Expansion joints and Cover box

3.1 M.S Expansion joints

3.1.1 Requirement

Expansion joints are necessary on the MS pipeline laid above ground to accommodate expansion and contraction of the MS line due to temperature variations, so that the expansion or contraction is not cumulative over several lengths. These joints permit linear movement of the pipe relative to the packing provided in the joint. Fabricated steel Bellow-type expansion joints, as per the EJMA standards, shall be provided and installed at the locations shown on longitudinal section of the pipeline.

Normally, on plain ground, the centre to centre distance of the expansion joints shall not be more than 300m. When the length of above ground pipeline is less than 300 m but more

than 100 m, one expansion joint at the centre shall be provided. The pipe line shall be anchored firmly with concrete anchor blocks between two expansion joints, so that the expansion or contraction between two anchor blocks is accommodated by the expansion joint provided between the blocks. Supports / saddles shall be placed on each side of the expansion joint at about one meter distance from the centre of the joint to avoid unequal deflection of the pipe on either side of the joint.

The item covers providing and packing, transportation to work site and fixing wherever required on the pipeline with hydraulic testing along with the pipeline section.

3.1.2 Acceptable makes

Acceptable makes for the Bellow-type expansion joints shall be as per the approved vendor list. All the expansion joints shall have the same make. Contractor should not place order with any other manufacturer for the above said item till has been recommended in writing by employer for the makes listed above.

3.1.3 MATERIAL OF CONSTRUCTION

BELLOWS MATERIAL	SA 240 GR. 304
CENTRE SPOOL / WELDENDS	IS 2062 GR. B
INTERNAL SLEEVE	SA 240 GR. 304
LIMIT RODS / NUTS & CHECK NUTS	IS 1367
FLANGES	IS 2062 (AS PER IS 1538 IIS 6392)

3.1.4 MS cover for expansion joints

3.1.5 Requirement

Circular MS covers as shown on drawing shall be fabricated and fixed on the expansion joint for protecting the joint from possible damages. The item covers the cost of plates and material required, nut bolts, all taxes and duties, providing and applying two coats of epoxy paint in addition to one primer coat, transportation and fixing charges etc complete

3.1.6 Manufacture, supply. and installation of MS dismantling joint

Bellow type Dismantling joint shall be provided for each online sluice valves, butterfly valve and washout valve to facilitate removal of the valve for repairs whenever required.

The joints shall be fabricated as per EJMA standard .The item covers cost of Bellow type Dismantling joint, including all taxes and duties and cost of coating, packing, transportation, cost of jointing including required material such as nut bolts, rubber packing, labour cost etc complete with hydraulic testing to required pressure.

3.1.7 Material of Construction

BELLOWS MATERIAL	SA 240 GR. 304
CENTRE SPOOL / WELDENDS	IS 2062 GR. B
INTERNAL SLEEVE	SA 240 GR. 304
LIMIT RODS / NUTS & CHECK NUTS	IS 1367
FLANGES	IS 2062 (AS PER IS 1538 IIS 6392), BS EN 1092-2

3.1.8 Acceptable makes

Acceptable makes for the Bellow-type Dismantling joints shall be as per the approved vendor list. All the dismantling joints shall have the same make. Contractor should not place order with any other manufacturer for the above said item till has been recommended in writing by employer for the makes listed above.

3.1.9 Supply and fixing of roller bearings

3.1.10 Requirement

Steel roller bearings shall be provided and fixed on the bearing plates fixed on concrete pedestals for above ground pipeline, as shown on drawing. The bearing boxes shall be firmly fixed to the bearing plate. Number of bearings and rollers, size of rollers etc shall depend on the pressure and thrust on the pipeline and shall be as directed by the Engineer-in-Charge in charge.

3.2 METALIC / RUBBER EXPANSION JOINTS / DISMENTALING JOINTS

Metalic / Rubber expansion joints shall be provided between the discharge head outlet and valve in delivery line each pump for easy assembling and dismantling of the pipe work. The metallic / rubber expansion joint shall withstand the internal test pressure and vacuum as specified in Schedule- design shall ensure that-

1. When assembled and under dynamic load the rigid bolts together withstand pull, equal to twice the duty head and no torque or pull is extending on the discharge head mounting fasteners.
2. During assembling or dismantling, the sliding flange can slide adequately to enable to detach discharge head and piping from each other.
3. The seal ring that joint shall be designed to withstand test pressure mentioned in Schedule 'B' without any leakage.

3.2.1 DESIGN AND CONSTRUCTION

Design of the expansion joints shall be restrained type with minimum three (3) tie rods.

BODY

Expansion bellow shall be manufactured from natural or synthetic rubber, with integral flanges at both ends. Split retaining rings of adequate design shall be supplied for severally holding the expansion joint with connecting pipe flanges.

CARCASS

Fabrics of high strength synthetic fibers shall be used in suitable number of pipes to hold the shape of the below at the working condition. All fabric pipe shall be impregnated with rubber or synthetic components to permit flexibility before them.

Copper coated steel wire or solid endless rings embedded in the carcass shall be coated with suitable material to protect the carcass from outside sewage and fluid corrosion.

Protective hypalon coatings shall be applied at the exterior.

3.2.2 CONTROL ROD ASSEMBLY

Each expansion joint shall be supplied with control rod assembly to prevent excessive elongation or contraction of the below. Control rod assembly will consist of long bolts, nuts

and lock nuts, spherical washer connecting plates (guest plates) for fixing the assembly with mating flanges.

Control Rod assembly shall allow transverse and rotation movements under limiting axial conditions of the Expansion Joints.

Design of control rod assembly shall take care of the maximum axial thrust across the Bellow, calculated on the bases of maximum fluid internal pressure and internal diameter of the each.

Expansion joints shall be provided with flanges drilled to suit the Pumps delivery flange.

3.2.3 INSPECTION AND TESTING

Tests at shop shall include but not be limited to the following

- a. Material test as per specification requirement.
- b. Vacuum test.
- c. Hydro-test

3.2.4 HYDRAULIC PRESSURE TEST AND LEAKAGE TEST

All expansion bellows shall be subjected to internal hydrostatic pressure test of equivalent to 1.5 times the shut off head of pumps and the following condition.

1. Free position of the bellow for five (5) minutes.
2. With permitted (design) elongation and lateral deflection for Two (2) minutes and
3. With design contraction and lateral deflection for two (2) minutes.

After the hydro test is over, the bellow shall be dimensionally inspected to check deformation, if any.

During the test, the control assembly shall be suitably adjusted to obtain the test condition of the Bellow.

At tests shall be carried out in presence of the Engineer or his representative.

3.2.5 CLEANING, PROTECTION AND PAINTING

Before installation, all expansion joints shall be properly cleaned, as necessary. All exposed finished metal surfaces shall be greased to prevent dust.

3.2.6 DIS MANTLING JOINT

Item Design, Manufacture, Supply & Erection of Dismantling Joints of various diameter including hoisting lowering in position fixing in true plumb & level etc. including tie rods hardware gaskets & other necessary material for making joints including all taxes, central state & local conveyance to site, loading, unloading safe storage till erection etc. complete.

General: The item providing & fixing in position dismantling joint of various dia. on the pipes. The design work man ship shall be to the specifications of Engineer & shall comply with one or more of the standards, regulations & codes issued by Bureau of Indian standard /B.S.

Item to Include:

The Unit includes:

- Manufacturing of Dismantling joints, providing gasket, tie rods, nut, bolts & studs.
- Quality control
- Conveyance to site.
- Storage till erection
- Erection with all jointing material and labour

- Successful commissioning.
- All taxes central, state and local and any other incidental expenses.

Design to be approved before manufacturing:

Before manufacturing the contractor shall submit to the Engineer-in-charge, the detailed drawing with relevant IS. The contractor shall not manufacture joints with not written approval of Engineer-in-charge to the design.

Material of construction & Design data:

- i) Name of Fluid Raw River Water
 - ii) Working Pressure 10Kg/cm.sq.
 - iii) Material of Construction
 - Inner shell f- MS as per IS 2062 Gr. B.
 - Outer Sheet f- MS as per IS 2062 Gr. B.
 - Pressure flange f- MS as per IS 2062 Gr. B.
 - Nuts bolts tie bar f- CS IS 1367 Gr. B.(Galvanized) studs
 - Gasket f- Rubber
 - 'O' Ring f- Neoprene {50 shore hardness}
 - iv) Governing standard
 - Flanges f- IR 1318
 - Fabrication f- IS 3589
 - v) Testing f- Test Pressure 16Kg/cm.sq.
- Test Certificate f- Hydraulic Test Certificate & Material Test Certificate

Before the joints are actually fixed, they shall be cleaned, greased & it should be seen that all the parts are perfectly in working conditions.

- 3.2.7 Dismantling joints shall be suitable for flange bolting individual to flanges of BFV & NRV.

Flange made segments & welded shall be stress relieved after welding.

Flange & machined surfaces shall be protected from corrosion during shipment and Subsequent storage by casting rust pan, preventative or equivalent which is easily removable with petroleum.

3.3 SURGE PROTECTION DEVICES

3.3.1 General

Doing Surge analysis and designing system to control anticipated Water hammer by installation of 'Spring operated Zero Velocity Valves' and 'Air Cushion Valves' etc. shall be responsibility of the Contractor.

The Water hammer control system should be such that :

- i. There is no significant head loss
- ii. Positive pressure shall not exceed 140% of the maximum Working pressure of the Pipeline and
- iii. Fall in pressure during forward flow shall not be below Atmospheric pressure.

The agency engaged for doing Surge analysis and supply of Water hammer control devices should have sufficient experience of doing similar to the proposed job and should guarantee control of Water hammer pressures within above parameters.

The design shall be got approved from "Indian Institute of Science, Bangalore" / IIT/NIT or Institute as approved by the Engineer-in-Charge. The design charges shall be at the cost of the contractor.

The specifications for above specified hammer control devices shall be as specified below:

3.3.2 **BLADDER VESSEL (Water Hammer Control Device)**

Supply, Erection, Testing & Commissioning of Surge protection system (Bladder Vessel) required following features.

1. Large inlet size to water chamber as per water hammer analysis.
2. Minimum vessel thickness is 6 mm inclusive of 2 mm corrosion allowance.
3. Water does not come in contact with vessel.
4. Full size floating bladder reinforced with high strength nylon coated with food grade impervious butyl rubber for long life.
5. Drain arrangement to check pre charged air pressure.
6. Easy availability of spares.
7. The vessel is subject to test pressure for 10 minutes at 1.5 time maximum pressure.
8. Vessel should be epoxy coated internally & externally
9. Bend, NRV, Butterfly Valve, Bypass lines, Air valve, are fitted as per the design.
10. The piping between rising main and bladder vessel has to be carried out as per contract.
11. Required foundation for the bladder vessel.
12. The vessel should be charged with air pressure as per Requirement.
13. The Bladder vessel shall be connected to rising main within $5 \times D$ Where D = Diameter of rising main

Any other Bladder Vessel Design can be considered alongwith necessary recommended equipment as per approved Surge Analysis Report by "Indian Institute of Science, Bangalore" / IIT/NIT or Institute as approved by the Engineer-in-Charge

3.3.3 **CONSTRUCTION**

Bladder vessel consists of Air Chamber and Water chamber. Both are separated by floating impervious bladder. The Air chamber is pre charged via air inlet valve. The bottom flange can be connected to pipe line via throttling orifice and control valve.

3.3.4 **Zero Velocity Valve**

The valve has an outer fabricated casing ('Main Body') in which a Central Rod' is held by struts. A 'Stationary Central Dome' creates an annular streamlined passage for smooth flow of water. Closing Disc is mounted on 'Central Rod'. Disc is held in closed position by a number of 'Stainless Steel Springs' (of AISI 304). Two 'Anti Rotation Guide' are provided on the edge of 'central disk' with minimum resistance to flow. 'Anti Rotation Guide' is lined with Stainless Steel Strip (of AISI 304) and 'Guide Fork' with brass liners. 'Bypass' with a 'Valve'

connects upstream and downstream sides of Zero Velocity Valve. A 'Man Hole' is provided on 'outlet' cone of main body, for maintenance and replacement of springs (if required) without removing the valve from line. A stainless steel sleeve (of AISI 304) is fitted on 'Central Shaft' and moves in brass bush fitted in 'Disc' for free movement. The 'Outer Shell', 'Dome' and 'Disc' are fabricated out of M.S. plates (of IS 2062.). The valve will be painted in Black Tar Enamel Paint from inside and outside.

MATERIAL OF CONSTRUCTION :

Sl. No.	Description	Material
1	Entry Barrel and Cone	MS-15- 2062
2	Exit Barrel and Cone	MS-15- 2062
3	Central Lap Ring	MS-15 -2062
4	Guide Dome	MS-15 -2062
5	Central Disk (With Spring Guides)	MS-15 -2062
6	Central Shaft(S.S. Lined)	MS-ST42
7	Entry Cone Support Ribs	MS-15-2062
8	Exit Cone Support Ribs	MS-15-2062
9	Springs	SS-AISI -3 04
10	Anti Rotation Guide (with SS Strip on Plate & Brass on fork)	MS+SS304+ BRASS
11	Stiffener	MS-ST-42
12	Hand Holes	MS-15- 2062
13	Support Bush	MS- ST-4 2
14	Bush for Disc (With Brass Inner Bush)	MS+BRASS
15	Support Bush	MS- ST-4 2
16	Bypass With Valve	1.5.-1239

3.3.5 Air Cushion Valve

The valve consists of a 'Main Body' and Top Housing'. On the side of main body, two 'Air Inlet Valves' loaded with a light spring are fitted. The 'Inlet' is protected by a cover. The 'Top Housing' has an opening for air escape. A spring loaded 'Poppet' with a brass seal and Neoprene 'Sealing Ring' covers the top of the opening. The spring pressure on the valve is adjustable by a screw (S.S. as per AISI-304). The 'Housing' has a tapered outlet, the opening of which is adjustable by a tapered plug and Screw (S.S. as per AISI-304).

The outlet is protected by a cover on its lower side a cage holding a ball float is fitted. 'Main Body', 'Top Flange', are fabricated from M.S. (as per 1.5. 2062/1.5. 1239). The 'Top Housing' is made from high grade cast iron. Main body, float ball and air inlet flange are hydraulically pressure tested. Stems of valves are in stainless steel (as per AISI-304), and work in 'Brass Bushes'. Sealing rings are of good quality rubber and seats are of brass.

The 'Valve' will be painted in "Black Tar Enamel Paint' from inside and outside'.

3.3.6 Material of Construction :

Sl. No.	Description	Material
1	Adjustable Screw	Stainless Steel
2	Spring (Out Let)	Spring Steel
3	Poppet Spindle	Stainless Steel
4	Poppet Valve Disc	C. I.
5	Seal (Out Let)	Neoprene Rubber
6	Seat (Out Let)	Brass
7	Cage	C. I. or M.S.
8	Ball Float Wood	(Rubber Coated)
9	Tapered Outlet	C. I.
10	Tapered Plug	Brass
11	Screw	Stainless Steel
12	Outlet Cover	C.I or M.S.
13	Seat For Ball	Brass
14	Top Housing	C. I.
15	Main Body	M.S. (Fabricated)
16	Air Inlet Body	M.S. (Fabricated)
17	Seat (Inlet)	Brass
18	Stem	Stainless Steel
19	Spring (Inlet)	Spring Steel
20	Inlet Cover	M.S. (Fabricated)
21	Inlet Disc	C.I/M.S.
22	Seal (Inlet)	Neoprene Rubber
23	Mounting Flange	M.S.

3.4 FLOW MEASUREMENT DEVICES:**3.4.1 Scope :**

Electromagnetic Flow Meter of appropriate size shall be installed at the end of the manifold to measure the quantity of water discharged into the Distribution Chamber.

3.4.2 Electromagnetic Full Bore Type Flow Meter

Full bore electromagnetic flow meter shall consist of flow sensor (i.e. flow tube), flow transmitter and flow indicator and integrator and any other item required to complete the system. 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 meter shall be provided, as required by the flow meter manufacturer and in line with the applicable standards. Contractor shall finalize the exact location of flow meter in consultation with Representative of Employer.

Flow measurement shall not be affected by physical properties of water viz., temperature, pressure turbidity etc., within given limits. Contractor shall provide compensating Electronic circuits, if required. Flow meter shall be installed as per OEM guideline & verify accuracy after installation by OEM.

A lockable enclosure shall be provided for the flow transmitter cum computing unit, if required.

Flow meters shall be suitable for the water turbidity at site during various seasons. Flow tube shall be rugged in construction and shall be suitable for continuous operation. Flow tube shall have waterproof construction and shall be suitable for installation on underground /above ground pipe lines.

The flow computer and transmitter shall be a single unit suitable for panel mounting. It shall accept inputs from flow tube, process the signals and shall provide an output proportional to the flow rate. The distance between transmitter and flow tube shall be maximum 250 mtrs. Taper pieces required for installation of flow meter shall not exceed an angle of 8" in order to avoid disturbance in flow profile.

- a) General:
 - (i) Accuracy of flow measurement during FAT $\pm 0.5\%$ of measured value
 - (ii) Overall accuracy of flow measurement loop. $\pm 1.0\%$ of measured flow

- b) Flow tube
 - (i) Application : The water pumping mains
 - (ii) Type: In line full bore electromagnetic
 - (iii) Size of flow tube : As approved by the Employer.
 - (iv) Process connection : Flanges as per BS 4504
 - (v) Weather Protection Class: IP 68 as per IS 13947
 - (vi) Surge protection devices (SPD) between flow tube and flow transmitter: Required for protection from lightning surges
 - (vii) Material of Construction :
 - Electrodes : SS 316, self cleaning pipe
 - Coil Housing : SS 316, fully welded construction. / S.S flow tube with carbon steel coil housing
 - Flanges: Carbon steel
 - Grounding ring: SS 316
 - (viii) Flow tube lining: ETFE/Neoprene/PTFE.

- c) Flow Transmitter Unit
 - (i) Type: Microprocessor based with facility to configure the ranges.
 - (ii) Type of display: 4 digit backlit LCD/ LCD, for flow rate in m³/hr. 8 digit backlit LCD/ LCD for totalized flow in ML
 - (iii) Units of display: Flow rate - m³ / hr
Totalized flow- ML
 - (iv) Input: From flow tube
 - (v) Output: 4-20 mA DC (isolated) proportional to flow rate

- (vi) Power Supply : 230VAC
- (vii) Zero and Span Adjustment : Required
- (viii) Weather Protection Class : IP 68 as per IS 13947
- (ix) Battery backup for totalized flow
 - Type Online
 - Capacity 2.5 mVA
 - Backup Time 8 hours.
- (xi) Facility for on line diagnosis : Required

3.4.3 Calibration:

The Electromagnetic flow meter shall be wet calibrated for the full flow range specified as per BS EN 29104 (Methods of evaluation of electromagnetic flow meters). The calibration method shall be either gravimetric method as per ISO 4185 (Measurement of fluid flow in closed conduits -weighing method) or volumetric method as per ISO 8316 (Calibration by Volumetric Method). The Contractor shall produce accreditation certificates for the test facility and calibration certificate for the flow meter for the review by representative of the Employer. The Contractor shall also demonstrate complete wet calibration on the test bed in the flow meter laboratory. The flow meter shall be acceptable if the accuracy and repeatability is equal to or better than those specified.

3.4.4 Flow Indicator and Integrator

Flow indicator and integrators shall be modular in design. It shall consist of two separate dedicated displays for flow rate indication and total flow indication. It shall accept 4-20 mA DC isolated input. The flow integration shall be carried out in the Programmable Logic Controller (PLC). The flow indicator cum flow integrator shall provide 4-20 mA retransmission output proportional to flow rate.

Sl. No.	Details	Description
1	Type	Microprocessor based
2	Mounting	Front facia of Control Panel
3	Display	Digital, seven segment back lit LCD / LED display
4	Digit Height	14 mm or Higher
5	No. of Digits for Flow indicator Flow integrator	4 Digits 6 Digits
6	Input	4-20 mA DC (Isolated) from flow transmitter through analogue signal multiplier (Refer Note 2)
7	Zero and span adjustment	Required
8	Manual Reset Facility	Required (shall be password protected)

51. No.	Details	Description
	for flow integrator	
9	Engineering units: -Flow rate indicator - Flow integrator	Cum/hr ML
10	Battery backup for integrator	Required
11	Retransmitted output	4-20 mA proportional to flow rate
12	Alarm outputs	1NO+ 1NC for high and low alarms (adjustable)
13	Communication port	RS-485 (With Mod bus protocol) for interfacing with PLC
14	Weather Protection	Class IP-52 of IS 13947 Part I
15	Accuracy	± 0.25% of span or better.

Notes:

1. Digital flow indicator and flow integrator shall be a combined unit.
2. Facility shall be available in the analog signal multipliers and in the flow indicator and integrator for providing excitation voltage for the flow transmitter in case of 2-wire flow transmitters.

3.4.5 Acceptable makes for Electromagnetic Flow meters

Acceptable makes for the Electromagnetic Flow meters shall be as per the approved vendor list. All the Electromagnetic Flow meters shall have the same make. Contractor should not place order with any other manufacturer for the above said item till it has been recommended in writing by employer for the makes listed above.

3.4.6 Installation

The installation of the Electromagnetic Flow meters shall be done at the locations decided by the Engineer-in-Charge. The job covers supply of the Electromagnetic Flow meters at work site with cost of all the required material and all types of taxes and duties, cost of packing, loading, transportation, unloading, stacking and installation at the specified location with cost of all jointing materials such as nuts and bolts, EPDM rubber gaskets etc. The job also covers field hydraulic testing of the Electromagnetic Flow meters after installation for the specified test pressure for the respective pipeline section.

3.5 PIPE, VALVES, FITTINGS OF AUXILIARY SYSTEM**3.5.1 CODE & STANDARDS**

The design, manufacture, shop testing, erection testing and commissioning of piping and valves shall conform to the latest revisions of applicable Indian standards.

3.5.2 SCOPE

The equipment & material to be supplied for each Pumping station under this section shall include but not be limited to the following.

Pipes, bends elbows, tees, branches laterals, crosses, reducing unions, couplings, cap, expansion joints, flanges, blank flanges, saddles, shoes, sampling connections etc. necessary for making a reliable piping system.

Gaskets, ringjoint, bracing rings, jointing material etc. as required.

Instrument tapping connection, stub and thermo wells.

Supply and machining work of flanges, pipe spools and matching pipes to conned flow measuring orifice nozzles etc., pressure accumulators as necessary.

Valve to start stop and regulate flow.

Strainers

Anchor block (for buried/ over ground piping), support brackets, clamps, supports etc. for the piping

Bolts, nuts, fasteners as required for interconnecting piping, valves and fitting as well as for terminal point.

Secondary steel for pipe supports and embedded steel. Also pipe supports and necessary embedment required to be embedded in concrete for under ground/above ground pipe.

Painting anti-corrosive coatings, etc. inside and outside of pipes as necessary.

All embedded parts required for all tanks, water-retaining structures made of RCC including puddle pipes shall be supplied by the contractor.

3.5.3 DESIGN, CONSTRUCTION AND ERECTION

Piping (General)

Material of construction for pipes carrying various fluids shall as below:

Sl. No	Service	Recommended Material
1.	Filtered Water	Carbon Steel/ GRP
2.	Acidic Water	Rubber lined Steel
3.	Acid (hydrochloric)	Rubber lined Steel
4.	Alkali (Sodium Hydroxide)	
	a. Strong (5% to 50%)	Stainless' Steel
	b. Dilute	Rubber lined steel/Stainless steel
5.	Waste effluent from OM Plant vessels & chemical solution tank's etc.	HDPE / Rubber lined Steel

3.5.4 Pipelines carrying water, chemicals, air etc., shall be sized on the following velocities.

	Pump Size	Velocity in m/sec.		
		Below 50 mm	50-100mm	200mm & above
a)	Pump suction	-	1.2-1.5	1.2- 1.8
b)	Pump discharge	1.2-1.8	1.8-2.4	2.1- 2.5
c)	Header		1.5- 2.4	2.1- 2.4

Pipe line under gravity flow shall be restricted to a flow velocity of $1m/sec$ generally. Channels under gravity flow shall be sized for a flow velocity in the range of $0.6 m/sec$. (maximum).

Material & Dimensional Standards for piping

All piping system shall be capable of withstanding the maximum pressure and temperature in the corresponding line.

The steel pipes (welded type) for the services of water/ clarified - water/ Filtered water shall conform to the following standard or codes.

1. Pipes up to 150 NB
 - a) IS: 1239 Part-1 (Heavy grade- Black)
 - b) ASTM-A53 Grade B Welded), such 80 up to 2 inch nominal size
2. Pipes 200 NB and above
 - a) IS: 3589- Grade 410
 - b) ASTM- A53 Grade B (welded)- Sch. 40

If pipes are manufactured from steel plates, the plates shall conform to IS: 2062, B grade. The thickness shall be as per the pressures to be handled but should not be less than 8 mm.

Pipes to be used for the rubber-lined construction shall conform the above clause 3.02.02 and Inside surface shall be completely de beaded and made suitable for lining.

various fittings to be used in the piping shall conform to the IS/BS/ANSI Standards and In conformity with the parent pipe standard.

3.5.5 Design of Piping Systems

For water, air and other services where steel pipes are used, joints of this size range shall be screwed/flanged type;

All unlined steel pipes 65 NB and above (other than .CI pipes and air service pipes) shall be jointed by butt welding.

All rubber lined pipes shall have flanged joints. Miter bends shall not be used on RL piping. Only forged fittings shall be used.

Steel pipe flanges shall be generally slip on or raised face type. Welded neck flanges shall be used when flange follows immediately after a butt-welding or where it is required with respect to service conditions. When weld neck or socket weld flanges are used, their bore must be made the same as that of the pipe being welded to. Socket welded or threaded flanges may be used, with the appropriate piping system for connection of pipe to the flanged equipment

All the piping flanges and counter flanges shall conform to ANSI B 16.5 Cl. 150.

For easy handling & removal of equipments, valves etc. and for maintenance purpose, break up flanges for 65 'NB and above sizes and suitable type of compression flexible coupling for flanged joints of 50 NB and below size shall be provided. The overgrown piping, wherever routed inside building, shall have a clear head room of minimum 2.1 meter from operating floor.

Buried piping shall be generally installed so that the top of pipe is 1.0 meter below the ground level unless otherwise specifically mentioned.

Complete supporting system for the pipe line shall be designed, fabricated and supplied by the Bidder. Inside the building, the overhead portion of the pipe line

may be supported from the building structures. No support shall be taken from the brick wall. Outdoor, pipes other than buried pipes shall run on steel trestles. Crossing of the road shall be on a pipe bridge with a clear height to at least 6.1 meters over the road surface. All the steel structures for the pipe bridge, and the supporting posts / trestles along with all necessary hangers clamps, connecting steel, fixing bolts, nuts etc., shall be supplied and erected by the Bidder.

Miter bends will not be accepted for steel pipes of 250 NB and below. For sizes 300 and above, the miter bends shall conform to BS: 534.

For rubber lined pipe, lining should be applied in two (2) layers, giving a total thickness not less than 3 mm.

3.5.6 Painting and application procedures shall be as follows:

- a) Surface to be painted shall be thoroughly cleaned of loose mill scale, rust etc, by wire brushing.
- b) For over ground exposed steel pipes, two coats of red oxide primer (zinc chromate). primer shall be applied on the cleaned surface. There after minimum two (2) coats of synthetic enamel paint of approved colour shall be applied on the same to total dry film thickness of not less than 200 microns.
- c) The protective coating of buried pipe shall consist of inside 406 microns food grade epoxy coating as per detailed specification and outside 700 microns PU coating as per IS 16719:2018 or 4mm thick coal tar taping as per IS 15337:2003 latest revision/ amendments if any.

3.5.7 VALVES AND STRAINERS

Valves will be used to start/stop & control flow.

All valves shall be suitable for service conditions i.e. flow temperature and pressure under which they are required.

Valves in Clarified Filtered water application

Either Butterfly type or sluice/ gate valves shall be used for isolation purposes.

Sluice/gate valve shall conform to IS: 780 & IS: 2906 of rating PN 1.0 (min). Stem, body,- seat ring and wedge facing ring shall be of stainless steel construction. Other parts shall be as per IS:780. Flanges shall be designed as per ANSI B 16.5 Cl. 150. to meet with the piping flanges. Valves shall be of outside screw and rising stem type.

Sluice/Gate valves shall be provided with the following accessories in addition to the standard items.

- a) Hand wheel
- b) Manual Gear reduction unit operator for valves 200 NB and above.
- c) Bypass valves for valves of sizes 350 NB and above.
- d) Draining arrangement wherever required.
- e) Arrow indicating flow direction
- f) Position indicator

Sluice/ Gate Valves shall be provided with back seating bush to facilitate gland renewal during full open condition.

Butterfly valves shall be of double flanged or lugged wafer type of low leakage rate confirming to AWWA-C-504 class 150 or BS: 5155 Class 150.

The various components of butterfly valves shall be of the following:

i)	Body	:	Cast Iron- ASTM A 48 Cl. 40; BS: 1452 Gr. 220 SG Iron - BS :2789
ii)	Disc	:	Cast Steel- ASTM A 216 GR. WCB; 85:1504 Eq. Gr.
		:	Cast Iron-ASTM A 48 Cl. 40:BS1452, Gr. 220 SG Iron- 8S 2789.
		:	Cast Steel- ASTM A216 Gr. WCB: 8S:1504 Eq. Gr.
iii)	Shaft	:	ASTM A 296 Gr. CF8M/AISI 316: AISI 420: BS 970 Gr. 316; BS 970 Gr. 420
iv)	Seat rings	:	Nitrile rubber, EPDM (Ethylene propylene rubber), Hypalon

Butterfly valves shall be fitted with sleeve type bearing such as PTFE. Valves of 350 NB and above shall be provided with one or two thrust bearings to hold the disc securely in the of valve seat without hydraulic or external axial shaft loads. Sleeve and other bearings fitted into the valves body shall be of self lubricated materials that do not have any affect on the fluid handled and other components of the valves.

All the butterfly valves shall be provided with Hand wheel or level as per the requirements. For larger sizes i.e. 150 NB and above hand wheel shall be provided. For level/wrench operated valves, means shall be provided for positively holding the disc in not less than three intermediate positions. Manually operated valves shall be provided with reduction gear unit for valves of size 200NB and above. Valve provided with motorized pneumatic actuator shall be with a hand wheel for manual operation. All the valves shall be equipped with adjustable mechanical stop-limiting devices to prevent over travel of the valve disc in the pen and closed positions. The valve operators (Hand wheel Gear reduction unit motor actuator etc. shall be designed as per relevant International Standard.

All the butterfly valves shall be provided with an indicator to show the position of the disc. Flanges shall conform to ANSI B 16.5 Cl. Conforming to the following technical specifications.

- a) Ball Valves
 - i) Design Standard BS:5351 Class 150
 - ii) Type :Welded/Flanged ends; Fullbore; Shlit
Body & Seat supported construction
- A. Material of Construction
 - Body Carbon Steel/ Cast Iron
 - Ball Stainless steel ANSI 420
 - Seat ring PTFE
 - Stem Stainless steel AISI 420
 - Seats Nitrile rubber; PTFE.
- iv) Valves shall be designed to be directly operable by a wrench/Hand lever.
- v) Suitable stops be provided for both the fully open & close condition.
- vi) All the valves shall be provided with an indicator for showing the position of the spindle.

b) Globe Valve

- i) Design Standard : IS:778 Class-1
- ii) Type : Straight, rising stem, with outside screw
- iii) Material of construction
 - 1. Body, Bonnet, stuffing Box&: Leaded Tin
Bronze conforming seat rings/Disc : IS:318 Gr.
 - 2. Stem : Stainless Steel, AISI - 316
 - 3. Disc : 15:318 Gr. 2/AISI-316
- i) Back seat shall be provided on the stem or on the disc.
- B. Renewable disc assembly shall consist of disc holder, disc, disc guide, Check nut and disc retaining nut with washer.
- C. Disc of globe valve may be provided with renewable rubber seating ring.
- iii) Handy wheels shall be marked with the word: 'OPEN' or 'SHUT' with arrow to indicate direction of opening or closing.

The valves shall conform to the following requirements:

i)	Design Standard	:	IS 780/ IS :2906 rating PN 1.0 or Equipment
ii)	Type	:	Double Flanged or wafer body, outside screw and rising stem type
iii)	Material Construction	:	
	Body	:	Cast Iron: 15:210 Gr. FG. 260
	Stem	:	Stainless Steel AISI 420
	Disc	:	Cast Iron 15:210 Gr. FG 260

The valves shall conform to the following specifications.

i)	Design	:	IS: 5312, BS: 1868, BS: 5153 or Eqvt.
ii)	Type	:	Swing check Type and Flanged ends.
iii)	Material of Construction (For non corrosive application)		
a)	Body & Cover Hinge disk/ door	:	Cast iron IS: 210 Gr. FG 260/or Cast Iron BS: 1452 Gr. 220 or Eqvt.
b)	Hinge Pin and Door/Disc. Pin	:	Cast steel ASTM A 216 Gr. WCB
c)	Disc facing ring	:	Stainless steel
d)	Body Seated ring	:	Stainless steel
e)	Bearing Bushes	:	Leaded Tin Bronze: IS: 318 Gr. 2
f)	Bolts	:	Carbon Steel

Flanges shall conform to ANSI B 16.5 Cl . 150 to match with the piping flanges as specified elsewhere.

Body shall be permanently marked with an "arrow" Indicating the direction of motion of the fluid for all the check valves.

Check valves for clarified/ filtered water may be offered in Gun metal construction & with threaded ends for sizes 50 NB and below conforming to IS:778 or Equipment.

3.5.8 Strainers

- a. Basket Strainers

- b. Basket strainers of simple design shall have the following materials of construction of raw/ clarified/ filtered water.

Body :Fabricated mild steel: IS:226 (Tested quality) Wire shall be stainless steel {AISI:316 18 BWG 30 mesh suitable reinforced. Reinforcement material shall also be of stainless steel construction.

Drain plug/Nuts: Gun metal;

- c. Inside of basket body shall be protected with one coat or red lead primer and minimum three coats of chlorinated rubber paints to a Total thickness of 200 microns.
- d. Suitable Vent and drain valves shall be provided for the strainers.
- e. Screen (strainer) flow area shall be at least four times pipe sectional area. Flow area in any portion of Basket strainer assembly shall not be less than the pipe cross sectional area.
- f. Pressure drop in clean condition shall not be more than 1.0MWC.
- g. Basket Strainer shall be provided with lifting lugs and suitable mounting arrangement.
- h. For OM water service. body shall be rubber lined to minimum 4.5 mm thickness (soft rubber of shore Hardness 85 ±5" A).

3.5.9 Y-Type Strainer

- a) Y-Type strainer for water application shall be constructed of following materials:
 Body Cast Iron 15:210 Gr: FG 260
 Strainers :Wires, of stainless steel AISI - 316. 18 BWG 30 mesh suitably reinforced. Reinforcement material shall also be of stainless steel construction.
 Drain Plug/Nuts : Gun metal (threaded construction).
- b) Y-Type strainers shall also conform to Cl. 4.-9.01 {b), {d), (e), end (t).
- c) Body of the Y -type strainers for alkali, and dematerialized water shall be of Cast Iron {IS: 210. Gr. FG 260) and lined with soft or hard rubber to a thickness of.3 mm.
- D) For acid services, apart from the rubber lined body material, the screen material, shall be polypropylene or HOPE wire cloth of suitable mesh and thickness.

3.5.10 TEST FOR PIPING, VALVES & FITTINGS

- A) Piping & Fittings
 - i) Pipe shall be hydraulically tested as per relevant standards
 - ii) Pipe which are to be of internal bead removed quality and subjected to pressure test after bead removal but before rubber lining.
 - iii) All rubber lining is to be subjected to the following test as per IS: 4682 Part -1
 - a) Adhesion test b) Bleeding Test c) Thickness of lining d) Shore hardness e) Spark test 5 KV/mm of lining f) Ageing test on the samples of rubber sheets shall be one as per ASTM- D 471, part 37 before lining g) visual inspection.
- Valves /Gages/ Strainers

All the valves shall be hydraulically tested for the body and test leak test as per relevant standard. For rubber lined valves, body shall be subject to hydro test before rubber lining.

Back seat leakage test shall be done wherever applicable.

Seat Air leakage test a kg/cm² shall be carried out wherever applicable as per relevant standards.

- iv) Elastomers wherever coated or lined for the valves shall be tested for the corrosion resistance against the medium for which those are selected as per relevant Standard and the test certificates shall be furnished for the Owner's approval.
- v) Rubber lining on valves/ Gates Strainers shall be checked in accordance with IS:4682 Part-1 including all tests as indicated above for piping & fittings.
- vi) Strainer shall be hydraulically tested for its strength. The pressure drop across the strainer assembly shall be verified at design flow for clean condition for each type and size. If already conducted for each size! type, test certificates may be produced of Owner's review and approval.

3.5.11 TEST AT SITE

- a) All piping, valves, Gates, resin traps, strainers and other fittings after erection at site shall be tested to hydraulic test pressure of two times the operating pressure or 1.5 times the maximum allowable pressure whichever is higher for a period of one hour.
- b) All valves (Manual/ Automatic) shall be operated throughout 100% of the travel manually and as well as from control panel and these should function without any trouble whatsoever.

N.B:- All the above specifications and material of construction are for guidelines. However the EPC contractor can propose for any new or combination type for approval by the CE, Megalift which should satisfy the relevant IS code or international code mentioned in the above Guidelines.

SECTION - VII
POWER SYSTEM CONNECTIVITY

IMPORTANT INSTRUCTION TO BIDDERS

- This Section comprises of two parts:
 - A. Technical Specification on construction of overhead lines(Sub-transmission, HT & LT) and Construction Practices for MSDSS and DSS.
 - B. Technical Specifications for supply of equipment& materials & respective Guaranteed Technical Particulars (GTP).
- Above shall be read in conjunction with Technical Specification Volume-II, Section II A “survey & Investigation, Planning, Design and Drawing” as they are integral parts of Technical Specification.
- Bidders are advised to follow Bureau of Indian standards, REC construction standards, approved manufacture specifications & other relevant manuals and construction standards that complies with relevant Regulations of CEA/CERC/OERC, for those items not provided specifically in this document, but required for turnkey completion of Sub-Stations and associated Sub-Transmission, HT & LT lines.
- SLD for system networking, drawings & physical scopes where ever mentioned in the Bid document give indicative scope of work. Drawings are complementary to specifications and shall be referred to for better understanding as well as for estimation of quantities for arising at lump sum bid price on turnkey basis. System connectivity & related equipment are on turnkey basis. The successful bidder shall be liable to abide by the specific requirements of DoWR at detailing stage with no financial liability to Owner.
- Bidders shall comply with the submittal list & duly fill up the required formats in complete shape including GTPs. For Bid purpose, only GTPs of important system elements like Power Transformers 33/6.9 KV (rating 5.0 MVA& 1.6 MVA), Distribution transformers (rating 100 KVA & 315 KVA), 33 KV Vacuum Circuit breakers, Conductors (AAAC) shall be submitted along with Technical Bid.
- Bidders are advised to ensure that all documents/ drawings are legible copies & drawings should be of size not less than A3.
-
- Non compliance with any of listed submittals or incomplete submittals shall be treated as “Non-responsive” Bid.

[Conventions: The following conventions are used throughout this document;

- a) The word “shall” denote a mandatory requirement.
- b) Italics are used to indicate titles of acts or publication.]

**A. CONSTRUCTION OF
33 KV SUB-TRANSMISSION
AND
6.6 KV, LT SUB-SYSTEM**

Index

SL. NO.	PARTICULARS	PAGE NO.
1	BROAD SCOPE	
2	GENERAL	
3	SCOPE OF PROPOSAL	
4	SYSTEM CONDITION(DESIGN PARAMETERS)	
5	SYSTEM CONNECTIVITY	
6	GENERAL PARTICULARS OF SYSTEM	
7	OWNERS STUDY	
8	SUBMITTALS	
	FORMATS:	
	ESC - 1 (DETAILS OF 33 KV FEEDERS EMANATING FROM EHV GRID SUB-STATIONS)	
	ESC – 2(DETAILS OF PROPOSED PRIMARY 33/6.6 KV (MSDSS) AND 33/0.433 KV SUBSTATIONS AND HT FEEDERS (6.6 KV) EMINATING FROM THESE SUBSTATIONS)	
	ESC – 3 [AGUMENTATION OF CONDUCTOR SIZE OF EXISTING 33 KV FEEDERS (PROPOSED UNDER THE SCHEME)]	
	ESC – 4 (DEVIATION SCHEDULE)	
9	CHAPTER – 1 SPECIFICATION FOR CONSTRUCTION OF OVERHEAD LINE A. (Sub-Transmission & HT). B. LT.	
10	CHAPTER – 2 CONSTRUCTION PRACTICE FOR 33/6.6 KV SUB-STATION (MSDSS).	
11	CHAPTER – 3 SPECIFICATIONS FOR DSS (TRANSFORMER CAPACITY UP TO & BELOW 250 KVA) ON DOUBLE POLE STRUCTURE.	

1.0 Broad Scope: Scope includes but is not limited to;

Planning, Design, Testing, Supply, Erection & Commissioning of:

- a. **Main Step-Down Distribution Sub-Station (MSDSS) [33/6.6 kV in relation to the projected load, voltage regulation & shall meet the basic requirements indicated in the attached single Line Diagram (SLD)]**
- b. **Lay-out of above outdoor switch yard.**
- c. **33 kV Sub-Transmission networking/ System Connectivity with identified EHT Grid Sub-Stations and/or identified DISCOMs network topology as shown in attached SLD.**
- d. **HT Line (6.6 kV) and LT over head lines.**
- e. **Distribution sub-stations DSS (6.6/0.433 kV, 33/0.433 kV) as per the requirements, including conductor/cable and supporting structures.**
- f. **Metering, Protection & control for 33 kV, 6.6 kV & LV systems.**
- g. **Earthing system & earth mat design**

GENERAL**2.0 Project Information:-**

- 'Project Synopsis' [enclosed with volume-1] provides details of identified Mega Lift Schemes with their Identification Number (ID) under each cluster.
- Each project and/or pool of projects needs physical connectivity with the distribution networks of concerned area distribution licensee, to effect power supply in terms of the provisions contained under '*ODISHA ELECTRICITY REGULATORY COMMISSION DISTRIBUTION (CONDITIONS OF SUPPLY) CODE, 2004*'.
- Odisha Power Sector is characterized by (i) four area Distribution Licensees, namely TPCODL, TPNODL, TPSODL & TPWODL (ii) State Transmission Utility, OPTCL and (iii) GRIDCO, the Intra State Trader, the sole bulk supplier of power to DISCOMs in Odisha.
- To meet the additional projected load on account of Mega Lift Projects, physical assessment of System augmentations at EHT level has been worked out & funds placed with OPTCL for execution. Augmentation covers up-rating of Power Transformers, installation of 3rd Transformer with associated 132kV bays and 33 kV feeder bays for the projects. Thus EHT back up for power supply to Mega- Lift Project rests with OPTCL (Transmission Utility).
- The project conceives connectivity at voltage level at 33 kV. Thus connectivity may be a direct interface with Transmission Utility's Grid Sub-stations or inter-connection with DISCOM's 33 kV network to be decided as per techno-economic analysis. Schemes, where dedicated Grid connectivity would not be feasible or not cost effective, solution like connectivity with local distribution 33 KV systems, may be considered, subject to technical feasibility. General practices adopted by concerned area distribution licensee (DISCOM) will be taken in to consideration so that infrastructure developed is compatible to their system.
- Intervening 33kV dedicated new lines linking nearest/identified Grid Sub-station & Point of supply of the beneficiaries [here 33/6.6 kV Main Distribution Sub-Station (MSDSS) and/ or DSS (33/.433 KV) to feed MLIPs] and other 33kV new lines, that may be required for integrating beneficiary's installation with DISCOM's existing and/ or ongoing (schemes like CAPEX Program/ ODSSP etc.) infrastructures, will be part of the bidder's scope.
- 33 KV new feeder bay, if any required at DISCOM's 33/11 KV existing and/ or ongoing schemes for power supply to Mega-Lift Scheme including augmentation (up rating of conductors) / rehabilitations (replacement of missing/damaged structures,

any missing accessories etc.) of existing sub-transmission system shall be assigned to DISCOM..

- 33kV infrastructure, so developed, will be handed over to area distribution Licensee for Operation & maintenance, with effect from “*date of commencement of supply*”. Modalities for handing over for O&M shall be decided by DoWR.
- Downstream electrical composite unit including 33/6.6 kV Main Step down Distribution Sub-Station (MSDSS) , Distribution S/S (6.6/.433 kV) and/ or (33/0.433 kV), apparatus (indoor, outdoor), 6.6 kV & LV lines, electrical motors, and underground cables, erected and wired by or on behalf of beneficiary, shall be termed as “*consumer installation*”. Planning, design, testing, supply, erection & commissioning of all related “*Consumer Installation*” shall be part of the bidder’s scope including operation & maintenance of the installation for a specified period as detailed in the bid document. .
- **DISCLAIMER:** This Document includes statements, which reflect various assumptions. Each Bidder should conduct its own estimation and analysis and should check the accuracy, reliability and completeness of the information in this Document and obtain independent advice from appropriate sources in their own interest. DoWR will have no liability whatsoever to any Bidder or any other person under the law or contract, the principle of restitution or unjust enrichment or otherwise for any loss, expense or damage whatsoever which may arise from or be incurred or suffered in connection with anything contained in this Documents and mater deemed to form part of this document.

Though adequate care has been take while issuing the Bid document, the Bidder should satisfy itself that documents are complete in all respects. **Intimation for any discrepancy shall be given to this DoWR immediately.**

3.0 Scope of Proposal:-

Scope of proposal shall be on the basis of single bidder’s responsibility, completely on turnkey basis, covering supply, erection, testing & commissioning of all equipments and new OH (33 KV & 11 KV) line as specified under the accompanying Technical Specifications/ SLD including other services. It would include the followings;

- ❖ Planning & development of suitable system connectivity: - Network planning shall be through consultation process with DISCOMs and STU (OPTCL). Owner’s indicative network enclosed in the Bid document is based on interaction/ consent with concerned DISCOMs & STU (OPTCL). Any modification to SLD needs to pass through similar process and approval. Network planning shall be duly supported by

appropriate computer aided network analysis through software package, preferably with Mi-Power package (being used by OPTCL). System impact study (LFA) by the EPC contractor shall be submitted to OPTCL for their review.

EPC developer shall provide Block diagram for System connectivity both for 33 KV & 6.6 KV based on SLD (as per discussion with OPTCL/GRIDCO/DISCOMs & PMU (Mega Lift)).

- ❖ Preliminary route survey, finalization of route alignment, detailed survey, structure (tower/pole) spotting, geo-technical investigation, optimization of structure location and check survey of Line, substation and preparation of SLD/BOQ;
- ❖ Design, selection and installation of foundation for structures, poles for single/double circuit over head line.
- ❖ The design, testing, supply and erecting of 33kV, HT (11 KV lines to be charged at 6.6 KV) and associated LT lines with single/double circuit support structures [low based tower structure/M.S rail pole/ GI RS Joist/ H poles/PSC poles (for lines other than 33 KV line)], associated cross arms, nuts, bolts & washers, D-shackles, support stays and accessories like danger plates, anti-climbing devices, structure identification plate and earthing devices;
- ❖ Supply of supports, conductors, insulators, insulator hardware, earth wire, joints, clamps for conductors, earth wire clamps and accessories including stringing;
- ❖ Design, manufacture, supply, erecting and stringing of special structures/towers including design and construction of foundations for crossings like Railways, Rivers, power lines etc;
- ❖ The slack span connections of conductors from terminal structures to the substation gantry structure at Transmission and/or Distribution licensee's interface (i.e. point of supply).
- ❖ Planning, design, testing, supply, erection & commissioning of MSDSS (33/6.6 kV), Distribution sub-stations (6.6 /0.433 kV and/or 33/0.433 kV) and all related "Consumer Installation" and operation & maintenance of the installation for a specified period as detailed in the bid document.
- ❖ Providing Engineering drawing, data including calculation sheets (both hard and soft copies in XL form), operational manual, etc for Owner's approval.
- ❖ Relevant drawings pertaining to safety aspect (General Lay-out with important elevations & sectional views of MSDSS/DSS including SLD, Earthing details, OH Lines including important crossings, shall be approved by statutory Authority, prior to field executions.

- ❖ Getting the relevant drawings for the substations and lines approved before execution & installation inspected after completion of work by Electrical Inspector.
- ❖ O&M of substation/installation for specified period as detailed in Bid document.
- ❖ Supply of testing instruments & maintenance kit for carrying out testing and measurement at MSDSS & DSS for O&M purposes.
- ❖ Supply of contingency reserve of 10% assets for system elements, Transformer, Transformer oil, CBs, Insulators, Supports/ conductor, conductor hardware, Cables for O&M.

4.0 SYSTEM CONDITIONS (Design Parameters):

The equipments/lines to be installed for altitude up to 1000 m above MSL shall be compatible to the system characteristics:

- i) System Parameters for HV System shall be as flows:

Parameter	33 kV	6.6 kV
Rated System Frequency(HZ)	50	50
Nominal System Voltage(kV)	33	6.6
Maximum System Voltage(kV)	36	7.2
Three Phase symmetrical short circuit rating for switch gear (KA)	25	25
Duration of short circuit fault current (Second)	3	
Dynamic short circuit current rating(KAp)	62.5	62.5 (Rated making current= $1.8 \times V^2 \times$ rated short circuit breaking current)
Insulation Level:		
1.2/50 μ s Impulse with stand (kV_{peak})	170	60
Power frequency one minute withstand in dry condition(kV_{rms})	70	20
Design ambient temperature ($^{\circ}C$)	50	
Wind Pressure	As per IS 802 (Part. I/ Sec.I)	
System earthing	Solidly earthed	Solidly earthed

- ii) System parameters for LT system shall be as follows:

Nominal system voltage (V)	415
Highest system voltage (V)	433
Voltage variation (%)	$\pm 10\%$
Frequency variation (%)	+3 to-5%
Maximum System fault level (KA)	50(for 1 sec)
System earthing	Solidly grounded

5.0 SYSTEM CONNECTIVITY:

- System networking should be planned & developed suitably, that shall be capable of providing reliable, economic and efficient power supply in terms of the provisions contained under ***CEA(Technical Standards for connectivity to Grid) Regulations 2007, CEA(Technical standard for construction of plant and lines) Regulations,2010, CEA(Measures relating to safety and Electric Supply) Regulations, 2010, Odisha Grid Code and “Distribution System Planning And Security Standards, Operating standards –1999” or its latest amendments, if any issued by OERC, ODSSP Technical specifications, Document and their relevant drawings, CBIP Manuals, IEEE/IEC/IS.***
- Independent 33 kV feeder from nearby EHT Grid Substation shall be provided for loads of 5 MVA and above. Service area for each MSDSS (33/6.6kV sub-station) shall be identified by pooling a set of nearby Schemes and such sub-distribution station can be fed by independent 33kV feeder from nearby EHT Grid Sub-stations in an integrated manner, with an overall objective of quality, reliability in supply & reducing 33 kV inventory. Such schemes should be based on Techno-economic study/ analysis.
- Schemes, where dedicated Grid connectivity would not be feasible or not cost effective, solution like connectivity with local distribution 33 KV systems, may be considered, subject to technical feasibility by concerned area distributor (DISCOM).
- For isolated Schemes (that are out of above supply zone of MSDSS) may be fed by spur lines to be extended from existing/ ongoing (CAPEX Program/ ODSSP) 33 kV infrastructure of distribution licensee, subject to permissible ***KVA-KM Loading.***
- 6.6 kV sub-distribution networks shall either over head or by cable & preferably in ring configuration.
- 6.6 KV over head line shall be 11 kV designed line.
- Comprehensive Sub-Transmission Planning & 6.6 kV distributions networking along with methodology, assumptions, ***load flow study*** and analysis thereof need to be submitted to OPTCL & for approval by DoWR.
- Earthing design (Earth mate) with relevant studies for MSDSS/DSS need to be submitted for approval.

6.0 General particulars of System:**Substation Philosophy:**

- MSDSS: 33 KV side will be AIS (outdoor) & indoor switchgear panels for both 33 & 6.6 KV systems.

- Vacuum type circuit breakers shall be used for voltage level of 33 KV and below [i.e. Outdoor type with its GI Supporting structure & indoor control panel for 33 KV & indoor type for voltage 6.6 KV].
- It will have at least two power transformers of adequate capacity to meet the projected load and operate at 80% of their rated capacity. Station supply (LV system) will be from a station transformer connected to 33 KV systems.
- Capacities of Power Transformers shall be selected as per the following guidelines:
 - MD of individual Scheme shall be calculated as per the guidelines given in clause 9.1.2 of Section-V-B, Vol-II.
 - Diversity factor of 1.0 shall be used on summation of MDs of Schemes to be fed from MSDSS& efficiency of transformer shall be as per the data from the manufacture (GTP data sheet).
 - There shall be at least two transformers that shall be able to operate in parallel operation & be selected from standard ratings of 630 KVA, 1 MVA, 1.6 MVA, 3.15 MVA & 5 MVA.
 - Loading of transformer shall not exceed 80% of rated capacity.
- DSS (33/.433 KV): 33 KV side will be AIS & indoor switchgear panels for both 33 KV & LT systems. It will have at least two distribution transformers of adequate capacity to meet the projected load and shall sustain the starting impact of largest LV motor. The 33/.433 KV distribution transformers shall normally have standard rating of 100, 160, 200, 315, 400, 500, 630, 1000, 1250, 1600, 2000 or 2500 KVA depending on requirement and shall be mandatory BIS certification (minimum of Energy efficiency level 2) complying to IS 1180(Part-1):2014.
- DSS (6.6/.433 KV): Location of DSS is preferred to be within 6.0 KM radius with stipulation to satisfy permissible KVA-KM for AAAC 100² mm. 6.6 KV side will be AIS & indoor switchgear panels for both 6.6 KV & LT systems. It will have at least two distribution transformers of adequate capacity to meet the projected load and reserve capacity to sustain the starting impact of largest LV motor. Distribution transformers shall normally have standard rating of 100, 160, 200, 250, 315, 400, 500, 630, 1000, 1250, 1600 KVA depending on requirement and shall be mandatory BIS certification (minimum of Energy efficiency level 2) complying to IS 1180(Part-1):2014.
- In case of contingency failure in or any transformers load interrupted shall not exceed 20% of the total demand on the substation. This shall be applicable to MSDSS/DSS. There would be at least one station transformer to meet the auxiliary load of MSDSS (33/6.6 KV).
- Formation level for Substation shall be at minimum 1.0 m above HFL. Adequate provisions in layout shall be made for protection of main control room against

flooding & shall be located at floor higher than that of main Pump- motor floor. DSS shall be either a ground AIS or on raised concrete platform, close to pumping station & well written permissible KVA-KM for conductor used for voltage grade of 33 KV/6.6 KV/LV system. DSS shall be easily approachable in all the seasons.

- Bay lay out & structural part for MSDSS/DSS shall be in lines with ODSSP structural model and control room should be in lines with existing arrangements of Mega Lift Projects & approved by PMU.
- Solar roof top shall be installed for both MSDSS and Pump-site to meet the emergency load/street lights with change over mechanism to main supply in case of battery are not charged.

Line Philosophy:

- 33 KV Lines may be single circuit and/or double circuit based on site requirements & as per the present practices adopted by respective DISCOM. Connectivity shall be from the identified EHT Substation and/or from identified 33 KV DISCOM network as per the attached SLD.
- Lines shall be designed/constructed with due consideration the area wind pressure zone & as per the general practices adopted by concerned area distribution licensee (DISCOM) so that infrastructure developed is compatible to their system.
- 33 KV lines will be Low based tower structure / GI RS Joist as per the practices adopted under DISCOM (under ODSSP).
- 11 KV out going lines (to be charged at 6.6 KV) will be with 10 mtr (300 Kg type) PSC poles for pin points up to 100 Deviation, 10 mtr PSC Pole with guy wire for more than 10° but up to 60° deviation and DP structure using GI RS Joist for deviation of more than 60° up to 90°.
- 33 KV trunk lines will be with 148 sq mm or 232 sq mm (AAAC) and 11 kV lines with 100 sq mm AAAC. Sizing of conductors will be based on findings of LFA.
- Relevant drawings shall be submitted to respective DISCOM for their views & vetting by Electrical Inspector.

7.0 Owners Study:

The Owner has developed an indicative system networking (enclosed) based on cited objectives & in consultation with State Transmission Utility (OPTCL)/GRIDCO & Concerned area DISCOM. Developer may like to submit at bid stage, any other, networking scheme with duly supported system studies (**Load flow analysis**), that ensures improvement on savings in technical loss & maintain permissible VR [Owner's Comfort zone for 33 kV < (-) 7%]. Physical projections, if any, mentioned under Owner's studies are indicative only.

7.1 over view of Sub transmission and Distribution Planning: Methodology, the planning criteria and guide lines that are used in planning and design of integrated system connectivity has been out lined in brief but not limited to;

A. Planning standard & criteria:

- 1) *Planning standard & criteria as specified in OERC Distribution Planning Standard & security Standard.*
- 2) *Over all approach to system planning is based on risk based deterministic approach: under which all the load cannot be supplied with a network element out of service (hence N-1 criteria are not met) but with due regard to acceptable degree of adequacy and security.*
- 3) *Risk based network planning aims to strike an economic balance between;*
 - *Cost of providing additional network capacity to remove any constraint and*
 - *Potential cost and other impacts that may be associated with low probability events*
- 4) *Augmentation criteria that would cover network augmentation and non-network alternatives to augmentation which take account to minimizes distribution losses & maintain voltage at permissible limit.*

B. Sub-Station Planning Criteria:

- 5) *Primary 33 KV sub-station (Less than 10 MVA) shall comply with Para 4.3.2.3 of DISTRIBUTION SYSTEM PLANNING AND SECURITY STANDARDS, OPERATING STANDARDS, issued by OERC; The layout shall generally conform to relevant Construction Standards of Rural Electrification Corporation Ltd / any other improved standards and provisions in Indian Electricity Rules, 1956 subject to the requirements mentioned in sub paragraph (a) below.*

a. The layout adopted shall include the following :

- ❖ *Group circuit Breaker control of Transformers.*
 - ❖ *Independent control of 11KV Feeders.*
 - ❖ *Single Bus.*
- 6) *Above stipulations shall be applicable to all transformers having capacity less than 1000 KVA. However, in lines with the provisions contained U/S 35(3)(i) (b) of CEA(Measures relating to safety and Electric Supply) Regulations.2010, a circuit breaker shall be provided on primary side of every transformer having capacity 1000 KVA and above installed in or after the year 2000.*
 - 7) *Loading in any current carrying component of the Distribution System (e.g. Conductors, Joints, Transformer, Switchgear, Cables, other apparatus etc.) shall not exceed 80% of the respective thermal limit.[U/S 4.4 of Security Standards issued by OERC]*
 - 8) *There shall be 33 KV incoming breaker (at Connection Point) having a minimum of over current and earth fault protection with or without directional features so that fault occurred at their end will not be reflected towards grid sub-station end. (U/S 9.8 of Odisha Grid Code)*

- 9) *Primary Distribution (MSDSS) sub-station shall normally have two or more transformers [U/S 48 (6) of CEA (Technical Standard for Construction of Plant & Lines) Regulations, 2010]. Model of banked transformer zone substation configuration has been adopted, where in multiple transformers are used but not segregated for system disturbances. For contingency loss of a transformer customer supply is interrupted prior to restoration. Considering to above stipulation & acceptable degree of adequacy & security, in DSS (that*

Feeds main pumping motors) shall have at least two distribution transformers.

- 10) *While sizing of transformers in MSDSS/ DSS, due consideration with regard to adequacy & security have been taken in lines with OERC "Distribution system planning & security standard. "Annual energy at risk" shall not exceed "N-1" station output capability rating of the substation. Capability of a zone substation with one transformer out of service is referred to as its (N-1) rating. & "N" being the capacity of substation with all transformers in service. Load interrupted shall be limited to not generally exceed 50 percentile of the total demand on the sub-station with rider that developer will ultimately bring down to 20% in span of three years. There is also 50% chance that actual demand during off season will be lower than projected demand in any one year. More over probability of a major transformer outage occurring over the duration of year is a low event (about 1% per transformer).*
- 11) *Preferred rating of power transformers shall be 1, 1.6, 3.15, 5, 6.3, 8, 10, 16 and 20 MVA. [U/S 54 (3) of CEA (Technical Standard for Construction of Plant & Lines) Regulations, 2010]*
- 12) *A Transformer with off-circuit tap changer shall have taps ranging from (+) 2.5% to (-) 10% each on high voltage winding.[U/S 54(9) of CEA (Technical Standard for Construction of Plant & Lines) Regulations, 2010]*
- 13) *On load tap changing (OLTC) device tap ranging from (+) 5% to (-) 15% in step of 2.5% shall be provided with Transformers of 3.15 MVA and higher rating [U/S 54(10) of CEA (Technical Standard for Construction of Plant & Lines) Regulations, 2010].*
- 14) *Normally vacuum type circuit breakers shall be used for voltage level of 33 KV and below [U/S 59(1) of CEA (Technical Standard for Construction of Plant & Lines) Regulations, 2010].*
- 15) *Distribution Transformer can be oil filled or dry type depending on requirement [U/S 54(10) of CEA (Technical Standard for Construction of Plant & Lines) Regulations, 2010]*
- 16) *Distribution transformers shall normally have standard rating as specified U/S 75 (7) of CEA (Technical Standard for Construction of Plant & Lines) Regulations, 2010.*

7.2. Reference Drawings: Drawings relating to Main Step-down Sub-Station (MSDSS) and Distribution Sub-Station (DSS) showing indicating scope of work are enclosed. Drawings are complimentary to the specifications and will be referred to for better understanding as well as for bidding purpose.

8.0 SUBMITTALS:

- I. **Methodology:** A brief write up on methodology, design & planning criteria on development of integrated system networking, Sub-Stations including O&M practices to be followed for "User installation".
- II. **Single line diagrams for system connectivity (SLD):** Showing 33 KV lines from points of connection with Transmission utility interface point (EHT sub-station), MSDSS (33/6.6 KV substation), DSS (33/.43 KV and/ or 6.6/.43KV), HT lines (11 KV to be charged at 6.6 KV) and location of schemes (with ID number). Projected distance of lines should be clearly mentioned in SLD.

[SLD is mandatory requirement under proviso 4.16 of Odisha Grid Code; the Bidder must submit either SLD of their own planning study or statement to the effect that they may like to follow Owner's indicative model.]

- III. **SLD of MSDSS [Covering HT (6.6 KV & LT)].**
This submittal is optional. Owner's Conceptual SLD has been given in this document for reference of the Bidder.
- IV. **SLD of DSS [33/.43 KV and/or 6.6/.433 KV].**
This submittal is optional. Owner's Conceptual SLD has been given in this document for reference of the Bidder.
- V. **Details of 33 KV feeders emanating from EHV sub-station- (Format ESC-1):** This submittal is applicable to those who would like to propose alternate connectivity configuration other than owner's indicative model. *VR & system loss may be calculated by long hand method as per REC standard and/ or submit the Load flow study in support of their proposed SLD.*
- VI. **Details of Proposed Primary 33/6.6 KV (MSDSS) and 33/0.433 KV Substations and HT Feeders (6.6 KV) emanating from these Substations - (Format ESC-2):**
This submittal is optional & may be submitted at detailed engineering stage.
- VII. **Details of augmentation of existing 33 KV Feeders- (Format ESC-3):**
This submittal is optional & it is to be submitted at detailed engineering stage.
- VIII. **Deviation schedules- (Format ESC-4):**
- ❖ Statement on deviations, if any, from the Bid technical stipulations/ specifications along with reasons & supporting documents, shall be submitted.
 - ❖ For supply of materials/ equipments- GTPs for major items like Power Transformer (rating 630 KVA & 1.6 MVA), Distribution transformers (315 KVA & 100 KVA), AAAC & 33 KV VCB shall be submitted along with Bid offer. Others shall be submitted at detailed engineering stage.
- IX. **Details of spares & maintenance kit for O&M:**
Bidder shall submit a list of spares for major system elements i.e. Conductors, insulators & hard wares, LAs, HT & LT Power cables, Cable jointing kits, Ststion transformer, Transformer oil etc. for the contingency events (forced outage and/or planned outages) and Testing instruments and Maintenance kits & other tools & plants. Above list shall be over & above the mandatory spare items that are supplied along with the equipments by manufactures. Reserve stock for maintenance shall be limited to 10% of respective population (considering Project as whole) for each of above cited critical system elements.
The schedule of testing instruments & maintenance kit given here are generally meant for carrying out testing and measurement at primary (MSDSS) & distribution substations (DSS) for O&M purposes. These kits shall be of reputed make; type tested and shall be subjected to acceptance as per approved specification of DoWR.

Item of testing kit	Unit	MSDSS/DSS
100 KV transformer oil break down voltage test set	Nos	1 per MSDSS
Insulation resistance tester (Megger); Voltage range (1 - 5 KV DC)	Nos	1 per MSDSS
Oil sample bottle	Nos	4 per MSDSS
LCD Clamp on meter	Nos	1 per MSDSS
Line tester	Nos	1 per MSDSS
Digital earth tester	Nos	1 (for Cluster)
Discharge rod as per standard for carrying out the switch yard maintenance work	Nos	6 per MSDSS
Relay tools kit	Sets	1 (for Cluster)

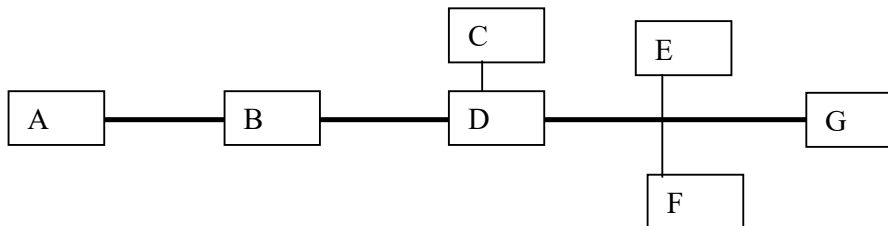
In addition to above, list of other tool & and Plants (T&P's) like set of "D" and" Ring " spanners, socket wrench with socket, insulated cutting pliers, nose pliers, monkey pliers,

Pipe wrench, Sly wrench, insulated screw drivers of different sizes, L-N keys set, hammers with handle etc as per requirements for O&M shall be given in the offer list.

DETAILS OF 33 KV FEEDERS EMANATING FROM EHV**GRID SUB-STATIONS:**

Name of Grid Sub-Station and Voltage Level (220 or 132 KV: -----)

Sl. No	Name of 33KV Feeder	33 KV Line Section						% Voltage regulation at pf 0.8	System Loss
		Line Section	Name of Originating substation	Name of Terminating station	Type & size of cond.	Length of section	Max. Projected demand on section		
						(Km)	(KVA)		
1	2	3	4	5	6	7	8	9	10
1	FEEDER-1	A-B	A	B					
		B-D	B	D					
		D-G	D	G					
		Sub-Total (FEEDER-1)							
2	FEEDER-2								
		Sub-Total (FEEDER-2)							
		Grand Total (All FEEDERS)							



1. Voltage regulation may be calculated by Long hand method using KVA-Km method or through Load flow analysis (LFA).
2. Regulation constant for conductor shall be as per the data given in REC construction Manual.
3. Diversity factor (DF) shall be based on pattern of consumption as proposed in Bid document. All the Pumps under the each scheme, are supposed to run continuously during working season. Owner recommends DF of 1.37 for VR calculation (For WESCO Zone).
4. Owner's comfort zone for VR is (-) 7% for sub-transmission lines.
5. Peak Loss (Watt) can be calculated based on KVA^2Km method as per REC manual.

(This submittal is applicable to those who would like to propose alternate system connectivity configuration as per their own planning study and/or Load flow study- Ref: Para 6.0 of this Chapter)

ESC-2

DETAILS OF PROPOSED PRIMARY 33/6.6 KV (MSDSS) AND 33/0.43 KV SUBSTATIONS AND PROPOSED FEEDERS (6.6 KV, LT) FROM THESE SUBSTATIONS:

No	SI.No of Substation	Power Transformer capacity (No x KVA) with respect to Projected load			Total anticipated Max. projected Demand including aux.	6.6 KV Feeders					
		Voltage ratio (KV)	(No x MVA)	Total capacity (MVA)		Feeder No.	Feeding to Scheme ID	Projected Length of the feeder (Km)	Condr. type & size	Projected demand on feeder (MVA)	Voltage regulation (%)
1	2	3	4	5	6	7	8		9	10	11
	MSDSS-1	33/6.6				1					
						2					
	MSDSS-2					1					
						2					

- ❖ Voltage regulation may be calculated by Long hand method using KVA-Km method or through Load flow analysis (LFA).
- ❖ Regulation constant for conductor shall be as per the data given in REC construction Manual.
- ❖ It is recommended to use unity diversity factor (DF) for radial feeder.
- ❖ Sizing of TRFs shall be in lines with Bid document.
- ❖ Owner's comfort zone for VR is (-) 7% for HT line.

ESC-3**AGUMENTATION OF CONDUCTOR SIZE OF EXISTING 33 KV FEEDERS (PROPOSED UNDER THE SCHEME)**

(Applicable to those Schemes that need connectivity with DISCOM network topology.)

Sl. No	Name of new line/section		Source Substation	Connecting Substation	Conductor size		Length (Km)	Remarks
	From (Location)	To (Location)			Existing	Proposed		
1	2	3	3	4	5	6	7	8
Sub Total								

(Note: This information is optional - Ref: Para 6.0 of this chapter. It is to be submitted at detailed engineering stage)

ESC-4

Deviation Schedule: (section VII)**A. Construction of 33 KV sub-Transmission & 6.6 KV, LT Sub-System**

Sl. No.	Reference to Bid document: (Para no & Page)	Subject matter	Deviation proposed by the Bidder	Remarks

B. Technical Specification on Supply Of Materials-GTPs

[Note: Relevant supporting documents (Provisions of Acts, Regulations, Standards & any other technical publications) in support of the proposals shall be enclosed.]

CHAPTER-1**SPECIFICATION FOR CONSTRUCTION OF OVERHEAD LINE****A. (Sub-Transmission & HT):****1.0 STANDARDS:**

Except where modified by this specification, the sub-transmission and distribution line, associated equipments shall be designed, manufacture, tested and erected in accordance with the *REC Constructions standards* with latest version of the following standards and associated specifications and practices adopted by DISCOMs under ODSSP;

<i>IEC/ISO</i>	<i>Indian standard</i>	<i>Subject</i>
<i>IEC:826</i> <i>IEC:652</i>	<i>IS:802 Part 1/1 (1995)</i> <i>Part 1/1 (1977)</i> <i>Part 1/2 (1992)</i> <i>Parts 2and3(1978)</i>	<i>Use of structural steel in Over Head Transmission Line Tower- Code of Practice</i>
	<i>IS:5613 Parts 1 and 2 (1985)</i> <i>Part 3 (1989)</i>	<i>Code of Practice for Design Installation and Maintenance of Over Head Power lines</i>
	<i>IS: 4091(1979)</i>	<i>Code of Practice for Design and Construction of Foundations for Transmission Line Towers and Poles</i>
<i>IEC:1089</i>	<i>IS:398</i>	<i>Round wire concentric lay overhead electrical conductor</i>
	<i>IS:1498</i>	<i>Classification and Identification of soil for general Engineering purposes</i>
	<i>IS: 1888</i>	<i>Method of Load test in soil</i>
	<i>IS: 1892</i>	<i>Code of Practice for sub-surface investigation of foundation</i>
<i>IEC:1089</i>	<i>IS: 2141</i>	<i>Galvanized steel wire</i>
	<i>IS: 9708</i>	<i>Stock Bridge Vibration Damper</i>
<i>ISO: 1460</i>	<i>IS: 2629</i>	<i>Hot deep galvanizing of steel and iron</i>
	<i>IS:2121</i>	<i>Conductor and earth wire accessories</i>
<i>ISO: 9000</i>		<i>Quality Management systems</i>
<i>ISO: 8501-1</i>		<i>Shot blasting</i>
	<i>IS: 6005</i>	<i>Phosphating of iron and steel</i>
	<i>IS: 2633</i>	<i>Test on galvanized steel</i>
	<i>IS:4043</i>	<i>Code of practice- earthing</i>

2.0 SURVEY AND MARKING: As detailed under Volume-II, section-II (Survey, Investigation, Design and Drawing).

3.0 Supports (Poles and Towers):

3.1 General:

The supports will be poles or narrow based lattice towers with fully galvanized structure as per the site requirements. Type of supports shall be as per the prevailing practices adopted by respective DISCOM.

- LBS/ GI RS joist will be used for 33kV line as per the requirement. For 11 KV lines, poles will be PSC and GI RS Joist as required, provided PSC poles shall not be used at cut points and as end poles. Supports shall be designed based on wind pressure of concerned zone and general practices adopted by concerned area Distribution licensee (DISCOM) and comply with Line Philosophy guide lines specified at para 6.0 above .
- Poles shall confirm to the specification as detailed in the schedule.
- PSC poles/ GI RS Joist preferred in plain area. For angle of deviation of more than 10° - 60° Double poles structure and four poles (FP) for 60° - 90° deviation, shall be used.
- For locations involving long spans or higher clearances on account of crossing of power line or communication lines or a railway line, special designed poles/lattice tower/ cables may be used. Relevant drawings & data shall be furnished to the appropriate authorities and obtain statutory clearance.
- The height of the pole above the ground level , length of the pole below ground and working load shall be decided taking into consideration wind zone, terrain, topography, and the statutory clearances required to be maintained and shall confirm to the relevant IS
- The average span length for 100 sq mm Conductor shall be 80 to 100 Mtrs& for 148 sq mm & 232 sq mm condr shall be 50-55 Mtrs. Span length shall be, where possible, no longer than 64% of normal span & depend on site conditions.
- One cut point in every 1km in rural area. But however, this can vary as per the site requirement.
- Provisional quantities/numbers of different types of tower structures/Joist poles/PSC poles shall be estimated and indicated in the BOQ Schedule. However final quantities for work shall be as determined by the successful bidder, on completion of the detail survey,

preparation of route profile drawing and designing of the different types of tower structures/Joist poles/PSC poles as elaborated in the specification.

3.2 Optimization of Pole Location:

3.2.1 Pole Spotting

To optimize the line length, the contractor shall spot the poles in such a way so that the line is as close as possible to the straight line drawn between the start & end point of the line.

3.2.2 Crossings

a) Road Crossings: - Road crossing will be with DP structure with 13 mtr long GI Joist pole. Where the clearance will not be sufficient, it will be with PC or PC+6 mtr lattice GI tower. At all road crossings, double tension HW fittings should be used. There should absolutely no joints in the conductors in all roads, power line and all other major crossing. The crossing angle shall be near possible to 90^0 but in any case shall not be less than 60^0 . The ground clearance from the road surfaces under maximum sag condition shall be not less than 7.1 Mtrs over roads. In National High way the minimum height of guarding at the maximum sagging point should be less than 8.5 Mtrs.

b) Railway Crossings: - The railway crossing overhead or underground shall be carried out in the manner as approved & prescribed by the railway authorities from time to time. The crossing shall normally be at right angle to the railway track. In case crossing is required to be done through underground cable, cost of the cable including laying and other accessories shall be in the scope of the contractor. During detailed engineering, the contractor shall submit his proposed arrangement for each railway crossing to the owner. The approval for crossing railway track shall be obtained by the owner from the Railway Authority.

c) Power Line Crossings: - Where the line is to cross over another line of the same voltage or lower voltage, provisions to prevent the possibility of their coming into contact with each shall be made in accordance with the *Indian Electricity Rules/ CEA Safety Regulations, 2010*. At all the crossing described above the contractor shall use protective guarding as per *REC Construction Standard A-1* to fulfill statutory requirements.

d) River Crossings: - For crossing crossings over major rivers, the clearance to be provided as per stipulations of Navigation authority. For non-navigable rivers the clearance shall be measured over highest flood level. The crossing angle shall be as near as possible to 90^0 but in any case shall not be less than 60^0 .

For river crossing of 33KV & 11KV line,

- For span length from 100mtr- 450 mtr shall be with PC+6 Tower & 11mtr H pole DP as anchoring with ACSR,

- For span length more than 450 mtr shall be with UR+6 Tower & 11mtr H pole DP as anchoring with ACRS.
- For span length from 70mtr to 100mtr, it shall be with 14mtr H pole DP & 11mtr H pole DP as anchoring.

For longer spans special crossing structures shall be required & the developer shall propose an appropriate solution for each situation as it arises (developer may adopt the standard designs of OPTCL for structure used for 132 KV/ 200 KV Lines). In such cases, the developer shall carry out sub-soil investigation, to ascertain soil parameters in locations where higher tower will be required to get adequate ground clearance.

No mid span joints shall be allowed in the crossing span.

3.2.3 Line Clearances: - Clearance from ground, buildings, trees and telephone lines shall be provided in conformity with the *Indian Electricity Rules, 1956/ CEA Safety Regulations, 2010* as amended up to date. The vendor shall select the height of the poles in order to achieve the prescribed electrical clearances.

Situation	Min Clearance (Mtrs)	
	33 Kv	6.6 Kv
<i>Over open country</i>	5.2	4.6
<i>Over Road</i>	7.10	7.10
<i>Along Road</i>	5.8	5.2
<i>Over Telecom. Line</i>	2.44	2.44
<i>Over railways</i>	14.10	14.10
<i>Over 11 Kv or LV line</i>	2.44	2.44

3.2.4 Support Structure Design and fabrication for over head lines: - The support structure shall comply with technical specification for line support structures and cross arms. IS: 5613(Part1/sect1) :(1985) shall be taken into consideration for wind pressure to be applied to conductors, insulators and support structures.

3.2.5 Factor of safety:-

- *For metal supports : 2.0*
- *For mechanically processed concrete supports: 2.5*
- *For stay wires, guard wires or bearer wires shall be 2.5 based on ultimate tensile strength of the wire*
- *For conductor, shall be 2.0 based on their ultimate tensile strength.*

3.2.6 Excavating Pits for erection of Poles:

Pole pit should be of size 600x900x1500mm or circular with 600 mm dia and base padding of 200mm thick with 1:3:6 cement concrete be done before erection of pole. The earthing coil

should also be grounded 800mm below ground level in a separate pit & filling the pit with soil. The earthing coil is jointed with the earth wire provided in the base of the PCC pole and metallic fittings should be earthed with the embedded wire in the PCC pole at the top. In case of RS Joist Pole/H Pole, the earthing coil is bolted with the same. PCC pole should be in vertical position & the pit is filled with 1:3:6 cement concrete mixture for size 450x600x1500mm and rest filled with boulders. The poles should be erected with maximum span of 100 meters.

3.2.7 Earthing of Poles:

In Sub-Transmission line & HT lines, each pole shall be earthed with coil type earthing as per *REC Construction Standard J-1*.

All DP & FP structure & the poles on both sides of railway, Telecommunication, road, drain & river crossing shall be earthed by pipe earthing as per *REC Construction Standard J-2*.

3.2.8 Providing of Guys/ Strut Poles to Support:

The arrangement for guys shall be as per *REC Construction Standard* for PSC Poles. Strut poles/ flying guys wherever required shall be installed on various pole locations as per *REC Construction Standard*. In case of 5 feet centre DP, six stays should be provided on the DP. The location of pit for embedding the anchor plate and stay rod shall carefully be determined either in true alignment.

The pit 0.4x0.6x1.6 Mtr. shall be excavated and anchor plate with stay rod shall be suitably aligned in such a manner that the stay wire when binded with anchor rod & stay clamp at pole, the same should make an angle of 30 degree to 45 degree from the pole in the tightened position. Cement concrete mix 1:3:6 shall be poured (about 0.3 cmt) in the pit, well packed with ramming adequately & cured properly. The stay clamp shall be located near and below the DC Cross arm to counter balance the tensile load of the line conductor. Stay wire shall be bound at both ends i.e. at the box and the stay rod. Fly guy/storm guy, as per the site conditions should be used after getting approval from DoWR. The stay set consisting of Anchor Rod, Anchor plate, turn buckle bow, thimble should be used at the tension locations.

3.2.9 Fixing of 'V' Cross-Arm, Top clamps, DC Channels etc. On Poles:

- The fitting such as V cross arm, top clamps, D.C. channel etc. should be fixed on poles as per *REC standard*. The fabrication of above fittings should also be got done as per the standard indicated in the schedule.
- The general specification of steel sections is given below:

Cross arm should be made out of M.S. Angle of size 75x75x6mm. The weight of one V cross arm is approximately 25.70 Kg/Cross Arm. Top clamp should be made of M.S. Angle of size 75x75x6mm. The weight of clamp should be approximate 4.08 Kg/Top clamp.

D.C. cross arm 5' centre should be made out of the M.S. channel of size 100x50x6.0 mm. The weight of one DC cross arm comes out 62.3 Kg D.C. and length 3245 mm.

Other special fittings if required may be got fabricated as per the drawings approved by DoWR.

The clamps for holdings the fittings should be fabricated out of M.S. flat 65x8 mm size.

All nuts & bolts used shall be of M.S. with combination of plain and spring washer and machine made.

3.2.10 Fixation of Insulators and Hardware fittings:

Insulator shall be handled carefully in all stages of loading and the individually checked for cracks, damages, loss of glaze etc. before assembling and erection of at site.

- a) The 33KV & 11KV galvanized steel pins made by process of forging suitable for 33KV pin/11KV pin insulators having maximum failing load of 10 K.N & 5 KN respectively with small steel head as per *IS 2486 (ii)/1974* shall be used. The dimension of pin shall conform to ref L-306N fig *69IS-2486 (ii)/1974*. The pin shall be provided with nut (hot dip galvanized) one plain washer and one spring washer (electro galvanized).
- b) The disc insulators should be fitted with respective voltage grade hardware for tensioning the conductor. Hardware should be fixed in the disc insulators as per the standard practice and in the correct position to bear the tension of conductor. The strain hardware fitting of aluminium alloy suitable for Dog Conductor (100 mm²) should be used conforming to *IS-2486 (Part-II) 1989*.
- c) Insulator Strings:

Sl. No.	Particulars	Single suspension string	Double suspension string	Single tension string	Double tension string
	(No. of standard Disc)	(Nos)	(Nos)	(Nos)	(Nos)
1	33KV	1x3	2x3	1x4	2x4
	11 KV	1x2	2x2	1x3	2x3
2	Size of Disc	Mm			
	33 KV, 11 KV	255x145	255x145	280x170	280x170

3.2.11 Final Schedule

The final schedule including Bill of quantity indicating location of poles specifically marking locations of failure containment pole/structure, line sectionalizes, line tapping points; angle of deviation at various tension pole locations, all type of crossings and other details shall be submitted for the approval of the owner. After approval, the contractor shall submit six more sets of the approved documents along with one set in reproducible form to purchaser for record purpose.

3.3 Conductor:

In normal practice ACSR / AAA conductors of 100 Sq mm will be used in 11 KV lines and that of 148 Sq mm (AAAC) & 232 sq. mm AAAC (Trunk line) will be used in 33 KV lines, as per the Line philosophy given at Para 6.0.

3.3.1 Stringing of conductor:

Conductor should be laid out from a rotating wheel supported on jacks for easy unwinding of the conductor snatch blocks shall be used for stringing the conductor and shall have grooves of a shape and size to allow easy flow of conductor and ensure damage free operation. Come along clamps should be used to grip the conductor at the time of stringing.

3.3.2 Sagging of conductor:

All conductors sagging shall be preferred in accordance with the sag and tension tables. After the conductors have been pulled to the required sag, intermediate spans shall be checked to determine the correct sag. The conductor shall be installed on insulators secured to it by means of 6 SWG aluminum binding wire. The jumpers at the tension locations should also be bound by 6 SWG aluminum binding wire. Before fixing the conductor on insulator and strain hardware, aluminum tape should be wrapped on the conductor.

3.4 Guarding:

Guarding cross arm is to be fitted on the pole as per the drawing for guarding the line with 6 SWG GI wire as guard wire and 8 SWG GI wire for lacing. Guarding cross arm made of 75x75x6 mm angle 8 feet long should be clamped at 300mm below the bottom arm of 'V' cross arm.

3.5 Anti-climbing device:

Barbed wire weighing 35 Kg per pole should be wrapped at a height of 3000 mm above ground level stretching in 900 mm length. Both ends of barbed should be clamped suitably to avoid Coming down from its location.

3.6 Danger board: Danger Board for 33KV or 11KV voltage and danger mark conforming to IS: 2551-1963 should be fixed on each location.

3.7 Pole Numbering System:

Each feeder support structure shall be uniquely identified along the route. Identification number to be painted on PSC and steel pole using stencils at a distance of 1.6 m from the ground, as per the approved scheme.

4.0 Project License: The eligible Contractor has to obtain project license from the competent authority (*ELBO*) in respect of the mentioned works prior to commencement of the works. All the expenses towards the project license and inspection thereof have to be borne by the contractor.

5.0 FINAL CHECKING, TESTING AND COMMISSIONING: After completion of the work, final checking of the line shall be carried out by the contractor to ensure that all foundation works, pole erection and stringing have been done strictly accordingly to the specification and as approved by DoWR. All the works shall be thoroughly inspected in order to ensure that:

- i. Sufficient backfilled earth covers each foundation pit and is adequately compacted.
- ii. All poles are used strictly according to final approved drawing and are free of any defect or damage whatsoever.
- iii. Stringing of conductors has been done as per desired clearances.
- iv. All conductor accessories are properly installed.
- v. All other requirements for completion of works such as fixing of danger plates, anti climbing devices etc have been fulfilled.
- vi. The insulation of the line as a whole is tested by the contractor through provision of his own equipments, labour, etc to the satisfaction of DoWR.
- vii. All poles are properly grounded.
- viii. The line is tested satisfactorily for commissioning purpose.

B. LT (Over head Lines):

1. **SCOPE:** Planning, supply, installation, testing and commissioning of 415 Volt over-head low tension line on 140 Kg. 8 meter long PCC Pole and necessary iron fitting etc. complete. All relevant supports fittings and fixtures, conductors shall conform to their respective *IS specifications and REC standard*. The physical layout of the work has to be got approved by DoWR before start of work.
2. **POLE:** The overhead LT line shall be supported on 140 Kg. 8 meter long PCC pole as specified in the schedule of item conforming to ISS. Normally one sixth of the pole length shall be buried in the ground. The supports shall suitable be spaced depending on the number and size of the conductors, road crossings etc. in general, the spacing of supports shall be approximately 50-60 meters depending upon road crossing, telephone crossing etc, and in no case the inter-distance between two consecutive support shall exceed 65 meters *as per rule 85 of the Indian Electricity Rules, 1956*. For erection of pole, a pit size of 600x900x1500 mm should be done and base padding of 200 mm thick should provided and back filling of pole pit with boulders. Suitable time of at least seven days shall be allowed for setting the base concrete with proper curing etc. Then the pole shall be laid in the center of the pit and shall attain vertical position & pit shall then be refilled with excavated soil and well consolidated.
3. **CROSS ARMS AND BRACKETS:** The LT cross arm shall be made up of M.S. Angle as follows: i) LT 3 Pin Cross Arm: 50x50x6 mm size 4.5 Kg/meter, 680 mm long ii) LT 4 Pin Cross Arm: 50x50x6 mm size 4.5 Kg/meter, 980 mm long The minimum clearance between holes for U clamps shall be 300mm. A minimum space of 40mm along the length of the bracket shall be kept spare from top hole and bottom hole of the bracket the length of cross arm and bracket shall be suitable for spacing of conductors, earth wire and guarding in accordance with the minimum spacing specified in relevant ISS and in accordance to *Indian Electricity Rules*. The width of the bracket shall be not less than 50 Cms.
4. **INSULATORS:** L.T. Porcelain shackle insulators of size 90x75mm conforming to IS: 1445-1977 shall be provided and fixed in 'U' clamps for holding the conductors. LT shackle hardware galvanizing shall conform to *ISL 2633-1964* for 4 dip tests. For holding neutral conductor Aluminium bobbin insulators of size 60x50mm size with nuts bolts shall be provided.
5. **CONDUCTORS:** AAAC 7/3.15mm (55 sq mm)/7/2.5 mm (34 sq mm) & 7/2.00 mm (22 mm sq. mm) may be used for phase conductors based on technical requirement. The conductors shall be laid out in such a manner that there is no damage to the conductors in any form. While stringing overhead conductors, there should not be any kinking. Reels of conductor should be handled carefully, so that there is no cutting, nicking or fraying of the conductor strands. 'D' loops shall be provided on each conductor on both sides of each LT pole and all jumpers of LT line.
6. **CLAMPS:** Back clamps and stay clamps for LT line should be made up of 50x6mm MS flats.
7. **GUARDING:** Suitable guarding shall be provided as per provision of Rules 88 of *Indian Electricity Rules*. The spacing between the outermost conductor and the guard wires shall not be less than 30 Cm. both vertically and horizontally. The guard wire shall be GI and shall in no case be less than 8 SWG in size and shall have a breaking strength of not less than 635 Kg.
8. **EARTHING OF PCC POLE:** Every *third pole should be suitably earthed as per REC Standards*.

CHAPTER -2**CONSTRUCTION PRACTICE FOR 33/6.6 KV SUB-STATION (MSDSS)****1.0 General Consideration:-**

- a) The Sub-Station shall be designed and constructed complying with requirements of the Project, applicable Indian Standards (IS), as well as other rules and Regulations as per the latest amendments. The design and construction of Sub-Station including civil works shall be such that they perform their intended functions. In case of conflict, more stringent provisions shall prevail. The civil scope generally covers Construction of Control room-cum-Switch gear room along with foundations. cable trenches along with covers, marshalling box/control cubicle foundations, switchyard dressing and leveling, site clearance, soil investigation, roads, drains, fencing/ compound wall, gravel filling and, transformer foundations, firewalls, PH facilities. .
- b) The Sub-Station shall be outdoor type. The bus bars may be of either rigid type or flexible strain type depending upon the choice of the designer conserving the overall suitability and economy of the substation to be installed.
- c) The Sub-Station should have the provision for data acquisition system for monitoring.
- d) *Each Sub-Station shall normally have two or more power transformers.* Each Sub-Station will have incoming feeders preferable from two different sources.
- e) *All Sub-Stations shall have independent circuit breaker control of 33 KV incoming feeders and all the incoming feeders feeding the Sub-Stations shall have independent circuit breaker at source end.*
- f) The 415 V AC Station load would be met from a 33KV/.433 KV Auxiliary TRF of appropriate capacity. Station Transformer may be conventional oil type (3 star rated by BEE) or dry type (capacity less than 200 KVA).
- g) DC system comprising of adequate capacity of 110 V DC battery and its chargers shall be provided for protection and monitoring system of the various panels, circuit breakers, isolators, lightings etc. of the entire switchyard system. DC power supply from maintenance free rechargeable seal lead acid batteries i.e. VRLA battery would be preferred.

The system parameters of 110 V DC systems shall be as follows:

Nominal system voltage (V)	110
Highest system voltage (V)	121
Voltage variation (V)	99-121
Ambient temperature ($^{\circ}\text{C}$)	50
System earthing	Unearthed
Maximum system fault level (KA)	25 (1 sec)

The ampere-hour capacity of DC storage battery shall be based on the three hour supply. The battery duty cycle:

Load	Duration	Type of Loads
Continuous load	3 hours	Relays, IEDs, HMIs, CB spring charging, isolator interlock loads & other miscellaneous permanently connected loads, etc.
Emergency load	1 hour	Emergency lighting loads

h) Any other items, not specifically mentioned here but required for commissioning of substation shall be deemed to be included in the scope.

i) Prior to commencement of supply/ works all relevant drawings, designs must be got approved by respective Statutory authorities/ Agencies and DoWR.

1.1 **Selection of site:-** The main points to bear in mind while selecting site for MSDS shall be as follows:-

- a) Selection shall be made after taking into consideration the capacity and location of the feeding Grid Sub-Station, the projected load, the existing network configuration, etc. and the economic, and environment consideration.
- b) As near to the load centre as feasible.
- c) Far away from obstruction to permit easy and safe approach of high voltage over head line transmission line.
- d) Easily accessible to the road to facilitate transport of plant & equipments in all the seasons.

- e) Formation level shall be 1 m above HFL.
- f) The land shall be reasonably leveled and shall not have any open drain/ nallah or road crossing it.
- g) The developer shall carry out detailed survey and Geo- technical Investigation of the area as per the specification given elsewhere in this document for finalization of the lay out approved *Single Line Diagram*, location of 33 kV and 6.6 kV bays, control room, incoming and outgoing 33 kV lines.

2.0 Lay out of Sub-station:- It may follow the standard lay out for 33/11kV Sub-Station, as standardized by REC/ CAPEX programme of DISCOMS. 33kV switch yard shall be outdoor type with indoor 6.6 kV switch gear. SLD is shown at Exhibit- ELEC/5-2014 is only for reference purpose only.

3.0 Control room Building:-

- i. Control room shall preferably be located to oversee the entire switch yard from control room. The minimum floor area requirement shall be 10 x 8 sq. m. The size which may vary at the time of detailed engineering to suit the actual site requirements. The layout and orientation of the control room shall be finalized as per the detailed engineering based on individual scheme and/ or pool of schemes under the Cluster and line corridor & future requirements.
- ii. The different rooms required for Control room would; Main Control room, JE's room, Battery room, Store room and WC/Bath/WB.
- iii. An open space of minimum 1 meter shall be provided on periphery of the rows of the Panel board and equipments in order to allow easy operator movements and access as well for maintenance. Working clearances should comply with provisions of **CEA (Measures relating to safety and Electric Supply) Regulations, 2010**.
- iv. Contractor shall comply with all applicable statutory *Acts, Rules & relevant Regulations*, while developing the Control Room.

4.0 Installation:- The physical layout of entire sub-station with positions of equipment, bus bar, structures and outgoing feeders shall be marked at site and drawings have to be got approved by Electrical Inspector & concerned competent officer of DoWR before start of works.

5.0 Structural:

- i. Switchyard structure to support buses, electrical equipments and terminals of line conductors shall be made of fabricated steel structure, 150 x150 GI RS joist Pole & GI Channels & angles as per the ODSSP drawings of suitable cross section for 33/6.6 KV (MSDSS) and 33/0.433 KV & 6.6/0.433 KV DSS. Steel structure shall normally be hot dip galvanized or painted.
- ii. All Pole mounted stations (for station supply) shall be as per *REC standard*.

- iii. Minimum strength of structural foundation concrete shall be M20 confirming to *IS: 456* as per drawing.
- iv. Blinding concrete below foundations, cable trenches, shall be PCC of minimum grade M-7.5.

X. **Erection of structure & Equipments:**

- XI. Supports shall not be guyed but may be suitably concreted. For erection of bus bar structure supports, normally one sixth of the support shall be buried in ground. A pit of size 0.6 Mtr. x 0.9 Mtr. of required 1.5 Mtr. depths shall be excavated. A layer of 20 cm thick of 1:3:6 cement concrete poured for base pad concreting of post is to be done by 1:3:6 ratio cement concrete of size 0.45 M x 0.60 M x 1.5 M. Suitable time shall be allowed for setting the cement concrete before removal of holding ropes. Proper curing of cement concrete by means of wet gunny bag for at least seven days shall be done. All precautions shall be taken to avoid any chance of injury or damage to labors working at site.
- XII. After the columns/supporting structures are erected respective equipments of 33/6.6 KV is to be erected carefully by suitable crane. The breaker and isolators are to be erected as 3 phase unit basis. Control relay panels are to be mounted inside the control room in the same order as in the switchyard. After the earth mat design is finalized, the earth mats with 50x6 mm GI flat are to be put for each equipment. Then flats are to be interconnected with each other. The bus bars are to be strung after all the columns and beams are fitted. Control and power cables should be laid in consultation with Engineer-in-Charge for safe and easy maintenance. All the equipments of each 33 bays are to be connected by suitable jumpers and clamps.
- XIII. **Muffing:** A layer of 1:3:6 mix cement concrete 45 cm x 45 cm on all sides of the pole up to a height of 45 cm and tapered on top shall be coated and adequately cured for seven days. One finishing coat of cement paste shall be applied on outer surfaces of the muffing.
- XIV. **GI Iron Fittings:** All channels used shall not be less than 100x50x 6 mm. All angle used shall not be less than 50 x 50 x 6 mm corresponding to *ISI 6565*. MS flats used shall be of sections as directed by Engineer-in-Charge. All nut-bolts used shall be GI with a combination of plain and spring washer.
- XV. **Painting of Pole:** - All steel poles, brackets, cross arms and all steel fittings shall be first painted with two coat of red oxide paint. The portion of the pole to be buried inside the ground shall be painted with two coats of bitumen tar. After erection of pole, the external

surface of pole and all steel items shall be painted with two coats of aluminium paint in an approved manner.

6.0 Transformers: The transformers and fittings and accessories shall comply with the Owner's technical specification and relevant IS. *The preferred rating standards for 33/6.6 KV transformers shall be 0.630, 1.0, 1.6, 3.15, 5.0 MVA and shall be three- phase, outdoor type.*

7.0 Protection:

7.1 *All 33 kV lines at Connection Points shall be provided with breakers having a minimum of over current and earth fault protection with or without directional features so that fault occurred at their end will not be reflected towards grid sub-station end.*

7.2 The life expectancy of power transformer is much dependant on right type of protection provided with a transformer. *One 33 kV breaker should be provided for group control when there are two transformers of capacity less than 1000 KVA each. A circuit breaker shall be provided on primary side of every transformer having capacity 1000 KVA and above installed in compliance with CEA (Measures relating to safety and Electric Supply) Regulations, 2010.*

7.3 In addition to basic protections, *transformers shall have O/C (three elements) & E/F numerical relays. For TRF of 5 MVA & above capacity, differential or REF relays may be provided. In addition all transformers 1.6 MVA and above shall be provided with gas-operated relays, temperature protection and winding temperature protection and oil temperature protection. Guidelines mentioned in protection manuals of Central Bureau of Irrigation & Power (CBI & P) may be kept in view. The contractor shall provide protection schemes in lines with proviso 9.8 of Odisha Grid Code, for approval by DoWR.*

7.4 The Intelligence Electronic Device (IEDs) shall provide numerical electrical protection of feeders/ equipments. Each numerical protection scheme shall have a serial interface on the front for communication on open protocol like MODBUS or IEC: 60870-5-10 for remote communication, data transfer etc.

7.5 Necessary auxiliary relays, timers, trip relays, etc. required for interlocking, alarm, logging, etc. and completeness of the scheme shall be provided.

8.0 Disconnectors (Isolators) and earth switches (applicable for AIS):

Disconnectors shall be of outdoor horizontal central break/ double break/ vertical break/ without earth switch as per IEC 62271-102. Type of disconnector shall be as per layout

requirement. 33 KV system disconnectors shall be manual operated type. Disconnectors/ earth switches shall be provided with pad-locking arrangement to prevent operation in case of emergency.

The earth switches shall be capable of discharging trapped charges associated with lines. Earth switches shall be locally operated. Mechanical and electrical safety interlocking shall be provided to prevent closing of disconnector when main earth switch is closed and vice-versa.

9.0 Bus Bar Conductor: Conductor used should be able to take the short circuit current corresponding to the fault level as notified in technical specification. Minimum Aluminum conductor steel reinforced of size 100/232 Sq.mm conforming to *IS: 398-1961* as specified in the schedule of item and directed by Engineer-in-Charge shall be used for 3 phase 3 wire 33 KV over head bus bars based on site fault level. Tension should then be adjusted until correct sag is obtained in spacing near the pulling end. Stringing chart should be used for proper stretching of conductor. The sag shall then be checked either by sighting method or by stopwatch reflected method. The conductor shall be installed on insulators secured to it by means of 6 SWG aluminium binding wire and aluminum tape on it maintaining proper tension and sag.

10. Cable and Earthing:

a. Cables: The cables shall be supplied, inspected, laid tested and commissioned in accordance with drawings, specifications relevant standard specifications and cable manufacturer's instructions. The MV cable shall be PVC insulated PVC sheathed aluminium conductor armoured cable of 1100 volts grade & FRLS type. The sizing of the power cable shall be based on current rating & fault level; however rating factors corresponding to temperature and grouping of cable shall be considered. All cable shall be inspected upon receipt at site and checked for any damage during transit by the Engineer-in-Charge before it lay down to trenches, walls etc.

b. Laying of Cables: Cable lying in general shall follow;

- a) Switch yard area: - In concrete cable troughs (cable trench having cable trays)
- b) Control room: - On cable racks consisting of slotted type and ladder type cable trays. Cable trays shall have standard width of 150 mm, 300 mm and 600 mm and standard lengths of 2.5 meters. Minimum thickness of mild steel sheets used for

fabrication of cable trays and fittings shall be 2 mm. The thickness of side coupler plates shall be minimum 3 mm.

c) Buildings: Conduits directly buried cables shall be used wherever necessary with the approval of DoWR.

Minimum vertical separation between layers of cable tray shall not be less than 300 mm.

Cables shall be laid by skilled and experienced workman using adequate rollers to minimize stretching of the cable. Great care shall be exercised in laying cables to avoid forming kinks. The relative position of cables shall be first marked to avoid the cables crossing each other. At all points of changes in direction in horizontal as well as in and vertical planes, the cables shall be bent smooth with a radius of bend not less than 12 times the diameter of the cables. For laying cables under-ground a trench of at least 750 mm deep of required width shall be excavated for entire length of cable route. The trench shall be brick masonry made. A bed of fine sand of 100mm thickness shall be dressed and well dressed. The cable shall be laid on the bed of sand with full precautions to avoid any kinking, twisting and damage of cable. Fine sand shall be spread over the cable and shall be flushed with top surface RCC Slab are to be placed at suitable size to cover cable trenches. For cables to run along the wall proper and accurate verticality shall be maintained. Before fixing the cables on walls vertical plumbed arcing shall first be made. Parallel cables shall be spaced at least 50 mm apart maintaining their relative position over the entire length. Saddles for gripping the cables shall be spaced not more than 1 meter apart in order to avoid undue stress on the cables due to its own weight.

Suitable routed cable trenches shall be provided to accommodate power and control cables from marshalling box in the yard to the respective panels in the control room building. The cable entering the control room building will be laid in pipes with suitable sealing at wall opening to prevent entry of water and rodents in to the building through cable trench opening.

b. **Earthing:**

To meet the requirements, an earthed system comprising of an earthing mat buried at suitable depth below ground and supplemented with ground rods at suitable points is provided in the substations. The impedance to ground should be as low as possible but it should not exceed 1.0 (one) ohm.

- i. All the non-current carrying metal parts of electrical installation shall be earthed properly. All metal conduits trucking, cable sheaths, switch gear, distribution fuse boards, light fittings and all other parts made of metal shall be banded together and connected by means of specified earthing conductors to an efficient earthing system. All earthing shall be in conformity with the *Indian Electricity Rules/ CEA (Measures relating to safety and Electric Supply) Regulations, 2010* and in accordance to *IS: 3043-1987/ IEEE80*. The Step and touch potentials shall be within safe limit. Design of earth mat shall be duly supported by computer based soft ware study.
- ii. All equipments, structures etc. shall be connected to the grounding mat as per IE Rules/ CEA Safety Regulations, 2010, code of practices for earthing and IEEE80 at two separate and distinct locations.
- iii. A grounding mat shall be provided at minimum depth of 600mm in the Substation/switchyard to provide low impedance path for lightning surges/ system fault current to earth.
- iv. The earthing conductor size shall be designed for life expentancy of minimum (forty) 40 years and system fault time of 1.0 Sec. whichever is higher. Minimum rate of corrosion of steel used for earthing conductor shall be considered as 0.12 mm per year for designing its size.
- v. All earthing conductors shall be of GI plate, GI pipe or earthing coil of specified size and shall be protected against mechanical injury or corrosion.
- vi. Under no circumstances the cross sectional area of earthing conductor shall be less than half of the largest current carrying conductor subject to an upper limit of 80 Sq mm. If the area of the largest current carrying conductor or bus bar exceeds 160 Sqmm. then two or more earthing conductor shall be used in parallel to provide at least half one cross sectional area of the largest current carrying conductor.
- vii. **Connections to Earth:** All sub-station equipment shall be earthed on a grid system. The grid around the substation connecting earthing stations shall be of bare GI conductor of size not less than 7/3.15mm.
 - The transformer neutral shall be directly connected to two pipe electrodes in treaded earth pits, which intern and shall be connected to station earth grid. All the electrodes shall be buried in cement pit

with cast iron cover hinged to cast iron frame to have an access to the joints.

- Earthing terminal of each lightning arrester and lighting down conductors shall be directly connected to rod electrode which in turn shall be connected to station earthing grid.
- All other sub-station equipment shall be earthed with separate and independent GI strip of required section or bare GI conductor of size 6 SWG connected to grid. The earthing conductors inside the buildings shall be properly supported with clamps and brass screws. GI strips outside the building shall be laid at-least 450 mm below the finished ground level.
- Over lapping in strips at joints where required shall be minimum 75 mm. The joints shall be reverted with rivets and brazed in approved manner. Sheathed lugs of adequate capacity and size shall be used for all termination of connection. Lugs shall be fitted to the equipment body to be earthed after the metal is cleaned of paint and other oily substance and properly tinned.

11. Lightning Protection:

- i. Lightening protection system installation shall be in strict accordance with latest edition of *Indian Electricity Rules, Indian Standards and Code of practice and Regulations* existing in the locality where the system is installed.
- ii. Direct stroke lightening protection (DSL) shall be provided in the switch yard by electrodes mounted in the Joist pole structure.
- iii. 25 mm dia 1000 mm long MS solid rod electrode shall be provided with each lighting mast.
- iv. Lighting protection system down conductors shall not be connected to conductors of earthing grid above ground level. Also no intermediate earthing connection shall be made to lightning arrester, transformer earthing leads, which shall be directly connected to rod electrode.
- v. Connection between each down conductor and rod electrode shall be made via joints located approximately 1500 mm from ground level. The joints shall be directly connected to earthing system.
- vi. Down conductors shall be cleated at the structure at 1000 mm interval.

- 12.0 Fire Protection:** Firefighting equipment of adequate capacity shall be provided in the sub-station to deal with fires likely to be encountered. The layout of the Sub-Station itself shall be such that the fire shall not spread from one to other equipment and areas as far as possible. Fire hydrant, carbon dioxide (CO₂) type fire extinguisher or dry chemical power type fire extinguisher conforming to latest IS shall be provided as per site requirement. All fire fighting equipments shall conveniently be located and conspicuously marked.

A fire wall shall be erected between the transformers if the free distance between the various pieces of equipment is less than 10 m, to protect each one from the effects of fire on another.

Fire walls shall also be erected between the power transformers if the free distance is less than ten meters. Fire walls shall extend at least two metres on each side of the power transformers and at least one metre above the conservator tank or safety vent. These dimensions might be reduced in special cases where there is lack of space.

- 13.0 Switch yard lighting:** 50 lux on main equipment at first level (equipment connection level), 20 lux on balance switchyard & road etc. Details shall be supplied by Engr-In- Charge.

- 14.0 Chain Link Fencing, Gate etc:** The outdoor switchyard shall compound wall or be enclosed by GI wire mesh chain link fencing over masonry works (0.78 meter height of brick work and 1.22 meter of chain link). The fencing shall be supported by adequate angle iron frame work of minimum size 50 x 50 x 6 mm and shall have iron bracings of the angle iron frames. Framework of gates of the switchyard shall be made up of M.S. flat and M.S. bars. The design of Compound wall for MSDSS and/or fencing arrangement for switch yard shall be as per the approved drawing by the Engineer-in-Charge. Switch yard area shall be filled with 150/100 mm thick gravels to restrict the growth of grass in the outdoor switchyard. Before laying the gravel fill, top layer of the soil shall be treated for anti-weed considering type of weeds found in the vicinity. It should be covered with granite metal jelly 15 to 20 mm size for purpose of effectively discouraging the growth of grass and weeds and to prevent the spreading of dust. All the areas adjacent to oil filled equipments such as breakers, transformers etc should be surfaced for additional purpose of absorbing leaking oil.

CHAPTER -3**SPECIFICATION FOR DSS, (TRANSFORMER CAPACITY UP TO & BELOW 250 KVA) ON DOUBLE POLE STRUCTURE****1. SCOPE:**

Design, planning, supply, installation, testing for commissioning of double pole structure (D.P.Structure) for pole mounting transformer Sub-station with all allied equipments etc. complete. The Sub-station plan shall be got approved by the competent authority of DoWR prior to erection work.

2. SUPPORTS:

The D.P. structure will be either with GI RS Joist supports or have two numbers 140 Kg. 8 meter long PCC Pole for 250 KVA Sub-station as specified in the schedule of items. Normally one sixth of the pole shall be buried in the ground. The support shall be placed at a distance of 2400 mm. For erection of pole, a pit digging of size 600x900x1500 mm should be done and base padding of 200 mm thick should be provided and concreting with 0.3 Cmt per pole with 1:3:6 cement concrete mixture for size 450x600x1500 mm.

Suitable time for at least seven days shall be allowed for setting the base concrete with proper curing etc. the pole shall then be laid in the center of the pit and tied with ropes of adequate strength of four side of the pole by means of suitable clamps fixed at right angles to each other. Loose ends of two sides of ropes forming straight line shall be tied firmly with deep driven iron pigs located equidistant from the center of the pole pit. One of the remaining two ends of remaining ropes shall be connected to turfer and the end of opposite rope shall be kept loose and ready to be tied with deep driven iron pigs shall be manned by skilled worker to control the unwanted deflection of pole while pulling it by turfer. The pole shall then be pulled by turfer and correctly aligned to its truly vertical position and then set in 1:3:6 cement concrete poured up to ground level. Suitable time shall be allowed for setting the cement concrete before removing the ropes. Proper curing of cement concrete for at least seven days shall be done. All precautions shall be taken to avoid any chance of injury or damage to labour and technicians working at site.

3. FITTINGS:

6.6 KV "V" cross arms shall be made up of MS Channel 65x65x6 mm size having phase to phase clearance of 1070 mm. 6.6KV top clamps shall be made up of MS angle 65x65x6 mm size 405 mm long. DC cross arms, single pole cut point DC, transformer mounting DC, AB Switch mounting DC, DO and LA mounting channel shall be made up of MS Channel 100x50x6 mm size of required length.

Back clamps and stay clamps shall be made up of 65x8 mm size.

MS Nut and Bolts conforming to IS: 1363-1902 shall be used of 5/8" (16mm) for fitting works and for earthing arrangements GI nut-bolts must be used.

4. AB Switch:

AB switches and DO Fuses should be supplied with base steel structure, terminal bi-metallic connectors / PG clamps / earth connector. They should be checked for proper alignment and free & smooth operation. The insulators should be cleaned before commissioning. The linkage of contacts should be checked for free and adequate grip. The AB switch should be checked for fully OPEN/CLOSED positions. Contact between two movable points should be checked and recorded. The contacts should be adequately lubricated before commissioning. Connection of terminal connectors shall be checked for proper tightness. Operating handle should be separately grounded. Equipments should be supplied with detail technical specifications enclosed. The associated mounting / connection accessories items shall not be considered for measurement under any head of Price Schedule even if they happen to be appearing in Price Schedule.

5. LIGHTENING ARRESTOR:

The 6.6 KV lightening arrestor shall be valve type arrestor consisting of an outer ceramic body containing 9 Set of resistance (Valves) and spark gaps in series. The resistance shall be made of special silicon carbide ceramic, which offer high resistance to power frequency voltages and low resistance to surge voltages. Arrestor should be installed as close as possible, to the HT line. The arrestor should be solidly earthed. The lightening arrestor shall be mounted on 100x50x6 mm MS Channel fixed approximately 1500mm below the 6.6KV tapping point.

6. D.O. FUSE UNIT:

The 6.6 KV drop out fuse unit shall have current carrying capacity of 200 Amps having 2 Nos 11KV post insulators fitted on bakelite base with fuse barrel as per BSS-1314. The DO fuse should be got checked and test certificate from CPRI Bangalore/Bhopal as per IS: 5792-1970 should be obtained and produced.

7. TRANSFORMERS:

The 6.6/0.4KV step-down distribution transformer shall be supplied and installed as per the specifications mentioned in the Transformer Section.

8. DISTRIBUTION BOX:

The distribution box suitable for 250 KVA transformers with isolator on incoming side and SPMCCB on outgoing side will be used. All sheet steel work shall undergo a process of digressing, pickling in acid, cold rinsing, phosphating, possivating and then sprayed with a high corrosive

resistant primer and then backed in oven. The finishing treatment shall be by application of two coats of synthetic enamel gray paint in an approved manner.

9. DANGER CAUTION BOARDS:

The danger of caution boards shall have to be displayed on pole, Transformer and LT distribution panel. The danger signboards should conform to *IS: 2551-1963*.

10. ANTI-CLIMBING DEVICE:

Anti-climbing device consisting of barbed wire extending to a minimum length of 900mm shall be provided on poles. Both ends of the barbed wire shall be secured to poles by means of suitable iron clamps as per the direction of Engineer-In-Charge.

11. PAINTING OF DP STRUCTURES:

All metallic parts except transformer and LT distribution box of D.P. structure and PCC Pole shall be painted in an approved manner.

12. EARTHING OF SUB-STATION:

Three numbers pipe earthing with 2.5 meter long GI Pipe 40mm dia used connecting pipe earthing with 4mm GI wire with LA transformer neutral, transformer body, DO earthing, Channel earthing. Pole pit is filled with soil.

**B. INSPECTION/ TESTING AND
SUPPLY OF
MATERIALS/SYSTEM ELEMENTS
FOR SYSTEM CONNECTIVITY
(33 kV SUB-TRANSMISSION AND 6.6
KV, LT SUB-SYSTEM)**

SECTION VII – B

INSPECTION/ TESTING AND SUPPLY OF
MATERIALS/SYSTEM ELEMENTS FOR SYSTEM CONNECTIVITY
(33 kV SUB-TRANSMISSION AND 6.6 KV, LT SUB-SYSTEM)

INDEX

SL. NO.	PARTICULARS	PAGE NO.
1	CHATER - 1 PSC POLES FOR 11 KV LINE/LT LINE	3
2	CHAPTER- 2 TECHNICAL SPECIFICATION FOR RS JOIST & WIDE FLANGE PARALLEL BEAM	11
3	CHAPTER- 3 TECHNICAL SPECIFICATION FOR AAAC	14
4	CHAPTER- 4 TECHNICAL SPECIFICATION FOR ACSR CONDUCTORS	20
5	CHAPTER- 5 TECHNICAL SPECIFICATION FOR 33/6.9 KV, 630 KVA, 1.6 MVA , 3.1 MVA& 5 MVA POWER TRANSFORMERS	34
6	CHAPTER- 6 TECHNICAL SPECIFICATION FOR 33 KV OUT DOOR V.C.B	58
7	CHAPTER- 7 TECHNICAL SPECIFICATION OF 33 KV LIGHTNING ARRESTOR (VOLTAGE CLASS SURGE ARRESTORS)	86
8	CHAPTER-8 TECHNICAL SPECIFICATION FOR 33 KV OUT DOOR P.T	91
9	CHAPTER-9 TECHNICAL SPECIFICATION FOR 33 KV OUT DOOR CT	96
10	CHAPTER-10 TECHNICAL SPECIFICATION FOR 33 KV MS CROSS-ARMS	105
11	CHAPTER-11 TECHNICAL SPECIFICATION FOR 33 KV PORCELAIN PIN INSULATORS SUITABLE FOR 33 KV OVER HEAD LINE.	106
12	CHAPTER-12 TECHNICAL SPECIFICATION FOR 33 KV G.I PINS WITH NUT FOR 33 KV PIN INSULATORS.	109
13	CHAPTER-13 TECHNICAL SPECIFICATIONS FOR 33 KV PORCELAIN POST INSULATORS SUITABLE FOR 33 KV OVERHEAD POWER LINES	111
14	CHAPTER-14 TECHNICAL SPECIFICATION FOR DISC FITTING (T&C TYPE) 45 KN FOR OVERHEAD LINES	114
15	CHAPTER-15 TECHNICAL SPECIFICATION: 20 MM DIA BLACK STAY FOR 33 KV LINES (NONE GALVANIZED, NOT-PAINTED)	117
16	CHAPTER-16 TECHNICAL SPECIFICATION FOR PORCELAIN DISC INSULATORS 70 KN (B&S TYPE) FOR 33 KV OVERHEAD POWER LINES.	119
17	CHAPTER-17 TECHNICAL SPECIFICATION FOR CONTROL & RELAY PANEL	123
18	CHAPTER-18 TECHNICAL SPECIFICATION OF EARTHING COILS	135
19	CHAPTER-19 TECHNICAL SPECIFICATION FOR OIL IMMERSED 250 KVA, 1000 KVA, 6600/430 V DISTRIBUTION TRANSFORMERS	136
20	CHAPTER-20 TECHNICAL SPECIFICATION FOR 6 KV SURGE TYPE LIGHTING ARRESTORS	156
21	CHAPTER-21 TECHNICAL SPECIFICATION FOR 6.6 KV INDOOR VACUUM CIRCUIT BREAKER	158
22	CHAPTER-22 TECHNICAL SPECIFICATION FOR 6.6 KV A B SWITCH	163
23	CHAPTER-23 TECHNICAL SPECIFICATION FOR CROSS- ARMS	170
24	CHAPTER-24 TECHNICAL SPECIFICATION FOR STAY SET	171
25	CHAPTER-25 DANGER NOTICE PLATES	174
26	CHAPTER-26 TECHNICAL SPECIFICATIONS FOR 415/240 V, PORCELAIN INSULATORS AND INSULATOR FITTINGS	175

SPECIAL NOTE:

1. If any part, whole or specific aspect of equipments is not being covered under the above list, the Bidder shall specifically bring out such aspect with their views/ suggestions, otherwise, the successful bidder shall be liable to abide by specific requirement of DoWR at detailing stage with no financial liability to DoWR.
2. Technical specifications for any other system elements/equipments for 33 KV & 11 KV OH line (to be charged at 6.6 KV) *and Substations*, not covered in this bid document, the relevant specifications adopted by OPTCL for execution of Govt. Of Odisha sponsored scheme “Odisha Distribution System Strengthening Project (ODSSP)” may be followed subject to approval from DoWR.
3. The material/equipments offered shall be procured from short listed approved vendors (specified in Tech. Document) and shall have been successfully Type tested during last five years on the date of signing of Agreement with EPC Developer. ***The materials/ equipments that do not meet the defined specification of the bid documents shall not be accepted.***
4. In case of any discrepancy observed in specifications, the bidder shall specifically bring out such aspects with their views. Otherwise, the successful bidder shall be liable to abide by the specific requirements of DoWR at detailing stage with no financial liability to Owner.
5. DoWR shall always have the authority, either on an application made by EPC Contractor or suo motto, to review, revoke, revise, modify, amend, alter or otherwise change any specification, if DoWR considers it to be appropriate.

CHAPTER – 1

PSC POLES FOR 11 KV LINE/ LT LINE

1.0 General:

PSC poles shall be of solid rectangular type with an overall length of 9.0 M & 11.0 M /300 Kg Poles suitable for use in 11 KV overhead power lines and 8.0 M long/140 kgs for LT lines.

2.0 Applicable Standards:

Except when they conflict with specific requirements in this Specification, the PSC poles shall comply with the relevant provisions made in the following Indian Standards or the latest versions thereof.

- a) IS: 1678, Specification for pre-stressed concrete poles for overhead power, traction and telecommunication lines.
- b) IS: 2905, Method of test for concrete poles for overhead power and telecommunication lines.
- c) IS: 7321, Code of Practice for selection, handling and erection of concrete poles for overhead power and telecommunication lines.

3.0 TERMINOLOGY:

For the purpose of this specification, following definitions shall apply:

(i) Average Permanent Load

That fraction of the working load, which may be considered of long duration over a period of one year.

(ii) Load Factor

The ratio of ultimate transverse load to the transverse load at first crack.

(iii) Transverse

The direction of the line bisecting the angle contained by the conductor at the pole. In the case of a straight run, this will be normal to the run of the line.

(iv) Transverse Load at First Crack

For design, the transverse load at first crack shall be taken as not less than the value of the working load.

(v) Working Load

The maximum load in the transverse direction, that is ever likely to occur, including the wind pressure on the pole. This load is assumed to act at a point 600mm below the top with the butt end of the pole planted to the required depth as intended in the design.

(vi) Ultimate Failure

The condition existing when the pole ceases to sustain a load increment owing to either crushing of concrete, or snapping of the prestressing tendon or permanent stretching of the steel in any part of the pole.

(vii) Ultimate Transverse Load

The load at which failure occurs, when it is applied at a point 600 mm below the top and perpendicular to the axis of the pole along the transverse direction with the butt end of the pole planted to the required depth as intended in the design.

4.0 APPLICATION

A. 9.0 M and 11.0 M Poles

These poles shall be used at tangent locations for 11KV in different wind pressure zones in accordance with REC Construction Standards referred to in the following table:

Pole Line description Reference to length REC Constrn. Standards

9.0M 11KV lines without earthwire L.T. A-4, B-5 lines, and horizontal formation.

11.0M 11KV lines with earthwire L.T. A-5, B-6 lines, and vertical formation.

The adoptable spans shall be as per REC Construction Standards A-8 (for 11 KV Lines). These poles shall be used for double pole structures of distribution transformer centers as per REC Construction Standards F-1 to F-4 and for special locations in 11 KV and L.T. Lines, such as road crossings etc. In case, rail poles/RCC poles are considered necessary for road crossing or for any other purpose, the same shall be in the scope of contractor and he shall quote for the same as specified in Bid Price Schedule (BPS).

(i) These poles shall be used at tangent locations of 11/0.4 KV lines using conductor formation and clearances as per REC Construction Standard M-3. These poles shall be designed for the working load of 200 Kg. (suitable for wind pressure of 100 Kg/mt.2). The maximum permissible spans shall be as per REC Construction Standard M-2.

(ii) These poles shall be used for double pole structures of distribution transformer centres as per REC Construction Standards F-1 to F-4 and for special locations in LT lines, such as road crossings etc.

B. 8M /140 kg Pole: These poles shall be used for LT lines in wind pressure zones of 50 kg /m², 75 kg. /m², and 100 kg./m² in accordance with REC construction standards

5.0 MATERIAL

(i) Cement

The cement used in the manufacture of prestressed concrete poles shall be ordinary or rapid hardening Portland cement conforming to IS: 269 - 1976 (Specification for ordinary and low heat Portland cement) or IS : 8041 E-1978 (Specification for rapid hardening Portland cement).

(ii) Aggregates

Aggregates used for the manufacture of prestressed concrete poles shall confirm to IS: 383 (Specification for coarse and fine aggregates from natural sources for concrete). The nominal maximum size of aggregates shall in no case exceed 12 mm.

(iii) Water

Water should be free from chlorides, sulphates, other salts and organic matter. Potable water will be generally suitable.

(iv) Admixture

Admixture should not contain Calcium Chloride or other chlorides and salts which are likely to promote corrosion of pre-stressing steel. The admixture shall conform to IS 9103.

(v) Pre-Stressing Steel

The pre-stressing steel wires including those used as untensioned wires (See Annex. I II and III), should conform to IS: 1785 (Part-I) (Specification for plain hard-drawn steel wire for pre-stressed concrete, Part-I cold drawn stress relieved wire), IS: 1785 (Part-II) (Specification for

plain hard-drawn steel wire) or IS: 6003 (Specification for indented wire for pre-stressed concrete). The type designs given in the annexure are for plain wires of 4 mm diameter with a guaranteed ultimate strength of 175 kg/mm² and for plain wires of 5 mm diameter with a guaranteed ultimate strength of 160 kg/mm². All pre-stressing steel shall be free from splits, harmful scratches, surface flaws, rough, aged and imperfect edges and other defects likely to impair its use in prestressed concrete.

Reinforcement for RCC poles

All reinforcing bars shall conform to IS 432 (Part I) or IS 432 (Part-II) or IS 1786 as the case may be. All reinforcement shall be free from loose scale, rust and coats of paint, oil, grease, clay or other material that may have deteriorating effect on the bond between the reinforcement and the concrete.

(vi) Concrete Mix

The concrete mix shall be designed to the requirements laid down for controlled concrete (also called design mix concrete) in IS : 1343 62- 1980 (Code of practice for pre-stressed concrete) and IS : 456 - 1978 (Code of practice for plain and reinforced concrete), subject to the following special conditions:

- a) Minimum works cube strength at 28 days should be at least 420 Kg/cm².
- b) The concrete strength at transfer should be at least 210 Kg/cm².
- c) The mix should contain at least 380 Kg. of cement per cubic meter of concrete.
- d) The mix should contain as low water content as is consistent with adequate workability. If it becomes necessary to add water to increase the workability, the cement content also should be raised in such way that the original value of water cement ratio is maintained.

6.0 DESIGN REQUIREMENTS

The poles shall be designed for the following requirements:

- a) The poles shall be planted directly in the ground with a planting depth as per IS : 1678. Wherever, planting depth is required to be increased beyond the specified limits or alternative arrangements are required to be made, on account of ground conditions e.g. water logging etc., the same shall be in the scope of the contractor at no extra cost to owner. The contractor shall furnish necessary design calculations/details of alternative arrangements in this regard.
- b) The working load on the poles should correspond to those that are likely to come on the pole during their service life. Designs given in the annexure are for 200 kg applied at 0.6M from top.
- c) The factor of safety for all poles above 9.0 Mts. shall not be less than 2.0. For 7.5 M and 8.0 M poles, the factor of safety shall not be less than 2.5.
- d) The average permanent load shall be 40% of the working load.
- e) The F.O.S. against first load shall be 1.0.
- f) At average permanent load, permissible tensile stress in concrete shall be 30 kg/cm².
- g) At the design value of first crack load, the modulus of rupture shall not exceed 53.0 kg/cm² for M-40.
- h) The ultimate moment capacity in the longitudinal direction should be at least one fourth of that in the transverse direction.
- i) The maximum compressive stress in concrete at the time of transfer of pre-stress should not exceed 0.8 times the cube strength.

- j) The concrete strength at transfer shall not be less than half, the 28 days strength ensured in the design, i.e. $400 \times 0.5 = 200 \text{ kg/cm}^2$.
For model check calculations on the design of poles, referred to in the annexure, a reference may be made to the REC "Manual on Manufacturing of solid PCC poles, Part-I - Design Aspects"

6.1 Dimensions and Reinforcements

The cross-sectional dimensions and the details of pre-stressing wires should conform to the particulars given in the annexure. The provisions of holes for fixing cross-arms and other fixtures should conform to the REC standards referred to in clause 1.4 of this specification.

6.2 Manufacture

- 6.2.1 All pre-stressing wires and reinforcements shall be accurately fixed as shown in drawings and maintained in position during manufacture. The untensioned reinforcement, as indicated in the drawings, should be held in position by the use of stirrups which should go round all the wires.
- 6.2.2 All wires shall be accurately stretched with uniform pre stress in each wire. Each wire or a group of wires shall be anchored positively during casing. Care should be taken to see that the anchorages do not yield before the concrete attains the necessary strength.

6.3 Cover

The cover of concrete measured from the outside of pre-stressing tendon shall be normally 20 mm.

6.4 Welding and Lapping of Steel

The high tensile steel wire shall be continuous over the entire length of the tendon. Welding shall not be allowed in any case. However, jointing or coupling may be permitted provided the strength of the joint or coupling is not less than the strength of each individual wire.

6.5 Compacting

Concrete shall be compacted by spinning, vibrating, shocking or other suitable mechanical means. Hand compaction shall not be permitted.

6.6 Curing

The concrete shall be covered with a layer of sacking, canvass, hessian or similar absorbent material and kept constantly wet up to the time when the strength of concrete is at least equal to the minimum strength of concrete at transfer of prestress. Thereafter, the pole may be removed from the mould and watered at intervals to prevent surface cracking of the unit; the interval should depend on the atmospheric humidity and temperature. The prestressing wires shall be detensioned only after the concrete has attained the specified strength at transfer (i.e. 200 or 210 kg/cm², as applicable). The cubes cast for the purpose of determining the strength at transfer should be cured, as far as possible, under conditions similar to those under which the poles are cured. The transfer stage shall be determined based on the daily tests carried out on concrete cubes till the specified strength indicated above is reached. Thereafter the test on concrete shall be carried out as detailed in IS: 1343 (Code of practice for prestressed concrete). The manufacturer shall supply, when required by the owner or his representative, result of compressive test conducted in accordance with IS: 456 (Code of practice for plain and reinforced concrete) on concrete cubes made from the concrete used for the poles. If the owner so desired, the manufacturer shall supply cubes for test purposes and such cubes shall be tested in accordance with IS : 456 (Code of

practice for plain and reinforced concrete). The dimensioning shall be done by slowly releasing the wires, without imparting shock or sudden load to the poles. The rate of detensioning may be controlled by any suitable means either mechanical (screw type) or hydraulic. The poles shall not be detensioned or released by cutting the prestressing wires using flames or bar croppers while the wires are still under tension.

6.7 Lifting Eye-Hooks or Holes

Separate eye-hooks or holes shall be provided for handling the transport, one each at a distance of 0.15 times the overall length, from either end of the pole. Eye-hooks, if provided, should be properly anchored and should be on the face that has the shorter dimension of the cross-section. Holes, if provided for lifting purposes, should be perpendicular to the broad face of the pole.

6.8 Holes for Cross Arms etc

Sufficient number of holes shall be provided in the poles for attachment of cross arms and other equipments.

6.9 Stacking & Transportation

Stacking should be done in such a manner that the broad side of the pole is vertical. Each tier in the stack should be supported on timber sleeper located as 0.15 times the overall length, measured from the end. The timber supported in the stack should be aligned in a vertical line. Poles should be transported with their broad faces placed vertically and in such a manner that shocks are avoided. Supports should be so arranged that they are located approximately at a distance equal to 0.15 times the overall length from the ends. The erection of the pole should be carried out in such a way that the erection loads are applied so as to cause moment with respect to the major axis, i.e. the rope used for hoisting the pole should be parallel to the broader face of the pole.

7.0 EARTHING:

7.1 Earthing shall be provided by having length of 8SWG GI wire embedded in concrete during manufacture and the ends of the wires left projecting from the pole to a length of 100mm at 250 mm from top and 150 mm below ground level.

7.2 Earth wire shall not be allowed to come in contract with the prestressing wires.

7.2.1 Tests

7.2.1.1 Transverse Strength Test

7.2.1.1.1 Poles made from ordinary Portland cement shall be tested only on the completion of 28 days and poles made from rapid hardening cement only on the completion of 14 days, after the day of manufacture.

7.2.1.1.2 The poles may be tested in either horizontal or vertical position. If tested in horizontal position, provisions shall be made to compensate for the overhanging weight of the pole, for this purpose, the overhanging portion of the pole may be supported on a movable trolley or similar device.

7.2.1.1.3 The pole shall be rigidly supported at the butt end for a distance equal to the agreed depth of planting

7.2.1.1.4 Load shall be applied at a point 600 mm from the top of the pole and shall be steadily and gradually increased to the design value of the transverse load at first crack. The deflection at this load shall be measured. A prestressed concrete pole shall be deemed not to have passed

the test if cracks wider than 0.1 mm appear at a stage prior to the application of the design transverse load at first crack and the observed ultimate transverse load is less than the design ultimate transverse load. The load shall then be reduced to zero and increased gradually to a load equal to the first crack load plus 10% of the minimum ultimate transverse load, and held up for 2 minutes. This procedure shall be repeated until the load reaches the value of 80 per cent of the minimum ultimate transverse load and thereafter increased by 5 per cent of the minimum ultimate transverse load until failure occurs. Each time the load is applied, it shall be held for 2 minutes. The load applied to prestressed concrete pole at the point of failure shall be measured to the nearest five Kilograms. The pole shall be deemed not to have passed the test if the observed ultimate transverse load is less than the design ultimate transverse load.

7.2.1.1.5 Measurement of Cover

After completion of the transverse strength test, the sample pole shall be taken and checked for cover. The cover of the pole shall be measured at 3 points, one within 1.8 meter from the butt end of the pole, the second within 0.6 meters from the top and the third at an intermediate point and the mean value compared with the specified value. The mean value of the measured cover should not differ by more than (+) 1 mm from the specified cover. The individual values should not differ by more than (+) 3 mm from the specified value. If these requirements are not met, the workmanship with reference to aligning of the end plates and prestressing wires and assembly of moulds should be improved and inspection at pre-production stage tightened suitably.

8.0 SAMPLING AND INSPECTION

8.1 Scale of Sampling

8.1.1 Lot: In any batch, all poles of the same class and same dimensions shall be grouped together to constitute a lot.

8.1.1.1 Sub-lot: If the number of poles in a lot exceeds 500, the lot shall be divided into a suitable number of sub lots such that the number of poles in any sub-lot shall not exceed 500. The acceptance or otherwise of a sub-lot shall be determined on the basis of the performance of samples selected from it.

8.1.2 The number of poles to be selected from a lot or a sub-lot shall depend upon its size.

9.0 NUMBER OF TESTS

9.1.1 All the poles as selected shall be tested for overall length, cross-section and uprightness. The tolerance shall be (+) 15 mm on overall length (+), 3 mm on cross sectional dimensions and 0.5 per cent on uprightness.

9.1.2 The number of poles to be tested for transverse strength test. These poles may be selected from those already tested.

9.2 Criteria for Conformity

9.2.1 A lot or sub-lot shall be considered as conforming to this specification if the conditions under 9.2.2 and 9.2.3 are satisfied.

9.2.2 The number of poles which does not satisfy the requirements of overall length, cross section and uprightness shall not exceed the corresponding number given in Col.3 of Table in 3.1.2. If the number of such poles exceeds the corresponding number, all poles in the lot or sub-lot shall be tested for these requirements and those not satisfying the requirements shall be rejected.

9.2.3 All the poles tested for transverse strength test shall satisfy the requirements of the test. If one or more poles fail, twice the number of poles originally tested shall be selected from those already selected and subjected to the test. If there is no failure among these poles, the lot or the sub-lot shall be considered to have satisfied the requirements of this test.

10.0 MARKING

The pole shall be clearly and indelibly marked with the following particulars either during or after manufacture but before testing at a position so as to be easily read after erection in position.

- a) Month and year of manufacture
- b) Transverse strength of pole in Kg.
- c) Maker's serial No. and mark.

11.0 DRAWINGS

- 11.1 The drawings submitted by the Contractor shall be approved /commented by the Owner as the case may be within thirty (30) days of receipt of drawings in Owner's design office. If the designs/drawings are commented by the Owner, the Contractor shall submit revised design/drawings duly incorporating all comments within fifteen (15) days of date of issue of comments.
- 11.2 Pole accessories drawings like name plate, danger plate, anti-climbing device etc. shall be prepared by the Contractor and submitted to the Owner in three copies along with one reproducible, for record. These drawings shall be prepared in A4 size only.
- 11.3 While submitting the drawings, the Contractor shall clearly indicate on each drawing Specification No., Name of the line, letter reference no. and date on which the submission are made. The same practice is also to be followed while submitting distribution copies.
- 11.4 The Contractor shall furnish the drawings in fifteen (15) copies to the Owner for necessary distribution within fifteen (15) days after the receipt of the approval from the Owner.

**GUARANTEED TECHNICAL PARTICULARS OF 9 MTR, 11 MTR LONG PSC POLES (FOR 11 KV LINES) &
8 MTR/140 Kg (FOR LT LINES)**

[GTP be submitted for each category of HT and LT Supports]

Sl. No.	PARTICULARS	UNIT	BIDDER'S OFFER
1	2	3	4
1.	Name of the Manufacturer		
2.	Over all length of the Pole		
3.	Depth of plantation.		
4.	Minimum Ultimate transverse Load		
5.	Weight of the Pole in Kgs.		
6.	Factor of safety		
7.	Working load applied at 300 mm from top.		
8.	Volume of the pole in cubic meter.		
9.	Dimensions of pole:		
a.)	Top Dimension.		
b.)	Bottom Dimension.		
10.	Actual consumption/quantity of material Used in manufacture of each PSC Pole		
i.)	Cement		
ii.)	Aggregate		
iii.)	Sand.		
iv.)	Stone Chips.		
v.)	Steel		
	a) Dia of Wire.		
	b) No. Of Wire.		
	c) Weight of Wire.		
vi.)	Other M.S Reinforcement		
	H.T Wire Rings		
	H.T Wire Hooks		
	Weight of Steel.		
11.	Process adopted for compacting & curing.		
12.	Ear thing arrangement in each PSC Pole.		
a.)	Length of G.I Wire & SWG		
b.)	Weight of G.I Wire.		
c.)	No. of Galvanised Bolts, with 2 nuts & 3 Washers		
13.	Method of Prestressing.		
14.	Concrete mix and cube strength after.		
i)	72 Hours.		
ii)	28 Days		
15.	Are these supports suitable for use at angle points where stays are needed.		

CHAPTER-2**Technical Specification for RS Joist****1. Scope:**

This specification calls for manufacture, stage testing, inspection and testing before dispatch, packing and delivery of following steel section to DoWR.

(i) 150x150 mm, @34.6 Kg/m	11 Mtr , 13 Mtr, 14 Mtr length
(ii) 175x85mm	11Mtr Length
(iii) 175x85 mm	9.3 Mtr Length
(iv) Other sections as per site requirements (for OH lines & for Substations)	Length as per site requirements

The materials shall conform, in all respect, to the high standard of design and workmanship and shall be capable of performing duties specified herein. Materials offered shall be complete in all respect. Steel structure to be inducted should be galvanized with minimum zinc coating of 610 gms/Sq. Mtrs.

2 STANDARDS:

2.1 Materials shall conform to the latest applicable Indian standards. In case bidders offer Steel Section and supports conforming to any other international specifications which shall be equivalent or better than IS, the same is also acceptable.

Sl. No.	Standard No	Title
1	IS:2062 Grade-A Quality	Specification for R.S. Joists
2	IS:2062	Chemical and physical composition of material
3	IS: 1852	Rolling and cutting tolerances for Hot rolled steel products

2.2 ACCEPTANCE OF OTHER AUTHORITATIVE STANDARDS: In the paragraph 2.1 above, relevant Indian standards specification has been mentioned. However, the material meeting any other authoritative international standards, which ensures equal or better quality than the standards, mentioned shall also be acceptable. Material for which Indian Standards are not available, the relevant British standards and IEC recommendations will be applicable. Please attach photocopy of all such standards according to which the materials have been offered.

3.0 LENGTH: The materials to be supplied shall be in the following lengths:-

R.S. Joists	9.3 meters , 11 meters,13 meters, 14 meters & different long (as per requirement)	Please ensure that material supplied in different lengths is as per specified quantities of those lengths only.

Length and tolerance as applicable as per IS 1852(-0 mm to +100 mm)

Technical Specification for Wide Flange Parallel Beam

2. Scope:

This specification calls for manufacture, stage testing, inspection and testing before dispatch, packing and delivery of following steel section to DoWR.

(v) WPB 160x160 mm @ 30.44 Kg Grade E-300 BR	14 Mtr length
(vi) Other sections as per site requirements (for OH lines & for Substations)	Length as per site requirements

The materials shall conform, in all respect, to the high standard of design and workmanship and shall be capable of performing duties specified herein. Materials offered shall be complete in all respect. Steel structure to be inducted should be galvanized with minimum zinc coating of 610 gms/Sq. Mtrs.

2 STANDARDS:

2.1 Materials shall conform to the latest applicable Indian standards. In case bidders offer Steel Section and supports conforming to any other international specifications which shall be equivalent or better than IS, the same is also acceptable.

Sl. No.	Standard No	Title
1	IS:12778:2004	WPB(Wide flange parallel beam)
2	IS:2062	Chemical and physical composition of material
3	IS: 1852	Rolling and cutting tolerances for Hot rolled steel products

2.2 ACCEPTANCE OF OTHER AUTHORITATIVE STANDARDS: In the paragraph 2.1 above, relevant Indian standards specification has been mentioned. However, the material meeting any other authoritative international standards, which ensures equal or better quality than the standards, mentioned shall also be acceptable. Material for which Indian Standards are not available, the relevant British standards and IEC recommendations will be applicable. Please attach photocopy of all such standards according to which the materials have been offered.

3.0 LENGTH: The materials to be supplied shall be in the following lengths:-

WPB	14 meters & different long (as per requirement)	Please ensure that material supplied in different lengths is as per specified quantities of those lengths only.

Length and tolerance as applicable as per IS 1852(-0 mm to +100 mm)

4.0 WEIGHTMENT: The weightment of Steel Section shall be witnessed by the consignee at the time of taking delivery. The weight recorded in the material receipt certificate issued by the consignees shall be final.

5.0 CHEMICAL COMPOSITION AND MECHANICAL PROPERTIES:

(Confirming to IS: 2062/84)

Sl. No.	Chemical composition	FOR Fe 410 WA GRADE	
1	C	0.2%	Max
2	Mn	1.5%	Max
3	S	0.045%	Max
4	P	0.045%	Max
5	SI	0.045%	Max
6	CE (carbon equivalent)	0.44%	Max

MECHANICAL PROPERTIES:

1. Tensile strength (min.) – 44 Kgf/mm² or 440 N/mm²
2. Yield stress Min. for thickness/diameter

< 20 mm	- 30 kgf/mm ² OR 300 N/mm ²
20–40mm	- 24 kgf/mm ² OR 240 N/mm ²
> 40 mm	- 23 kgf/mm ² OR 230 N/mm ²

3. Elongation % (Min) 22%

Bend test (Internal dia) ≤25mm=2t, >25mm=3t As per IS 2062,E250-BR

6.0 TOLERANCE IN QUANTITY: Variation in ordered quantity for any destination and over-all ordered quantity shall be only to the extent of **± 2%**. Rolling and weight tolerances shall be as per latest version of IS: 1852 or to any equivalent International Standard. Any claim of quantity supplied in excess of above limits shall not be admitted.

7.0 MARKING: It is desirable that the Contractor should put his identification marks on the finished materials. The mark shall be in “legible English letters” given with marking dies of minimum 18 mm size.

8.0 INSEPTION & TEST CERTIFICATE: The materials to be supplied will be subject to inspection and approval by DoWR. The firm is required to offer the finished material for inspection well in advance to DoWR. The finished materials shall be delivered to consignees only after the same are inspected by DoWR. The materials shall be tested in ISI approved Laboratory of the tenderer having all facilities available for conducting all the tests as prescribed in relevant ISS. The materials shall be tested either in their ISI approved Laboratory or in any Govt. approved laboratory. The tenderers are required to specifically indicate that:- (i) They hold valid ISI License against respective ISS. (ii) That the materials offered against this tender are bearing ISI certification marks. (ii) The tenderers are required to submit a copy of the valid

ISI License clearly indicating size and range of roll-able product against respective ISS along with their offer. It is to be noted that in case any of the two conditions as mentioned above i.e. (i) holding of valid ISI License and (ii) finished materials bearing ISI certification marks, are not fulfilled, the tender shall not be accepted / considered.

- 9.0 GUARANTEE PERIOD:** - If during the course of 18 months subsequent to the date of receipt of consignment or 12 months from the date of commissioning, whichever is earlier, any of the goods are found to be defective in material or workmanship or develop defects during service, they will have to be replaced / repaired by the suppliers free of all charges.

CHAPTER – 3

TECHNICAL SPECIFICATION FOR AAAC**1.0 SCOPE:**

This specification covers details of all aluminium alloy stranded conductors for use on 33 kV, 11 kV and LT overhead lines in Mega-Lift Project. All sizes of conductor shall be supplied with ISI mark.

2.0 SERVICE CONDITIONS:

The conductor to be supplied against these specifications shall be suitable for satisfactory continuous operation under the following tropical conditions.

- a) Maximum ambient temperature (Degree C)..... 50
- b) Maximum temperature in shade (Degree C)..... 45
- c) Minimum temperature of air in shade (Degree C)..... 3.5
- d) Relative Humidity (%) 10 to 100
- e) Maximum Annual Rainfall (mm)..... 1450
- f) Maximum Wind Pressure (kg/sq.m.)..... 150
- g) Maximum altitude above mean sea level (meter)..... 1000
- h) Isoceraunic level (days/ year)..... 50
- i) Seismic level (Horizontal acceleration)..... 0.3 g
- j) Moderately hot and humid tropical climate conducive to rust and fungus growth

3.0 CONDUCTOR SIZES:

- i) 7/ 2.00 mm (22 sq.mm)
- ii) 7/2.5 mm (34 sq.mm)
- III) 7/3.15 mm (55 sq.mm)
- iv) 7/4.26 mm (100 sq.mm)
- v) 19/ 3.94 mm (232 sq.mm)

4.0 APPLICABLE STANDARDS:

Unless otherwise stipulated in this specification, the conductor shall conform to the following Indian Standards (amended up to date).

Sl. No.	INDIAN STANDARDS	TITLE
1	IS : 398 (Part IV) / 1994	Specification for aluminium conductors for Overhead transmission purpose.
2	IS : 1778	Reels and drums for bare conductors.
3	IS : 1841	E.C.Grade Aluminium rod produced by rolling.
4	IS : 5484	E.C.Grade Aluminium rod produced by continuous casting and rolling.

5.0 PROPERTIES OF CONDUCTOR:

The properties of stranded all aluminium alloy conductors of various sizes shall be as detailed in the Table;

TABLE-1

Actual Area	Standing & wire dia.	Approx. overall dia.	Approx. mass	Calculated resistance at 20° C(max)	Approx. calculated Breaking load	Reactance per km	Current rating
1	2	3	4	5	6	7	8
Mm sq.	Mm	Mm	Kg/km	Ω/km	kN	Ω	Amp
22	7/2.00	6.00	60.16	1.5410	6.45	0.3556	115
100	7/4.26	12.78	272.86	0.3390	29.26	0.3394	325
232	19/3.94	19.70	636.67	0.1471	68.05	0.3146	520

6 (a) PROPERTIES OF WIRES:

The properties of aluminium alloy wires to be used in the construction of the Stranded conductors shall be as in Table-2

ALUMINIUM ALLOY WIRES USED IN THE CONSTRUCTION OF STRANDED ALUMINIUM ALLOY CONDUCTORS.

Diameter		Cross sectional area of normal dia.wire	Mass	Minimum breaking load after standing	Resistance at 20° C
Nom	Max.				
Mm	Mm	mm.sq	Kg/km	kN	Ω/km
2.00	2.02	3.142	8.482	0.92	10.653
3.94	3.98	12.190	32.92	3.58	2.746
4.26	4.30	14.250	38.48	4.18	2.345

6 (b) TOLERANCE ON NOMINAL SIZES:

No negative tolerance shall be permitted on the nominal diameter aluminium wire used in the manufacture of AAAC. However, positive tolerance in this respect shall be as provided in IS: 398 (Part IV)/1994 (amended up to date).

7.0 FREEDOM FROM DEFECTS:

The wire shall be smooth and free from all imperfections such as spills, splits, slag inclusion; dia. marks scratches, fittings, blow holes, projections, looseness, overlapping of strands, chipping of aluminium layers etc. and all such other defects which may hamper the mechanical and electrical properties of the conductor. Special care should be taken to keep away dirt, grit etc. during stranding.

8.0 JOINTS. IN WIRES:

8.1 Conductors containing seven wires:-

There shall be no joint in any wire of a stranded conductor containing seven wires, except those made in the base rod or wire before final drawing.

8.2 Conductors containing more than seven wires:-

In conductors containing more than seven wires, joints in individual wires are permitted in any layer except the outermost layer (in addition to those made in the brass rod or wire before final drawing) but no two such joints shall be less than 15 m apart in the complete stranded conductor, such joint shall be made by resistance or cold pressure butt welding. They are not required to fulfill the mechanical requirement of unjointed wires. Joints made

by resistance butt welding shall, subsequent to welding, be annealed over a distance of at least 200 mm on each side of the joint.

9. STRANDING:-

9.1 The wires used in the construction of a stranded conductor shall, before stranding satisfy all the relevant requirements of this standard.

9.2 The lay ratio of the different layers shall be within the limits given in the Table-III.

TABLE - III: LAY RATIOS FOR ALUMINIUM ALLOY STRANDED CONDUCTORS

No. of wires in conductors	Lay Ratio in			
	6-wire layer		12- wire layer	
	Min.	Max.	Min.	Max.
7	10	14	-	-
19	10	16	10	14

9.3 In all constructions, the successive layers shall have opposite directions of lay, the outer most layer being right handed. The wires in each layer shall be evenly and closely stranded

9.4 In aluminium alloy stranded conductors having multiple layers of wires, the lay ratio of any layer shall not be greater than the lay ratio of the layer immediately beneath it.

10. TESTS:

The samples of individual wires for the test shall normally be taken before stranding. The manufacture shall carry out test on samples taken out at least from 10 % of the aluminium wire spools. However, when desired by the purchaser, the test sample may be taken from the stranded wires. The wires used for alloy conductors shall comply with the following tests as per IS: 398 (Part - IV) / 1994 (amended up to date):

- i) Breaking load test
- ii) Elongation test
- iii) Resistance test

11. PACKING AND MARKING:

The conductors shall be wound in reels or drums conforming to the latest versions of IS: 1778 - 1961 (amended upto date), ' Specification for Reels and Drums for bare wire.

11.1 PACKING:

11.1.1 The gross mass of packing for various conductors shall not exceed by more than 10% of the values given in the following table

Conductor Size in sq mm.	Gross Mass in Kg.
22 (7/2.00mm)	1100
100 (7/4.26 mm)	2000
232 (19/3.94 mm)	2400

11.1.2 The normal length of various conductors shall be as given in the following table:

Conductor Size in sq mm.	Normal length in km
22 (7/2.00mm)	2.0
100 (7/4.26 mm)	2.0
232 (19/3.94 mm)	2.0

11.1.2.1 LENGTHS AND VARIATION IN LENGTHS:

The standard length of AAA Conductor shall be 2 (two) kms. Tolerance of +/- 5 % (plus or minus five percent) shall be permitted in this standard length. All the lengths outside these limits of tolerances shall be treated as random length.

Random length shall not be less than 80%(eighty percent) of the standard length specified as above and the total acceptable quantity of such random lengths shall be within 7% (seven percent) quantity of the allotted quantity to each consignee of the respective size of the conductor.

11.2 MARKING:

The following information be marked on each package:

Manufacturer's name

b) Trade mark, if any

c) Drum or identification number

d) Size of conductor

e) Number and lengths of conductors

f) Gross mass of the package

g) Net mass of conductor

h) ISI certification mark.

12. INSPECTION:

All tests and inspection shall be made at the place of manufacturer unless otherwise especially agreed upon by the manufacturer and purchaser at the time of purchase. The manufacturer shall afford the inspector representing the purchaser all reasonable facilities without charges, to satisfy him that the material is being furnished in accordance with this specification.

13. VERIFICATION OF LENGTH OF CONDUCTOR:

i) The Company shall ascertain the length of AAA Conductor at supplier's works and at the receiving store centers by measuring the actual length by length measuring machine used for the purpose. The supplier should ensure that length measuring machine is available for measurement of the length by inspecting officer of DoWR.

ii) Both ends of the AAA Conductor will be sealed by the supplier and seals will be contained in the drum and not exposed out of drum.

iii) The declared length will be measured between manufacturer's seals at both ends of AAA Conductor.

iv) The weight of AAA Conductor will also be checked for ensuring correct lay and length of the AAA Conductor.

v) For the verification of the length of the conductor, 10 %of total lot (in Drums) should be selected at the works. The physical verification of the length of the conductor should be carried out for maximum up to 5 (five) drums. If there are anymore drums left for verification, then weight of each verified drum should be carried out and average weight may be calculated.

Then the weight of each of all the remaining selected drums may be taken and if these weights are matching with the average weight, then that particular lot may be accepted otherwise rejected.

vi) Verification of length of conductor will also be carried out at each stores center for two drums out of each lot. If the average length is found correct or more, the lot will be accepted. If the average length is found to be less than the declared, the percentage of such short length will be applied for reduction for the entire quantity supplied in the lot at respective stores for acceptance. vii) In case of dispute, joint inspection along with the representative of the supplier shall be carried out after giving 10 (ten) days notice to the supplier to remain present at stores center for the purpose. If the representative fails to attend on stipulated date for joint inspection, the decision of the consignee shall be final and binding.

14. REJECTION:

- i) While measuring the length, the sample piece from each length shall be taken for carrying out the test as per IS: 398 (Part IV) / 1994 (amended up to date). All the values of each sample should not exceed the value as per the relevant IS. In case of deviation, whole lot will be rejected at works.
- ii) Specific resistivity of Aluminium Alloy wire used should not exceed 0.0328 ohm sq.mm./m at 20 degree centigrade as prescribed in IS: 398 (Part IV)/1994 (amended up to date). If the results are at variance, whole lot shall be rejected.

15. BIS CERTIFICATION MARKS:

The AAA Conductor with BIS (ISI) marking only is required by the DoWR against this tender specification and as such, only those tenderers/ suppliers who hold valid BIS license for AAA Conductor need quote.

GUARANTEED TECHNICAL PARTICULARS (GTP) FOR AAAC

[Size: 22,100 & 232 Sq.mm]

PART- A

1. Name of the tenderer / Contractor:
2. Name of the manufacturer:

PART- B

BIDDER TO CONFIRM FOLLOWING IMPORTANT REQUIREMENTS.

Sl. No.	Particulars	Conformation
1	Conductor shall be manufactured as per IS-398 part-IV/1994 or latest amendment of it	
2	Wooden drums shall be as per IS- 1778/1980 with latest amendments.	
3	Spacing between outer layer of the conductor and inner surface of lagging shall be 75 mm min.	
4	Standard length 2000 Meters +/- 5%.	
5	Drum size 9 as per IS-1778/80 with latest amendment.	
6	Conductor drum shall carry ISI Mark.	
7	Marking of drum as per clause	
8	Conductor shall have 7 Nos for wires of size 100 sq.mm & below and 19 No for 232 sq.mm size.	
9	Properties of individual wires shall be as under:	

The properties of stranded all aluminum alloy conductors of various sizes shall be as detailed in the Table-1

Actual Area	Standing & wire dia.	Approx. overall dia.	Approx. mass	Calculated resistance at 20 ⁰ C(max)	Approx. calculated Breaking load	Reactance per km	Current rating
1	2	3	4	5	6	7	8
Mm sq.	Mm	Mm	Kg/km	Ω/km	kN	Ω	Amp
22	7/2.00	6.00	60.16	1.5410	6.45	0.3556	115
100	7/4.26	12.78	272.86	0.3390	29.26	0.3394	325
232	19/3.94	19.70	636.67	0.1471	68.05	0.3146	520

10 Lay ratio

Lay ratio for AAAC of various sizes shall be as detailed in the Table:

No. of wires in conductors	Lay Ratio in			
	6-wire layer		12- wire layer	
	Min.	Max.	Min.	Max.
7	10	14	-	-
19	10	16	10	14

PART-C

Packing specification of Conductor:

Size of Conductor (Sq. mm)	Diameter of reel without lagging (mm)	Width of reel (mm)	Width of lagging (mm)	Thickness of lagging (mm)	Gross wt. of conductor on reel (Kg)	Net wt. of conductor on reel (Kg)
22						
100						
232						

PART-D

Bidder has to mention deviation if any, quoting relevant clauses of specification.

CHAPTER – 4

TECHNICAL SPECIFICATION FOR ACSR CONDUCTORS

1.OSCOPE:

This specification provides for the manufacturing, testing and supply of ACSR Conductors as per the following details:

2.STANDARDS:

The Conductor shall conform to the following Indian Standard specifications which shall mean latest revisions with amendments /changes adopted and published unless specifically stated otherwise in the specification.

1.	IS: 398(Part-II) 1976/1990	Specification for Aluminum Conductors.
2.	IS:2629-1985/1990	Hot dip Galvanizing of Iron and Steel
3.	IS: 4826/1979	Specification for Hot Dipped Galvanized coatings on Round Steel Wires.
4.	IS:209/1966/1992	Electrolytic High Grade Zinc.
5.	IS:1778-1980	Specification for Reels and Drums for Bare Conductors
6.	IS: 2633-1992	Method of Testing uniformity of coating of Zinc coated Articles.

3. MATERIAL AND WORKSMANSHIP

- 3.1 Material used in manufacture of the conductor shall be of the highest quality of its kinds obtainable and except where modified by the specification, shall comply in all respect with the standards laid down by Indian Standard Institution.
- 3.2 The Aluminum Wire (Strands) shall be hard drawn from electrolytic Aluminum rods having purity not less than 99.5% Test certificates of Aluminum Manufacturer, in respect of impurity content of Aluminum Conductivity etc. shall have to be furnished in order to assess its quality.
- 3.3 The Steel Wire (Strands) shall be drawn from High Carbon Steel Wire Rods produced by either the acid or the basic open hearth process, or by the electric Furnace process. The steel wires shall be hot dip Galvanized conforming to IS: 2629:1985 and shall have weight of Zinc coating as per IS:4826/1979. The quality of zinc used for coating on steel wires strands shall be as per ZN98 of IS: 209:1966/1992 i.e. Electrolytic High Grade Zinc of 99.95% purity.
Zinc coating shall be reasonably smooth, continuing of reasonable uniform thickness and free from all defects not consistent with good commercial practice. The steel wire shall be of such quality and purity that when drawn to the size of wire specified and coated with zinc, the finished strands and the individual wire shall be of uniform quality and have the same properties and characteristics as prescribed in the relevant Indian Standard.
- 3.4 All the Aluminum as well as Steel wire strands shall be reasonably smooth, uniform and shall be free from all defects such as die-marks, scratches, abrasions and kinks etc. after drawing and also after stranding.
- 3.5 The finished conductor shall have a smooth surface without any surface dent, abrasions, scuffs marks and shall be free from dirt grit etc. Also the conductor shall be free from loose strands. The ends of the conductor shall be properly sealed to avoid unwinding of the strands.
- 3.4 Particular care has therefore, to be taken during the manufacture, handling packing and transportation of the conductor, to see that the surface is not dented, cut or damaged in anyway.

4.0 MODULUS OF ELASTICITY AND COEFFICIENT OF LINEAR EXPANSION

The value of the find modulus of elasticity and coefficient of linear expansion for ACSR conductors shall be as below:

Sl. No.	Conductor	Find Modulus of Elasticity G N / m ² (Practical)	Co-efficient of linear expansion per °C
1.	ACSR Weasel	79	19.1×10^{-6}
2.	ACSR RABBIT	79	19.1×10^{-6}
3.	ACSR RACCOON	79	19.1×10^{-6}
4.	ACSR Dog	75	19.8×10^{-6}
5.	ACSR Wolf	75	17.8×10^{-6}
6.	ACSR Panther	80	17.8×10^{-6}

5.0 JOINTS:

5.1 There shall be no joint of any kind in the steel core of the conductor. Joints in the Aluminum strands, if any shall be as per IS398 (part-II) 1976/1990. Joints shall be made by cold pressure butt welding and shall withstand a stress of not less than the breaking strength of individual strand guaranteed. A certificate to this effect shall be recorded by the supplier on each and every invoice / bill and Challan.

6.0 STRANDING:

The wires used in manufacture of standard conductor before stranding shall conform to all the relevant requirements of IS: 398 (Part-II) 1976/1990.

7.0 TOLERANCES

(i) For ACSR "RABBIT" Conductor

a) Diameter of Aluminum and Steel Strands

	Standard	Max	Min
Aluminum	3.35 mm	3.38 mm	3.32 mm
Steel	3.35 mm	3.42 mm	3.28 mm

b) Lay ratio of Conductor

	Max	Min
Aluminum 6 wire layer	14	10

(ii) For ACSR "RACCOON" Conductor

a) Diameter of Aluminum and Steel Strands

	Standard	Max	Min
Aluminum	4.09 mm	4.13 mm	4.05 mm
Steel	4.09 mm	4.17 mm	4.01 mm

b) Lay ratio of Conductor

	Max	Min
Aluminum 6 wire layer	14	10

(iii) For ACSR "DOG" Conductor

a) Diameter of Aluminum and Steel Strands

	Standard	Max	Min
Aluminum	4.72 mm	4.77 mm	4.67 mm

Steel 1.57 mm 1.60 mm 1.54 mm

b) Lay ratio of Conductor

	Max	Min
Steel 6 wire layer	28	13
Aluminum 6 wire layer	14	10

(iv) For ACSR "WOLF" Conductor

a) Diameter of Aluminum and Steel Strands

	Standard	Max	Min
Aluminum	2.59 mm	2.62 mm	2.56 mm
Steel	2.59 mm	2.64 mm	2.54 mm

b) Lay ratio of Conductor

	Max	Min
Steel 6 wire layer	28	13
Aluminum 6 wire layer	14	10
18 wire layer	16	10

(V) For ACSR "PANTHER" conductor

- a) Size of conductor: 30/7/3.00 mm
- b) Standing and wire diameter:

Aluminum	30/3.00mm
Steel	7/3.00 mm
- c) Sectional Area of Aluminum: 212 10 mm²
- d) Approximate total mass; 974 kg/km
- e) Calculate resistance at 20° C Max: 0.139 ohm/KM
- f) Calculated breaking load of composite conductor (UTS) (Min); 89.67 KN
- g) Lay ratio:-

Steel core: Max-28
Min-13
<u>Aluminum Layers</u>
12 wire layer (layer below outside layer) Max-16
Min-10
18 Wire (outside Layer) Max-14
Min -10
- h) Modulus of elasticity : 0.815x 10⁶Kg/ CM² (80 GN/M²)
- i) Co-efficient of Linear expansion of conductor: 17.8 x 10⁶/ °C
- j) Standard area of cross Section in sq.mm of conductor : 261.50 Sq.mm
- k) Diameter of complete conductor in mm: 21 mm

8.0 PACKING & MARKING

- 1) The conductor shall be supplied in non returnable, strong, wooden drums provided with lagging of adequate strength, constructed to protect the conductor against any damage and displacement during transit, storage and subsequent handling and stringing operations in the field. The Contractor shall be responsible for any loss or damage during transportation handling and storage due to improper packing. The drums shall generally conform to IS: 1778-1980, except as otherwise specified hereinafter.

- 2) The drums shall be suitable for wheel mounting and for letting off the conductor under a minimum controlled tension of the order of 5 KN.
- 3) The Contractor should submit their proposed drum drawings along with the bid.
- 4) The Contractor may offer more than one length of the conductor in a single drum.
- 5) All wooden components shall be manufactured out of seasoned soft wood free from defects that may materially weaken the component parts of the drums. Preservative treatment shall be applied to the entire drum with preservatives of a quality, which is not harmful to the conductor.
- 6) The flanges shall be of two ply construction with 64 mm thickness with each ply at right angles to the adjacent ply and nailed together. The nails shall be driven from the inside face flange, punched and then clenched on the outer face. Flange boards shall not be less than the nominal thickness by more than 2mm. There shall not be less than 2 nails per board in each circle. Where a slot is cut in the flange to receive the inner end of the conductor the entrance shall be in line with the periphery of the barrel.
- 7) The wooden battens used for making the barrel of the conductor shall be of segmental type. These shall be nailed to the barrel supports with at least two nails. The battens shall be closely butted and shall provide a round barrel with smooth external surface. The edges of the battens shall be rounded or chamfered to avoid damage to the conductor.
- 8) Barrel studs shall be used for the construction of drums. The flanges shall be holed and the barrel supports slotted to receive them. The barrel studs shall be threaded over a length on either end, sufficient to accommodate washers, spindle plates and nuts for fixing flanges at the required spacing.
- 9) Normally, the nuts on the studs shall stand protruded of the flanges. All the nails used on the inner surface of the flanges and the drum barrel shall be counter sunk. The ends of barrel shall generally be flushed with the top of the nuts.
- 10) The inner cheek of the flanges and drum barrel surface shall be painted with bitumen based paint.
- 11) Before reeling, card board or double corrugated or thick bituminized water-proof bamboo paper shall be secured to the drum barrel and inside of flanges of the drum by means of a suitable commercial adhesive material. The paper should be dried before use. Medium grade Kraft paper shall be used in between the layers of the conductor. After reeling the conductor, the exposed surface of the outer layer of conductor shall be wrapped with water proof thick bituminized bamboo paper to preserve the conductor from dirt, grit and damage during transport and handling.
- 12) A minimum space of 75 mm for conductor shall be provided between the inner surface of the external protective tagging and outer layer of the conductor. Outside the protective lagging, there shall be minimum of two binders consisting of hoop iron/ galvanized steel wire. Each protective lagging shall have two recesses to accommodate the binders.
- 13) Each batten shall be securely nailed across grains as far as possible to the flange, edges with at least 2 nails per end. The length of the nails shall not be less than twice the thickness of the battens. The nails shall not protrude above the general surface and shall not have exposed sharp, edges or allow the battens to be released due to corrosion.
- 14) The nuts on the barrel studs shall be tack welded on the one side in order to fully secure them. On the second end, a spring washer shall be used.

- 15) A steel collar shall be used to secure all barrel studs. This collar shall be located between the washers and the steel drum and secured to the central steel plate by welding.
- 16) Outside the protective lagging, there shall be minimum of two binders consisting of hoop iron/galvanized steel wire. Each protective lagging shall have two recesses to accommodate the binders.
- 17) The conductor ends shall be properly sealed and secured with the help of U-nail on the side of one of the flanges to avoid loosening of the, conductor layers during transit and handling.
- 18) As an alternative to wooden drum Contractor may also supply the conductors in non-returnable painted steel drums. After preparation of steel surface according to IS : 9954, synthetic enamel paint shall be applied after application of one coat of primer. Wooden/Steel drum will be treated at par for evaluation purpose and accordingly the Contractor should quote in the package.

MARKING:

Each drum shall have the following information stenciled on it in indelible ink along with other essential data:

- (a) Contract/Award letter number.
 - (b) Name and address of consignee.
 - (c) Manufacturer's name and address.
 - (d) Drum and lot number
 - (e) Size and type of conductor
 - (f) Length of conductor in meters
 - (g) Arrow marking for unwinding
 - (h) Position of the conductor ends
 - (i) Number of turns in the outer most layers.
 - (j) Gross weight of drum after putting lagging.
 - (k) Average weight of the drum without lagging.
 - (n) Net weight of the conductor in the drum.
 - (o) Month and year of manufacture of conductor
- The above should be indicated in the packing list also.

9.0 CHECKING OF CONDUCTOR LENGTH

Sufficient facilities should exist at contractor's premises to measure the conductor length by the inspecting officers. For this purpose motorized system to facilitate quick measurement should be available at the works.

10.0 TOLERANCE OF QUANTITIES

The total permissible variation for the entire quantity ordered shall subject to limit of $\pm 1\%$ for order up to 500 km. and $\pm \frac{1}{2}\%$ for orders above 500 km.

11.0 TESTING: The conductor shall be subjected to the following tests in accordance with IS: 398 (Part-II) 1976.

- 11.1 Check for diameter of individual Aluminum and Steel strands.
- 11.2 Check for lay ratio of various layers of Aluminum and Steel
- 11.3 Breaking load tests on Aluminum and galvanized Steel wires.
- 11.4 Wrapping test on Aluminum and galvanized steel wires.
- 11.5 Electrical resistance test on Aluminum wires only.
- 11.6 Ductility test on galvanized steel wire only.

- 11.7 Galvanizing test on galvanized Steel wires only.
- Weight of Zinc coating.
 - Uniformity of Zinc
- 11.8 Checking of conductor's surface, declared length and weight.
- 11.9 Visual examination test on conductor drums as per IS: 1778/1980.
- 11.10 The rejection & retest procedure shall be followed as stipulated in IS: 398 {Part-II} 1976.

12. TESTING AND TEST CERTIFICATE

The conductor shall be subject to all tests laid down in the relevant ISS at contractor's works or at approved test laboratory at contractor's cost. Certified copies of test certificate in respect of tensile test of both Aluminum and Steel strand, electrolytic quality of Aluminum and galvanized coating test of Steel strand and all other tests as prescribed in the relevant ISS shall be furnished by contractor to owner.

13. CALIBRATION OF TESTING EQUIPMENTS:

The tensile testing machine and Kelvin's Bridge machine etc. shall be got checked from the competent authority for calibration once in a year. Calibration certificates, when demanded by the Inspecting Officer, shall be produced for verification purposes. In case of dispute regarding calibration, the instruments shall be jointly scaled and sent to institutions, lab or deputed for calibration at the cost of supplier. The result of such checking shall be binding on the supplier.

SCHEDULE OF TECHNICAL PARTICULARS FOR ACSR WEASEL

		Minimum Guaranteed Value	Proposed Value
A	Name of tenderer / contractor		
B.	Tender specification No.		
C.	Name of manufacturer of equipment.		
1.	Code name of conductor	Weasel	
2.	Nominal Aluminum Area (mm ²)	30	
3.	No. of strands	6	
	(a) Aluminum		
	(b) Steel	1	
4.	Strand's Diameter in mm		
	(a) Aluminum	2.59	
	i) Standard		
	ii) Maximum	2.62	
	iii) Minimum	2.54	
	(b) Steel	2.59	
	i) Standard		
	ii) Maximum	2.64	
	iii) Minimum	2.54	
5.	Tolerance on standard diameter of		
	i) Aluminium	±1%	
	ii) Steel Wires	±2%	

6.	Approximate overall diameter of complete conductor (mm)	7.77	
7.	Minimum breaking load of each strand in KN		
	a) Aluminium	0.89	
	i) Before stranding		
	ii) After Stranding	0.85	
	b) Steel	6.92	
	i) Before Stranding		
	ii) After stranding	6.57	
8.	Approximate calculated breaking load (KN)	11.12	
9.	Maximum resistance of conductor of each strand at 20°C (ohms/km)	5.490	
10	Calculated resistance of conductor in ohms/km at 20°C	0.9289	
11	Weight of Zinc coating in respect of steel core (GM/m ²)	230	
12	Approximate mass of each strand in kgs/km		
	a) Aluminium	14.24	
	b) Steel	41.09	
13	Minimum guaranteed mass in kg/km		
	a) Aluminium	87	
	b) Steel	41	
	c) Total	128	
14	Lay ratio		
	Aluminium	14	
	(i) Maximum		
	(ii) Minimum	10	

SCHEDULE OF TECHNICAL PARTICULARS FOR ACSR RABBIT

		Minimum Guaranteed Value	Proposed Value
A	Name of tenderer / contractor		
B.	Tender specification No.		
C.	Name of manufacturer of equipment.		
1.	Code name of conductor	ACSR Rabbit	
2.	Nominal Aluminum Area (mm ²)	50	
3.	No. of strands	6	
	(a) Aluminum		
	(b) Steel	1	
4.	Strand's Diameter in mm		
	(a) Aluminium	3.35	
	i) Standard		

	ii)Maximum	3.38	
	iii) Minimum	3.32	
	(b) Steel	3.35	
	i) Standard		
	ii) Maximum	3.42	
	iii) Minimum	3.28	
5.	Approximate overall diameter of complete conductor (mm)	10.05	
6.	Minimum breaking load of each strand in KN		
	a) Aluminium	1.43	
	i) Before stranding		
	ii) After Stranding	1.36	
	b) Steel	11.58	
	i) Before Stranding		
	ii) After stranding	11.00	
7.	Approximate calculated breaking load (KN)	18.25	
8.	Maximum resistance of each Aluminum strand at 20°C (ohms/km)	3.265	
9.	Calculated resistance of conductor in ohms/km at 20°C	0.5524	
10.	Weight of Zinc coating in respect of steel core (GM/m ²)	250	
11.	Approximate mass of each strand in kgs/km		
	a) Aluminum	23.82	
	b) Steel	68.75	
12.	Minimum guaranteed mass in kg/km		
	a) Aluminum	145	
	b) Steel	69	
	c) Total	214	
13	Lay ratio		
	a) Steel Wire	-	
	(i) Maximum		
	(ii) Minimum	-	
	b) Aluminium	14	
	(i) Maximum		
	(ii) Minimum	10	

SCHEDULE OF TECHNICAL PARTICULARS FOR ACSR RACCOON

		Minimum Guaranteed Value	Proposed Value
A	Name of tenderer / contractor		
B.	Tender specification No.		
C.	Name of manufacturer of equipment.		
1.	Code name of conductor	ACSR Raccoon	
2.	Nominal Aluminum Area (mm ²)	80	
3.	No. of strands	6	
	(a) Aluminum		
	(b) Steel	1	
4.	Strand's Diameter in mm		
	(a) Aluminium	4.09	
	i) Standard		
	ii) Maximum	4.13	
	iii) Minimum	4.05	
	(b) Steel	4.09	
	i) Standard		
	ii) Maximum	4.17	
	iii) Minimum	4.01	
5.	Approximate overall diameter of complete conductor (mm)	12.27	
6.	Minimum breaking load of each strand in KN		
	a) Aluminum	2.00	
	i) Before stranding		
	ii) After Stranding	1.98	
	b) Steel	17.27	
	i) Before Stranding		
	ii) After stranding	16.41	
7.	Approximate calculated breaking load (KN)	26.91	
8.	Maximum resistance of each Aluminum strand at 20°C (ohms/km)	2.194	
9.	Calculated resistance of conductor in ohms/km at 20°C	0.3712	
10.	Weight of Zinc coating in respect of steel core (GM/m ²)	275	
11.	Approximate mass of each strand in kg/km		
	a) Aluminum	35.51	
	b) Steel	102.48	
12.	Minimum guaranteed mass in kg/km		
	a) Aluminum	216	
	b) Steel	103	

	c) Total	319	
13	Lay ratio		
	a) Steel Wire (i) Maximum	-	
	(ii) Minimum	-	
	b) Aluminum (i) Maximum	14	
	(ii) Minimum	10	

SCHEDULE OF TECHNICAL PARTICULARS FOR ACSR DOG

		Minimum Guaranteed Value	Proposed Value
A	Name of tenderer / contractor		
B.	Tender specification No.		
C.	Name of manufacturer of equipment.		
1.	Code name of conductor	ACSR Dog	
2.	Nominal Aluminum Area (mm ²)	100	
3.	No. of strands	6	
	(a) Aluminum		
	(b) Steel	7	
4.	Strand's Diameter in mm		
	(a) Aluminium i) Standard	4.72	
	ii) Maximum	4.77	
	iii) Minimum	4.67	
	(b) Steel i) Standard	1.57	
	ii) Maximum	1.60	
	iii) Minimum	1.54	
5.	Tolerance on standard diameter of		
	i) Aluminium of wire	±1%	
	ii) Galvanised Steel Wires	±2%	
6.	Approximate overall diameter of complete conductor (mm)	14.15	
7.	Minimum breaking load of each strand in KN		
	a) Aluminum i) Before stranding	2.78	
	ii) After Stranding	2.64	
	b) Steel i) Before Stranding	2.70	
	ii) After stranding	2.57	
8.	Approximate calculated breaking load (KN)	32.41	

9.	Maximum resistance of each Aluminum strand at 20°C (ohms/km)	1.650	
10.	Calculated resistance of conductor in ohms/km at 20°C	0.2792	
11.	Weight of Zinc coating in respect of steel core (GM/m ²)	150	
12.	Approximate mass of each strand in kg/km		
	a) Aluminum	47.30	
	b) Steel	15.10	
13.	Minimum guaranteed mass in kg/km		
	a) Aluminium	287.6	
	b) Steel	106.4	
	c) Total	394	
14	Lay ratio		
	a) Steel core 6 wire layer (i) Maximum	28	
	(ii) Minimum	13	
	b) Aluminium - Ist Layer (i) Maximum	14	
	(ii) Minimum	10	
	IInd Layer (i) Maximum	-	
	(ii) Minimum	-	

SCHEDULE OF TECHNICAL PARTICULARS FOR ACSR WOLF

		Minimum Guaranteed Value	Proposed Value
A	Name of tenderer / contractor		
B.	Tender specification No.		
C.	Name of manufacturer of equipment.		
1.	Code name of conductor	ACSR Wolf	
2.	Nominal Aluminium Area (mm ²)	158.1	
3.	No. of strands	30	
	(a) Aluminium		
	(b) Steel	7	
4.	Strand's Diameter in mm		
	(a) Aluminium	2.59	
	i) Standard		
	ii) Maximum		
	iii) Minimum	2.59	
	(b) Steel	2.59	
	i) Standard		
	ii) Maximum		
	iii) Minimum	2.59	
5.	Tolerance on standard diameter of		
	i) Aluminium of wire	±1%	

	ii) Galvanised Steel Wires	±2%	
6.	Approximate overall diameter of complete conductor (mm)	18.13	
7.	Minimum breaking load of each strand in KN		
	a) Aluminium	0.89	
	i) Beforestranding		
	ii) After Stranding	0.85	
	b) Steel	6.92	
	i) Before Stranding		
	ii) After stranding	6.57	
8.	Approximate calculated breaking load (KN)		
9.	Maximum resistance of each Aluminium strand at 20°C (ohms/km)	5.49	
10.	Calculated resistance of conductor in ohms/km at 20°C	0.1871	
11.	Weight of Zinc coating in respect of steel core (GM/m ²)	190	
12.	Approximate mass of each strand in kgs/km		
	a) Aluminium		
	b) Steel		
13.	Minimum guaranteed mass in kg/km		
	a) Aluminium	436	
	b) Steel	291	
	c) Total	727	
14	Lay ratio		
	a) Steel core 6 wire layer (i) Maximum		
	(ii) Minimum		
	b) Aluminium - (a) 6 layer	(b) 18 layer	
	(i) Maximum 14	16	
	(ii) Minimum 10	10	

SCHEDULE OF TECHNICAL PARTICULARS FOR ACSR PANTHER

		Minimum Guaranteed Value	Proposed Value
A	Name of tenderer / contractor		
B.	Tender specification No.		
C.	Name of manufacturer of equipment.		
1.	Code name of conductor	ACSR Panther	
2.	Nominal Aluminum Area (mm ²)	212.10	
3.	No. of strands	30	
	(a) Aluminum		

	(b) Steel	7	
4.	Strand's Diameter in mm		
	(a) Aluminium	3.00	
	i) Standard		
	ii) Maximum	3.03	
	iii) Minimum	2.97	
	(b) Steel	3.00	
	i) Standard		
	ii) Maximum	3.06	
	iii) Minimum	2.94	
5.	Tolerance on standard diameter of		
	i) Aluminium of wire	±1%	
	ii) Galvanised Steel Wires	±2%	
6.	Approximate overall diameter of complete conductor (mm)	21	
7.	Minimum breaking load of each strand in KN		
	a) Aluminum	1.17	
	i) Before stranding		
	ii) After Stranding	1.11	
	b) Steel	9.29	
	i) Before Stranding		
	ii) After stranding	8.83	
8.	Approximate calculated breaking load (KN)	89.67	
9.	Maximum resistance of each Aluminum strand at 20°C (ohms/km)	1.650	
10.	Calculated resistance of conductor in ohms/km at 20°C	0139	
11.	Weight of Zinc coating in respect of steel core (GM/m ²)	150	
12.	Approximate mass of each strand in kg/km		
	a) Aluminum	47.30	
	b) Steel	15.10	
13.	Minimum guaranteed mass in kg/km		
	a) Aluminium		
	b) Steel		
	c) Total	974	
14	Lay ratio		
	a) Steel core 6 wire layer (i) Maximum	28	
	(ii) Minimum	13	
	b) Aluminium - 1st Layer (i) Maximum	16	

	(ii) Minimum	10	
	IIInd Layer (i) Maximum	14	
	(ii) Minimum	10	

The above particulars shall stand modified if the provision of relevant IS are amended.

CHAPTER – 5**TECHNICAL SPECIFICATION FOR 33/6.9 KV, 630 KVA, 1.0 MVA, 1.6 MVA, 3.15 MVA,
5.0 MVA OUT DOOR OIL IMMERSED POWER TRANSFORMERS****1.0 SCOPE**

This specification covers the design, manufacture shop testing inspection and supply of above cited rating, 3 phase, 50 Hz, 33/6.9 KV power transformers complete with all fittings, accessories, associated equipment, Spares, 10% extra Transformer Oil, required for the MSDSS with off load tap changer/ on load tap changer suitable for local operation.

The offered rating transformer should have been tested for “Short Circuit withstand capability test” and “Impulse test” and “Temperature rise Test” in an NABL accredited Government Laboratory as per relevant IS/IEC and valid Type Test certificates in complete shape shall be accompanied with the bid offer.

2.0 STANDARDS

The transformers shall conform in all respects to ISS: 2026/1977 with latest amendment thereof except where specified otherwise. Fittings and accessories shall also comply generally with latest editions of relevant Indian Standards.

3.0 TECHNICAL REQUIREMENTS OF POWER TRANSFORMER

The transformers shall be core type construction, with two windings oil immersed, naturally cooled weatherproof construction and shall be suitable for installation of step down transformers. The rating and electrical characteristics of transformers shall be as following.

1	Rated MVA of Transformer (ONAN rating)	0.63MVA / 1.0 MVA / 1.6 MVA / 3.15 MVA/ 5.0 MVA
2	No. of Phases	3
3	Type of Installation	Out door
4	Frequency	50 HZ (-5% to + 3%)
5	Cooling medium	Insulating oil (ONAN)
6	Type of mounting	On wheels, mounted on rails
7	Rated voltage	
	a) High voltage winding	33 KV
	b) Low voltage winding	6.9 KV
8	Highest continuous system voltage	
	a) Maximum system voltage ratio (HV/LV)	36 KV/12 KV
	b) Rated voltage ratio (HV/LV)	33KV/6.9 KV
9	No. Of windings	Two winding Transformers
10	Type of cooling	ONAN (Oil natural & air natural)
11	MVA rating corresponding to ONAN cooling system	100%
12	Method of connection	
	HV:	Delta
	LV:	Star
13	Connection symbol	Dyn 11
14	System of earthing	Neutral of LV side to be solidly earthed
15	Percentage impedance voltage on normal tap and	% impedance for:-

	MVA base at 75°C corresponding to HV/LV rating and applicable tolerance	630 KVA-4% 1.0 MVA-5% 1.6 MVA-6% 3.15MVA-7% 5.0MVA-7% (Tolerance+10%) (No negative tolerance will be allowed)
16	Intended regular cyclic overloading of windings of winding	As per IEC-76-1, Clause 4.2
17	a) Anticipated unbalanced loading	Around 10%
	b) Anticipated continuous loading of windings (HV/LV)	110% of rated current
18	Type of tap changer	OFF Load up to 3.15 MVA TRF and beyond that ON Load
	Range of tapping	+ 5% to – 20% in steps of 5.0% each on HV winding, 7 tap positions. Tap No 3 will be the Principal tap position.
19	Neutral terminal to be brought out	On LV side
20	Overvoltage operating capability and duration	125% of rated voltage (Continuous)
21	Maximum Flux Density in any part of the core and yoke at rated MVA, rated voltage (33/6.9KV) and 50 HZ.	1.5 Tesla
22	Insulation levels of Windings:-	33 KV 6.9 KV
	a) 1.2/50 microsecond wave shape Impulse withstand (KVP)	170 75
	b) Power frequency voltage withstand (KVms)	70 35
23	Type of winding Insulation	
	a) HV winding	Uniform
	b) LV winding	Uniform
24	Withstand time for three phase short circuit	As per IS
25	Noise level at rated voltage & frequency	As per NEMA Publication
26	Permissible Maximum temperature rise over ambient temperature of 50°C	
	a) Of top oil measured by thermometer	35°C
	b) Of winding measured by resistance	40°C
	c) Hotspot Temperature rise	54°C
27	Minimum clearance in air (mm):-	Phase to Phase Phase to ground
	a) HV	400 320
	b) LV	280 140
28	Terminals:-	
	a) HV winding line end	36 KV oil filled communicating type porcelain bushing (Antifog type)
	b) LV winding	17.5 KV porcelain type of bushing (Antifog type)
29	Insulation level of bushing:-	HV LV
	a) Lightning Impulse withstand(KVP)	170 95
	b) 1 minute Power frequency withstand voltage	70 38

	(KV-rms)	
	c) Creep age distance(mm) (minimum)	900 300
30	Material for HV & LV conductor	Electrolytic copper
31	Maximum current density for HV and LV winding for rated current at normal tap	2.4 A/ mm ²
32	Polarisation Index i.e ratio of Megger values at 600 sec. to 60 sec for HV to earth, L.V to earth and HV to LV	Shall be greater than or equal to 1.5, but less than or equal to 5.
33	Core Assembly	Boltless
34	Temperature Indicator	
	a) Oil	One number
	b) Winding	One number
35	Maximum permissible no load loss at rated voltage and rated frequency	3.15 MVA- 3.0 KW (Maximum) 1.6 MVA- 2.5 KW (Maximum) 1.0 MVA- 1.8 KW(Maximum) 5.0 MVA- Guaranteed data sheet to be submitted by Manufacturer.
36	Maximum permissible load loss at rated current at normal tape and at 75 ⁰ C	3.15 MVA- 17.0 KW(Maximum) 1.6 MVA - 13.5 KW(Maximum) 1.0 MVA - 9.5 KW (Maximum) 5.0 MVA- Guaranteed data sheet to be submitted by Manufacturer.

4.0 TAPS

- 4.1 Transformers with off circuit tap changing gear shall have taps ranging from (+) 5 % to (-) 20% in equal steps of 5.0% each on HV side with 7 tape position. Tap 3 will be the principal tap position.
- 4.2 The tap changing switch shall be located in the convenient position so that it can be operated from ground level. The switch handle will be provided with a locking arrangement along with tap position indication thus enabling the switch to be locked in position.

5.0 CORE

Transformer core shall have construction using high grade, non-aging cold rolled grain oriented (CRGO) silicon steel laminations confirming to HIB grade with lamination thickness not more than 0.23mm to 0.27mm or better quoted grade core. The core shall be properly annealed to relieve stresses. The original invoices of material procured to be furnished. The core and coil assembly shall be securely held in position to avoid any movement under short circuit conditions. Laminations of different grade(s) and different thickness(s) are not allowed to be used in any manner or under any circumstances.

6.0 MAXIMUM FLUX DENSITY

- a) The maximum flux density in any part of core and yoke at normal voltage and frequency on any particular tapping shall not exceed 15000 lines per sq. cm (1.5 Tesla). The design calculations in support of flux density shall be furnished by the TRF manufacturer along with drawing of core steps and calculation of effective X sectional area of the core. For

finding out no load current average values of all the three limbs and phases should be taken into consideration. The Bidder shall provide saturation curve of the core material, proposed to be used.

b) LOADING OF TRANSFORMER

The transformers shall be capable of operation continuously in accordance with IS: 6600-1972 and latest revision thereof at their continuous maximum rating and overload at any ratio.

c) PARALLEL OPERATION

The transformers shall operate satisfactorily in parallel among themselves and with similar units to be installed.

d) DUTY UNDER FAULT CONDITIONS

i) Transformer shall be designed and constructed to withstand/without damage the thermal and dynamic effects of external short circuit under the conditions laid down in IS:2026 (Part-I).

ii) The thermal & dynamic ability to withstand short circuit shall be demonstrated by tests thermal and carried out on the transformer of same design.

7.0 NO LOAD CURRENT

The no load current at rated voltage and at 112.5% rated voltage shall not exceed 1% and 2% respectively. The variation shall be as per IS: 2026(Part-I). The design calculation, in respect of no load current at full voltage shall be furnished by the contractor.

8.0 MAXIMUM CURRENT DENSITY:

Maximum current density for HV and LV winding for rated current at normal tap in any case shall not exceed 2.4 Amp./mm.²

9.0 TRANSFORMER OIL:

The transformer oil shall be EHV grade & comply with IS: 335 and latest amendments thereof. No inhibitors shall be used in the oil. 10% extra oil shall be provided. The extra quantity of oil shall be supplied in non-returnable drums along with the oil required for the radiator banks.

10.0 CONTINUOUS MAXIMUM RATING AND TEMPERATURE RISE:

Each transformer shall be capable of operating continuously at their normal rating without exceeding temperature rise limits with maximum daily average ambient temperature of 50 deg C as specified below:

i) Hot Spot:

The maximum spot temperature shall be limited to 54 deg C over ambient temperature.

ii) Winding:

Temperatures raise 40 deg. C by resistance measurement.

iii) Oil:

35 deg C by thermometer measurement.

11.0 IMPEDANCE VALUE:

The percentage impedance shall be as per required specification above & guided by IS: 2026 (part-5)/2011.

12.0 TRANSFORMER LOSSES:

- 12.1 The no load losses in kilowatt at rated voltage and frequency shall be 3.0 KW (Max) and Maximum Load losses at rated full load current and frequency at 75 Deg. C at normal tap position & rated frequency shall be guaranteed to 17 KW with no positive tolerance. (Ref: SI 35 & 36 of Technical Requirement)
- 12.2 In case during testing the actual losses are found within guaranteed figures the transformers shall be accepted without any advantage to contractor for lower loss.
Where actual losses during testing are found in excess of maximum guaranteed figures, the transformers shall be rejected.
- 12.3 Measurement of losses shall form part of type test/routine/ acceptance test. The losses of first and subsequent transformers supplied shall also be guaranteed at the time of pre commissioning test and the losses exceeding guaranteed figures shall stand rejected. The supplier shall replace the transformer without any financial liability to the purchaser.
The supplier shall supply two copies of the type test/routine test certificate to each consignee with each transformer on receipt of dispatch instructions.

13.0 INSULATION

All windings of transformers shall have uniform class insulation when tested in Accordance with relevant IS: 2026/1981. The maximum hot spot temperature rise shall be limited to 54 Deg. C. over ambient temperature. The highest system voltage and the minimum basic impulse with stand level of winding for 1.2/50 μ s full wave shall be as given below:

Rated voltage (KV)	Highest system volt. (KV)	Minimum basic impulse with Stand level (KVP)
LV Side 6.9	12	75
HV Side 33	36	170

Temperature gradient between winding and oil should not exceed the permissible limits.

14.0 HV/LV TERMINAL ARRANGEMENT:

- i) HV terminal shall be brought out into suitable solid porcelain type weather proof or oil communicating type bushing with single gap arcing horns. Terminal connectors for HV shall be suitable for dog/panther conductor.
LV terminal shall be brought out into suitable solid porcelain type weather proof bushing the terminal connectors for LV shall be suitable for Panther conductor.
The neutral of the transformer winding shall be brought out into separate weather proof bushing on the top cover of the transformer for being earthed.
- ii) The electrical characteristics of bushing insulators shall be in accordance with IS: 2099/1977 as amended from time to time. All type and routine test shall be carried out in accordance with IS: 2099/1977. The test voltage for various tests as stipulated in IS: 2099/1977 is reproduced below:-

Normal System Voltage(KV)	Rated Voltage of the bushing (KV)	Visible Discharge Test(KV)	One minute wet & dry withstand test (KV)	Lightning Impulse with stand test (Imp. volt) (KV)
LV Side 6.9 KV	12	09	38	95
HV Side 33	36	27	70	170

- iii) Dimensions of the 12 KV bushing (6.6 KV side) shall conform to IS 3347/Part-III) and those of 36 KV bushing (33KV Side) shall conform to IS 3347/ (Part-V). The creepage distance for 33KV shall be 900mm and for 6.6 KV shall be 300mm.
- iv) The transformer shall be supplied with first filling of fresh insulation oil. The oil shall conform to IS/335/1983 and its latest amendment, if any.
- v) All insulating materials used in the manufacturer of the transformers shall be of the best quality of their respective kind, containable in the market and shall conform to relevant IS.
- vi) The design and all materials including insulating materials used in construction of transformers shall be such as to reduce to maximum the risk of development of acidity in oil during the course of service.

15.0 A) FITTINGS AND ACCESSORIES TO BE PROVIDED ON EACH TRANSFORMER:

- i) Inspection covers
- ii) Diagram and rating plate
- iii) Terminal marking plate
- iv) Two earthing terminals
- v) Lifting lugs
- vi) Jacking lugs
- vii) Flanged wheels
- viii) Thermometer pocket
- ix) Oil filling hole with plug
- x) Air release device
- xi) Drain valve with plug with locking arrangements
- xii) Filter valves, one suitable valve located at the top of the tank and one of similar size at the bottom of the tank mounted diagonally opposite to each other.
- xiii) Three no. oil sampling valve for taking out sample from top, middle and bottom of tank
- xiv) Conservator
- xv) Dehydrating breather
- xvi) Radiators
- xvii) Pressure relief device
- xviii) Gas and oil actuated relay
- xix) Magnetic type oil gauge
- xx) Dial type oil temperature indicator
- xxi) Dial type winding temperature indicator
- xxii) KIOSK
- xxiii) Any other parts if necessary.

B) SPARE PARTS:

The suppliers shall provide the following mandatory spares for each of Transformer supplied at no extra cost.

1. H.V. & L.V. Bushing & Studs –Each 2 Nos

2. Bimetallic connector for H.V & L.V. Bushings – Each 2 sets

- C)** Any fittings, accessories of apparatus which might not have been mentioned in the specification but which are usual and necessary in the equipment of similar nature and are recommended by the manufacturer for satisfactory operation are to be provided by the

contractor without extra cost. All apparatus must be complete in all details whether mentioned in the specification or not.

16.0 RATING AND TERMINAL MARKING PLATE:

16.1 RATING PLATE:

Each transformer shall be provided with a non-detachable rating and terminal Marking plate(s) of weather proof material, fitted in visible position, mentioning complete information as given in clause-15.1 and 15.2 of latest version of IS: 2026 (Part-I) and clause-20 of IS: 1180 part-I-1989.

In place of serial number of transformer/ unique no. shall be punched on rating plate. Unique number has been allotted indicating the name of firm, capacity, specification and serial number of the transformers. No-load/Load losses must also be engraved on the diagram plate. The entries on the rating plate as per Clause-15.1 and 15.2 of latest version of IS: 2026 (Part-I) shall be invariable marked (by etching engraving or stamping) Plate should be firmly riveted with tank so that it may not be detached afterwards.

16.2 In addition to above plate, the following details shall be punched on a mild steel plate of size 150x150x3 mm. And this plate shall be welded firmly on the transformer tank just above the rating plate in a visible position.

- (1) Unique number
- (2) Name of firm
- (3) Warranty period/Date of manufacture.
- (4) DoWR PROPERTY.

16.3 The rating diagram plate shall be fixed to the transformer tank at an average height of 1750mm. above the ground level.

17.0 TANK:

17.1 The transformer tank and cover shall be fabricated from good commercial grade low carbon steel of tested quality, suitable for welding. The minimum thickness of which shall be 6mm. for the side and 10mm for the bottom & cover for transformers with longer sides having a horizontal length up to but not exceeding 1800mm. For horizontal length above 1800 mm, the minimum side plate thickness shall be 10mm. and the thickness of bottom and cover plate shall be 12mm.

The tank and the cover shall be welded construction. All seems shall be welded and wherever practicable, they shall be double welded.

Tanks stiffeners shall be continuously welded to the tank and designed to prevent retention of water.

17.2 The main body of the tank shall have sufficient strength to withstand and without permanent distortion.

- i) A vacuum of 760mm. of mercury.
- ii) Continuous internal gas pressure of 0.7 atmosphere above atmosphere pressure with oil at Operating level i.e. the transformer tank should be able to withstand 100% vacuum and also one atmosphere pressure above atmosphere internal pressure.

17.3 The detachable tank cover shall be bolted to the tank and the transformer design shall be such that the tank will not split between the lower and upper cooler connections.

17.4 Each tank shall be provided with the following:

- a) Lifting lugs suitable for lifting the transformer complete with all accessories filled with oil by cranks.
A minimum of four jacking lugs in accessible position to enable the transformers complete with oil to be raised or Lowered using hydraulic or screw jacks.
The minimum height of jacking lugs above base shall be:
 - a) Transformers above 10 tones weight: 500 mm
 - b) Transformer up to and including 10 tones weight: 300 mm
 - b) Horizontal plates with 50 mm dia draw holes drilled the rein should be fitted adjacent to each corner of the rectangular tank at more than 750 mm from the base to permit haulage in any direction. On the rounded tanks the draw holes shall be located on the diagonals of the rectangular formed by the overall boundaries of the tank,
- 17.5 Each tank cover shall be of adequate strength and shall not distort when lifted. Inspection opening shall be provided to give easy access to lower ends of bushing terminals etc. for changing ratio or winding connection or testing to each connection. These shall be of adequate size not less than 450mmx350mm. Inspection hole(s) with welded flange(s) and bolted cover(s) shall be provided on the tank cover. The inspection hole(s) shall be of sufficient size to afford easy access to the lower ends of the bushings, terminals etc.
- 17.6 All bolted connections to the tank shall be fitted with suitable oil tight gaskets of nitrile rubber or equivalent, which shall give satisfactory service under the operating conditions. Special attentions shall be given to the methods of making the hot oil tight joints between the tank and cover as also between the cover and the bushings and all other outlets to ensure that the joints can be remade satisfactorily and with ease, with the help of semi-skilled labor. Gaskets of neoprene and / or any kind of impregnated / bonded core or cork only which can easily be damaged by over-pressing is not acceptable. Use of hemp as gasket material is also not acceptable.
- 17.7 Suitable guide shall be provided for positioning the various parts during assembly or dismantling. Adequate space should be provided between the cores and winding and the bottom of tank for collection of any sediment.
- 17.8 Lifting eyes or lugs shall be provided on all parts of the transformers requiring independent handling assembly or dismantling.
- 18.0 CLEANING AND PAINTING:**
- 18.1 Before painting or filling with oil, all non galvanized parts shall be completely cleaned, freed from rust, scale and grease and all external surface cavities shall be filled by metal deposition.
- 18.2 Interior of all transformer tanks and other oil filled chambers and internal actual works shall be cleaned of all scale and rust by shot blasting. In case the process of shot blasting is not adopted it is to be thoroughly cleaned by chipping, wire brushing and sound reporting etc. These surfaces shall be painted with hot oil resisting varnish or paint.
- 18.3 External surface shall be given a priming coat and two finishing coats of durable oil and weather resisting paint or enamel. The colour of the finishing coat shall be dark admirable, gray conforming to no. 632 of ISS colour for ready mixed paints (second revision).
- 18.4 The requirement for the dry film thickness (DFT) of paint and the material to be used shall be as given below.

Sl. No.	Paint type	Area to be painted	No of coats	DFT (Min)
1	Liquid paint			
	a) Zinc Chromate (Primer)	Out side	02	45 micron
	b) Polyurethane (Finished coat)	Out side	02	35 micron
	c) Hot oil	Inside	01	35 micron

19.0 PACKING:

The packing may be in accordance with the manufacturer's standard practice so as to ensure safe transit by goods train which may involve transshipment. Special arrangement should be made to facilitate handling and to protect the projecting parts against damage in transit.

Although the method of packing is left to the discretion of manufacturers, it should be robust enough for rough handling that is occasioned during transportation by ship/rail/road. The transformer shall be dispatched filled with oil/inert gases as per standard practice of the manufacturer but purchaser shall be informed accordingly.

20.0 COOLING OF TRANSFORMERS:

The transformer shall have 'ON-AN' cooling only. The cooling arrangement shall consist of detachable radiators, which may be directly mounted on the transformers. Connections between the radiators and tank shall be made with flanges provided with gaskets and an indicating short valve provided at both connection ends, which can be fastened in either open or closed position.

The radiators shall be so arranged that these can be detached from the tank or bank without disturbing the oil in transformer. These shall be designed to withstand the vacuum and pressure specified for the tank.

Radiators shall be so designed as to be accessible for cleaning and painting to prevent accumulation of water on the outer surface, to completely drain oil from the tank or bank and to ensure against formation of gas pockets when the tank is being filled. All connections between the radiators and tank or bank and between the bank and tank shall be provided with blank Flanges when the particular item is detached. Each radiator shall have a lifting eye, an oil drain and Vent at top.

c) CONSERVATOR:

A conservator complete with sump and drain valve shall be provided in such a position so as not to obstruct the electrical connection to the transformer, having a capacity between highest and lowest visible levels to meet the requirement of the expansion of the total cold oil volume in the transformer and cooling equipment from the minimum ambient temperature of 0Deg. C to 90Deg. C. The minimum indicated oil level shall be with the food pipe from the tank covered with not less than 15mm. Depth of oil and the indicated range of oil level shall be minimum to max.

If the sump is formed by extending the food pipe inside the conservator this extension shall be for at least 25mm.

The conservator shall be provided with two filter valves, one at the bottom and the other at the top at opposite and for filtration purpose.

One oil gauge magnetic type with provision for low level shall be mounted on conservator to indicate the minimum normal and maximum level as below: -

Minimum -5Deg.C

Normal +30Deg.C

Maximum +90Deg.C

One end of the conservator shall be bolted into position so that it can be removed for clearing/ repairing purpose.

The oil connection from transformer tank to the conservator vessel shall be arranged at a rising angle of 3 to 9 Deg. C to the horizontal up to gas oil actuated relay and shall consist of 50mm. inside diameter pipe.

- i) The passage of air is through silica gel.
- ii) The external atmosphere is continuously in contact with silica gel.
- iii) The moisture absorption indicated by a change in colour of the tinted crystals can be observed from distance.
- iv) The silica gel Breathers shall have minimum quantity of silica gel as 1 Kg for every 3500 Ltrs of oil in the tank. The container for the dehydrating agent shall be of transparent plastic of best quality, to be approved by DoWR. The breather is mounted at approx. 1400mm. above ground level.

D) PRESSURE RELIEF DEVICE:

A safety valve of the chimney type with an equalizer pipe inter connecting the top of the conservator and upper most part of the safety valve should be provided to prevent rise of oil in the safety valve pipe. A stopcock should also be provided in the inter connecting pipe. An air release cock shall also be fitted in convenient position.

The safety valve pipe shall preferably take off from the side of the transformer tank near to the tank covers and not from the top of tank cover. This is with a view to prevent the gases forming in the tank, from rising into the safety valve pipe and there by passing the gas and oil actuator Relay (defeating its purpose) and for avoiding the necessity for providing, a bottom diaphragm for the safety valve pipe, which would be necessary in case, it takes off from the tank cover.

E) GAS AND OIL ACTUATED RELAY:

A double float type gas and oil actuated relay (Buchholz Relay) shall be provided with alarm and tripping contracts to deduct accumulation of gas and sudden change in oil pressure, complete with shut off valves on both sides and flange couplings and to permit easy removal without conservator, a bleed valve for gas venting and test valve. The device shall be provided with two electrically independent potential free contracts, one for alarm on gas accumulation and the other for tripping on sudden rise of pressure.

F) TEMPERATURE INDICATING DEVICE:

Minimum 150mm dia suitable dial type thermometer with maximum pointer and re-setting device with alarm and trip contacts to read the temperature in the hottest of oil shall be provided.

A dial type winding temperature indicator shall be provided to indicate the hottest spot winding temperature with contacts for alarm and tripping to be set at will.

G) MARSHALLING BOX OR KIOSK:

The transformer shall be provided with marshalling box or kiosk made of sheet steel, in which all the leads for gas and oil-actuated relays, oil winding temperature indication and alarm, low oil level alarm shall be brought out to suitable terminals. This KIOSK shall be perfectly mounted on transformers. Temperature indicators shall be housed in the KIOSK so that these are clearly visible.

The box shall have slopping roof and the interior and exterior painting shall be in accordance with the specification. Padlock along with duplicate keys shall be supplied for marshalling box. The degree of protection shall be IP-55 or better.

All incoming cables shall enter the kiosk from the bottom and the gland plate shall not be less than 450 mm from the base of the box. The gland plate and associated compartment shall be sealed in suitable manner to prevent the ingress of moisture from the cable trench.

The schematic diagram of the circuitry inside the marshalling box be prepared and fixed inside the door under a suitable sheet.

21.0 AXLES AND WHEELS:

- a) The transformer tank shall be supported on a structural steel base equipped with forged steel or cast steel single flanged wheel suitable for moving the transformer completely filled with oil. These wheels shall be suitable for being turned through an angle of 90 Deg. C and locked in that position when the tank is jacked up.

b) **CENTER OF GRAVITY:**

The center of gravity of the assembled transformer shall be low and as near the vertical center line as possible. The transformer shall be stable with or without oil. The location of center of gravity shall be shown on the outline drawing in all the views showing there in the position of transformer track also.

c) **CLEARANCE IN AIR:**

The clearance in air between live conductive parts and live conductive parts to earthed structure shall be as IS stipulation.

22.0 CORE:

Stage inspection for core shall be carried out by the owner through a Third party Agency.

The core shall be built up with **high grade, non-aging cold rolled grain oriented (CRGO) silicon steel laminations confirming to HIB grade with lamination thickness not more than 0.23mm to 0.27mm or better quoted grade core.**

The flux density in any part of cores and yoke at normal voltage and frequency shall not be more than 1.5 Tesla.

For Transformer Manufacturer (TM), who has in-house core-cutting facility, the packed core coils shall be verified at their works as per followings along with witnessing of core-cutting.

- a) Invoice of supplier
- b) Test certificate
- c) Packing list
- d) Bill of lading
- e) Bill of entry certificate to customs
- f) Gross weight
- g) Net weight
- h) Grade & thickness of core material

After being sheared, the lamination shall be treated to remove, all burns and shall be re-annealed to remove all residual stresses. At least one side of each lamination shall be coated with an insulation coating as many as approved by the ISS and as per modern manufacturing

practice which shall be inert to the action of hot transformer oil and shall not deteriorate due to mechanical pressure.

The design of magnetic circuit shall be such as to avoid static discharge, development of short circuit path within itself or to the earthed clamping structure and the production of flux components at Right angles to the plane of laminations which may cause local heating. The laminations shall be flat and the final assembled core shall be free from distortion. Oil ducts shall be provided where necessary to ensure adequate cooling.

The core shall be rigidly clamped and fastened to ensure adequate technical strength and to prevent vibration during operation. The bolts used in the assembly of the core shall be suitably insulated and clamping structure shall be so constructed that eddy currents will be minimum.

The core shall be provided with lugs suitable for lifting the complete core and the coil assembly of the transformer.

The core and coil shall be so fixed in the tank that movement does not occur relative to tank during lifting, transport and installation.

The supporting framework of the core shall be designed so as to avoid the presence of pockets which would prevent complete emptying of the tank through the drain valve or case trapping of air during filling.

The magnetic circuit shall be earthed to the clamping structure at one pint only through a link placed in as accessible position beneath an inspection opening in the tank cover. The connection to the link shall be on the same side of the core, as the main earth connection.

Where coil-clamping rings are of metal at earth potential, each ring shall be connected to the adjacent core clamping structure on the same side of transformer as the main earth connection.

All earthing connection with the exception of these from the individual coils clamping rings shall have a cross sectional area of not less than 0.8 sq. cm.

No metal component including MS bolts and nuts should be kept floating in the vicinity of high voltage of coil and should be earthed.

23.0 WINDING CONNECTION AND VECTORS:

- a) The primary winding shall be connected in delta and secondary winding in star as per vector symbol DY-11(IS: 2026). So as to produce a positive displacement of 30 deg. From the primary to the secondary vectors of the same phase (Vector rotation assumed counter clock wise).

The neutral point of the secondary (LV) winding shall be solidly earthed and should be brought out to a separate insulated terminal, enabling a current transformer for an earth leakage relay to be connected wherever required.

- b) The winding shall be so designed that all coil assemblies of identical voltage ratings shall be inter changeable and field repairs to the windings can be made ready without special equipment's. The coil shall be supported between adjacent sections by insulating spacers and the barriers bracing's and other insulations used in the assembling at the winding shall be arranged to ensure free circulation of the oil and to reduce hot spots in the windings.
- c) The coil shall be dried under vacuum and submerged in dried insulating oil to develop the full electrical strength of the winding. All material used in the insulation and assembly of the winding shall be insoluble, non-catalytic and chemically inactive in hot transformer oil and

shall not soften, ooze out, shrink, collapse or otherwise be adversely effected under the operating conditions.

- D) All threaded connections shall be provided with locking facilities. All loads from the winding to the terminal board and bushing shall be rigidly supported to prevent injury from vibration. Guide tubes shall be used where practicable.
- E) The windings shall be clamped securely in place, so that they will not be displaced or deformed, during short circuits. The assembled core and windings shall be vacuum dried and suitably impregnated before removal from the trending tank. The copper conductors used in the coil structure shall be best suited to the requirement and all permanent current carrying joints in the windings and the leads shall be welded or brazed.

24.0 TRANSFORMER ASSEMBLY AND TESTS:

- a) The following tests shall be carried out in order to determine whether the transformer and its components comply with the specification and to provide necessary data. As many tests in the opinion of the purchaser as are possible shall be arranged by the manufacturer.
- b) The transformer shall be completely assembled and tested as per ISS: 2026/1977 and any amendment thereof, at the factory. All the tests are to be carried out in the presence of any authorized representative of the EPC Developer/Third party as per direction of Engineer of Contract. Test shall be performed in compliance with standard practice and relevant ISS. The routine tests shall be carried out on transformer at the manufacturer's cost at their works/other institute of repute, before dispatch.

However it may be noted that no call for final inspection of the transformer shall be entertained if the transformer has not passed the stage inspection or its waiver has not been issued by DoWR. The supplier is required to place the call for stage inspection in advance as illustrated in subsequent clauses of technical specification.

d) ROUTINE TESTS:

Transformer routine tests shall include tests stated in latest issue of IS: 2026 (Part –1). These tests shall also include but shall not be limited to the following:

- i) Measurement of winding DC resistance.
- ii) Measurement of voltage rating on each tapping.
- iii) Check for polarity and voltage vector relationship.
- iv) Measurement of No Load loss and current at 90%, 100% and 110% of rated voltage.
- v) Measurement of percentage impedance on principal tap and extreme taps.
- vi) Load loss at principal tap measured at rated frequency by applying an approximately Sinusoidal supply to one winding sufficient to reduce rated current in the winding with the other winding short-circuited.
- vii) Measurement of insulation resistance.
- viii) Polarization index i.e Insulation Resistance for 10 minutes and one minute ($R_{10\text{ mt}} / R_{1\text{ mt}}$).
- viii) Induced over voltage withstand test.
- ix) Separate source voltage withstand test.
- x) Dielectric test on transformer oil shall also include testing of oil sample drawn from transformer out of the offered at the suppliers work for BDV of oil (fresh from storage of tank as well as from transformer).
- xi) Oil leakage test.

All tanks and oil filled compartments shall be tested for oil tightness by being completely filled with air/ oil of a viscosity not greater than that of insulating oil conforming to IS: 335 at an ambient temperature and subject to pressure equal to 0.7 atmosphere above atmospheric pressure measured at the base of tank. This pressure shall be sustain for a period of not less than 12 Hours for oil and one Hours for air during which time no leakage shall be occur.

E) TYPE TEST:

The offered equipment must be of proven design through successful type testing particularly Temperature rise Test/ Short circuit Test/ Lightning impulse withstand Test, as per IS:2026 or latest amendment thereof (during last 5 years counted from the date of opening of tender) at CPRI, Bangalore/Bhopal or NTH, Ghaziabad or ERDA, Varodara,. The manufacturer shall carry out type tests in accordance with IS: 2026 on one piece of one rating. Before conducting the Temperature rise Test, short circuit test and Impulse test, the firm will offer for both stage inspections and final inspection of the transformer by through a 3rd party agency as well as EPC's authorized executives at the manufacturer's works. If the transformer complies with the specification and offered technical parameters, the transformer will be sealed by authorized engineer(s) of EPC Developer and thereafter the transformer can be transported to CPRI/ NABL unit for required type tests in presence of EPC Developer's authorized representative(s) who will verify the seal & allow for conducting the type tests. The type tests shall include:

(1) Vacuum Test:

Transformer tank at an internal vacuum limiting to one atmosphere but not more than the pressure of 3.33 KN./Sq.m. (25 mm of Hg.) for one Hour.

The permanent deflection of flat plates after vacuum has been released shall not exceed the value specified below without affecting the performance of the transformer:

Horizontal Length of flat plate (mm)	Permanent deflection
Up to & including 750	05
751 to 1250	6.5
1251 to 1750	08
1751 to 2000	9.0
2001 to 2250	11
2251 to 2500	12.5
2501 to 3000	16
Above 3000	19

(2) Pressure Test:

Transformer tank together with its radiators, conservators, vessels and other fittings shall be able to with stand a pressure corresponding to 0.7 atmosphere above atmospheric pressure measured at the base of the tank and will be maintained for one hour. The permanent deflection of the flat plate after the excess pressure has been released shall not exceed the figures specified above.

(3) Short Circuit Test:

As per ISS: 2026/1977 and latest amendment thereof.

(4) IMPULSE VOLTAGE WITHSTANDS TEST LIGHTING IMPULSE TEST:

This test is to be carried out as per IS: 2026/1981(Part-III) Para 13 and latest amendments thereof on all limbs of HV and LV. The tapping position for each limb shall be selected as recommended in clause 6.3 of above IS.

(5) Measurement of acoustic noise level.

e) The transformer having passed successfully through the type tests along with verification of losses by test house shall be considered as acceptable design. The physical dimensions of this transformer shall form the guidelines for subsequent supplies. In case of any variation in any dimension incorporated in the approved drawings, shall be finally got approved by the engineer of the Contract taking into consideration, the dimensions offered in GTP/drawings as per test reports and drawings finally approved by CPRI/BHEL/Govt. Test House after conduction of type test.

In case, it is found during the joint inspection of transformers(s) by the executive of EPC Agency and/or representative of the third party entrusted with the work of inspection and/or representative of the firm that the firm has supplied substandard material then also the above penal action shall be taken. If the representative of the third party and/or of supplier or both are not present at the time of above joint inspection, then DoWR has right to take the penal action, as mentioned above. In the event of cancellation of orders no compensation shall be given to the firm by EPC Agency with no liability to DOWR.

TOLERANCE:

However, no negative tolerance on all the parameters including physical of dimensions tank certificated by test house/ laboratories as mentioned in respect of the equipment which has been successfully type tested shall be allowed.

SPECIAL TEST:

Measurement of zero sequence impedance test on one transformer. Inspection shall be carried out only after routine test results are submitted to 'Engineer of the Contract' , giving serial number of transformer.

All the original type test reports including verification of load/No. load losses from CPRI/BHEL/Govt. Test House/ERDA Vadodara along with detailed drawing approved by CPRI/BHEL/Govt. Test House as approved by the purchaser shall be submitted after successful "Type Testing" to prove that the design as successfully type tested.

25.0 INSPECTION & TESTING OF TESTING INSTRUMENTS AND RAW MATERIALS AND STAGE INSPECTION:

The supplier shall offer the core, windings and tank of each transformer for inspection by a 3rd party agency as well as EPC Agency representative(s). During stage Inspection, all the measurements like diameter, window height, leg centre, stack width, stack thickness, thickness of laminations etc. for core assembly, conductor size, Insulation thickness, I.D., O.D, winding height, major and minor insulations for both H.V and L.V windings, length, breadth, height and thickness of plates of Transformer tank, the quality of fittings and accessories will be taken / determined. The supplier can offer for final inspection of the transformers subject to clearance of the stage Inspection report by the DOWR.

Transformer manufacturer shall offer type test report of bought out item like HV Bushing, LV bushing, NCT, for review. All the measuring instruments i.e. Voltmeter, Avometer, CT, PT'S and other instruments used in inspection and testing shall be properly calibrated and sealed once in a year. Calibration Certification when demanded by the inspection officer

shall be produced for verification purposes. In case of disputes regarding calibration of instruments, instruments shall be sealed and signed by the representative of suppliers and purchaser and will be sent to institution/lab. of reputes or its own lab. for calibration at the cost of supplier. The result of such testing shall be binding on the supplier.

The purchaser reserves the right to depute his representative/agency for carrying out stage inspections at any stage of manufacturing process for checking quality of manufacturing and also the raw materials.

The contractor shall offer all reasonable facilities for such inspection. The contractor shall furnish detailed production schedule including different phase of material procurement, manufacture and fabrication to facilitate the purchaser for deputing his representative/agency for carrying out stage inspection.

The contractor shall inform the purchaser likely date of assembly of core and readiness of HT & LT coils enabling the purchaser to depute his officers for stage inspection or issuing waiver of stage inspection.

Records shall be maintained off all the test carried by the supplier on transformer offered for inspection and test shall produce when demanded by the inspection officer to satisfy that the transformer are being offered after carrying all the necessary tests by the supplier.

26.0 SPARE PARTS:-

The suppliers shall provide the following mandatory spare s for each of Transformer supplied

1. H.V. & L.V. Bushing & Studs –Each 2 Nos
2. Bimetallic connector for H.V & L.V. Bushings – Each 2 sets

27. DOCUMENTS TO BE SUBMITTED FOR CONSIDERATION.

1. Source of purchase of core stampings along with its grade to be used in manufacturer (copy of invoice of CRGO sheet manufacturer or their authorized agent in India or quotation from their reputed processors of core lamination may be enclosed).
2. Calculation of flux density.
3. Calculation of effective cross sectional area of the core at 97% staking factor .
4. Calculation of core weight.
5. Calculation of no load current at 100% and 112.5% voltage.
6. Calculation of no-load loss.
7. Calculation of load loss at 75 Deg.C
8. Calculation of heat dissipation.
9. Enclosure of curves relating to characteristics of CRGO steel and from which the values are read off for above calculation.

28.0 DRAWING/ INSTRUCTIONS BOOKS/ OPERATION & MAINTENANCE MANUAL ETC:

The Manufacturer shall submit following drawings:

- a) Outline dimensions drawings of transformers and accessories giving complete details of main components parts and transportation details showing dimension and weight of the each package. (Top, Front & side views). Off load tap changer equipment earthing details, top cover/flange fill arrangement.
- b) Name plate diagram with tap changing details and guaranteed maximum load and no- Load losses without any plus tolerance.

- c) Systematic control and wiring diagram of all auxiliary equipment including marshalling Boxes with terminal number of various accessories.
- d) Bushing drawing, porcelain portion drawings and terminal connector drawing with their Electrical and mechanical characteristics in tabular form.
- e) Drawing giving the weight for foundation of transformer.
- f) Drawing of core and winding (including sectional view) along with the clamping Arrangement giving details viz. Core dia, weight, stacking HV/LV winding weight and size/ number of coils/limbs, inner dia, outer dia, axial length, clamping channel, Size of the rod dia meter, it's nos. and length etc. Cores steps details to be shown Separately and clearly indicating the clearance provided inside and outside the transformer.

The manufacturer shall supply 2 copies of instruction books/operation and maintenance manuals spare parts booklets along with descriptive literature and date of transformer construction, winding, bushing, heat exchanger, tap changing gear etc. to each consignees with each transformer and to DoWR.

All tests and inspection shall be made at the place of manufacturer unless otherwise specifically agreed upon by the manufacturer and the engineer of the contract at the time of the purchaser. The manufacturer shall offer the inspecting officer (s). Representing the Engineer of the Contract, all reasonable facilities without charge to satisfy him that the materials are being manufactured in accordance with this specification.

NOTE: Inspection shall be carried out only after routine test results are submitted to Engineer of the contract and Unique number of transformers are given.

29.0 GUARANTEED TECHNICAL PARTICULARS:

The guaranteed technical particulars shall be subject to tolerance as per relevant ISS. However no negative tolerance shall be allowed on ways and dimensions that of quoted and further no negative tolerance shall be allowed in weights and dimensions then that of short circuit tested transformers.

The tolerance of guaranteed performance figures shall be specified in ISS: 2026/1985 (Part-I) amended from time to time except where specified otherwise.

- a) The tender shall be required to give the following details in their tenders:
 - i) Materials to confirm to the relevant ISS technical specification etc.
 - ii) Tenders shall confirm that the raw material would be of standard quality giving of source of purchase, name of manufacturer etc.
 - iii) In case any local items (raw materials) purchased from local market, are to be used the same shall clearly satisfied.
 - iv) Details of facilities if any, for testing of raw materials. In case the same is to be tested at the raw material supplier's premises, or any other test house, the same shall be mentioned. If only test certificates of raw materials are proposed to be submitted, details of the authorities issuing the test certificate shall be mentioned.
 - v) A facility available at the works and details of equipment's available for the manufacturing process and their capacity.
 - vi) Details of technical supervisory staff available.
 - vii) Details of test facilities available for the testing as per ISS/ technical specification.
 - viii) Test certificates of the testing and calibration of test equipments. This will be inspected by the inspecting teams at the time of acceptance of material.
 - ix) Details of after sales service available.

- x) Tenderers will have to submit his quality assurance plan, vender rating will be decided on QAP submitted by the tenderer, manufacturing facilities adequate testing facilities etc. available with him.
- b) Inspection at the supplier's inspection point (SIP). The stage will be as follow:-
- i) Raw material/components inspection.
 - ii) In process inspection OR stage inspection.
 - iii) The work of stage inspection referred to above will for the time being confirmed to all types of transformers. In case of provision of stage inspection, the manufacturing work shall continue only after approval of the inspection team.
- 26.0 SPARES:
- a) Tenderers shall submit list for any special tools required during erection and maintenance and the spares are given below:-
 - i) HV Bushing.
 - ii) LV cable box complete with bushing.
 - iii) Neutral bushing.
 - iv) Set of gaskets.
 - v) Oil temperature indicator.
 - vi) Magnetic oil level gauge.
 - vii) Silica gel charge for breather.
 - viii) Explosion vent diaphragm.
 - ix) Set of coils for core limit of winding.
 - b) The tenderer shall also submit for any other items of spares recommended for five years normal operation. The purchaser will decide the actual spares to be ordered on the basis or the list and the item-wise price of spare parts.
 - c) The cost of spare tools and accessories will not be taken into consideration for bid evaluation purposes.

SCHEDULE OF GUARANTEED TECHNICAL PARTICULARS FOR 33/6.9KV, TRANSFORMERS

1.	Name of Manufacturer	
2.	Type of Transformer	
3.	Rating	
a.	Rated output (MVA)	
b.	Rated Voltage of HV&LV (KV)	
c.	Rated Current of HV&LV (A)	
d.	No load Voltage ratio	
e.	No. of Phases	
f.	Rated frequency	
4.	Connections	
a.	High Voltage	
b.	Low Voltage	
c.	Vector Group Symbol	
5.	Cooling Arrangement	

a.	Type of cooling	
b.	Number of Cooling tubes / fins per radiator and number of radiators	
c.	Size of radiator fins	
d.	Thickness of sheet	
e.	Horizontal distance between radiators	
f.	Vertical distance between Core center line and radiator center line	
6.	Dimension of inside of tank (mm)	
a.	Length	
b.	Breadth	
c.	Height	
d.	Weight of tank without fitting	
7.	Thickness of transformer tank Plate (mm)	
a.	Sides	
b.	Bottom	
c.	Cover	
8.	Overall Dimension of Tank with Fittings (mm)	
a.	Length	
b.	Breadth	
c.	Height	
9.	Details of Oil	
a.	Standards of Oil	
b.	Quantity of Oil (Ltr. and Kg.)	
C	Quantity of extra oil (Ltr and Kg)	
10.	Details of Core	
a.	Material of core lamination & Grade	
b.	Thickness of core plates	
c.	Insulation of Core lamination	
d.	Window Height	
e.	Leg Center	
f.	Core Diameter (approx.) (mm)	
g.	Core cross sectional area (gross) (mm ²)	
h.	Core cross sectional area (net) (mm ²)	
i.	Maximum flux density in core at normal voltage, frequency and ratio	
j.	Weight of stamping in core and yoke separately in Kgs.	
	i) Core	
	ii) Yoke	
i.	Size and No. of clamping channels	
li	Weight of clamping channels with stiffeners	
k.	Size & number of tie rod (if used)	
l.	Size & number of core bolt	

(Note: Please enclose details of core-steps, its drawing and flux density, weight of core, fittings, copper, oil, Off Load Tap Changer separately).		
11.	Weight of transformer	
a.	Weight of core only	
b.	Weight of core assembly excluding HV & LV coils	
c.	Weight of complete core coil assembly	
d.	Value of Transformer Oil	
e.	Weight of Transformer oil	
f.	Weight of insulated conductor in HV	
g.	Weight of insulated conductor in LV	
h.	Weight of Tank and fittings (Kgs.) including tap changer.	
i.	Total weight of transformer with oil	
12.	Details of Winding	HV / LV
a.	Type of winding and material	
b.	Conductor Size (bare)	
c.	Cross sectional area (mm ²)	
i.	Gross	
ii.	Net	
d.	Type of insulation of conductor	
e.	Size of insulated conductor	
f.	Number of disc / coil per limb	
g.	No. of coils per disc	
h.	Internal dia of coil	
i.	Outer dia of coil	
j.	Axial length	
k.	Mean length of turns (mm)	
l.	No. of turns	
m.	Inter turn insulation	
n.	End turn insulation	
o.	Type of axial coil supports	
p.	Details of end clamping rings	
q.	Whether windings are inter leaved	
r.	Size of cooling ducts	
s.	Weight of bare conductor used in one leg (kg.)	
t.	Weight of insulated conductor used in one leg (kg.) (dry)	
u.	I ² R loss at 75°C (per phase)	
v.	Maximum current density in winding at CMR – Amp./Sq cm.	
W	Polarization index (ratio of Megger values at 600 sec to 60 sec for HV to earth and HV to LV)	Shall be greater than or equal to 1.5
u.	Resistance of winding (with 5% tolerance) a) at 20 °C (Ohms) :	

	b) at 75 °C (Ohms)	
(Note: Enclose calculation of losses with complete details of factor assumed, core & winding details of drawing)		
13.	Thermal time constants – Hrs.	
14.	Terminal arrangement HV side	
15.	Terminal arrangement LV side	
16.	Regulation at full load at 75°C	
a.	At unity power factor	
b.	At 0.8 power factor (lagging)	
17.	Percentage efficiently at normal ratio, rated voltage and at 75°C average winding temp.	
		UPF
a.	Full Load	
b.	3/4 Full Load	
c.	1/2 Full Load	
d.	1/4 Full Load	
18.	No load current as percentage of full load current at rated volt. and frequency in %	
19.	Power factor and no load current at normal volt. and frequency in %	
20.	RMS value of symmetrical short time current rating as per ISS which the transformer can withstand and its duration	
a.	H.V. Winding	
b.	L.V. Winding	
21.	Maximum out of balance force in winding on short circuit at the terminals	
22.	Clearance between phases in Air (mm)	
a.	H.V. Side	
b.	L.V. Side	
c.	L.V. to Earth	
23.	Clearance in oil (mm)	
a.	Internal clearance between inner walls of Tank & core coil	
b.	On length side	
c.	On Breadth Side	
d.	Radial clearance between H.V. & L.V. Winding	
e.	Phase of phase clearance between H.V. Limb	
f.	Radial clearance of L.V. coil from core	
g.	Minimum clearance between LV Pole to earth	
h.	Horizontal duct between H.T. disc	
i.	End clearance of H.T. coil from Yoke (with angle shaped windings)	
j.	Minimum clearance between core & tank bottom	
k.	Angular ducts between LT & HT winding	

24.	Insulation Details	
a.	End spacing of L.V.	
b.	End spacing of H.V.	
c.	L.V. winding to core	
d.	Between HV & LV winding	
e.	Inter phase barrier	
f.	End phase barrier	
25.	Insulation Level	H.V.
a.	Separate source power frequency Volt. Withstand – KV.	
b.	Induced over voltage withstand – KV	
c.	1.2/50 μ s full wave lighting impulse withstand voltage-KV	
	i) Impulse	
	ii) Power frequency (Dry & Wet)	
d.	Voltage to earth for which the star point will be insulated – KV	
	i) Impulse	
	ii) Power frequency (Dry & Wet)	
26.	Performance reference Temp. (Deg. C)	
27.	Volts per coil of HV winding (Volts)	
28.	Approx. Volts per layer of HV winding (Volts)	
29.	Impedance voltage at rated full load and transformation	
30.	Percentage reactance Ratio at rated voltage & frequency at 75°C.	
31.	Percentage resistance at 75°C	
32.	Impedance voltage at principal tapping and at 75°C average winding temperature expressed as percentage of rated voltage between HV & LV winding - %	
33.	Permissible duration of over load following continuous running at normal rated load in an ambient Temp. of 50 Deg. C.	
a.	10% overload	
b.	20% overload	
c.	30% overload	
34.	Maximum temperature rise at full load (above max. average ambient Temp. of 50 °C.)	
a.	Of top oil by thermometer Deg. C.	
b.	Of winding by resistance method Deg. C.	
c.	By hot spot temperature indicator Deg. C.	
35.	Limit of hot spot temperature for which designed – Deg. C.	
36.	Temperature Gradient between winding and oil – Deg. C.	
37.	Maximum No. load loss at rated voltage on principal tapping at rated frequency (Guaranteed without any plus tolerance) (including 25% stray no load loss for considering in-consistencies of B-H characteristics of core material and	

	workmanship).	
38.	Maximum load loss at rated current on principal tapping at 75°C. (Guaranteed without any plus tolerance) including 10% stray load loss)	
39.	Resistance voltage drop at rated current for principal tapping at 75°C average winding temperature as percent of rated voltage - %	
40.	Reactance voltage drop expressed as percent for rated voltage - %	
41.	Temperature indicators	<u>Oil Temp Ind.</u>
a.	Make and Type	
b.	Permissible setting ranges for alarm & trip.	
c.	No. of contacts	
d.	Current rating of each contact.	
42.	Gas and oil actuated relay description data & range of settings, schematic diagram etc.	
43.	Type of pressure relief device & pressure at which it operates.	
44.	Details of magnetic oil gauge	
45.	Weight of silica gel (Grm.)	
46.	Particular of Bushings	H.V. / LV
a.	Name of manufacturer	
b.	Type	
c.	Voltage rating – KV	
d.	Visible power frequency voltage discharge test – KV	
e.	Dry power frequency withstand voltage for one minute	
f.	Wet power frequency withstand voltage for 30 minutes	
g.	Dry standard lightning impulse with stand volt-KV	
h.	Creepage distance in air (mm) (protected and total)	
i.	Recommended Gap setting – mm	
j.	Weight of assembled bushing KG	
47.	Free space required at the top for removal of bushing – mm	
48.	Minimum clearance height for lifting core & windings from tank	
Note: Type tests Reports of bushings shall be submitted		
49.	Details of Off load tap changer	
a.	Make	
b.	Type	
c.	Rating	
	i) Rated voltage	
	ii) Rated current	
	iii) step voltage	
	iv) No. of steps.	

50.	Shipping details	
a.	Parts detached for transport	
b.	Approx. Weight of heaviest package – kg.	
c.	Approx. dimension of largest package-mm	
	i) Length	
	ii) Breadth	
	iii) Height	
51.	Type Testing	
a.	Whether the transformer of the offered design has been type tested during last 5 years from the date of opening of tender?	
b.	If yes, when and where was it type tested?	
c.	Is there any deviation in the technical specification of offered for 33/6.9 KV, power transformer?	
52.	Details of test reports	

Sl. No.	Name of Test	Date of Test	Whether test reports enclosed or not (Yes / No)	If yes no. of sheets.
1.	Temperature Rise Test			
2.	Vacuum Test			
3.	Pressure Test			
4.	Impulse Voltage with stand test (lightning Impulse Test)			
5.	Short Circuit Test			
6.	Thermal ability Test			
7.	Zero sequence Impedance Test			

CHAPTER-6

TECHNICAL SPECIFICATION FOR 33KV OUTDOOR VACUUM CIRCUIT BREAKERS

1. SCOPE

1.1

This specification covers design, engineering, manufacture, testing, and inspection before dispatch packing of 33KV Outdoor Vacuum Circuit Breakers for use in the 33/6.6KV MSDSS and/ or DSS for Power Supply to Mega-Lift Schemes.

1.2

All vacuum circuit breakers must be manufactured by ISO 9000 certified Organization and shall have been type tested at CPRI or any Govt. approved laboratory within last 5 years. The Bidder shall demonstrate compliance with this requirement by supplying with the bid, copies of the type test certificates together with performance certificates from purchasers/ users.

The users certificate must include the detail address of the user, date of commissioning of the equipment, date of issue of the letter, No. of years of satisfactory performance of the equipment with Model/ Type used. At least one of the users certificate shall be submitted from the state or Central Government or their undertaking.

1.3

The Dimension of Type Tested VCBs can only be accepted.

1.4

The scope also includes **G.I.** supporting structure for the circuit breaker and current and potential transformers, operating mechanism, local/ remote control cabinet, relay control panel, foundation bolts, all the accessories and auxiliary equipment mandatory spares and special tools for satisfactory installation and operation.

1.5

The circuit breakers shall conform in all respects to the highest standards of engineering, design, workmanship, this specification and the latest revisions of relevant standards at the time of offer and the owner shall have the power to reject any work or materials, which, in his judgment, is not in full accordance therewith.

2. STANDARDS

Expect where modified by this specification, the circuit breakers and the accessories shall be designed, manufactured and tested in accordance with latest editions of the following standards.

<i>IEC/ISO/BS</i>	IS	Subject
<i>IEC: 56</i> IEC: 62271-100 & 200		High voltage alternating current circuit breakers general requirement.
<i>IEC: 694</i>	IS : 12729	Common clauses of high voltage switch-gear and control gear standards (for voltage exceeding 1000 V).
<i>IEC: 60</i>	IS : 9135	High Voltage testing techniques.
<i>IEC: 427</i>	IS: 13516	Method of synthetic testing of HV .A.C circuit breakers.
<i>IEC: 1233</i>		HV. AC. Circuit breakers- inductive load switching.
<i>IEC: 17A/CD: 474</i>		HV. AC. Circuit breakers- capacitive switching.
<i>IEC: 529</i>	IS: 13947	Degree of protection provided by enclosure.

<i>IEC:137</i>	IS: 2099	Insulating bushing for A.C. voltages above 1000V
<i>IEC:233</i>	IS : 5621	Hollow insulators for use in electrical equipment & testing.
<i>IEC:273</i>	IS: 5350	Characteristics of indoor and outdoor post insulators for systems with nominal voltages greater than 1000V.
<i>IEC:815</i>	IS: 13134	Guide for selection of insulators in respect of polluted conditions.
<i>IEC: 34</i>	IS : 996	A.C motors
<i>ISO:1460 BS:729</i>	IS:2629	Hot dip galvanizing
	IS:2633	Method of testing uniformity of zinc coated articles.
	IS: 5	Colour for ready missed paints and enamels
	IS: 6005	Code of practice for phosphating or iron and steel.
<i>IEC: 227</i>	IS:1554	P.V.C Insulated cables for voltages up to and including 1100 Volt.
<i>IEC:269</i>	IS:13703	Low voltage fuses for voltages not exceeding 1000volt.
<i>ISO:800</i>	IS:1300	Phenolic moulding materials.
	IS:13118	Guide for uniform marking and identification of conductors and apparatus terminals.
<i>IEC: 185</i>	IS: 2705	Current transformers.
<i>IEC: 296</i>	IS: 335	Specification for unused insulating oil for transformer and switchgear.
<i>IEC:186</i>	IS: 3156	Potential transformers.
CBIP Technical Report No. 88 revised July, 1996 read with amendment issued (April, 99, September, 99 and also any other amendment thereafter)		Specification for AC Static Electrical Energy Meter.

This list is not to be considered exhaustive and reference to a particular standard or recommendation in this specification does not relieve the Supplier of the necessity of providing the goods and services complying with other relevant standards or recommendations.

3.

REQUIREMENTS:

The circuit breakers to be supplied against this specification shall be required to control the primary side of 33/6.6 KV power transformers in MSDSS, incoming 33KV feeders or the outgoing feeders in these sub-stations. The circuit breakers shall be suitable for 3 phase 50Hz solidly grounded neutral system and shall have normal current carrying capacity and symmetrical short circuit current breaking capability as mentioned hereunder. **Preference will be on the following make Vacuum Interrupter such as AREVA, ABB, CGL, Megawin & BEL, as per the vendors listed in the Bid documents. No other make will be considered.**

3.1 BASIC TECHNICAL REQUIREMENTS:

The vacuum circuit breakers are required to meet the following basic technical requirements. (Reference standards IEC: 62271 - 100 & 200 and associated standards listed in this specification.

Basic Technical Requirements

Sl. No	Particulars	Requirements
1	Service type	Outdoor
2	No. of Poles	3
3	Nominal system voltage	33KV
4	Highest system voltage	36KV
5	Rated normal current at 50°C	
i)	For Bus-bar of Circuit Breaker	1250 A
ii)	For Interrupter	2000 A
iii)	For Outgoing Feeders/ For incomer	1250 A
6	Rated short circuit breaking current (rms) for 3 Sec	25KA
7	Rated short circuit making current (peak)	62.5KA
8	Rated short time current withstand capability for 3 sec.	25KA(Panel)/ 25KA (Interrupter)
9.	Rated insulation level:	
i)	One minute power frequency withstand voltage to earth (wet and dry) rms	
	Dry	95

	Wet	75
ii)	Impulse withstand voltage to earth with 1.2/50μsec, wave of +ve and –ve polarity (Peak)	170KV
10	First – pole – to clear factor	1.5
11	Rated operating sequence (for auto reclosing)	0-0.3 Sec- CO-3 min-CO
12	Maximum break time	3 cycles
13	Rated out of phase breaking current	25% of the symmetrical short circuit breaking current
14	Maximum pole scatter	10 mili seconds
15	Rated Auxiliary supply for spring charge motor, lamp & heater circuit.	230V A.C
16	Rated supply voltage for trip/close coil	48 V D.C/110 V DC as per manufacturer
17	Minimum creepage distance (mm)	900mm
18	Minimum protected creepage distance (mm)	580mm

4. SERVICE CONDITIONS:

The service conditions shall be as follows:

◆	Maximum a altitude above sea level	1,000m
◆	Maximum ambient air temperature	50°C
◆	Maximum daily average ambient air temperature	35°C
◆	Minimum ambient air temperature	5°C
◆	Maximum temperature attainable by an object exposed to the sun	60°C
◆	Maximum yearly weight average ambient temperature	32°C
◆	Maximum relative humidity	100%
◆	Average number of thunderstorm days per annum (isokeraunic level)	70
◆	Average number of rainy days per annum	120
◆	Average annual rainfall	1500mm
◆	Maximum wind pressure	260Kg/m ²

5. 33 KV VACUUM CIRCUIT BREAKERS

5.1 General

The circuit breakers shall be structure mounted open type with vacuum as interrupting media incorporating separate interrupters of 2000 A rating for each phase mounted on single frame. There shall be a common drive mechanism actuating the interrupters, which must work in synchronism. These breakers shall be provided with suitable local control while provision shall be made for remote control.

The circuit breakers shall be fitted with spring mechanism type. The inherent design of these circuit breakers shall be such that they shall satisfactorily perform all test duties and interrupt out-of-phase current and produce very low over voltage ($<2.0p.u.$) on all switching circuits, capacitive and inductive to **IEC:62271 - 100 & 200** and other associated standards mentioned in the clause of this specification.

The terminal pads shall have **Al. Alloy with very smooth finishing's & carry 2000 A W/o any temperature rise**. The design of the circuit breakers shall be such that inspection and replacement of contracts, coils, vacuum bottles and any worn or damaged components can be carried out quickly and this ease. The contract gaps shall be adjustable to allow for wear.

The mechanism and the connected interrupters shall satisfy the mechanical endurance requirements of **IEC: 62271 - 100 & 200** and all additional requirements specified herein.

5.2 Porcelain Insulator

External parts of the circuit breakers, which are under continuous electrical stress, shall be of hollow porcelain. The creepage and flashover distance of the insulators shall be dimensioned and the type and profile designed in accordance with IEC:815 or IS: 13134 and shall be suitable for the worst environmental conditions specified in this specification. The creepage distance across the interrupting chambers shall suite the outdoor service conditions mentioned in the relevant standards for heavily polluted atmosphere and shall be not less than 900 mm with protected creepage distance 50 percent of the total. Internal surfaces of hollow insulators shall also be glazed. The insulators shall comply with IS: 5621 and tested in accordance with IEC:233.

All porcelain whether, used on the interrupting chamber or on the support insulator shall have the following properties:

Higher strength, homogeneity, uniform glaze, free from cavities and other flaws and high quality uniform finish porcelain components and shall withstand the maximum expected static and dynamic loads to which the circuit breakers may be subjected during their service life.

5.3 Interrupting media

5.3.1 Vacuum:

In vacuum circuit breakers, facilities shall be provided for monitoring the contact erosion and any change in contact gap. The vacuum bottles shall be easily replaceable at site and the mechanism shall be conveniently adjustable to permit resetting the contact gap.

The vacuum circuit breaker poles shall be sealed to prevent contamination of the spaces surrounding the interrupters. The Bidder shall demonstrate how this is achieved by supplying technical details with the bid.

5.4 Auxiliary contacts

12 auxiliary contacts (6N.O. +6N.C.) of 48 Volt D.C grade and 10 amps DC rating shall be provided in each circuit breaker.

5.5 Indication

A mechanically operated circuit breaker position indicator of non corroding material shall be provided in a location visible from the operating side of the breaker without the necessity to open the mechanism door. The word 'OFF' in white letter on green background shall be used to indicate that the breaker is in the opening position and the word 'ON' in white letters on a red background to indicate that the breaker is in the closed position. The drive for the device shall be positive in both directions and provision shall be made for local and remote electrical indication.

Indication of spring charging condition shall be provided as mentioned in this specification. Mechanical counters to record the number of closing operations shall be provided for each circuit breaker mechanism.

5.7 Operation and controls

The breaker shall normally be operated by remote electrical control with electrical tripping by **two nos.shunt trip coil**. Provision shall be made for local electrical operation and mechanical operation.

The following facilities shall be provided in the circuit breaker local control cabinet:

- LOCAL/ REMOTE selector switch of stay put type. The selection of 'local' operation shall inhibit the operation of the breaker from any remote source.
- ON/NEUTRAL/ OFF control switch or ON and OFF push buttons. The push buttons shall be momentary contract type with rear terminal connections. The close push button shall be of green colour and the open push button red colour.
- MECHANICAL EMERGENCY TRIP DEVICE: suitable for manual operation in the event of failure of electrical supplies. **The device shall be accessible without opening any access doors and distinctly labeled.** It shall be shrouded and protected against inadvertent operation.

- Means shall be provided for manual operation of these circuit breakers during failure of auxiliary power in addition to electrical operation.
- Means shall be provided to prevent the mechanism from responding to a close signal when the trip coil is energized or to reclosing from a sustained close signal either opening due to a trip signal or failure to hold in the closed position.

The circuit breaker shall be able to perform 10,000 operating cycles at no load in accordance with IEC: 17A/474/CD for circuit breakers for auto reclosing duties.

6 PROTECTIVE RELAY & METERS OF CONTROL PANEL

Indoor & Outdoor control panels with protective relay and meter shall be provided by the supplier suitable for above breakers. The equipment shall have protection scheme with the following relay & shall comply with provisions contained under Odisha Grid Code:

(i) Triple pole IDMTL type combined over current (3Nos) & Earth fault (1No) relay (Draw out type) preferably Communicable numerical relay **of AREVA, ER, ABB or SIEMENS make with supporting protocol IEC:61850 or 60870.**

Plug setting range of the over current and earth fault relays shall be 5% to 250%.

(ii) 3 elements auxiliary relay for transformer fault, trip for Buchholz, winding temperature & oil temperature. **(Electro mechanical AREVA & Megawin)**

(iii) Master trip relay for inter tripping. **(Electro mechanical AREVA, Megawin)**

(iv) Restricted Earth fault relay. **(Only for Transformer CR Panel) (Numerical Communicable type AREVA, ER, ABB & SIEMENS with supporting protocol IEC: 61850 or 60870.)**

(v) One alarm bell scheme with bell (24V DC).

7. METERS:

The following meters shall be provided.

- Ammeter: - 1 No. , 0-100-200 A/ 1 Amp (**Size: 96x96 mm**).
- Volt meter: - 1 No., 0- 40 KV (**size : 96 x 96 mm**).
- Ammeter selector switch- 1 No. Make – Kaycee or any other reputed make.
- Volt meter selector switch- 1No. Make- Kaycee or any other reputed make.
- 09 watt CFL lamp with switch- 1 No.
- Plug & Socket- 1 No.

vii) Fuses & Links- 1 No.

viii) Test terminal Blocks- Test terminal Block **should** be provided for testing relays & meters.

ix) Indication Lamp- Red- Breaker 'ON'

(24V DC LED type) Green Breaker 'OFF'

Amber- Breaker 'AUTO TRIP'

Blue- Spring charge indication.

White-Healthy Trip illuminated push bottom switch

7.1 CONTROL CIRCUIT & ANNUNCIATION

1. One TNC Switch

2. Alarm Bell Accept Push Button

3. Alarm Bell Reset Push Button

8. OTHER EQUIPMENTS

8.1 In door Control- Relay Panel

8.1.1 General

The electrical controls, relays, instruments, meters, annunciation scheme shall be provided in a sheet steel enclosure conforming to IEC: 298 or IS:3427 mounted on support base on the floor. The panel shall be free standing, dust, moisture and rodent and vermin proof suitable for outdoor/Indoor installation. The panel shall have a high degree of protection IP: 54 for outdoor installation with relevant standard.

Each panel shall comprise of rigid welded structure frame enclosed completely by metal sheet of thickness not less than **2.5mm**. The sheets shall be cold rolled with smooth finish leveled and free from flaws. The structural frame and all load bearing members of the enclosure shall have minimum thickness of 2.5mm. Size of the CR panel should be **750 mm** Width x 600mm Depth x 1600 mm Height.

The Indoor CR Panels shall have hinged door at the back for excess to low voltage wiring. All door panels and removable covers shall be gasketed all round with neoprene bonded gasket. Ventilating louvers shall be provided to limit the temperature rise as provided in IEC: 694 and 298 or IS:12729 and 3427. They shall be provided with filters encased in fine wire screens for non-ferrous metal or stainless steel unaffected by moisture and rain water. A 230V AC heater with auto temperature control shall be provided in the cabinet to prevent moisture condensation.

The housing shall be surface treated and painted in accordance with the clause on Surface Treatment of this specification.

9.0 Protective Relay & Meter of Control Panel.

9.1 Wiring

Each panel shall be supplied with all internal wiring complete.

Panel wiring shall be suitably bunched and clamped for neat appearance. The conductors used for wiring purpose shall be **PVC** insulated **1100** volt grade semi-flexible heat resistant, flame retardant and vermin proof electrolytic copper cable conforming to IEC:227, 502 or IS:1554. The wiring shall be securely supported and taken through PVC troughs. Each wire shall be continuous from end to end without any joint in between. All panel wiring shall be capable of withstanding a voltage of 2KV AC 50Hz for one minute.

Cable and wire for connections within the switchgear and between the switchgear and terminal blocks shall have a minimum temperature rating of 90 degree Celsius. The size of the conductors for panel wiring shall be not less than 2.5mm². For CT secondary wiring, two such wires shall be used in parallel or 4mm² conductor can be used.

9.2 Panel wiring protection

The panels shall be equipped with links and HRC cartridge fuses conforming to IEC:269 or IS:13703 in **1100** Volt grade phenolic moulded fuse holder consisting of fuse carrier and base or miniature circuit breakers conforming to IEC:947-2 or IS:13947-2 at appropriate locations. The carriers and bases shall be made of high grade flame retardant and non hygroscopic phenolic moulded material with hard glass surface. Each fuse or MCB shall be identified with engraved plastic label.

In general, fuses and MCBs shall be limited to the minimum required for safety. The protection scheme shall include fuses for VT secondary circuits and DC supply to each panel and fuses for MCB for spring charging motor and incoming AC supply.

CEMLP2017

9.3 Terminal blocks

Terminal blocks of brass studs rated for 10 amps continuous current, 650 volt DC grade covered by moulded insulating materials with adequate electrical clearances shall be provided for terminating the panel wiring and outgoing connections. The termination shall be made by crimping lugs or bare conductor with insulating sleeves at ends. The arrangement can be horizontal or vertical as per standard practice adopted by the manufacturer. All terminals must be numbered and wire termination provided with numbered ferrules for identification. All numbering and marking including those in wiring diagram shall follow the guidelines provided in IS:11353. All circuit breaker auxiliary **contacts** including spare contacts shall be wired to the terminal blocks. Ten percent spare terminals shall be provided.

9.4 **Colour and numbering**

The wiring used for 230V AC supply for illumination lamp, panel heater and other devices shall be coloured red for phase wire and black for the neutral. The colour of wires connecting directly to Earth shall be black. All other panel wires shall be of one colour to be approved.

Engraved core identification plastic ferrules marked to correspond with the panel wiring diagram shall be fixed at both ends of each wire. Ferrules shall fit tightly on the wire and shall not fall off when the wire is disconnected from the terminal block. Numbers 6 and 9, if used shall be under scored to enable differentiation.

9.5 **Circuit diagram**

A durable copy of the circuit wiring diagram shall be affixed to the inner side of the door of the Control compartment. Labels shall be provided inside the compartment to describe the functions of the various items of equipment.

The scope of the supply shall include the panel mounting base plate and all special equipment, bolts, nuts and washers necessary for making the supporting.

9.6 **Supporting Structure for Breaker**

The supply of the material shall be complete with mounting structures of mild steel sections conforming to IS:226 or equivalent ISO. The supporting structure shall be designed and constructed to withstand the maximum combined effects of the circuit breaker dead weight, its maximum dynamic load and maximum effect of wind loading. The supporting structure shall be **hot dip galvanized** as per clause on surface treatment of this specification.

9.7 **Local control cabinet**

The operating mechanism, local controls and monitoring shall be provided in a metal clad control cabinet fitted to the same structure supporting the breaker and mounted at a convenient height for safe operation from ground level or from platform to be supplied under the contract.

The cabinet shall be made of minimum **2.5mm** sheet steel and shall be constructed as a dust, weather and vermin proof outdoor housing with protection of IP-54 class as defined in IEC:529 or IS:13947. It shall have single door and transparent windows for reading the circuit breaker ON or OFF position and spring charge position without opening the door. The door and any removable covers shall be gasketed all round with neoprene bonded gaskets. A ventilating louver shall be provided with fine wire non-ferrous metal or stainless steel screen and filter. A 230V AC heater with auto temperature control shall be provided in the cabinet to prevent moisture condensation and also a 230 volt lamp for internal illumination with door operated switch.

The local control cabinet shall be subjected to surface treatment and painting as per clause on surface treatment of this specification.

9.8 Panel wiring and accessories

Panel wiring shall be suitably bunched and clamped for neat appearance. The conductor used for wiring purpose shall be PVC insulated **1100V** grade semi-flexible copper cable conforming to IEC: 227 or IS:1554, heat resistant, flame, vermin and rodent proof. The wiring shall be securely supported and taken through PVC troughs. All panel wiring shall be capable of withstanding a voltage of 2KV AC 50Hz for 1 minute. Each wire shall be continuous from end to end without any joint in between.

The sizes of the control cable for wiring in the cabinet shall be not less than 2.5mm². CT secondary wiring shall be not less than 4 mm² wires.

9.9 Fuse protection

The cabinet shall be equipped with links and HRC cartridge fuses in **1100** volt grade fuse holders consisting of fuse carrier and base. The holders shall be made of high grade, flame retardant and non hygroscopic phenolic moulded material of dark brown colour with hard glass surface. Each fuse shall be identified with engraved plastic labels.

9.10 Terminal blocks

Terminal blocks rated for 10 amps continuous current, **1100** volt grade covered by moulded insulating materials with adequate electrical clearances shall be provided for terminating the panel wiring and outgoing connections. The termination shall be made by crimping lugs or bare wire with insulating sleeves at ends. The arrangement can be horizontal or vertical as per standard practice adopted by the manufacturer. All terminals must be numbered and wire termination provided with numbered ferrule for identification. All numbering and marking include those in wiring diagram shall follow the guidelines provided in IS: 11353. Ten percent spare terminals shall be provided.

9.11 Colours

The wiring used for AC supply for illumination lamp and heater shall be differently coloured from control wiring so that these can be distinguished from each other. The colour of all earth wire shall be black.

9.112 Circuit diagram

A durable copy of the circuit wiring diagram shall be affixed to the inner side of the control cabinet. Labels shall be provided inside the cabinet to describe the functions of the various items of equipment.

9.13 Cable Entry

A removable gland plate shall be provided at the bottom of the cabinet for entry of Purchaser's control and auxiliary power cables in the cabinet. Required number of electroplated brass cable glands of appropriate sizes with shrouds shall be provided in consultation with the Purchaser in the gland plate for the control and power cables. Provision shall be made for earthing of the cable armours in the gland.

10 OPERATING MECHANISM**10.1 General**

The operating mechanism of the circuit breaker shall be motor wound spring charged type. It shall be electrically and mechanically trip free with anti pumping device (as per IEC: 694 definition). All working parts in the mechanism shall be of corrosion resistant material. Self lubricating, wearing resistant bearings shall be provided in the mechanism.

The mechanism shall fully close the circuit breaker and sustain it in the closed position against the forces of the rated making current and shall fully open the circuit breaker without undue contact bounce at a speed commensurate with that shown by tests to be necessary to achieve the rated breaking capacity in accordance with IEC:62271 - 100 & 200. The mechanism shall be capable of being locked in either the open or closed position. The mechanism shall be capable of fully closing and opening again after the auto-reclose time interval specified as 0.3 second in this specification.

10.2 Spring mechanism (For Spring Charged Breakers Only)

The spring operating mechanism shall be with spring charging motor, opening and closing springs with limit switches and all accessories necessary for automatic charging. In normal operation, recharging of the operating springs shall commence immediately and automatically upon completion of the closing operation so that a complete sequence of closing and opening operation should be possible.

It shall be possible to hand charge the operating spring with the circuit breaker in either the open or closed position conveniently from the ground level. Closure whilst a spring charging operation is in progress shall be prevented and release of the springs shall not be possible until they are fully charged.

The state of charge of the operating springs shall be indicated by a mechanical device showing '**SPRING CHARGED**' when closing spring is fully charged and operation is permissible and '**SPRING FREE**' when closing spring is not fully charged and the operation is not possible. Provision shall be made for remote electrical indication of 'Spring Charged' and 'Spring Free' conditions.

The operating mechanism shall be such that the failure of any auxiliary spring shall not cause tripping or closing the circuit breaker but shall not prevent tripping against trip command.

Closing action of the circuit breaker shall charge the opening spring ready for tripping. From the close position with spring charged, one open-close-open operation shall be possible without recharging the spring.

10.3 Motor

The motor for spring charging shall be single phase 230 Volt A. C motor. Continuous motor rating shall be at least ten percent above the maximum load demand of the driven equipment. It shall remain within its rated capacity at all operating points that will arise in service. It shall be protected by MCB. The motor shall comply with IEC: 34 or IS:996.

11. AUXILIARY POWER SUPPLY

The operating mechanism shall be suitable to operate with the following auxiliary power supplies.

- a) 230V, 50Hz Single phase A.C- For spring charging motor
- b) DC supply 48 Volts or 110 V as per manufacturer specification For close and open coils, indication & Alarm

The mechanism shall be designed to operate satisfactorily despite fluctuations of auxiliary power supplies as under:

AC supply:	Voltage	From 115% to 85% of normal voltage
	Frequency	From 105% to 95% of normal frequency
	Combined voltage and frequency variation	From 115% to 85% of normal
DC supply:	Voltage	From 120% to 70% of normal voltage

12. INTERLOCKS

The circuit breaker shall be capable of being mechanically and electrically interlocked with the associated line isolator so that the isolator cannot be operated with the breaker in the closed position.

All doors or shutters which give access to live parts shall be interlocked in such a way that these cannot be opened unless the circuit breaker is in the open position.

Other interlocks shall be provided as deemed necessary for safety.

13. PROTECTION AND METERING

- Inter-tripping for simultaneous tripping other circuit breaker.

14. TERMINAL CONNECTOR

Suitable terminal connectors of bi-metallic type suitable for both horizontal and vertical connection shall be provided on the terminal pad both on the incoming and the outgoing side for connection of jumpers of ACSR or AAAC conductor. The size of the conductor may vary between 100mm² and 232mm² depending upon the location of the circuit breaker. The terminal connection drawing and details are to be approved by the Purchaser before fabrication. The terminal connectors shall be bi-metallic type to avoid bi-metallic corrosion.

15. INSULATION AND CLEARANCE

a) The insulation to ground, the insulation between open contacts and insulation between phases of the circuit breaker shall be capable of satisfactorily withstanding dielectric test voltages.

b) The minimum clearance in open air shall be as follows:

- Between poles - 460mm
- Phase to earth - 400mm
- Ground clearance for live part - 3700mm

16. TEMPERATURE RISE

The temperature rise and the maximum temperature of any part of the circuit breaker under continuous load condition and exposed in the direct rays of the sun shall not exceed the permissible limits as provided in Table V of IEC publication 694 or table 4 of IS:12729. These limits shall not be exceeded when corrected for the difference between the ambient temperature at site and the ambient temperature specified in the standard. The correction proposed shall be stated in the tender.

17. TESTS**17.1 Type and routine tests**

The circuit breakers shall be subjected to routine and type tests in accordance with the standards listed in this specification including the following IEC and IS standards with the latest amendments: Type test reports shall be submitted with the Offer.

- Circuit breaker IEC:62271 - 100 & 200 and relevant other standards
- Porcelain insulator IEC:233 and IS:5621 and relevant other standards

The tests shall include but not limited to the following:

17.2 Short circuit tests

The circuit breaker shall satisfactorily perform the out of phase and short circuit duties specified in IEC:62271 - 100 & 200, IEC:17A(Sectt.) and IEC:17A/CD/474, IS-13118 and IS:13516.

The circuit breaker shall be capable of performing at least twenty five (25) open operations at the rated short circuit current before maintenance or inspection is required.

17.3 Capacitive current switching

Capacitive switching tests shall be performed in accordance with IEC: 62271 - 100 & 200 and IEC: 17A/CD/474 at 1.3U preferably by direct test method or alternatively using synthetic method to IEC: 427 or IS:13516. The test circuits shall simulate the most onerous site conditions.

17.4 Dielectric tests

At zero gauge loss of vacuum inside the interrupter chamber, the open contracts shall withstand continuously, the rated phase to ground voltage and it shall be possible to break normal current in these conditions. During the dielectric type tests, no flashover external or internal shall be acceptable.

The circuit breakers shall be subjected to a power frequency AC voltage test for one minute in dry and wet conditions and there shall be no external flash over to earth.

17.5 Mechanical endurance

In addition to the requirements of IEC:62271 – 100 & 200, an extended mechanical endurance test is required to show that the circuit breaker is capable of at least 10,000 operations at no load in accordance with IEC:17A/474/CD. Between the specified test series in IEC: 17A/474/CD, some maintenance such as lubrication and mechanical adjustment is allowed and shall be performed in accordance with manufacturer's instructions. Change of contracts is not permitted.

17.6 Low current switching

The circuit breakers shall produce very low over voltage (<2.0 pu) on all switching circuits inductive current including reactor switching to IEC-1233 and capacitive current switching to IEC:17A (Secretariat) 438 and IEC 17A/CD/474 the circuit breaker shall be re-ignition or re-strike free for all duties.

17.7 Duty requirement tests

Apart from auto-reclosing and the other duties mentioned above, the breakers shall be able to perform the following duties for which type tests are to be conducted as per IEC:62271 - 100 & 200.

1. Breaking the steady and the transient magnetising current of the transformer.
2. Breaking 25% of rated fault current at twice the rated voltage as per IEC/IS.
3. Cable charging breaking current.
4. Back-to-back capacitor bank breaking current.

5. Single capacitor bank breaking current.

6. Capacitor bank in rush making current.

Test for the resistance of the main circuit shall also be conducted.

17.8 Temperature rise test

Temperature rise test is to be conducted on the circuit breaker and the accessories in accordance with IEC: 62271 - 100 & 200. The temperature rise shall be limited as per this specification.

18. PERFORMANCE REQUIREMENTS

The supplier shall declare the circuit breaker opening and closing times at 120 percent, 100 percent and 70 per cent of the rated voltage of the opening and closing devices when measured at the terminals of the trip and closing coils. The minimum make break time at rated voltage and total break time of the CB shall be stated. The total break time must not exceed 60m. sec.

19. EARTHING

All metal parts not intended for carrying current or not alive shall be connected to duplicate earthing system and suitable electroplated brass earthing terminals shall be provided on each circuit breaker in conformity with IEC:62271 - 100 & 200. Suitable identification mark for the earth terminals shall be provided adjacent to the terminal.

Earth continuity conductors shall be provided down to the ground level for earth connection to purchaser's earthing grid. It shall have sufficient cross sectional area to afford a low resistance path for the full fault current envisaged. Such conductor shall also be provided for the CTs up to the ground level.

The size of the earth continuity conductor shall be large enough to reduce the potential rise of the metal frame of the breaker in the even of fault to minimum but in any case not more than 10V. The size of the conductor shall also be adequate to restrict the temperature rise without causing any damage to the earth connection in the case of fault. No riveted joints in the earth conducting path shall be permissible and only bolted joints of adequate size shall be provided with nuts, bolts and plain and spring washers. The surfaces to be jointed shall be perfectly flat without any unevenness to ensure that there is no contact resistance.

An earth busbar of copper strip shall be provided inside the local control cabinet to which all earthing connections must be made. The earth busbar shall be terminated into two electroplated brass earthing terminals of adequate size with nuts, bolts and washers for connecting to earth continuity conductor mentioned above.

20. Mandatory Spare Parts for 33KV VCB

The supplier shall provide the mandatory spares as follows.

Sl. No	Description
1	Complete pole assembly of the circuit breaker
2	Vacuum interrupter bottle (for vacuum type only)
3	Tripping coils
4	Closing coils
5	Insulated drive rod
6	Spring charging motor
7	Set of spring charging limit switches
8	Set for gaskets complete for one circuit breaker
9	Upper Housing Porcelain Insulator
10	Lower Housing assembly Porcelain Insulator

GUARANTEED TECHNICAL PARTICULARS FOR 33 KV OUTDOOR VACUUM CIRCUIT BREAKER

SL . NO.	DESCRIPTION	As Per Specification	UNITS	BIDDER's OFFER
1	GENERAL			
	- Name of manufacture			
	- Make, type/Model of Vacuum Interrupter			
	- Governing standards	IEC:62271 - 100 & 200		
	- No. of poles of circuit breaker	3	no.	
	- No. of breaks per phase	1	no.	
	- Total length of break per phase		mm	
	Type – Vacuum	Yes, Vacuum	Yes/No	
2.	NOMINAL VOLTAGE			
	- Rated voltage	33	KV	
	Maximum(continuous)service rated voltage	36	KV	
3.	RATED NORMAL CURRENT			
	- Under normal condition	1250	Amps	
	- Under site condition	1250	Amps	
4.	SHORT CIRCUIT PERFORMANCES			
	- Rated short circuit breaking current for 3 Sec:			
	Symmetrical, rms	25	KA	
	Asymmetrical including DC component	31.25	KA	
	- Rated short circuit making current; peak	62.5	KA	
	- Short time current withstand capability:			
	Peak value	62.5	KA	
	Rms value	25	KA	
	Duration	3 Seconds	Sec	

SL . NO.	DESCRIPTION	As Per Specification	UNITS	BIDDER's OFFER
5.	MAX. TEMP. RISE OVER AMBIENT OF 50°C			
	- At normal continuous current		°C	
	- After performing the operating sequence		°C	
	- At 10% rupturing capacity		milli-sec	
6	Make & Break Times			
	Total break times			
	At 10% rupturing capacity	60	milli-sec	
	At rated rupturing capacity	60	milli-sec	
	Arcing time at rated breaking current	60	milli-sec	
	Make time form giving close command	60	milli-sec	
	- Minimum reclose time at full rated interrupting Capacity from trip coil energisation		sec	
	- Minimum dead time for 3 phase reclosing		milli-sec	
	- Circuit breaker opening time:			
	at 125% of rated voltage of opening device	60	milli-sec	
	at 100% of rated voltage of opening device	60	milli-sec	
	at 70% of rated voltage of opening device	60	milli-sec	
	- Circuit breaker closing time:			
	at 125% of rated voltage of closing device	60	milli-sec	
	at 100% of rated voltage of closing device	60	milli-sec	
	at 70% of rated voltage of closing device	60	milli-sec	

SL. NO.	DESCRIPTION	As Per Specification	UNITS	BIDDER's OFFER
7	RESTRIKING VOLTAGES FOR 100% RATED CAPACITY			
	- Amplitude factor		KV	
	- Phase factor		KV	
	- Natural frequency		KHz	
	- Rate of rise of recovery voltage	0.57	kv/ μ s	
8	RATED INSULATION LEVEL			
	- Dry and wet power frequency withstand test voltage (rms) for 1 minute			
	Between live terminals and grounded objects	70	KV	
	Between terminals with breaker contacts open	70	KV	
	- 1.2/50 μ sec full wave impulse withstand voltage +ve and - ve polarity (peak)			
	Between live terminals and grounded object	170	KV	
	Between terminals with breaker contacts open	170	KV	
	One minute power frequency voltage of auxiliary wiring	2	KV	
9	OPERATING PERFORMANCE			
	- Rated transient recovery voltage	0.57	KV/ μ s	
	Rated cable charging breaking current	50	Amps.	
	Rated single capacitor bank breaking current	400	Amps.	
	Rated back-to-back capacitor bank breaking current		Amps	
	Rated capacitor bank in-rush making current		KA	

SL . NO.	DESCRIPTION	As Per Specification	UNITS	BIDDER's OFFER
	Rated small inductive breaking current	25	KA	
	First pole-to-clear factor	1.5		
	Rated operating sequence	O-0.3 Sec-CO-3 Min-CO		
	Rated out-of-phase breaking current	25	KAmp	
	Re-ignition and Re-strike free	Yes	Yes/ No	
10	NUMBER OF OPERATION POSSIBLE WITHOUT MAINTENANCE			
	at full rated interrupting current	> 100	no.	
	at 50% of rated interrupting current	> 100	no	
	at 100% of full load current	10,000	no	
	at no load		no	
11	MINIMUM CLRRANCE IN AIR			
	- Between phases	460	mm	
	- Live parts to earth	400	mm	
	- Live parts to ground level	3700	mm	
12	WEIGHTS AND DIMENSIONS			
	Total weight of one complete breaker, including mounting structure		kg	
	Mounting structure weight		kg	
	Control cabinet weight		kg	
	Dimensions: Height		mm	
	Width		mm	
	Depth		mm	
	Drawings must be provided			
13	HOLLOW INSULATOR HOUSING			
	Type and make of insulators.			
	Power frequency withstand test voltage for one minute:			
	- Dry	70	KV	

SL. NO.	DESCRIPTION	As Per Specification	UNITS	BIDDER's OFFER
	- Wet	70	KV	
	Flash over value			
	- Dry	135	KV	
	- Wet	95	KV	
	1.2/50 impulse voltage withstand capability			
	- positive polarity	170	KV	
	- negative polarity	170	KV	
	Creepage distance total	900	mm	
	Creepage distance protected	450	mm	
	Weight of assembled housing		kg	
	Corona shield provided or not	Yes		
14	SUPPORT INSULATOR			
	Type and make of insulators			
	Power frequency withstand test voltage for one minute:			
	- Dry	70	KV	
	- Wet	70	KV	
	Flash over value			
	- Dry	135	KV	
	- Wet	95	KV	
	1.2/50 impulse voltage withstand capability			
	- positive polarity	170	KVp	
	- negative polarity	170	KVp	
	Creepage distance, total	900	mm	
	Creepage distance, protected	450	mm	
	Weight of assembled housing		kg	
	Corona shield provided or not	Yes		
15	CONTACTS			
	Type of main contacts	Butt		
	Type of auxiliary contacts			
	Material of auxiliary contacts	Silver Plated Brass		

SL. NO.	DESCRIPTION	As Per Specification	UNITS	BIDDER's OFFER
	Type of plating, if any	Silver		
	Thickness of plating	20	micron	
	Contact pressure		gm/sq.mm	
	No of auxiliary contacts provided:	6 NO + 6 NC		
	Those closed when breaker is closed	6	no	
	Those open when breaker is closed	6	no	
	Those adjustable		no	
16	OPERATING MECHANISM			
	Opening type	Shunt Trip		
	Closing type	Motor / Manual spring charge, Shunt operation		
	Force applied by charged spring for closing		kg	
	Time taken by motor for charging the spring from fully discharged to fully charged position	<30	sec	
	Full sequence of operation	O-0.3sec-CO-3min-CO		
	Whether limit switches are provided with spring	Yes	yes/no	
	Whether spring limit switches start & stop the motor	Yes	yes/no	
	Type and material of spring employed			
	Whether trip free	Yes		
	Whether anti pumping device provided	Yes		

SL. NO.	DESCRIPTION	As Per Specification	UNITS	BIDDER's OFFER
17	AUXILIARY AND CONTROL POWER SUPPLY			
	Normal auxiliary A.C supply voltage	230	Volts	
	Voltage limits for proper operation		Volts	
	Maximum	115%	Volts	
	Minimum	85%	Volts	
	Frequency limits for proper operation			
	Maximum	+5%	Hz	
	Minimum	-5%	Hz	
	for circuit breakers :		Volts	
	Normal DC control circuit voltage	24	Volts	
	Voltage limits for proper operation			
	Maximum	120%	Volts	
	Minimum	70%	Volts	
	Power required for trip coil	300	Watts	
	Power required for closing coil	300	Watts	
18	LOCAL CONTROL PANEL			
	- Material			
	- Degree of protection			
	- Vermin proof provisions	Yes	Yes/no	
	- Weather proof provision	Yes	Yes/no	
	- Dust proof provision	Yes	Yes/no	
	- Ventilation provision	Yes	Yes/no	
	- Thickness of sheet materials used	3	mm	
	- Overall dimensions		mm	
	- Total weight		kg	
	- Mounting arrangement			
19	TERMINAL CONNECTOR			
	- Material			
	- Bi-metallic or not	Yes		
	- Weight		kg	

SL. NO.	DESCRIPTION	As Per Specification	UNITS	BIDDER's OFFER
	- Dimensions		mm	
	- Size and type of conductor it can accommodate	100	sq mm	
	- Terminal pads silver plated or not	Yes		
	- Thickness of silver plating		microns	
20	CORROSION PREVENTION SYSTEM FOR CIRCUIT BREAKER AND CONTROL CABINET	Preferable Galvanised		
	- Surface preparation			
	- Rust inhibition			
	- Zinc thickness/paint thickness		microns	
	- Treatment of fasteners			
21	CORROSION PREVENTION SYSTEM FOR SUPPORT STRUCTURE	Hot Dip Galvanised		
	Surface preparation			
	Rust inhibition			
	Zinc thickness		microns	
	Treatment of fasteners.			
22	VACUUM CIRCUIT BREAKER SEALING	Hermetically Sealed		
	Degree of protection of circuit breaker pole enclosure. (IEC 529, IS 13947)			
	Method of sealing the circuit breaker pole enclosure.			

SL . NO.	DESCRIPTION	As Per Specification	UNITS	BIDDER's OFFER
	Oil resistance varnish			
23 A.	<u>INSTRUMENTS & METERS</u> <u>(Ammeter & Voltmeter)</u>	-		
	1. Type & make of instruments & meter	Analogue		
	2. Size	96 X 96	Mm	
	3. Whether magnetically shielded or not	Yes		
	4. Limits or error in the effective range	$\pm 2 \%$		
	5. Scale length	90 ⁰	KV	
	6. Whether Tropicalised	Yes		
	7. short time overload rating	200%		
	8. V A Burden:			
	Current coil			
	Potential coil			
	9. Power consumption of current & potential coil			
B.	<u>BACK UP RELAYS</u>			
	1. Type of relay	3 O/C + 1 E/F or 2 O/C + 1 E/F, Self actuated , 1 Amp, aux. Volt-24 V DC/Numerical & Communicable Type		
	Make	SIEMENS/AREVA/ABB/, ER make		
	2. Current coil rating	1	Amp	
	3. Tap range	5% - 250%		
	4. VA Burden Highest tap & lowest tap	3	VA	
	5. Power consumption at highest tap & lowest tap		Watts	
	6. Time of operation at maximum time dial seting at			
	i) 5 times tap setting current	1.6-1.9	Second	
	ii) 10 times tap setting current	1.3	Second	

SL. NO.	DESCRIPTION	As Per Specification	UNITS	BIDDER's OFFER
	7. Type of characteristic	IDMTL		
	8. Whether draw out type or not.	Yes		
	9. Trip contact ratings Amps.	5 Amp-Continuos	Amp	
	10. Whether seal In contacts provided or not	Yes		
	11. No. of contacts	2 NO+2 NC		
	12. Flag	Required		
C.	Three element voltage operated Aux. Relay			
	Type & make of the Relay	JVS/AREVA/ Megawin make		
	Voltage coil rating	24 V DC	Volts	
	No. of elements	3	No.	
	Mounting	Flush		
	Aux. Contact on each pole	1 NO + 1 NC		
	Flag	Required		
	Purpose	Trf protection		
	D. High speed Tripping Relay			
	Type & make of the Relay	AREVA/Megawin make		
	Voltage coil rating	24 V DC	Volts	
	Contact(Hand reset)	3 NO +1 NC		
	Flag	Required		
	E. High speed Harmonic Restraint Differential Relay	Only for transformer CR Panels		
	Type & make of the Relay	AREVA, ABB, SIEMENS,ER, make Numerical communicable type		
	Voltage coil rating	24 V DC	Volts	
	Aux. Contacts(Hand reset)	2 NO		
	Mounting	Flush		
	CT secondary	1 Amp.		
	Differential current setting	15%		
	Bias setting	15-30-40 %		
	Flag	Required		

CHAPTER – 7**TECHNICAL SPECIFICATION OF 33 KV LIGHTNING ARRESTOR (VOLTAGE CLASS SURGE ARRESTORS)****1.0 SCOPE:**

The specification covers the design, manufacture, shop & laboratory testing before dispatch, supply delivery of Station class heavy duty, gapless metal oxide Surge Arrestors, with insulating base, clamps, complete fittings & accessories suitable for 33/6.6 kV, SDS including arrester's electrode earthing.

2.0 STANDARDS

- 2.1 The design, manufacture and performance of Surge Arrestors shall comply with IS: 3070 Part-3 and other specific requirement stipulated in the specification Unless otherwise, specified, the equipment, material and processes shall conform to the latest applicable Indian/International Standards as listed hereunder:

IS: 2071-1993 (Part-1)	:	Methods of High Voltage Testing General Definitions & Test Requirements.
IS: 2071-1974 (Part-2)	:	Test Procedures
IS: 2633-1986	:	Methods for Testing uniformity of zinc coated Articles.
IS: 3070-1993 (Part-3)	:	Specification for surge arrester for alternating current system Metal-Oxide lightening Arrestors without gaps.
IS:4759-1996	:	Specification for hot dip zinc coating on Structural Steel and other allied products.
IS: 5621-1980	:	Hollow Insulators for use in Electrical Equipment.
IS: 6209-1982	:	Methods of Partial discharge measurement.
IS: 6745-1980	:	Methods for determination of mass of zinc coating on zinc coated iron and steel articles.
IEC:TC-37	:	Test Procedures.
ANSI/IEEE-C.62.11(1982)	:	Metal Oxide, Surge Arrester for A.C. Power Circuits.
IEE-99-4	:	Surge Arrestors.

The equipment complying with any other internationally accepted standards shall also be considered if it ensures performance equivalent to or superior to the India Standards.

3.0 GENERAL REQUIREMENT

- 3.1 The Metal Oxide gap less Surge Arrester without any series or shunt gap shall be suitable for protection of 33 KV power transformers, associated equipment and 33 KV lines from voltage surges resulting from natural disturbance like lightening as well as system disturbances.
- 3.2 The surge arrester shall draw negligible current at operating voltage and at the same time offer least resistance during the flow of surge current.
- 3.3 The surge arrester shall consist of non-linear resistor elements placed in series and housed in electrical grade porcelain housing/silicon polymeric of specified creepage distance.
- 3.4 The assembly shall be hermetically sealed with suitable rubber gaskets with effective sealing system arrangement to prevent ingress of moisture.

- 3.5 The surge arrestor shall be provided with line suitable for 100 mm², 148 mm² & 232 mm² AAAC/ ACSR for vertical and horizontal take off. The earth terminals shall be provided of suitable size. The groundside terminal of surge arrestor shall be connected with 50x6 mm - galvanized strip, one end connected to the surge arrestor and second end to a separate ground electrode (Electrode type of earthing). The contractor shall also recommend the procedure which shall be followed in providing the earthing/system to the Surge Arrestor.
- 3.6 The surge arrestor shall not operate under power frequency and temporary over voltage conditions but under surge conditions, the surge arrestor shall change over to the conducting mode.
- 3.7 Surge arrestor shall have a suitable pressure relief system to avoid damage to the porcelain/silicon polymeric housing and providing path for flow of rated fault currents in the event of arrestor failure.
- 3.8 The reference current of the arrestor shall be high enough to eliminate the influence of grading and stray capacitance on the measured reference voltage.
- 3.9 The surge arrestor shall be thermally stable and the contractor shall furnish a copy of thermal stability test with the bid.
- 3.10 The arrestors for 33 KV systems shall be suitable for mounting on transformers as well as in the yard. The supplier shall furnish the drawing indicating the dimensions, weight etc. of the surge arrestors for the design of mounting brackets.
- 3.11 The arrestor shall be capable of handling terminal energy for high surges, external pollution and transient over voltage and have low losses at operating voltage.

4.0 ARRESTOR HOUSING

- 4.1 The arrestor housing shall be made up of porcelain/silicon polymeric housing and shall be homogenous, free from laminations, cavities and other flaws or imperfections that might affect the mechanical and dielectric quality. The housing shall be uniform brown colour, free from blisters, burrs and other similar defects.
- Arrestors shall be complete with insulating cases, fasteners for stacking units together, surge counters with leakage current meters and terminal connectors.
- 4.2 The housing shall be so coordinated that external flashover shall not occur due to application of any impulse or switching surge voltage up to the maximum design value for arrestor. The arrestors shall not fail due to contamination. The 33 KV arrestors housing shall be designed for pressure relief class as given in Technical Parameters of the specification.
- 4.3 Sealed housing shall exhibit no measurable leakage.

5.0 TESTS

5.1 Test on Surge Arrestors

The Surge Arrestors offered shall be type tested not earlier than 5 years before the date of agreement with EPC Developer. The surge arrestors shall be subjected to routine and acceptance tests in accordance with IS: 3070(Part3)-1993. In addition, the suitability of the Surge Arrestors shall also be established for the following:

- * Residual voltage test
- * Reference voltage test
- * Leakage current at M.C.O.V.
- * P.D. Test
- * Sealing test

- * Thermal stability test
- * Aging and Energy capability test
- * Watt loss test

Each metal oxide block shall be tested for guaranteed specific energy capability in addition to routine/acceptance test as per IEC/IS.

- 5.2 The maximum residual voltages corresponding to nominal discharge current of 10KA for steep current, impulse residual voltage test, lightning impulse protection level and switching impulse level shall generally conform to Annexure-K of IEC-99-4.
- 5.3 The contractor shall furnish the copies of the type tests and the characteristics curves between the residual voltage and nominal discharge current of the offered surge arrester and power frequency voltage V/s time characteristic of the surge arrester subsequent to impulse energy consumption as per clause 6.6 of IS: 3070 (Part-3) offered along with the bid.
- 5.4 The surge arrestors housing shall also be type tested and shall be subjected to routine and acceptance tests in accordance with IS: 2071.
- 5.5 Galvanization Test

All Ferrous parts exposed to atmospheric condition shall have passed the type test and be subjected to routine and acceptance test in accordance with IS: 2633 & IS: 6745.

6.0 NAME PLATE

- 6.1 The nameplate attached to the arrestors shall carry the following information: -

- * Manufacturing Trade Mark
- * Year of Manufacturer
- * Rated Voltage
- * Continuous Operation Voltage
- * Pressure relief rated current
- * Name of Client- DoWR, GoO.
- * Purchase Order Ref.

7.0 INSPECTION

- 7.1 All tests and inspection shall be made in the manufacturer's works unless otherwise specifically agreed upon by the manufacturer and purchaser at the time of placement of purchase order. The manufacturer shall afford to the inspector representing the purchaser, all reasonable facilities, without charge to satisfy him that the material being furnished is in accordance with these specifications. The purchaser reserves the right to get any component/material being used by the manufacturer of the Surge Arrester tested from any recognized test house.
- 7.2 The inspection by the purchaser or his authorized representative shall not relieve the contractor of his obligation of furnishing equipment in accordance with the specifications.

8.0 DRAWING AND INSTRUCTION MANUALS

Tenderer shall furnish to the purchaser the following drawings and literature for approval:

- (i) Outline dimensional drawings of Surge Arrester and all accessories.
- (ii) Assembly drawings and weights of main component parts.
- (iii) Instructions manual
- (iv) Drawing showing details of pressure relief value
- (v) Volt-time characteristics of surge arrestors.

- (vi) Detailed dimensional drawing of porcelain housing/Silicon polymeric i.e. internal diameter, external diameter, thickness, height profile, creepage distance, dry arcing distance etc.

GUARANTEED TECHNICAL PARTICULARS 33 KV LIGHTNING ARRESTOR (VOLTAGE CLASS SURGE ARRESTORS)

A	Name of tenderer / contractor	
B.	Tender specification No.	
1.	Name of manufacturer of equipment.	
	Surge Arrester	
	Line Dis-Connector	
	Metal oxide block	
	Terminal Clamp	
2.	Name & Address of collaborator if any	
3.	Standard to which surge arrestors confirms	
4.	Surge Arrester	
4.1	Voltage rating (kV rms)	
A	Continuous Operating Voltage (kV rms)	
B	Leakage current at continuous operation voltage:	
C	Partial discharge at 1.05 COV (PC)	
D	Permitted leakage current of arrester beyond which arrester is faulty:	
5.	Frequency (Hz)	
6.	Nominal discharge current (wave shape=8/20 micro second)(kA)	
7.	Pressure relief rated current (kA rms)	
8.	Steep current protection level at 10Ka	
A	Lighting impulse protector level at 5 kA and 10kA (kVP)	
B	Switching Impulse protection level with 40x80 micro-sec. Wave at 500/1000A.	
9.	Long duration current impulse withstand capacity and virtual duration	
10.	Line discharge class	
11.	Thermal runaway limit of arrester	
12.	Energy capability (kJ/KV)	
13.	Pressure relief rating	
14.	Dry arcing distance	
15.	Reference current and reference voltage	
16.	Arrester housing	
16.1	Power frequency one minute wet withstand voltage (kV rms)	
16.2	Lighting impluse dry withstand voltage (kVP)	
16.3	Creepage distance	
A	Construction Details	
B	Total	
16.4	Short circuit withstand capacity	
16.5	Bending moment (mm)	

CHAPTER-8
TECHNICAL SPECIFICATION FOR 33 KV 1 PHASE DUEL CORE, OUTDOOR TYPE, POTENTIAL TRANSFORMER.

1.0 SCOPE:

1.1 This specification covers the design, manufacture, assembly, testing at Manufacturer's works, supply & delivery at site of Potential Transformers in three phase system of 33 KV class.

1.2 These Potential Transformers will be used Bus-side PT, for voltage indication by voltmeter through selector switch and supply of voltage to meters, protection relays for feeder protection and synchronized devices.

2.0 STANDARDS:

The Potential Transformers and accessories covered by this specification shall comply with the requirement of latest edition of the following standards unless otherwise stated in this specification:

IS:3156 Part (I-IV)	:	Specification for voltage Transformer.
IS: 4146	:	Application guide for voltage Transformers.
IS: 2099/IS: 5621	:	Specification for bushings for alternating voltages above 1000 volts.
IS: 335	:	Specification for Insulating oil.
IS: 3024	:	Specification for Core Materials.
IEC: 60044-2	:	Specification for Voltage Transformer.

3.0 DEVIATION: Normally the offer should be as per the Technical Specification without any deviation. But any deviation felt necessary to improve performance, efficiency and utility of equipment must be mentioned in the deviation schedule with reasons duly supported by documentary evidence. Such deviation suggested may or may not be accepted by DoWR.

4.0 DESIGN & CONSTRUCTION OF POTENTIAL TRANSFORMERS: The design features and construction details shall be in accordance with the requirement stipulated hereunder;

i)	The PT shall be complete in all respects and shall conform to the modern practice of design and manufacture.		
ii)	The PT shall be electromagnetic, outdoor type, single phase, oil filled, self cooled, having shaded porcelain bushing as per IS: 2099 or Dry outdoor PT, suitable for operation under the service conditions without protection from sun, rain and dust.		
iii)	The maximum temperature rise at 1.1 times rated primary voltage, rated frequency and rated burden, shall not exceed the following values above stated maximum ambient temperature.		
	Class of Insulation		Max tem rise °C
	A	For winding with class A insulation immersed in oil (measured by resistance method)	50°C
	B	Oil at the top of the tank	40°C

		(measured by Thermometer)	
	C	With 1.5 times rated voltage for 30 seconds	10°C more than above value after contentious application of 1.1 times rated voltage
	D	Max. ambient temp to be considered	50°C
	E	For Dry type	55°C above ambient of 50°C
IV)	The PT shall be capable to withstand line discharge effect and also the ferro resonance effect.		
V)	The PT shall be suitable for up right mounting on steel structure.		
VI)	The PT shall be complete with accessories like primary terminals, terminal connectors		
VII)	Oil immersed PT, shall be provided with class A insulation and Dry type shall have minimum class A insulation or better. Oil type PT shall be hermetically sealed type construction to prevent air & moisture from entering the tank.		
VIII)	The core of the PT shall be high grade non-aging, silicon laminated steel of low hysteresis loss and highly permeability to ensure high accuracy at normal and over voltages confirming to IS: 3024.		
IX)	PT Characteristics shall be such as to provide satisfactory performance for burdens ranging from at least 25% to 100% of the rated burden over a range of at least 5% to 110% rated voltage in case of protective cores and voltage range of 80% to 129% (0.8lagging) in case of measuring core.		
X)	The PT secondary terminals shall be brought out through fuse of suitable rating in weather poof terminal box for easy access.		

5.0 BUSHING (applicable for oil immersed type):

- a) Shaded porcelain bushing confirming to latest edition of IS:5621 & IS:8603 shall be used for PT
- b) Cast metal end caps for the bushings shall be of high strengths & made of Brass. They shall have smooth surface to prevent discharge taking place between metal parts and porcelain as a result of ionization.
- c) The insulation of bushing shall be co-ordinate with that of potential transformer such that the flash over, if any will occur only external to the PT.
- d) Each of the Bushing cap/ head shall be complete with the following features: Primary terminals suitable for connection through rigid connectors for AAAC/ ACSR Conductor.
- e) Oil level gauge and convenient means of oil and nitrogen filling, sampling and draining of oil is to be provided in the tank.

6.0 INSULATING OIL: (applicable for oil immersed type)

The quality of insulating oil for filling of complete unit shall comply in all respect with provisions of the latest edition of IS:335.

7.0 GROUING TERMINALS: Two grounding terminals on diagonally opposite sides of adequate size suitable for connecting MS Flat of size 50mmx 6 mm shall be provided. HV Nutral Terminal earthing and body earthing should be marked distinctly and be physically well separated. The terminal of high voltage winding intended to be earthed shall be brought out through a bushing, insulated from case or frame to be earthed by separate arrangement (Through link).

8.0 TERMINAL CONNECTOR:

- a) All casting of connectors shall be free from holes, surface blisters, cracks and cavities.
- b) No part of the connector shall be less than 10 mm thick.
- c) All ferrous parts shall be hot dip galvanized confirming to IS: 2633.
- d) Rigid connectors shall be made from Aluminum Alloy.
- e) All current carrying parts of the connectors shall have minimum contact resistance.
- f) Connector shall be suitable for connection with AAAC 100, 148 & 232 mm².

9.0 SECONDARY TERMINAL BOX:

- i. All secondary terminals shall be brought out in a compartment on one side of each PT.
- ii. The terminal box shall be provided with removable cable gland plates at the bottom of the mounting cable glands suitable for 1.1 KV grade steel wire armoured, PVC insulated 3Cx 2.5 sq. mm stranded copper conductor cables.
- iii. The terminal box shall be provided with cover in front so as to have easy access of secondary terminals. The cover shall have sealing/locking arrangement and shall be suitable to prevent ingress of moisture and rain water. The degree of protection shall not be less than IP-55 as per IS; 2147.
- iv. All terminals shall be clearly marked with identification number to facilitate connection to external wiring in accordance with relevant IS.

10. PAINING:

- a) The tank and top metallic parts shall be hot-dip galvanized/ painted. All steel surfaces shall be cleaned by sand blasting or chemical proccess as required to produce smooth surface, free from scale, grease and dirt.
- b) Steel surface in contact with insulating oil shall be painted with heat resistance oil insoluble insulating varnish.

11. TESTS AT FACTORY AND TEST CERTIFICATES:

- i. Each PT shall comply with the requirement of routine test as per specified in the relevant Part (I to III) of IS: 3156 and IS: 4146.

12. SPECIFIC TECHNICAL PARAMETERS OF 33 KV PT:

SL. No.	DESCRIPTION	33 KV
1	Rated System Voltage KV (rms)	33
2	Highest System Voltage (rms)	36
3	System Frequency (HZ)	50
4	System Neutral earthing	Rigid earthed
5	Installation	Out door
6	Voltage variation	10%
7	Rated insulation Level	
	1.2/50 microsecond impulse withstand voltage KV (peak)	170
	One minute. Dry power frequency withstand voltage KV (rms)	3 KV
8	Power frequency over voltage withstand requirements for secondary winding	3 KV
9	Creep age distance (mm)	900
10	Accuracy	PT shall be of accuracy class 0.5 for metering and 3P for protection as per IS;3156/IEC 186, 60044-2
11	Ratio	
	Primary side (KV)	33/ $\sqrt{3}$
	Secondary side (V)	110/ $\sqrt{3}$
	No. Core	2
	Rated Burden [For metering per phase (VA)]	100
	Rated Burden [For Protection per phase (VA)]	100

GUARANTEED TECHNICAL PARTICULARS
(To be filled up by the Tenderer)

1.	Name of the Manufacturer		
2.	Rated Primary Voltage		
3.	Rated Secondary Voltage		
	Winding-I		
	Winding-II		
4	Volt factor and Duration		
5	Rated burden and accuracy Class		
	Core-I		
	Core-II		
6	Temperature Rise:		
	With 1.2 times rated primary volt continuously		
	By resistance method		
	BY thermocouple/ thermometer		
7	Rated Insulation Level:		

	With 1.2/50 micro sec. Impulse withstand voltage on primary side		
	1 minute power frequency withstand voltage (dry) on primary side		
	1 minute power frequency withstand voltage (wet) on primary side		
	1 minute power frequency withstands voltage on secondary side.		
8	Minimum Creepage distance (mm)		
	Whether PT is hermetically sealed or not (for oil type PT only)		
	Name of Dry Inert Gas (for oil type PT only)		
9	Whether Pressure Release Valve Provided (For oil type PT only)		
10	Characteristics:		
	Ratio & Phase angle error		
11	Total Weight		
12	Weight of oil (For oil type)		
13	Overall dimensions		
14	Mounting details		
15	Drawing & Literatures		
16	Test reports		
17	Deviation sheet		
18	Applicable standards		

CHAPTER-9**TECHNICAL SPECIFICATION FOR 33 KV CURRENT TRANSFORMERS****1.0 SCOPE:**

This specification covers the design, engineering, manufacture, inspection, assembly, packing, and forwarding & FOR destination and testing at manufacture's works for outdoor type 33 KV current transformers as per the schedule of requirement.

2.0 STANDARD:

The current transformers shall comply in all respects with latest issues of IS: 2705 (part-I, II, III & IV)-1992.

3.0 CLIMATIC CONDITIONS:

1	Maximum ambient air temperature (shade).	50 ⁰ C
2	Maximum daily average air temperature	35 ⁰ C
3	Maximum yearly average ambient air temperature	30 ⁰ C
4	Maximum temperature attainable by a body exposed to the sun.	50 ⁰ C
5	Max. altitude above mean sea level (Meters)	Not exceeding 1000
6	Minimum ambient air temperature	5 ⁰ C
7	Maximum relative humidity.	100%
8	Minimum number of rainy days per annum	70
9	Average number of rainy days per annum	120
10	Average annual rain fall.	150 cm
11	Number of months of tropical monsoon conditions	4
12	Maximum wind pressure.	260 Kg./ m ²
13	Degree of exposure to atmospheric pollution	Normal

4.0 TYPE & RATING:

4.1 The current transformers shall be outdoor type, single phase suitable for 3 phase, 33 KV solidly earthed system under the climatic conditions specified above.

4.2 The rating and other electrical characteristics shall be as follows:

33 KV transformer CTs of ratio 200-100/1-1-1 amp /300-150-75/1-1-1

		Core-I	Core-II	Core-III
I	Purpose	REF	Back up (O/C)	E/F
II	Primary current rating	200-100 Amp	200-100 Amp	200-100 Amp
III	Secondary current rating	1.0 A	1.0 A	1.0 A

IV	Rated burden	-	15 VA	15 VA
V	Accuracy class	PS	0.5	5P
VI	Accuracy limit factor	PS	10	10
VII	Min. knee point voltage & CT secondary Res. At 75 ⁰ C	To be governed by relation $V_k = 90(R_{ct} + 0.5)$. R_{ct} = Resistance of secondary winding at 75 ⁰ C	-	-
VIII	Max. Exciting current	Not exceeding 75 mm at $V_k/2$ where V_k is the minimum knee point voltage	-	-

[Note: 1. Restricted earth fault protection is not required for T/F having the capacity of 5 MVA & below. 2. For 33 KV transformers for single breaker controlling two transformers up to 2x 1 MVA, the CT ratio shall be 200-100/1-1-1]

4.3 33 KV Line CTs of Ratio 300-150-75/1Amp or 200/100/1 Amp. [Purpose:- Composite over current/Earth fault protection & ammeter]

I	Primary current rating	300-150-75 Amps
ii	Secondary current rating	1 Amp
iii	Accuracy class	5P
iv	Accuracy factor	10
V	Rated burden	20 VA

4.4 Highest system voltage	36 KV
4.5 Normal system voltage	33 KV
4.6 Frequency	50 HZ + 3% and – 5%
4.7 1.2 /50 Micro second impulse withstand voltage	170 KV (Peak)
4.8 One minute power frequency with stand voltage	70 KV (rms)
4.9 Short time current rating	25 KA for 3 sec.
4.10 Dynamic peak current	40 KA
4.11 Max temp. rise in terms of clause 7.2 of IS: 2705 (part-I)-1992	50 ⁰ C
4.12 Creepage distance	900 mm

5.0 GENERAL: The current transformer shall be single phase oil immersed and self cooled type for services indicated and complete in all respects confirming to the modern practice of design and manufacture.

5.1 The core shall be high grade, non ageing electric silicon lamination steel of low hysteresis loss and high permeability to ensure high accuracy at both normal and over current.

5.2 The current transformer shall be hermetically sealed to eliminate breathing and prevent air and moisture from entering into tank. These shall be provided with oil level gauge and suitable means in form of pressure release device shall be provided to relieve abnormal internal pressure.

5.3 All exposed ferrous parts shall be either hot dip galvanized conforming to latest IS: 2633 or painted with corrosion resistive paints.

6.0 WINDING:

6.1 The rating & accuracy of the secondary winding shall be as specified. The secondary terminals shall be brought out in weather proof terminal box, having an open on one side of CT for each access. The terminal box shall have provision for suitable sealing & the same shall be temper-proof. Facility shall be provided for short circuiting and grounding the CTs secondaries at the terminal box. The secondary taps shall be adequately reinforced to withstand normal handling without damage.

6.2 Earthing of CTs to be provided as specified at 5.2 of IS: 2705 (Part-I)-1992.

6.3 Terminal and polarity marks shall be legibly marked on each CT and all the lead terminations at the associated terminals and polarity marks shall be in accordance with relevant IS.

6.4 Each CT shall be provided with rating & connection diagram plate showing the particulars as required by relevant IS.

7.0 MARKING: In order to facilitate shorting and erection at site, every part of the equipment shall be suitably marked. The markings on the rating plate shall carry all the particulars specified in clauses 6.2 & 6.2.2 of IS: 2705/1992, Part-I and clause 5 of IS: 2705 of IS: 2705/1992 (Part-IV) or equivalent IEC where applicable.

8.0 PACKING: All material shall be suitably packed for transportation and contractor shall be responsible for all damages/ losses due to improper packing.

9.0 INSULATION OIL: The oil shall be a type normally marked in India and shall conform to the requirement of IS: 335-1993 (Latest addition) or equivalent IEC The oil required for first filling of each CT shall be included in the scope of supply.

10.0 TYPE & MOUNTING: The current transformers shall be suitable for mounting on RCC or Steel structures. Necessary flanges bolts etc for base of CT shall be supplied and these shall be galvanized.

11.0 TERMINAL CONNECTORS: Suitable terminal connectors for connecting ACSR conductor and/or AAAC 232 sq.mm shall be supplied. Suitable terminal earth connectors for earthing connection shall also be provided. The terminals shall be such as avoid bimetallic action.

12.0 TESTS: Each CT shall comply with the type test stipulated in latest edition of IS: 2705 (Part-I,II,III & IV). The reports of all type test and other tests conducted shall be supplied along with the bid documents. Type test reports should not more than 5 years old reckoned from date of bid opening. The type tests should be got carried out from the Govt / Govt approved test house as per relevant ISS.

13.0 INSPECTION: All tests and inspection shall be made at the place of manufacture unless otherwise especially agreed upon by the manufacturer and the purchaser at the time of purchase. The purchaser has the right to get the tests carried out at his own cost by independent agency, whenever there is dispute regarding the quality of supply.

14.0 DRAWINGS: The tendered should submit with his bid, dimensioned drawings of the equipment offered along with illustrated and descriptive literature. Magnetization covers for each of the core CTs should be furnished with tender.

15.0 SPARE PARTS: A list of spare part recommended for 5 years operation for each CT shall be furnished with the tender.

16.0 DEVIATIONS FROM SPECIFICATIONS: Any deviation from this specification shall be clearly brought out separately. In the absence of any specific mention, it shall be implied that the equipment offered is entirely according to this specification.

17.0 COMPLETENESS OF EQUIPMENT: Any fittings, accessories or apparatus which might not have been specifically mentioned in this specification, but which are usual and necessary shall deemed to have included in the contract and shall be supplied by the supplier without any extra charges. All plants and equipment shall be complete in all details whether such details have mentioned in this specification or not.

GUARANTEED TECHNICAL PARTICULARS FOR 33 KV OUTDOOR CURRENT TRANSFORMERS.

Sl. No.	Description	200-100/ 1-1-1 A	200-100/1-1 A	Bidder's Offer
1	Name and address of the Manufacture			
2	Manufacture's type designation			
3	Standards applicable	As Per IS- 2705/1992		
4	Rated frequency (HZ)	50 HZ		
5	Rated Voltage (KV)	33 KV		
6	Rated current (A)	200-100/ 1-1-1 A	200-100/1-1 A	
6.1	Rated extended primary current (A)	120% of rated primary current		
6.2	Rated extended primary current (A)			
7	Short time thermal current withstand for 3 secs (KA)	25ka for 3sec		
8	1.2/50 micro second impulse withstand voltage (KA _p)	170		
9	One minute dry and wet power frequency withstand voltage (KV rms)	70		
10	No. of cores per CT	3	2	
11	Transformation Ratio	33 KV		
12	Rated output at all ratios for metering core (VA)	15	15	
13	Accuracy class	0.5	0.5	
14	Minimum Knee point voltage at different taps for all 'PS' class cores (V)	400		
15	Instrument security factor at different ratios.	5	5	
16	Whether auxiliary CT provided for metering winding			
17	Corona extinction voltage (KV rms)			
18	Total creepage distance (mm)			
19	Primary			
19.1	No. of primary turns			
19.2	Material and cross- section of primary (mm ²)			
19.3	Whether bar type or ring type primary?			
20	Whether CT is suitable for transportation horizontally?			
21	Percentage current (ratio) error and phase displacement in minutes at rated burden and at:			
21.1	20% rated current	As Per IS-2705/1992		

21.2	120% rated current			
22	Quantity of oil per CT (Litres)			
23	Standard to which oil conforms generally.	As per IS- 335		
24	Characteristics of oil (prior to filling)	As per IS- 335		
24.1	Breakdown voltage (KVrms)			
24.2	Dielectric dissipation constant (tan delta)			
24.3	Water content (ppm)			
24.4	Gas content			
24.5	Interfacial tension at 27°C (N/m)			
24.6	Specific resistance			
24.6.1	At 90°C (W cm)	As per IS- 335		
24.6.2	At 27°C (W cm)			
25	Whether current transformers are hermetically sealed, if so, how?	Yes		
26	Total weight (Kg)			
27	Transport weight (Kg)			
28	Temperature rise over an ambient temperature of 50°C for continuous operation at rated continuous thermal current.	40°C		
28.1	Winding	40°C		
28.2	Oil	35°C		
28.3	External surface of the core, metallic parts in contact with or adjacent to insulation.	40°C		
29	Whether CT characteristic curves enclosed	Yes/No		
29.1	Ratio and phase angle curve	Yes/No		
29.2	Magnetization curves	Yes/No		
29.3	Ratio correction factor curves	Yes/No		
30	DATA ON PRIMARY WINDING			
30.1	Rated Primary Current (A)	200-100 A	200-100 A	
30.2	No. of conductors in one turn	1	1	
30.3	No. of turns of primary wdg.			
30.4	Material of the primary conductors	Electrical grade copper		
30.5	Size of the primary conductor (Bare/ Insulated (mm x mm)			
30.6	Cross- sectional area of primary winding (mm ²)			
30.7	Total cross- section area of primary winding (mm ²) conductors.			
30.8	Current density (A/mm ²)			

	i) At highest ratio			
	ii) At intermediate ratio			
	iii) At lowest ratio			
30.9	Short circuit current density (A/mm ²)			
	i) At highest ratio			
	ii) At intermediate ratio			
	iii) At lowest ratio			
30.10	Ampere- turn of primary (AT)			
	i) At highest ratio			
	ii) At intermediate ratio			
	iii) At lowest ratio			
31	CORE			
31.1	Metal and grade of the core	CRGO M3 or Better		
31.2	Thickness of core laminations (mm)	0.23 mm		
31.3	Net Iron cross-sectional area of core (mm ²)			
31.3.1	Core-1			
31.3.2	Core-2			
31.3.3	Core –3			
31.4	Mean magnetic path length			
31.4.1	Core-1			
31.4.2	Core-2			
31.4.3	Core-3			
31.5	Whether furnished B-H curve for the core material used? (B-wb/m ² , H-AT/cm)			
31.6	Whether specific loss vs. flux density graph for the core material used furnished?			
31.7	Weight of the core (kg)			
31.7.1	Core-1			
31.7.2	Core-2			
31.7.3	Core-3			
32	SECONDARY WINDING			
32.1	Rated secondary current(A)			
32.2	Material of the secondary windings	Electrolytic Copper		
33	INSULATION			
33.1	Name and class of insulating materials between core and secondary winding.	Polyster B / Crape Paper A, Oil A		
33.2	Name/s of Insulating materials between secondary winding and primary windings.	Crape Paper A, Oil A		
33.3	Insulating materials used to achieve grading of capacitance	Crape Paper A, Oil A		

34	DIAMETER OF WINDINGS			
34.1	Inside/outside diameter of secondary windings (mm)			
34.1.1	Core-1			
34.1.2	Core-2			
34.1.3	Core-3			
34.2	Inside/outside diameter of primary windings (mm)			
34.3	Minimum clearance of primary from tank (mm)			
34.4	Minimum clearance of secondary from tank (mm)			
35	TERMINAL CONNECTOR			
35.1	Manufacturer's name			
35.2	Applicable standard	IS- 5561		
35.3	Type			
35.4	Material of connector			
35.5	Clamp body			
35.6	Bolts and Nuts			
35.7	Spring washers			
35.8	Rated current (Amp)			
35.9	Rated terminal load (Kg)	---		
35.10	Factor of safety	---		
35.11	Minimum thickness of any part (mm)			
35.12	Weight of clamp complete with hardware (kg)			
35.13	Type test reports as per IS enclosed.	Yes/No		
35.14	OGA drawing enclosed.	Yes/No		
36	INSULATOR			
36.1	Manufacturer's name			
36.2	Type			
36.3	Applicable standard	As per IS 2099		
36.4	Height (mm)			
36.5	Diameter (top) (mm)			
36.6	Total creepage distance (mm)	900mm		
36.7	Rated Voltage (KV)	33KV		
36.8	Power frequency withstand voltage for 1 min. dry and wet. (KV-rms)	70 KV		
36.9	1.2/50 μ sec impulse withstand voltage (KVp)	170 KVP		
36.10	Corona extinction voltage (KV rms)	As per IS- 2099		
36.11	Weight (kg)	.		
36.12	Maximum allowable span (mm)			
36.13	Cantilever strength (kg)	As per IS- 2099		
36.14	The drawing enclosed.	Yes/No		

37	Dielectric dissipation factor at 36/1.732 KV (33KV C.T) and 12/1.732 KV (12KV CT) at ambient temperature.	As per IS- 2099	
38	Accuracy class of standard C.T. to be used towards determination of ratio errors and phase angle errors for metering cores.	0.05	

CHAPTER – 10
TECHNICAL SPECIFICATION FOR 33 kV MS CROSS-ARMS

1.0 'V' SHAPE M.S. CROSS ARM WITH CLAMPS

- 1.1 X-arms shall be made out of 100 x 50 x 6 mm and 75 x 40 x 6 mm M.S.Channel.
- 1.2 The cross arm shall be hot dipped galvanized generally conforming to IS –2633/72.
- 1.3 The X-arm should not be welded/ jointed at any place except as specified.
- 1.4 The clamps for the X-arm shall be of G.I. & shall be hot dipped galvanized generally conforming to IS – 2633/72.
- 1.5 The clamps shall be designed to fit for the specified rail & PSC poles.

2.0 Shape & Size

- 2.1 The cross arms shall be of MS channel.
- 2.2 The cross arms shall have two holes of 26 mm dia for fixing of pin insulators. The center- to-centre distance between the holes shall be 1525 mm and holes shall be in the middle of the top width of cross arm.
- 2.3 If required by the owner, holes of specified size and spacing shall also be provided for fixing of pole back clamp to suit the pole.

3.0 Marking

The following information shall be marked on each cross arm:

- a) Manufacturer's name or trademark.
- b) Year of manufacture

CHAPTER–11**TECHNICAL SPECIFICATION FOR 33KV PORCELAIN PIN INSULATORS SUITABLE FOR 33 KV OVER HEAD LINE.****1. SCOPE:**

This specification covers the details regarding design, manufacture and supply of the porcelain Insulators for use on 33KV Overhead Lines.

2. GENERAL REQUIREMENTS:

- 2.1 The porcelain shall be sound, free from defects, thoroughly vitrified and smoothly glazed.
- 2.2 The glaze shall be BROWN in colour. The glaze shall cover all the porcelain parts of the insulators except those areas, which serve as supports during firing or are left unglazed for the purpose of assembly.
- 2.3 The design of the Insulators shall be such that stresses due to expansion and contraction in any part of the insulators shall not lead to deterioration. The porcelain shall not be engaged directly with hard metal.
- 2.4 Cement used in the construction of the Insulator shall not cause fracture by expansion or loosening by contraction and proper care shall be taken to locate the individual parts correctly during cementing. The cement shall not give rise to chemical reaction with metal fittings and its thickness shall be as uniform as possible.
- 2.5 Metal parts made of any other metal/alloy having composition other than specified in respect of different items shall not be acceptable under any circumstances.

3. MARKING:

- 3.1 Each insulator shall be legibly and indelibly marked to show the following: -
 - (a) Name and trade mark of the manufacturer.
 - (b) Month and year of manufacturer.
 - (c) Minimum failing load in KN
 - (d) Country of manufacturer.
- 3.2 Insulators may also be marked with ISI certification marks, if any.
- 3.3 Marking on porcelain shall be printed and shall be applied before firing.

4. PACKING:

All Insulators shall be packed in wooden crates suitable for easy but rough handling and acceptable for rail/road transport. Where more than one insulator is packed in a crate, wooden separators shall be fixed between the Insulators, to keep individual Insulators in position without movement within the crate.

5. SALIENT FEATURES:**5.1 33 KV PIN INSULATORS:****5.1.1 APPLICABLE STANDARD:**

Unless otherwise stipulated in this specification, the insulators shall comply with the Indian Standard specification IS: 731-1971 or its latest version thereof.

5.1.2 CLASSIFICATION:

These insulators shall conform to Type 'B' of ISI: 731-1971.

5.1.3 BASIC INSULATION LEVELS:

- (a) The Basic insulation levels of the insulators are given as under in Table- 'A'.

TABLE – ‘A’

Highest system voltage KV (rms.)	Visible discharge test KV (rms.)	Wet power withstand KV (rms.)	Power frequency puncture withstand test KV (Peak)	Impulse voltage withstand test KV (Peak)
1.	2.	3.	4.	5.
36	27	75	180	170

(b) In this specification, power frequency voltages are expressed as peak divided by $\sqrt{2}$ and impulse voltage are expressed as Peak values.

(c) The withstand and flashover voltages are referred to the reference atmospheric conditions specified in IS: 731-1971 or the latest version thereof.

5.1.4 MECHANICAL FAILING LOAD:

(a) 33 KV Pin Insulator shall be suitable for a minimum failing load of 10 KN.

5.1.5 CREEPAGE DISTANCE:

The minimum creepage distance is given below in Table- ‘B’.

TABLE – ‘B’

Highest System Voltage (KV)	Normal and moderately polluted atmosphere (Total)
1.	2.
36	580 mm.

5.1.6 TESTS:

The Insulators shall simply to all the type routine and acceptance tests as per latest edition of IS: 731-1971 and its amendment thereof, if any.

They shall furnish along with the Bid attested Photostat copy of the latest certificate for all the Type Tests from Govt. tests house/recognized laboratory of repute along with the Drawing duly certified by the testing authorities in accordance with the ISS.

5.1.7 GUARANTEED TECHNICAL PARTICULARS:

The contractor shall furnish the guaranteed technical particulars in the proforma enclosed.

6. DRAWING:

The bidders are required to submit drawing of the Insulator indicating all dimensional details and materials used in different parts of the Insulators along with their tender.

THIMBLE:

The Pin hole for 33 KV Pin Insulators shall be completed with cemented Zinc or Lead thimble and shall be suitable for receiving a steel headed galvanized pin, the dimensions of which shall be as per Fig., 1 ref L & B ref. of IS: 2486 part-II 1974 and its latest amendment thereof.

GUARANTEED TECHNICAL PARTICULARS FOR 33 KV PORCELAIN PIN INSULATORS

Sl. No.	Name of Firm/ Particulars.	
1.	Maker's name	
2.	Electrical characteristics of Insulators	
(a)	Nominal system voltage.	
(b)	Highest system voltage	
(c)	Visible discharge voltage	
(d)	Dry one minute power frequency withstand voltage	
(e)	Wet one minute power frequency withstand voltage.	
(f)	Power frequency puncture withstand voltage.	
(g)	Impulse (1.2/50 Micro second wave) withstand voltage.	
(h)	Impulse flashover (1.2/50 Micro second wave) withstand voltage.	
	Positive	
	Negative	
(i)	Wet power frequency flashover voltage.	
3.	Mechanical characteristics of Insulator.	
(a)	Minimum failing load	
(b)	Minimum creepage distances.	
4.	Colour of Glaze	
5.	Standard according to which Pin Insulators shall be manufactured and tested.	
6.	Size of Insulators	
(a)	Height	
(b)	Overall outside diameter.	
7.	Minimum weight per unit.	
8.	Packing particulars.	
(a)	Weight of each package (App.)	
(b)	Number of Insulators in each package.	
9.	Tolerance in dimension, if any.	
10.	Other particulars, if any.	

CHAPTER – 12**SPECIFICATION FOR 33 KV G.I. PINS WITH NUT FOR 33 KV PIN INSULATORS****1. SCOPE**

This specification covers the design, manufacture, testing, supply and delivery of G.I. Pins for 33 kV Pin Insulators suitable for use on 33 kV Over Head Power Lines.

2. APPLICABLE STANDARD:

Except when they conflict with the specific requirements in the specification the Pins shall comply with the Indian Standard Specification IS: 2486 (Part-I) 1971, IS: 2486 (Part-II & III) 1974 or the latest version thereof.

3. GENERAL REQUIREMENT:

The pins shall be of single piece obtained preferable by the process of forging. These shall not be made by joining, welding, shrinks fitting of any other process from more than one piece of material. These shall be of good finish free from flaws and other defects. The finish of the collar shall be such that a sharp angle between the collar and the shank is avoided.

3.1.1 G.I. PINS FOR 33 KV PIN INSULATORS:

Pins with large steel head type L300 N as per figure 1B(ref. L) of IS: 2486 (Part-II) having stalk length 300 mm and shank length 150 mm with minimum failing load of 10 KN shall be used.

Weight of a G.I. Pin including nut and washer shall not be less than 2.80 kg. They shall be screwed into a thimble of equivalent component fixed in the pin hold of insulators. The complete details of pin are given in Drawing ESPC-III/5/90 (Figure-1) for 33 kV Pin (enclosed).

3.1.2 The nuts provided with the Pins shall be hexagonal and threads and nuts shall be with worth type throughout.**3.2 SUITABILITY**

The pins shall be so as to match with the Pin Insulators as per IS: 731-1971 or its latest version thereof.

4. MATERIAL**4.1** The Pins shall be made of forged steel conforming to clause '2' of IS: 2004-1970 or its latest version thereof.**4.2** The nuts shall be made of material conforming to property class '4' of IS: 1367 (Table-12).**4.3** Spring washers shall be made of spring steel.**4.4** For galvanizing, Zinc conforming to grade Zn 98 of IS: 209-1966 shall be used.**5. GALVANISING**

The pins, spring washers and nuts shall be not dip galvanized including the threaded portion of the pin with the exception of female threads of nuts which shall be out after galvanism and shall be protected from rust by means of greasing. The hot dip galvanizing shall be done conforming to IS: -1985 or its latest edition if any and shall also fulfill the requirements of IS: 2633-1977, 1984 or latest edition, if any in respect of uniformity, thickness and weight of zinc coating. The galvanizing should be uniform so as to give smooth finish.

6. TESTING

The Pins shall be subjected to all the tests as per IS:2486 (Part-I) IS:2486 (Part-II) and Galvanizing test as per IS:2629, IS:2633 and IS:4759 and material test as per IS:2004 and IS:288 as enumerated below: -

(i) **ACCEPTANCE TEST**

- (a) Checking of threads of heads.
- (b) Galvanizing Tests.
- (c) Mechanical Tests

To be carried out by inspection team on each lot offered.

(ii) **ROUTINE TESTS**

- (a) Visual examination test shall be carried out as routine test.

Certificate of having done routine test to be submitted alongwith each offer of inspection for a particular lot.

7. **MARKING**

The pins shall be legible and invariable marked / embossed with trade mark of the manufacturer.

8. **PACKING**

The packing of the Pins shall be done in rail worthy double gunny bags. The heads and threaded portion of pins shall be properly protected against damage. The gross weight of each packing will not normally exceed 50 kg.

9. **TOLERANCE**

± 2.5% in dimension only. No (-) tolerance is permitted in minimum guaranteed weight.

10. **GUARANTEED TECHNICAL PARTICULARS**

The guaranteed technical particulars are given in proforma enclosed.

GUARANTEED TECHNICAL PARTICULARS FOR 33 KV G.I. PINS

SI No.	Name of Firms/ Particulars	Bidder's OFFER
1	2	3
1	Maker's name and Address	
2	Standard to which the pins conform	
3	Minimum failing load	
4	Type of steel head	
5	Length of thread portion in the shank	
6	Galvanizing shall conform to IS: 2633 – 1964 and zinc confirming to grade Zn –98 of IS: 209 – 1966 had to be used	
7	Shank Length	
8	Minimum weight of the pin	
9	Tolerance in dimensions	
10	Marking as per specification	
11	Other particulars, if any	
12	Packing	

CHAPTER – 13**TECHNICAL SPECIFICATIONS FOR 33 KV PORCELAIN POST INSULATORS SUITABLE FOR 33 KV
OVERHEAD POWER LINES**

1. GENERAL REQUIREMENT:
 - 1.1 The porcelain shall be sound, free from defects, thoroughly vitrified and smoothly glazed.
 - 1.2 The glaze shall be BROWN in colour. The glaze shall cover all the porcelain parts of the insulators except those areas, which serve as supports during firing or are left unglazed for the purpose of assembly.
 - 1.3 The design of the Insulators shall be such that stresses due to expansion and contraction in any part of the insulator shall not lead to deterioration.
2. MARKING:
 - 2.1 Each insulator shall be legibly and indelibly marked to show the following:-
 - (a) Name and trade mark of the manufacturer.
 - (b) Month and year of manufacture.
 - (c) Minimum failing load in KN (except in case of 33 KV Post Insulators).
 - (d) Country of manufacturer.
 - 3.2 Insulators may also be marked with ISI certification marks, if any.
 - 3.3 Marking on porcelain shall be printed and shall be applied before firing.
4. PACKING:
 - 4.1 All Insulators shall be packed in wooden crates suitable for easy but rough handling and acceptable for rail/road transport.
 - 4.2 33 KV Post Insulators (2×22 KV pedestal types)
 - 4.2.1 Applicable Standard:

Unless otherwise stipulated in this specification the insulators shall comply with the IS: 2544.
 - 4.2.2 Classification:

These Insulators shall conform to Type-B of IS: 2544.
 - 4.2.3 Precaution shall be taken during design and manufacture to avoid retention of water in the recesses of metal fittings. Also shapes which do not facilitate easy cleaning by normal method shall be avoided.
 - 4.2.4 The threads of the tapped holes in the Post Insulators metal fittings shall be cut after giving anticorrosion protection and shall be protected against rust by greasing or other similar means; all other threads shall be cut before giving anticorrosion protection. The tapped holes shall be suitable for bolts with threads having anticorrosion protection and shall conform to IS: 4218 (Part-I to IV). The effective length of thread shall not be less than the nominal diameter of the bolt.
 - 4.2.5 The post insulator unit shall be assembled in a suitable jig to ensure the correct positioning of the top and bottom metal fittings relative to one another. The faces of the metal fittings shall be parallel and at right angles to the axis of the insulators and corresponding holes in the top and the bottom metal fittings shall be in a vertical plane containing the axis of the insulators.
 - 4.2.6 The cap and pedestal shall be of malleable cast iron properly cemented. The malleable cast iron parts shall be hot dip galvanized as per IS: 2629 and shall also fulfill requirements of IS:

2633 in respect of uniformity, thickness and weight of Zinc coating. The galvanizing shall be uniform so as to give smooth surface finish. The top metal cap shall be provided with 4 nos. tapped holes of 12 mm diameter and 16 mm depth having with worth threads .The base of the pedestal shall be provided with 4 nos. holes of 15 mm diameter & 76 mm PCD. The thickness of the base shall not be less than 11 mm.

4.2.7 The Basic Insulation Level:

The basic insulation levels should comply with;

Table – ‘A’ (IS: 2544- Table-1)

Highest System voltage KV (rms)	Visible discharge test KV (rms)	Wet power frequency with stand units KV (rms)	Power frequency puncture with stand test on test KV (rms)	Impulse voltage withstand KV (rms)
1	2	3	4	5
36	27	75	1.3 times the actual dry flashover voltage of the unit	170

4.2.8 Mechanical Characteristics:

The minimum mechanical strength value of the outdoor pedestal post insulators shall not be less than the value specified below: -

Cantilever strength: -

- (i) Upright: 450 Kg.
- (ii) Inverted: 340 Kg.

4.2.9 Creep age Distance:

The minimum creep age distance shall be 760 mm as specified for PA 170 Post Insulator in Table ‘5’ of IS: 5350 (Para-III 1971).

4.2.10 Tests:

The insulators shall comply with all type routine and acceptance test as per latest edition of IS: 2544. Supplier shall furnish attested Photostat copy of the latest type tests certificates for all tests in accordance with the ISS from Govt / recognized laboratory of repute along with the Drawings duly certified by the Testing authorities.

5.0 GUARANTEED TECHNICAL PARTICULARS FOR POST INSULATOR.

Sl. No.	Particulars.	
I.	Makers Name	
1.	Standard according to which Post Insulators shall be manufactured and tested.	
II.	Electrical characteristics of Insulators	
(a)	Nominal system voltage.	
(b)	Highest system voltage	
(c)	Visible discharge voltage	
(d)	Dry one minute power frequency withstand voltage	
(e)	Wet one minute power frequency	
(f)	Power frequency puncture withstand voltage.	
(g)	Impulse (1.2/50 Micro second wave) withstand voltage.	
(h)	Impulse flashover (1.2/50 Micro second wave) withstand voltage.	
(i)	Positive	
(ii)	Negative	
(i)	Dry flashover voltage	
(j)	Wet flashover voltage.	
III.	Mechanical characteristics of Insulator.	
(a)	Minimum failing load	
(i)	Upright	
(ii)	Inverted	
(b)	Minimum creepage distances.	
IV.	Colour of Glaze	
V.	Minimum weight of insulators as per latest type test report	
VI.	Dimensions	
(a)	Height	
(b)	Overall outside diameter.	
(c)	Top metal fitting pitch circle dia	
(d)	Bottom metal fitting pitch circle dia	
VII.	Fixing arrangement	
(i)	Pitch circle dia top and bottom metal fittings	
(ii)	No. of holes	
(iii)	Dia of holes	
(iv)	Depth of holes	
(v)	Thickness of base	
VIII.	Packing particulars.	
(a)	Type of packing	
(b)	Dimension of each crate	
(c)	No. of insulators in each package	
(d)	Weight of each crate	
IX.	Other particulars, if any	

CHAPTER – 14**TECHNICAL SPECIFICATION FOR DISC FITTING (T&C TYPE) 45 KN FOR OVERHEAD LINES****1. SCOPE:**

This specification covers the design, manufacturing, testing, supply and delivery of disc fitting suitable for use on high tension overhead power lines.

2. APPLICABLE STANDARD:

Unless otherwise stipulated in this specification the disc fitting shall comply with the latest edition of IS: 2486 (Part-I) 1993 and IS: 2486 (Part-II&III) 1979 or their latest version.

3. GENERAL REQUIREMENTS:

All forgings and casting shall be of good finish and free from flaws and other defects. The edges on outside of the fittings such as at the eye, clevis and holes shall be rounded.

All parts of different fittings which provides inter connection, shall be made such that sufficient clearance is provided at the connection point to ensure free movement and suspension of the insulator string assembly. All eye and clevis connection shall be free in such a manner that too much clearance between eye and tongue of the clevis is avoided.

All ferrous fittings and the parts other than those of stainless steel shall be hot dip galvanized in accordance with IS: 2669/1985 and IS: 6745/1972 or its latest edition if any and shall also fulfill the requirements of IS: 2633/1986 and 4759/1996 or their latest editions in respect of uniformity, thickness and weight of Zinc coating. The galvanizing should be uniform so as to give smooth finish. Small fitting parts like spring washer, nuts etc., shall also be hot dip galvanized.

4. MATERIAL:

The material for the string insulator fittings shall be such that it gives the required mechanical strength with specified dimensions. The following materials for particular type of fitting may be used.

- (a) Mild steel conforming to IS: 1570/1961
- (b) Forged steel conforming to IS: 2004/1970.
- (c) Malleable iron conforming to IS: 2108/1962.
- (d) Aluminum alloy (for clamps only). Preferably the composition of the Aluminum Alloy shall be declared by the manufacturer giving reference to the relevant Indian standard.

NOTE: - strain clamps of aluminum alloy only shall be acceptable. No other material composition except Aluminum alloy be acceptable for strain clamps.

Security clips and split pins shall be of phosphor bronze conforming to IS: 1385 of suitable temper with minimum hardness of 100HV conforming to IS: 410.

Cotter pins and Bolts shall be made of forged steel conforming to class 2 of IS: 2004.

All nuts shall be made of material conforming to proper class 4.8 of IS: 1367 with regard to its mechanical properties.

Spring washer shall be made of spring steel;

Plain washer shall be made of mild steel conforming to IS: 1570.

For galvanizing, Zinc conforming to grade Zn 98 of IS: 205, 1966 shall be used.

5.1 TENSION FITTING (T & C) TYPE 45 KN:

- 5.1.1 The fitting shall be suitable for use with tongue and clevis type 11 KV Disc Insulators having E.M., strength of 4500 Kg. Conforming to IS: 2486 Part-II and IS: 731.

5.1.2 The fittings shall comprise of the following parts.

- (i) A set of cross arm straps complete with one 16 mm dia bolt, one spring washer, one nut and split pin suitable for fitting to cross arm channel having flanges 125 mm apart on one side and to the clevis on the other side as per fig., 26 of IS: 2486 (Part-II).
- (ii) Set of clevis cum snail type strain clamp complete with keeper having 'U' Bolt of 10 mm diameter, nuts, plain washer, spring washer etc., and cotter bolt with drawing as per drawing enclosed. The clevis arrangement shall be as per fig. 25 of IS: 2486 (Part-II). The clamp shall be accommodating ACSR conductor up to size 80 mm² (ACSR Raccoon Conductor). The slip strength of the strain clamp shall not be less than 90% of the breaking strength of the conductor for which fitting are to be used.

5.1.3 The minimum failing load of complete disc fitting as well as that of clevis cum snail type strain clamp shall not be less than 4500 kgs. When tested in accordance with IS:2486 (Part-I)/1971.

6.0 INSPECTION TESTING:

Material shall be inspected and tested at the manufacturers' works / at stores of DoWR to verify that these are being supplied in accordance with technical specification guaranteed technical particular and approved drawing, if any.

All instruments used in inspection and testing should be properly calibrated and sealed once a year. Calibration certificate when demanded by the inspecting officer shall be produced for verification purpose. In case of any dispute regarding calibration of instrument, instrument shall be sealed and signed by representative of the supplier and purchaser and will be sent to institution / laboratory of repute & govt. approved as decided by purchaser for calibration at the cost of the supplier. The result of such testing shall be binding on supplier.

7.0 TESTS:-

Disc fitting shall comply with all type, routine and acceptance tests as per IS: 2486 (Part-I)/Part-II or their latest amendment. They shall furnish all attested Photostat copy of latest type test certificate for the test in accordance with ISS from Govt. test house/recognized laboratory of repute along with certified copy of drawing with their offer. **The type test should be conducted within five years from the date of opening of tender.**

7.1 ACCEPTANCE TESTS:-

Acceptance tests as per relevant ISS (as per ISS: 2486 Part –I or their latest amendment) shall be carried out in the presence of inspection team for each lot offered.

7.2 ROUTINE TESTS:

Routine tests as per relevant ISS (as per ISS: 2486 Part-II or their latest amendment) shall be submitted along with every offer for inspection.

8.0 The firm shall also submit along with their offer:-

- (a) Test certificates for the items offered for the test showing the respective drawing duly signed by the testing laboratory authorities.
- (b) Detailed drawing of each item offered indicating the material composition, dimension etc.
- (c) Bill of materials for each items offered.

9.0 MARKING:

The tension clamp of the fittings shall be legibly and invariably embossed with the trademark of manufacturer & DoWR..... and sl. no. from 1 to last no of supply.

10.0 PACKING;

The packing of the fittings shall be done in rail worthy double gunny bags. The Gross weight of each packing shall not normally exceed 50 Kg.

11.0 TOLERANCES:

($\pm$) 2.5% in dimensions only ($\pm$ 1 mm for dimensions less than 2.5mm).

12.0 GUARANTEED TECHNICAL PARTICULARS :

The bidders shall fill in the guaranteed technical particular in Performa enclosed as per schedule.

SL. No.	Name of Firms/Particulars	
1	2	3
1	Manufacturer's Name	
2	Type	
3	Ultimate strength	
4	Whether dimension other than specified are in accordance to IS: 2486	
5	MATERIAL USED & REFERENCE TO STANDARD	
	(i) Cross arm snail type	
	(ii) Clevis arm snail type	
	(iii) Slit pin	
	(iv) Nuts	
	(v) Coulter Pins and bolts	
	(vi) Spring Washer	
	(vii) Plain Washer	
	(viii) Zinc confirming to grade	
6	WEIGHT PER SET	
	(i) Gross weight of complete fitting	
	(ii) Weight of clamp	
	(iii) Weight of Nuts and Bolt & rivets	
	(iv) Weight of cross Arm straps	
	(v) Weight of ferrous parts	
	(vi) Minimum guaranteed weight of complete fitting	
	(vii) Whether galvanized conform to IS: 2633 – 1964	
7	PACKING DETAILS	
	(i) Net weight	
	(ii) Gross Weight	
	(iii) Contents of each pack	
	(iv) Type of packing	
8	Tolerance in dimensions, if any	

CHAPTER – 15**TECHNICAL SPECIFICATION: 20 MM DIA BLACK STAY SETS FOR 33 KV LINES
(NONE GALVANIZED, NOT-PAINTED):**

AVERAGE WEIGHT OF FINISHED STAY SETS: 7.922 Kg. (Minimum)

(EXCLUDING NUTS, THIMBLES & WASHERS): 8.699 Kg. (Maximum)

1. The stay sets (Line Guy set) will consist of the following components:-
 - i) Anchor rod with one washer and nuts: Overall length of rod should be 1800mm to be made out of 20mm MS rod, one end threaded up to 40mm length with pitch of 4 threads per cm and provided with one square MS washer of size 50x50x1.6mm and one MS Hexagonal nut conforming to IS:1367/1967 and IS:1363/1967. Both washer and nut to suit the threaded rod of 20mm dia. The other end of rod to be made into a round are having an inner dia of 40mm with best quality welding.
 - ii) Anchor Plate Size 300x300x8mm: To be made out of MS plate of 8mm thickness. The Anchor plate should have at its center 22mm dia hole.
 - iii) Turn Buckle: (a) Eye bolt with 2 nuts: To be made of 20mm dia MS Rod having an overall length of 450mm. One end of rod to be threaded up to 300mm length of pitch of 4 threads per cm. The 20mm dia bolt so made shall be provided with two MS Hexagonal nuts of suitable size conforming to IS:1637/1967 & IS:1363/1967. The other end of rod shall be rounded into a circular eye of 40 mm inner dia with proper and good quality welding.
(b) Bow with welded angle: To be made out of 20mm dia MS Rod. The finished bow shall have an overall length of 995mm and height of 450mm. The apex or top of the bow shall be bent at an angle of 10 R. The other end shall be welded with proper and good quality welding to a MS Channel 200mm long having a dimension of 100x50x4.7mm. The channel shall have 2 holes of 18mm dia and 1.22mm dia hole at its centre.
 - iv)Thimble: 2 Nos to be made on 1.5mm thick MS sheet into a size of 75x22x40mm.
2. WELDING:
The minimum strength of welding provided on various components of 20mm dia stay sets shall be 4900Kgs. Minimum 6mm fillet weld or its equivalent weld area should be deposited in all positions of the job i.e. at any point of the weld length. The welding shall be conforming to relevant IS: 823/1964 or its latest amendment. Welding if found short in lengths or not done properly as required shall be rejected.
3. THREADING:
The threads on the Anchor Rod, Eye Bolt and Nuts shall be as per specifications IS: 4218/1967(ISO Metric Screw Threads). The nuts shall be conforming to the requirement of IS: 1367/1967 & have dimensions as per IS: 1363/1967. AVERAGE WEIGHT OF FINISHED STAY SETS: 14.523 Kg. (Minimum). (EXCLUDING NUTS, THIMBLES & WASHERS): 15.569 Kg. (Maximum).
TEST CERTIFICATE: The supplier shall be required to furnish the test certificates from Govt./Recognized testing laboratory giving result of following tests along with the inspection report of material of first lot in individual size separately.
Tensile load of 3100Kg/4900Kg applied for one minute on the welding & maintained for one minute for 16 mm & 20 mm dia Stay Sets respectively.
In view of non-submission of above test certificates inspection report shall not be acceptable.

IV. IDENTIFICATION MARK:

All stay sets should carry the identification mark of the manufacturer. For this, the firm must engrave identification mark of about 3 capital letters as advised in the order. This should be engraved on the stay plate and possible on stay rods to ensure proper identification of the material. On account of this, no extra charges will be paid.

V. The nuts should be a size compatible with the threaded portion of rods and there should be no play or slippage of nuts.

VI. Welding wherever required should be perfect and should not give way after erection.

II. TOLERANCES:

The tolerances for various components of the stay sets are indicated below subject to the condition that the average weight of finished stay sets of 16 mm and 20mm dia excluding nuts & thimbles and washers shall not be less than the weight specified above:-

SL. NO.	Item	Section Tolerance	Fabrication tolerance	Material
1	Anchor plate	6 mm thick (+12.5%,-5%) 8mm thick (+12.5%,-5%)	200x200 mm (+1%), 33x300 mm (+1%)	MS plate 6mm MS plate 8 mm
2	Anchor rod	16mm dia (+5%, -3%), 20mm dia (+3%,-2%),	Length 1800mm (+5%), Round wire 40mm inside Threading 40mm + 11% - 5%	MS Rod 16 mm MS Rod 20 mm
3	Turn Buckle	16mm dia + 5%	Length 995mm	MS Round 16mm
4	Eye Bolt Rod	16mm dia + 5% 20mm dia + 3%	Length 450mm, Threading 300mm+1%, Round Eye 40mm inside dia +3%. Threading 300mm+1% Round Eye 40mm inside dia +3%.	MS Rod 16 mm MS Rod 20 mm

CHAPTER – 16**TECHNICAL SPECIFICATION FOR PORCELAIN DISC INSULATORS 70 KN (B&S TYPE) FOR 33 KV
OVERHEAD POWER LINES.****1. SCOPE:**

This specification covers the details regarding design manufacture and supply of the porcelain insulator for use on Overhead Power Lines.

2. GENERAL REQUIREMENTS:

The porcelain shall be sound, free from defects, thoroughly vitrified and smoothly glazed.

The glaze shall be brown in color. The glaze shall cover all the porcelain parts of the insulator except those areas, which serve as supports during firing or left unglazed for the purpose of assembly.

The design of the insulators shall be such that stresses due to expansion and contraction in any part of the insulator shall not lead to deterioration. The porcelain shall not engage directly with the hard metal.

Cement used in the construction of the insulator shall not cause fracture by expansion or loosening by contraction, and proper care shall be taken to locate the individual parts correctly during cementing. The cement shall not give rise to chemical reaction with metal fittings and its thickness shall be as uniform as possible.

3. MARKING:

3.1 Each insulator shall be legibly and indelibly marked to show the following:

- (a) Name of Trade Mark of the manufacturer.
- (b) Month and year of manufacture.
- (c) Minimum failing load in KN.
- (d) Country of manufacture.

3.2 Insulators may also be marked with ISI certification marks, if any.

3.3 Markings on porcelain shall be printed and shall be applied before firing.

4. PACKING:

All insulators shall be packed in wooden crates suitable for easy but rough handling and acceptable for Rail / Road transport. Where more than one insulator is packed in a crate, wooden separators shall be fixed between the insulators to keep individual insulator in position, without movement within the crates.

5. SALIENT FEATURES:

DISC INSULATORS:

5.5.1 APPLICABLE STANDARDS:

Unless otherwise stipulated in this specification, the insulator shall comply with the Indian Standard specification, IS: 731-1971 or its latest version thereof.

5.1.2 CLASSIFICATION:

The insulators shall conform to Type 'B' of IS: 731-1971.

5.1.3 BASIC INSULATION LEVEL:

- a. The basic insulation levels of the insulators are given as under in table 'A'

TABLE 'A'

Highest system voltage KV (rms.)	Visible discharge test voltage KV (rms.)	Wet power frequency withstand voltage. KV (rms.)	Power frequency puncture withstand test voltage. KV (Peak)	Impulse voltage withstand test. KV (Peak.)
1.	2.	3.	4.	5.
12	9	35	105	75

- b. In this specification, power frequency voltage is expressed as peak divided by $\sqrt{2}$ and impulse voltage is expressed as peak value.
- c. The withstand flashover voltage are referred to the atmospheric conditions specified in IS: 731-1971 and the latest version thereof.

5.1.4 **MECHANICAL FAILING LOAD:**

11 KV Insulators Ball and Socket type 70 KN shall be suitable for minimum failing load of 70 KN.

5.1.5 **CREEPAGE DISTANCE:**

The minimum creepage distance shall be given here under in Table 'B'.

Table 'B'

Highest system voltage (KV)	Normal and moderately polluted atmosphere (total)
12	230 mm.

5.1.6 **BALL & SOCKET ARRANGEMENT DESTINATION & MATERIAL.**

The ball and Socket arrangement to be provided in the disc Insulation shall be of designation 16 mm alternatively 'B' for 70 KN EMS having dimensions as per table of figure-8 for pin balls and as per table of figure -9 for socket provided in the latest edition of IS: 2486 (Part-II).

The figure or ball and socket arrangement shall be black heart malleable cast iron conforming to latest edition of IS: 2108 and shall be hot dip galvanised as per latest edition of IS: 2629 and shall fulfill the requirement of IS: 2633. The metal parts shall be such that it gives the required mechanical strength with specified dimensions and it shall be in accordance with latest edition of IS: 2486 (Part-I).

6. **TESTS:**

The insulators shall comply with all the type, Routine and Acceptance tests as per latest editions of IS: 731-1971 and amendment thereof, if any.

They shall furnish attested Photostat copy of the latest certificate for all the type tests in accordance with the ISS from Govt. test house/recognized laboratory of repute along with the drawing duly certified by the testing authorities.

6.1 **TYPE TEST:**

- Visual examination.
- Verification of Dimensions.
- Visibly discharge Tests.
- Impulse voltage withstand test.
- Wet power frequency withstand test.
- Temperature Cycle Test.

- (g) Mechanical failing load Test.
- (h) Puncture Test.
- (i) Porosity Test.

6.2 **ACCEPTANCE TESTS:**

- (a) Verification of Dimensions.
- (b) Temperature Cycle Test.
- (c) Mechanical failing load Test.
- (d) Puncture Test.
- (e) Porosity Test.

To be carried out in the presence of inspection Team on each lot offered.

6.3 **ROUTINE TEST:**

- (a) Visible examination Test.
- (b) Electrical Routine Test.

To be submitted along with each offer of inspection for a particular lot and its record to be maintained at your works. This record may be available to the inspection team on their request.

7. **Guaranteed Technical Particulars (G.T.P.):**

The material shall conform to the Guaranteed Technical particulars, required to be filled in the annexed proforma.

GUARANTEED TECHNICAL PARTICULARS FOR DISC INSULATORS 70 KN (B&S)

Sl. No.	Name of Firm / Particulars.		
1.	Name of Manufacturer.		
2.	Electrical characteristics of Insulators		
(a)	Nominal system voltage.	KV	
(b)	Highest system voltage	KV	
(c)	Visible discharge voltage	KV	
(d)	Dry one minute power frequency withstand voltage	KV	
(e)	Wet one minute power frequency withstand voltage.	KV	
(f)	Power frequency puncture withstand voltage.	KV	
(g)	Impulse (1.2/50 Micro second wave) withstand voltage.	KV	
(h)	Impulse flashover (1.2/50 Micro second wave) withstand voltage.		
(i)	Positive	KV (Peak)	
(ii)	Negative	KV (Peak)	
(i)	Wet power frequency flashover voltage.	KV	
3.	Mechanical characteristics of Insulator.		
(a)	Minimum failing load/EMS	KN	
(b)	Minimum creepage distances.	mm.	

4.	Colour of Glaze	Brown	
5.	Standard according to which porcelain Insulators shall be manufactured & tested		
6.	Size of Insulators		
(a)	Height	Mm	
(b)	Overall outside diameter.	Mm	
7.	Minimum weight per unit as per latest type test report..	Kg.	
8.	Packing particulars.		
(a)	Weight of each package (Approx.)	Kg.	
(b)	Number of Insulators in each package.	Nos.	
9.	Tolerance in dimension, if any.		

CHAPTER – 17

TECHNICAL SPECIFICATION FOR CONTROL & RELAY PANEL

TYPE OF PANELS

1.1 Simplex Panel

Simplex panel shall consist of a vertical front panel with equipment mounted thereon and having wiring access from rear for control panels & either front or rear for relay panels. In case of panel having width more than 800mm, double leaf-doors shall be provided. Doors shall have handles with either built in locking facility or will be provided with pad-lock.

All the equipments/ Relays/CTs/PTs to be installed / housed in the Air insulated panel, must be type tested & from short listed approved vendors. Dimension of Type Tested equipments are only be accepted.

1.2 CONSTRUCTIONAL FEATURES

(i) Control and Relay Board shall be of panels of simplex type design as indicated in bill of quantity. It is the responsibility of the contractor to ensure that the equipment specified and such unspecified complementary equipment required for completeness of the protective/control schemes is properly accommodated in the panels without congestion and if necessary, provide panels with larger dimensions. No price increase at a later date on this account shall be allowed. However, the width of panels that are being offered to be placed in existing switchyard control rooms, should be in conformity with the space availability in the control room.

(ii) Panels shall be completely metal enclosed and shall be dust, moisture and vermin proof. The enclosure shall provide a degree of protection not less than *IP-52* in accordance with IS: 2147.

(iii) Panels shall be free standing, floor mounting type and shall comprise structural frames completely enclosed with specially selected smooth finished, cold rolled sheet steel of thickness not less than 3 mm for weight bearing members of the panels such as base frame, front sheet and door frames, and 2.0mm for sides, door, top and bottom portions. There shall be sufficient reinforcement to provide level transportation and installation.

(iv) All doors, removable covers and panels shall be gasketed all around with neoprene gaskets. Ventilating louvers, if provided shall have screens and filters. The screens shall be made of either brass or GI wire mesh.

(v) Design, materials selection and workmanship shall be such as to result in neat appearance, inside and outside with no welds, rivets or bolt head apparent from outside, with all exterior surfaces tune and smooth.

(vi) Panels shall have base frame with smooth bearing surface, which shall be fixed on the embedded foundation channels/insert plates. Anti vibration strips made of shock absorbing materials that shall be supplied by the contractor, shall be placed between panel & base frame.

(vii) Cable entries to the panels shall be from the bottom. Cable gland plate fitted on the bottom of the panel shall be connected to earthing of the panel/station through a flexible braided copper conductor rigidly.

1.3 MOUNTING

- (i) All equipment on and in panels shall be mounted and completely wired to the terminal blocks ready for external connections. The equipment on front of panel shall be mounted flush. No equipment shall be mounted on the doors.
- (ii) Equipment shall be mounted such that removal and replacement can be accomplished individually without interruption of service to adjacent devices and are readily accessible without use of special tools. Terminal marking on the equipment shall be clearly visible.
- (iii) Contractor shall carry out cut out, mounting and wiring of the free issue items supplied by others which are to be mounted in his panel in accordance with the corresponding equipment manufacturer's drawings. Cut outs if any, provided for future mounting of equipment shall be properly blanked off with blanking plate.
- (iv) The center lines of switches, push buttons and indicating lamps shall be not less than 750mm from the bottom of the panel. The center lines of relays, meters and recorders shall be not less than 450mm from the bottom of the panel
- (v) The center lines of switches, push buttons and indicating lamps shall be matched to give a neat and uniform appearance. Likewise the top lines of all meters, relays and recorders etc. shall be matched.
- (vi) No equipment shall be mounted on the doors.
- (vii) At existing station, panels shall be matched with other panels in the control room in respect of dimensions, colour, appearance and arrangement of equipment (center lines of switches, push buttons and other equipment) on the front of the panel.

1.4 PANEL INTERNAL WIRING

- (i) Panels shall be supplied complete with interconnecting wiring provided between all electrical devices mounted and wired in the panels and between the devices and terminal blocks for the devices to be connected to equipment outside the panels. When panels are arranged to be located adjacent to each other all inter panel wiring and connections between the panels shall be furnished and the wiring shall be carried out internally.
- (ii) All wiring shall be carried out with 650V grade, single core, stranded copper conductor wires with PVC insulation. The minimum size of the multi stranded copper conductor used for internal wiring shall be as follows:
 - All circuits except current transformer circuits and voltage transfer circuits meant for energy metering - one 1.5mm sq. per lead.
 - All current transformer circuits one 2.5 sqmm lead.
 - Voltage transformer circuit (for energy meters): Two 2.5 sqmm per lead.
- (iii) All internal wiring shall be securely supported, neatly arranged, readily accessible and connected to equipment terminals and terminal blocks. Wiring gutters & troughs shall be used for this purpose.
- (iv) Auxiliary bus wiring for AC and DC supplies, voltage transformer circuits, annunciation circuits and other common services shall be provided near the top of the panels running throughout the entire length of the panels.
- (v) Wire termination shall be made with solder less crimping type and tinned copper lugs, which firmly grip the conductor. Insulated sleeves shall be provided at all the wire terminations. Engraved core identification plastic ferrules marked to correspond with panel wiring diagram shall be fitted at both ends of each wire. Ferrules shall fit tightly on the wire and shall not fall off when the wire is disconnected from terminal blocks. All wires directly connected to trip circuit breaker or device shall be distinguished by the addition of red coloured unlettered ferrule.

(vi) Longitudinal troughs extending throughout the full length of the panel shall be preferred for inter panel wiring. Inter-connections to adjacent panel shall be brought out to a separate set of terminal blocks located near the slots of holes meant for taking the inter-connecting wires.

(vii) Contractor shall be solely responsible for the completeness and correctness of the internal wiring and for the proper functioning of the connected equipments

1.5 TERMINAL BLOCKS

(i) All internal wiring to be connected to external equipment shall terminate on 'Elmex' type CAT-M4 or equivalent type terminal blocks. Terminal blocks shall be 650 V grade and have 10 Amps continuous rating, moulded piece, complete with insulated barriers, stud type terminals, washers, nuts and lock nuts. Markings on the terminal blocks shall correspond to wire number and terminal numbers on the wiring diagrams. All terminal blocks shall have shrouding with transparent unbreakable material.

(ii) Disconnecting type terminal blocks for current transformer and voltage transformer secondary leads shall be provided. Also current transformer secondary leads shall be provided with short circuiting and earthing facilities.

(iii) At least 20% spare terminals shall be provided on each panel and these spare terminals shall be uniformly distributed on all terminal blocks.

(iv) Unless otherwise specified, terminal blocks shall be suitable for connecting the following conductors of external cable on each side

- All CT & PT circuits: minimum of two of 2.5mm Sq. copper.
- AC/DC Power Supply Circuits : One of 6mm Sq. Aluminum.
- All other circuits: minimum of one of 2.5mm Sq. Copper.

(v) There shall be a minimum clearance of 250mm between the first row of terminal blocks and the associated cable gland plate or panel side wall. Also the clearance between two rows of terminal blocks edges shall be minimum of 150mm.

(vi) Arrangement of the terminal block assemblies and the wiring channel within the enclosure shall be such that a row of terminal blocks is run in parallel and close proximity along each side of the wiring-duct to provide for convenient attachment of internal panel wiring. The side of the terminal block opposite the wiring duct shall be reserved for the Owner's external cable connections. All adjacent terminal blocks shall also share this field wiring corridor. All wiring shall be provided with adequate support inside the panels to hold them firmly and to enable free and flexible termination without causing strain on terminals.

(vii) The number and sizes of the Owner's multi core incoming external cables will be furnished to the contractor after placement of the order. All necessary cable terminating accessories such as gland plates, supporting clamps & brackets, wiring troughs and gutters etc. (except glands & lugs) for external cables shall be included the scope of supply.

1.6 PAINTING

(i) All sheet steel work shall be phosphated in accordance with the IS:6005 "Code of practice for phosphating iron and steel".

(ii) Oil, grease, dirt and swarf shall be thoroughly removed by emulsion cleaning.

(iii) Rust and scale shall be removed by pickling with dilute acid followed by washing with running water rinsing with a slightly alkaline hot water and drying.

(iv) After phosphating, thorough rinsing shall be carried out with clean water followed by final rinsing with dilute dichromate solution and oven drying.

(v) The phosphate coating shall be sealed with application of two coats of ready mixed, stoved type zinc chromate primer. The first coat may be "flash dried" while the second coat shall be stoved.

(vi) After application of the primer, two coats of finishing, synthetic enamel paint shall be applied, each coat followed by stoving. The second finishing coat shall be applied after inspection of first coat of painting. The exterior colour of paint shall be of a slightly different shade to enable inspection of the painting.

(vii) A small quantity of finished paint shall be supplied for minor touching up required at site after installation of the panels.

(viii) In case the contractor proposes to follow any other established painting procedure like electrostatic painting, the procedure shall be submitted for Engr- In-Charge's review and approval.

1.7 MIMIC DIAGRAM

(i) Coloured mimic diagram and symbols showing the exact representation of the system shall be provided in the front of control panels.

(ii) Mimic diagram shall be made preferably of anodised aluminum or plastic of approved fast colour material, which shall be screwed on to the panel and can be easily cleaned. Painted overlaid mimic is also acceptable. The mimic bus shall be 2mm thick. The width of the mimic bus shall be 10mm for bus bars and 7mm for other connections.

(iii) Mimic bus colour will be decided by the Engr- In- Charge and shall be furnished to the successful contractor during Engineering.

(iv) When semaphore indicators are used for equipment position they shall be so mounted in the mimic that the equipment close position shall complete the continuity of mimic.

(v) Indicating lamp, one for each phase, for each bus shall be provided on the mimic to indicate bus charged condition.

1.8 NAME PLATES AND MARKINGS

(i) All equipment mounted on front and rear side as well as equipment mounted inside the panels shall be provided with individual name plates with equipment designation engraved. Also on the top of each panel on front as well as rear side, large and bold name plates shall be provided for circuit/ feeder designation.

(ii) All front mounted equipment shall also be provided at the rear with individual name plates engraved with tag numbers corresponding to the one shown in the panel internal wiring to facilitate easy tracing of the wiring.

(iii) Each instrument and meter shall be prominently marked with the quantity measured e.g. KV, A, MW, etc. All relays and other devices shall be clearly marked with manufacturer's name, manufacturer's type, serial number and electrical rating data.

(iv) Name Plates shall be made of non-rusting metal or 3 ply lamicaid. Name plates shall be black with white engraving lettering.

(v) All the panels shall be provided with name plate mounted inside the panel bearing LOA No & Date, Name of the Substation & feeder and reference drawing number.

1.9 MISCELLANEOUS ACCESSORIES

(i) Plug Point:

240V, Single phase 50Hz, AC socket with switch suitable to accept 5 Amps and 15 Amps pin round standard Indian plug, shall be provided in the interior of each cubicle with ON-OFF switch.

(ii) Interior Lighting:

Each panel shall be provided with a fluorescent lighting fixture rated for 240 Volts, single phase, 50 Hz supply for the interior illumination of the panel controlled by the respective panel door switch. Adequate lighting shall also be provided for the corridor in Duplex panels.

(iii) Switches and Fuses:

Each panel shall be provided with necessary arrangements for receiving, distributing and isolating of DC and AC supplies for various control, signalling, lighting and space heater circuits. The incoming and sub-circuits shall be separately provided with miniature circuit breakers (MCB). Selection of the main and sub-circuit MCB rating shall be such as to ensure selective clearance of sub-circuit faults. MCBs shall conform to IS :13947 . Each MCB shall be provided with one potential free contact and the same shall be wired for annunciation purpose. However voltage transformer circuits for relaying and metering shall be protected by fuses. All fuses shall be HRC cartridge type conforming to IS:13703 mounted on plug-in type fuse bases. . Fuse carrier base as well as MCBs shall have imprints of the fuse 'rating' and 'voltage'.

(iv) Space Heater:

Each panel shall be provided with a space heater rated for 240V, single phase, 50 Hz Ac supply for the internal heating of the panel to prevent condensation of moisture. The fittings shall be complete with switch unit.

1.10 EARTHING

(i) All panels shall be equipped with an earth bus securely fixed. Location of earth bus shall ensure no radiation interference for earth systems under various switching conditions of isolators and breakers. The material and the sizes of the bus bar shall be at least 25 X 6 sq.mm perforated copper with threaded holes at a gap of 50mm with a provision of bolts and nuts for connection with cable armours and mounted equipment etc for effective earthing. When several panels are mounted adjoining each other, the earth bus shall be made continuous and necessary connectors and clamps for this purpose shall be included in the scope of supply of Contractor. Provision shall be made for extending the earth bus bars to future adjoining panels on either side.

(ii) All metallic cases of relays, instruments and other panel mounted equipment including gland plate, shall be connected to the earth bus by copper wires of size not less than 2.5 sq. mm. The color code of earthing wires shall be green.

(iii) Looping of earth connections which would result in loss of earth connection to other devices when the loop is broken, shall not be permitted. However, looping of earth connections between equipment to provide alternative paths to earth bus shall be provided.

(iv) VT and CT secondary neutral or common lead shall be earthed at one place only at the terminal blocks where they enter the panel. Such earthing shall be made through links so that earthing may be removed from one group without disturbing continuity of earthing system for other groups.

1.11 INDICATING INSTRUMENTS

All instruments, meters, recorders and transducers shall be enclosed in dust proof, moisture resistant, black finished cases and shall be suitable for tropical use. All Watt /Var, Bus Voltage and Line current indicating instruments shall of Moving Iron (MI) type and these shall be calibrated to read directly the primary quantities. They shall be accurately adjusted and calibrated at works and shall have means of calibration check and adjustment at site. The supplier shall submit calibration certificates at the time of delivery. However no separate

transducers are envisaged for digital bus voltmeters and digital frequency meters and the indicating meters provided in the synchronising equipment.

(i) Indicating Instruments

- a. Unless otherwise specified, all electrical indicating instruments shall have circular scale and with a dial of 96mm x 96mm. They shall be suitable for flush mounting.
- b. Instruments dial shall be with white circular scale and black pointer and with black numerals and lettering. The dial shall be free from warping, fading, and discoloring. The dial shall also be free from parallax error.
- c. Instruments shall conform to IS: 1248 and shall have accuracy class of 5 or better. The design of the scales shall be such as to have resolution suitable for the application. The marking of centre zero Watt /Var meters shall be IMPORT (on left) and EXPORT (on right) to indicate the direction of active/reactive power flow towards or away from the substation bus bars respectively.

(ii) Energy Metering Instruments

- (a) Watt and Var hour meters shall be of static trivector type as per details given else.
- (b) Energy Meter shall be provided on all 33 and 11 kV feeders.

(iii) Annunciation System

- a. Alarm annunciation system shall be provided in the control board by means of visual and audible alarm in order to draw the attention of the operator to the abnormal operating conditions or the operation of some protective devices. The annunciation equipment shall be suitable for operation on the voltages specified in this specification.
- b. The visual annunciation shall be provided by annunciation facia, mounted flush on the top of the control panels.
- c. The annunciator facia shall be provided with translucent plastic window for alarm point with approximate size of 35mm x 50mm. The facia plates shall be engraved in black lettering with respective inscriptions. Alarm inscriptions shall be engraved on each window in not more than three lines and size of the lettering shall not be less than 5 mm.
- d. Each annunciation window shall be provided with two white lamps in parallel to provide safety against lamp failure. Long life lamps shall be used. The transparency of cover plates and wattage of the lamps provided in the facia windows shall be adequate to ensure clear visibility of the inscriptions in the control room having high illumination intensity (350 Lux), from the location of the operator's desk.
- e. All Trip facia shall have red colour and all Nontrip facia shall have white colour.
- f. The audible alarm shall be provided by Buzzer/ Hooter /Bell having different sounds and shall be used as follows. Hooter Alarm Annunciation Bell Annunciation DC failure Buzzer AC supply failure
- g. Sequence of operation of the annunciator shall be as follows:

SL.No.	Alarm Condition	Fault contact	Visual annunciation	Audiable Annunciation (by Hooter)
1	Normal	Open	Off	Off
2	Abnormal	Close	Flashing	On
3	Accept push button	Close	Steady on	Off

4	Reset push button is pressed	Open Close	Steady On	Off Off
5	Lamp test push button pressed	Open Open	Off Steady on	off off

h. Audible annunciation for the failure of DC supply to the annunciation system shall be provided and this annunciation shall operate on 240 Volts AC supply. On failure of the DC to the annunciation system for more than 2 or 3 seconds. (adjustable setting), a bell shall sound. A separate push button shall be provided for the cancellation of this audible alarm alone but the facia window shall remain steadily lighted till the supply to annunciation system is restored.

i. A separate voltage check relay shall be provided to monitor the failure of supply (240V AC) to the scheme mentioned in Clause above. If the failure of supply exists for more than 2 to 3 seconds. This relay shall initiate visual and audible annunciation. Visual and audible annunciation for the failure of AC supply to the annunciation system shall be provided and this annunciation shall operate on Annunciation DC and buzzer shall sound.

(iv) SWITCHES

a. Control and instrument switches shall be rotary operated type with escutcheon plates clearly marked to show operating position and circuit designation plates and suitable for flush mounting with only switch front plate and operating handle projecting out.

b. The selection of operating handles for the different types of switches shall be as follows:

Breaker, Isolator: Pistol grip, black control switches

Synchronizing: Oval, Black, Keyed handle switches (one common removable handle for a group of synchronizing switches or locking facility having common key).

Selector switches: Oval or knob, black Instrument switches: Round, knurled, black Protection Transfer: Pistol grip, lockable and switch black.

c. The control switch of breaker and isolator shall be of spring return to neutral type. The switch shall have spring return from close and trip positions to "after close" and "after trip" positions respectively.

d. Instrument selection switches shall be of maintained contact (stay put) type. Ammeter selection switches shall have make-before break type contacts so as to prevent open circuiting of CT secondary when changing the position of the switch. Voltmeter transfer switches for AC shall be suitable for reading all line- to-line and line-to-neutral voltages for non effectively earthed systems and for reading all line to line voltages for effectively earthed systems.

e. The contacts of all switches shall preferably open and close with snap action to minimize arcing. Contacts of switches shall be spring assisted and contact faces shall be with rivets of pure silver or silver alloy. Springs shall not be used as current carrying parts

f. The contact combination and their operation shall be such as to give completeness to the interlock and function of the scheme.

g. The contact rating of the switches shall be as follows:

Description	Contact rating Amps
24 v DC	10
Continuously make & carry	30
Break for: Revised load	20

(v) INDICATING LAMPS

- a. Indicating lamps shall be of multiple LED panel mounting type with rear terminal connections. Lamps shall have translucent lamp covers to diffuse lights coloured red, green, amber, clear white or blue as specified. The lamp cover shall be preferably of screwed type, unbreakable and moulded from heat resisting material.
- b. The wattage of the lamps shall be 5 to 10 watts for DC voltage of 24 Volt as well as 220 V AC.
- c. Lamps and its parts shall be interchangeable and easily replaceable from the front of the panel. Tools, if required for replacing the bulbs and lenses shall also be included in the scope of supply.
- d. The indicating lamps shall withstand 120% of rated voltage on a continuous basis.

(vi) Position Indicators

- a. Position indicators of "SEMAPHORE" type shall be provided when specified as part of the mimic diagrams on panels for indicating the position of circuit breakers, isolating/earthing switches etc. The indicator shall be suitable for semi-flush mounting with only the front disc projecting out and with terminal connection from the rear. Their strips shall be of the same colour as the associated mimic.
- b. Position indicator shall be suitable for DC Voltage as specified. When the supervised object is in the closed position, the pointer of the indicator shall take up a position in line with the mimic bus bars, and at right angles to them when the object is in the open position. When the supply failure to the indicator occurs, the pointer shall take up an intermediate position to indicate the supply failure.
- c. The rating of the indicator shall not exceed 2.5 W.
- d. The position indicators shall withstand 120% of rated voltage on a continuous basis.

1.12 Relays

- (i) All relays shall conform to the requirements of IS:3231/IEC-60255 or other applicable standards. Relays shall be suitable for flush or semi-flush mounting on the front with connections from the rear.
- (ii) All protective relays shall be of Numerical type housed in draw out or plug-in type/modular cases with proper testing facilities. Necessary test plugs/test handles shall be supplied loose and shall be included in contractor's scope of supply.
- (iii) All AC operated relays shall be suitable for operation at 50 Hz. AC Voltage operated relays shall be suitable for 110 Volts VT secondary and current operated relays for 5 amp CT secondary. All DC operated relays and timers shall be designed for the DC voltage specified, and shall operate satisfactorily between 80% and 110% of rated voltage. Voltage operated relays shall have adequate thermal capacity for continuous operation.
- (iv) The protective relays shall be suitable for efficient and reliable operation of the protection scheme described in the specification. Numerical relays, if provided, shall be provided with RS 485 port and be compatible for 'MODBUS' protocol. Necessary software for data down loading and analysis of stored data in Numerical relay shall be supplied on 'CD'. Software to be compatible to Windows XP or higher 'OS'.
- (v) Necessary auxiliary relays and timers required for interlocking schemes for multiplying of contacts suiting contact duties of protective relays and monitoring of control supplies and circuits, lockout relay monitoring circuits etc. also required for the complete protection schemes described in the specification shall be provided. All protective relays shall be provided with at least two pairs of potential free isolated output contacts. Auxiliary relays and timers

shall have pairs of contacts as required to complete the scheme, contacts shall be silver faced with spring action. Relay case shall have adequate number of terminals for making potential free external connections to the relay coils and contacts, including spare contacts.

(vi) All protective relays, auxiliary relays and timers except the lock-out relays and interlocking relays specified shall be provided with self-reset type contacts.

(vii) No control relay, which shall trip the power circuit breaker when the relay is de-energized shall be employed in the circuits.

(viii) Provision shall be made for easy isolation of trip circuits of each relay for the purpose of testing and maintenance.

(ix) Auxiliary seal-in-units provided on the protective relays shall preferably be of shunt reinforcement type. If series relays are used the following shall be strictly ensured :

(a) The operating time of the series seal-in-unit shall be sufficiently shorter than that of the trip coil or trip relay in series with which it operates to ensure definite operation of the flag indicator of the relay.

(b) Seal-in-unit shall obtain adequate current for operation when one or more relays operate simultaneously.

(c) Impedance of the seal-in-unit shall be small enough to permit satisfactory operation of the trip coil on trip relays when the D.C. Supply Voltage is minimum.

(x) All protective relays and alarm relays shall be provided with one extra isolated pair of contacts wired to terminals exclusively for future use.

(xi) The setting ranges of the relays offered, if different from the ones specified shall also be acceptable if they meet the functional requirements.

(xii) Any alternative/additional protections or relays considered necessary for providing complete effective and reliable protection shall also be offered separately. The acceptance of this alternative/ additional equipment shall lie with the Engr-In-Charge.

(xiii) The contractor shall include in his bid a list of installations where the relays quoted have been in satisfactory operation. All relays and their drawings shall have phase indications as R-Red, Y-yellow, B-blue

PROTECTION:

(a) Over current relay (two number) shall

- have directional IDMT characteristic with a definite minimum time of 3.0 seconds at 10 times setting and have a variable setting range of 50-200% of rated current
- have low transient, over reach high set instantaneous unit of continuously variable setting range 500-2000 % of rated current
- have a characteristic angle of 30/45 degree lead
- include hand reset flag indicators or LEDs.

(b) Earth fault relay shall

- have directional IDMT characteristic with a definite minimum time of 3.0 seconds at 10 times setting and have a variable setting range of 20-80% of rated current
- have low transient, over reach high set instantaneous unit of continuously variable setting range 200-800 % of rated current
- have a characteristic angle of 45/60 degree lag
- include hand reset flag indicators or LEDs
- include necessary separate interposing voltage transformers or have internal feature in the relay for open delta voltage to the relay

(xiv) Tripping Relay

High Speed Tripping Relay shall

- (a) be instantaneous (operating time not to exceed 10 milli-seconds).
- (b) reset within 20 milli seconds
- (c) be D.C. operated
- (d) have adequate contacts to meet the requirement of scheme, other functions like auto-reclose relay, LBB relay as well as cater to associated equipment like event logger, Disturbance recorder, fault Locator, etc.
- (e) be provided with operation indicators for each element/coil.

(xv) Flag Relays

These shall have

- (a) hand reset flag indication
- (b) have minimum two contacts (NO or NC or combination as required) for each relay

(xvi) Trip Circuit Supervision Relay

- (a) The relay shall be capable of monitoring the healthiness of each 'phase' trip-coil and associated circuit of circuit breaker during 'ON' and 'OFF' conditions.
- (b) The relay shall have adequate contacts for providing connection to alarm and event logger.
- (c) The relay shall have time delay on drop-off of not less than 200 milli seconds and be provided with operation indications for each phase.

(xvii) Dc Supply Supervision Relay

- (a) The relay shall be capable of monitoring the failure of D.C. supply to which, it is connected.
- (b) It shall have adequate potential free contacts to meet the scheme requirement.
- (c) The relay shall have a 'time delay on drop-off' of not less than 100 milli seconds and be provided with operation indicator/flag.

(xviii) RELAY TEST KIT

One relay test kit shall comprise of the following equipment as detailed here under

1 set Relay tools kits.

2 nos. Test plugs

1 no. Special type test plugs for using with modular type cases (if applicable)

1.13 COMMON INDICATION & ANUNCIATION PANEL**(HT SWITCHGEAR DC SUPPLY SYSTEM)**

A separate panel shall be provided for duplication of annunciation from 33kV indoor switchgear room. This annunciation shall be suitably wired up and properly integrated into the common annunciation system of the substation. All the annunciations considered important for remote monitoring from C&R room (by operating staff) shall be provided in the panel.

- i) Protection trip (feeder wise)
- ii) DC supply failure
- iii) LT AC supply Failure
- iv) Healthiness of 33KV BUS

This panel shall also have indication lamps for

- i) 33 kV Breaker status (On/Off)

Further this panel shall also have following annunciation facility for monitoring 110/50 V DC system

- i) Earth Fault in 110V DC-I/II
- ii) Charger trouble 110/50V-I/II

1.14 TYPE TESTS

(i) The following type tests shall be conducted on the Protective relays, Fault locator and, Disturbance recorder.

a) Insulation tests as per IEC 60255-5

b) High frequency disturbance test as per IEC

60255-4 (Appendix -E) -Class III (not applicable for electromechanical relays)

c) Fast transient test as per IEC 1000-4, Level III (not applicable for electromechanical relays)

d) Relay characteristics, performance and accuracy test as per IEC 60255

- Steady state Characteristics and operating time

- Dynamic Characteristics and operating time for distance protection relays and current differential protection relays

e) Tests for thermal and mechanical requirements as per IEC 60255-6

f) Tests for rated burden as per IEC 60255-6

g) Contact performance test as per IEC 60255-0- 20 (not applicable for Event logger, Distance to fault locator and Disturbance recorder)

(ii) Steady state & Dynamic characteristics tests on the relays (distance protection relays and current differential protection relays), as type test, shall be carried out based on general guide lines specified in CIGRE Committee 34 report on simulator/ network analyzer/PTL.

1.15 CONFIGURATION OF C&R PANELS

The following is the general criteria for the selection of the equipments to be provided in each type of panel. The details such as type of panels (Simplex/ Duplex), quantity of each type panels, number of bays for each voltage level for the purpose of bus bar protection, number of bays to be accommodated in each control panel etc shall be specified elsewhere (i.e. in " BILL OF QUANTITIES").

(i) CONTROL PANEL

Various types of control panels shall consist of the following

A	Ammeter	1 set	for each bay
B	Wattmeter	1 set	for each line, transformer
C	Var meter	1 set	for each bay, transformer,
D	CB control switch	1 no	for each bay breaker
E	Isolator Control switch	1 no	for each isolator
F	Semaphore	1 no	for each earth switch
G	Red indicating Lamp	1 no	for each Circuit breaker
H	Red indicating lamp	1 no	for each isolator
I	Green indicating lamp	1 no	for each Circuit breaker
J	Green indicating lamp	1 no	for each isolator
K	White indicating lamp	2 no	for each feeder
L	Annunciation windows with associated annunciation relays	10 no	for each feeder
M	Push button for alarm Accept/reset/lamp test	3 no	for each control panel

N	Mimic to represent SLD	Lot	In all control panel
O	Voltmeter with selector	1 no	For each line
P	Cut out, mounting and wiring for RWTI and selector switch	Lot	

Note:

- 1 For transformer feeders, all equipments of control panel shall be provided separately for HV and LV sides.
- 2 The above list of equipments mentioned for control panel is generally applicable unless it is defined elsewhere and in case of bay extension in existing substations, necessary equipments for matching the existing control panel shall be supplied.
3. Common synchronizing switch is also acceptable in Synchronizing trolley for new Substations. In this case, individual synchronizing selector switch is not required for each Circuit Breaker in control panel.
4. Each line /HV side of transformer/LV side of transformer/TBC shall be considered as one feeder for above purpose.

(ii) BREAKER RELAY PANEL

The breaker relay panel shall comprise of the following With A/R

DC supply Supervision relay: 2 no.

Trip circuit supervision relays: 6 nos.

Flag relays, aux. relays, timers, trip

relays etc as per scheme requirements : Lot

5 Bus frequency meter (Analog): 1 no. for each main bus with transducer

6 Bus voltmeter (Digital): 1 no. for each main bus

7 Bus frequency meter (Digital): 1 no. for each main bus

8 Bus healthy indication lamps: 3 nos. for each bus

CHAPTER – 18**TECHNICAL SPECIFICATION OF EARTHING COILS**

(MADE OF HOT DIP GALVANISED SOFT QUALITY – MILD STEEL WIRE 4 MM DIA)

1. Earthing coils shall be fabricated from soft GI Wire Hot Dip Galvanized. The Hot dip galvanized wire shall have clean surface and shall be free from paint enamel or any other poor conducting materials. The coil shall be made as per REC constructions standard J-1 (drawing enclosed). The Hot Dip Galvanizing shall conform to IS: 2629/1966, 2633/1972 and 4826/1979 with latest amendments, galvanizing should be heavily coated and should stand for the following tests:-
 - I. Galvanizing Test:
 - (i) Minimum Mass of Zinc:-
 - (a) ON GI Wire used 280 gm/m²
 - (b) After Coiling – 266 gm/m². The certificate from recognized laboratory should be submitted towards mass of zinc.
 - (ii) Dip test :- Shall stand 3 dips of 1 minute and one dip of ½ minute before coiling and 3 dips of 1 minute after coiling as per IS:4826/ 1979.
2. The Dimensional requirement:-
 - (a) Nominal dia of GI Wire 4 mm [Tolerance+ (-) 2.5%]
 - (b) Minimum number of turns – 115 nos.
 - (c) External dia of Coil (Min) – 50 mm,
 - (d) Length of Coil (Min) – 460 mm
 - (e) Free length of GI Wire at one end coil (Min) - 2500 mm.
3. The Turn should be closely bound.
4. Weight of one finished Earthing coil (Min) – 1.850 kg.
5. Adhesion Test: As per ISS 4826-1979

CHAPTER – 19**TECHNICAL SPECIFICATION FOR OUT DOOR TYPE, OIL IMMERSED DISTRIBUTION TRANSFORMERS
up to and including 2500 KVA, 33 KV- None sealed type****1.0 SCOPE**

This specification provides for the manufacturing, testing and supply of Distribution Transformer suitable for outdoor application having mandatory BIS certification. Transformers should be of Energy Efficiency Level-2.

2.0 STANDARDS

The transformer shall comply with **the latest revision of IS 1180 (part I): 2014** and with the relevant parts of standards mentioned below;

IS: 10561	Application guide for power transformers
IS-2026	Specification for Power Transformers
IS: 10028	Code of practice for selection, installation and maintenance of transformers
IS : 1866	Code of practice for maintenance and supervision of mineral insulating oil.
IS: 2099	Bushing for alternating voltages above 1000 V.
IS-7421	Specification of low voltage bushings
IS-6262	Method of test for power factor and dielectric constant of electrical insulating Liquids
IS: 335	New insulating oil for transformers.
IIS : 6600	Guide for loading of oil immersed transformers
IS : 3639	Fittings and accessories for power transformers.
IS: 2099	Bushings for AC voltage above 1000V
IS: 3637	Gas operated relays
CBI&P Publication	Manual on Transformers

The equipment covered under this specification shall comply with all the latest applicable statutory rules, regulations, acts and safety codes in force. Nothing in this specification shall be construed as to relieve the supplier of the responsibility for correctness of the design and construction of the equipment. All the standards being followed shall be listed out in the bid. Where any other standard is being followed, the copy of the same shall be provided with the bid.

3.0 SERVICE CONDITION

- 3.1 Ambient Air temperature: Minimum 5°C to Maximum 55°C with daily average ambient air temperature of 50° C.
- 3.2 Altitude: Maximum up to 1000 meters above MSL.
- 3.3 Humidity: Relative humidity maximum up to 100% during rainy season.
- 3.4 Location: outdoor.

4.0 DESIGN FEATURES/ TECHNICAL REQUIREMENTS:

- 4.1 The design of the transformers and accessories shall be in accordance with the latest standard practice and shall be such as to facilitate inspection, cleaning, repairs, maintenance and operation and shall ensure safety operations under situation of supply voltage fluctuation up to Plus 12.5% to minus 12.5%. These transformers shall be able to sustain starting impact of Induction motors used for Lift Irrigation.

4.2 **Technical requirements of Distribution Transformers:**

1	Rated KVA of Distribution Transformer (ONAN rating)	Std Ratings (KVA)	
	a) 33 KV/ .433KV	100 / 160 /200 /315 / 400 / 500/ 630/ 1000 / 1250 /1600	
	b) 6.6 KV/ .433 KV	100 /160 /200 /250/ 315 /400 / 500/ 630/ 1000 /1250/1600	
2	No. of Phases	3	
3	Type of Installation	Out door	
4	Frequency	50 HZ (-5% to + 3%)	
5	Cooling medium	Insulating oil (ONAN)	
6	Type of mounting	On wheels, mounted on rails	
7	Rated voltage:		
	a) High voltage winding:	33/.433 KV TRF	6.6/.433 KV
		33 KV	6.6 KV
	b) System voltage (Max)	36 KV	7.2 KV
	c) Low voltage winding	.433 KV	
8	No. Of windings	Two winding Transformers	
10	Type of cooling	ONAN (Oil natural & air natural)	
11	KVA rating corresponding to ONAN cooling system	100%	
12	Method of connection		
	HV:	Delta	
	LV:	Star (Neural Brought out)	
13	Connection symbol	Dyn – 11	
14	System of earthing	Neutral of LV side to be solidly earthed	
15	Percentage impedance at 75°C	As per IS 1180 (Part 1): 2014	
16	Intended regular cyclic overloading of windings of winding	As per IEC-76-1, Clause 4.2	
17	a) Anticipated unbalanced loading	Around 10%	
	b) Anticipated continuous loading of windings (HV/LV)	110% of rated current	
18	Type of tap changer	Off Load Type	
	Range of tapping	+ 5% to – 20% in steps of 5% each on HV winding, 7 tap positions. Tap No 3 will be the Principal tap position.	
19	Neutral terminal to be brought out	On LV side	
20	Overvoltage operating capability and duration	125% of rated voltage (Continuous)	
21	Maximum Flux Density in any part of the core and yoke at rated KVA, rated voltage and 50 HZ.	1.5 Tesla	

22	Insulation levels of Windings:-	33 KV	6.9 KV
	a) 1.2/50 microsecond wave shape Impulse withstand (KVP)	170	75
	b) Power frequency voltage withstand (KVms)	70	35
23	Type of winding Insulation		
	a) HV winding	Uniform	
	b) LV winding	Uniform	
24	Withstand time for three phase short circuit	As per IS	
25	Noise level at rated voltage & frequency	As per NEMA Publication	
26	Permissible Maximum temperature rise over ambient temperature of 50 ⁰ C		
	a) Of top oil measured by thermometer	35 ⁰ C	
	b) Of winding measured by resistance	40 ⁰ C	
27	Minimum clearance in air (mm):-	Phase to Phase	Phase to ground
	a) HV (For 33 KV TRF)	400	320
	b) HV(For 6.6 KV TRF)	280	140
28	Terminals:-		
	a) HV winding line end (For 33 KV TRF)	36 KV oil filled communicating type porcelain bushing (Antifog type)	
	b) HV winding line end (For 6.6 KV TRF)	17.5 KV porcelain type of bushing (Antifog type)	
29	Insulation level of HV bushing:-	33 KV TRF	6.6 KV TRF
	d) Lighting Impulse withstand(KVP)	170	95
	e) 1 minute Power frequency withstand voltage (KV-rms)	70	38
	f) Creep age distance(mm) (minimum)	900	300
30	Material for HV & LV conductor	Electrolytic copper	
31	Maximum current density for HV and LV winding for rated current at normal tap	2.4 A/ mm ²	
32	Polarisation Index i.e. ratio of Megger values at 600 sec. to 60 sec for HV to earth, L.V to earth and HV to LV	Shall be greater than or equal to 1.5.	
33	Core Assembly	Boltless	
34	Temperature Indicator		
	c) Oil	One number	
	d) Winding	One number	
35	Maximum permissible total losses at rated current at normal tap and at 75 ⁰ C	As guided by IS1180(Part I); 2014	

4.3 Mechanical Features

- a) The transformer shall be able to withstand the electro-dynamic stress due to terminal short circuit of the LV side assuming the HV side fed from an infinite bus. All leads, windings in cores shall be properly supported, clamped and tightened after vacuum drying to ensure the short circuit withstand ratings. The short circuit withstand duration shall be minimum 3 sec.
- b) The transformer shall be so designed as to minimize any undue noise and vibration.

5.0 CONSTRUCTIONAL DETAILS

5.1 Core:

- a) The transformer core shall be made of high grade non-ageing grain oriented cold rolled silicon steel lamination having low loss and good grain properties, coated with hot oil proof insulation. Lamination thickness should not be more than 0.23 to 0.27mm.
- b) The flux density in any part of cores and yoke at normal voltage and frequency shall not be more than 1.5 Tesla.
- c) For Transformer Manufacturer (TM), who has in-house core-cutting facility, the packed core coils shall be verified at their works as per followings along with witnessing of core- cutting.
 1. Invoice of supplier
 2. Test certificate
 3. Packing list
 4. Bill of lading
 5. Bill of entry certificate to customs
 6. Gross weight
 7. Net weight
 8. Grade & thickness of core material
- d) Preferably no bolt shall be used in the cores. Clamping shall be done externally to the limb. The core structure shall be securely grounded to prevent electrostatic potential. Lifting eyes and lugs shall be provided on the limbs and coils assembly.
- e) The design of the magnetic circuit shall be such as to avoid static discharges, development of short circuit paths within itself or to the earthed clamping structure and the production of flux component at right angles to the plane of lamination which may cause local heating.
- f) Cores and windings shall be capable of withstanding shocks during transport, installation & service and adequate provision shall be made to prevent movement of core and winding relative to tank during these conditions.
- g) The manufacturer shall furnish the exact type of core material, its BH curve, design flux density at normal tap and the source of procurement. The bidder should offer the core for stage inspection by the Owner through Third Party and approval during manufacturing stage.

5.2 Tanks:

- a) Tanks shall be of welded construction and fabricated from boiler steel plates. The minimum thickness of which shall be 6mm. for the side and 10mm for the bottom & cover for transformers with longer sides having a horizontal length up to but not exceeding 1800mm. For horizontal length above 1800 mm, the minimum side plate thickness shall be 10mm. and the thickness of bottom and cover plate shall be 12mm.
- b) All seams and joints those are not required to be opened at site shall be factory welded and wherever possible they shall be double welded.
- c) All joints of tank and fittings shall be oil tight and no bulging should occur during service. Inside tank shall be painted with varnish/hot oil resistance paint.

- d) Tanks stiffeners shall be provided for general rigidity and these shall be designed to prevent retention of water.
- e) The main body of the tank shall have sufficient strength to withstand and without permanent distortion.
 - i) A vacuum of 760mm. of mercury.
 - ii) Continuous internal gas pressure of 0.7 atmospheres above atmosphere pressure with oil at Operating level i.e. the transformer tank should be able to withstand 100% vacuum and also one atmosphere pressure above atmosphere internal pressure.
- f) Mechanical shocks during transportation
- e) The transformer tank and its accessories shall be designed without pockets wherein gas may collect.
- f) Adequate space shall be provided at the bottom of the tank for settlements of sediments.
- g) Suitable guides shall be provided in the tank for positioning the core and coil assembly.
- h) The tank shall be suitable for movement in both directions during shipment. Each tank shall be provided with
 - 1. Lifting lugs suitable for lifting the complete transformer
 - 2. A minimum of four jacking pads to be raised or lowered using hydraulic or screw jacks.
- i) All bolted connections to the tank shall be fitted with suitable oil tight gaskets of nitrile rubber or equivalent, which shall give satisfactory service under the operating conditions. Special attentions shall be given to the methods of making the hot oil tight joints between the tank and cover as also between the cover and the bushings and all other outlets to ensure that the joints can be remade satisfactorily and with ease, with the help of semi-skilled labor. Gaskets of neoprene and / or any kind of impregnated / bonded core or cork only which can easily be damaged by over-pressing is not acceptable. Use of hemp as gasket material is also not acceptable.

5.3 CLEANING AND PAINTING:

- a) Before painting or filling with oil, all non galvanized parts shall be completely cleaned, freed from rust, scale and grease and all external surface cavities shall be filled by metal deposition.
- b) Interior of all transformer tanks and other oil filled chambers and internal actual works shall be cleaned of all scale and rust by shot blasting. In case the process of shot blasting is not adopted it is to be thoroughly cleaned by chipping, wire brushing and sound reporting etc. These surfaces shall be painted with hot oil resisting varnish or paint.
- c) External surface shall be given a priming coat and two finishing coats of durable oil and weather resisting paint or enamel. The colour of the finishing coat shall be dark admirable, gray conforming to no. 632 of ISS colour for ready mixed paints (second revision).
- d) The requirement for the dry film thickness (DFT) of paint and the material to be used shall be as given below.

Sl. No	Paint type	Area to be painted	No of coats	DFT (Min)
1	Liquid paint			
	a) Zinc Chromate (Primer)	Out side	02	45 micron
	b) Polyurethane (Finished coat)	Out side	02	35 micron
	c) Hot oil	Inside	01	35 micron

5.4 TANK COVER

- a) The tank cover shall be sloped to prevent retention of rain water and shall not distort when lifted.
- b) At least two adequately sized inspection covers one at each end of the tank shall be provided for easy access to bushings and earth connection. The inspection covers shall have suitable lifting arrangement.
- c) Bushings, inspection covers etc. shall be designed to prevent ingress of water into or leakage of oil from the tank.
- d) All bolted connections shall be fitted with weather proof hot oil resistant neoprene gasket in between for complete oil tightness. If gasket is compressible metallic stop shall be provided to prevent over compression.

5.5 MOUNTING ARRANGEMENT

- a) The transformers shall be provided with two nos. bi-directional skids and pulling eyes integral with the tank body for fixing the transformer tank on foundation.
- b) These skids shall be such that the bottom of the tank is at a sufficient height above foundation for cleaning purposes. Each transformer shall be provided with uni-directional, flat rollers of 1000 mm length.

5.6 CONSERVATOR TANK

- a) The conservator tank shall have adequate capacity to accommodate oil preservation system and volumetric expansion of the total cold oil volume in the transformer and radiators for a change in temperature from minimum ambient air temperature of 5°C to 110°C.
- b) The conservator shall be bolted into position so that it can be removed for cleaning purposes.
- c) The conservator tank shall be fitted with a silicagel filter breather.
- d) The conservator shall be fitted with plain oil level gauge. The oil level at 30°C shall be marked on the gauge.

5.7 Explosion vent

- i) The transformers shall be provided with the single type of explosion vent.
- ii) An 142equalizer pipe shall be connected to explosion vent from the conservator.

5.8 WINDINGS

- a) The conductors shall be of electrolytic grade copper free from scales and burns.
- b) All windings shall be fully insulated. No graded insulation shall be accepted. Use of enamel as a sole conductor insulation is prohibited.
- c) The insulation of transformer windings and connections shall be free from insulating compounds which are liable to soften, ooze out, shrink or collapse and be non-catalytic and chemically inert in transformer oil during service.
- d) Coil assembly and insulating spacers shall be so arranged as to ensure free circulation of oil and to reduce the hot spot of the winding.
- e) Tapings shall be so arranged as to preserve the magnetic balance of transformers at all voltage ratios.
- f) Rated basic insulation level to which the transformers may be subjected are as under:

Nominal system voltage (kV rms)	Rated basic insulation level(KVp)
6.6	60
33	170

Transformer manufacturer may take this aspect into account while designing the transformer for the through fault withstands capability.

g) All bus bars and leads shall be adequately supported in insulated cleats or frames from the clamping structure.

h) The studs, set screws or bolts provided for securing cleats or frames shall be effectively locked.

i) Bus bars and leads shall be supported throughout their length to ensure they will not move under normal service or transport or be forced from the prescribed position during any short circuit.

j) The impedance values shall be 4 % to 10 %.

k) The winding shall be connected to achieve a vector group of DY11.

l) The transformer shall have two or three winding as specified in the Annexure-I.

5.9 INSULATION MATERIALS

a) Class 'A' insulating materials specified in IS: 1271 or latest version shall be used. Wood insulation, where used, shall be well seasoned and treated.

b) Insulating Oil

i) The new insulating oil supplied with the transformer shall conform to the requirements of IS: 335 tested at bidder's premises. No inhibitors shall be used in the oil.

ii) Prior to filling the oil in the main tank suitable number of samples shall be tested for BDV, moisture content, resistivity at 900 C, tan delta at 900 C and interfacial tension. The oil samples taken from the transformer at site shall conform to the requirements of IS: 1866.

iii) The manufacturer shall dispatch the transformer filled with oil. The manufacturer shall take care of the weight limitation on transport and handling facility at site.

Ten percent (10%) extra oil shall be supplied for topping up, in non returnable sealed containers suitable for outdoor storage.

5.10 EARTHING TERMINALS

Two earthing terminals suitable for connecting 50 x 8 mm mild steel flat shall be provided at positions close to the two diagonally opposite bottom corners of tank. These grounding terminals shall be suitable for bolted connection.

5.11 OIL PRESERVATION SYSTEM

The transformers shall be provided with the conventional conservator preservation system with a single compartment with dry air filling of space above the oil. The top of the conservator shall be connected to the atmosphere through a silica gel filter breather. It shall be so designed that:

i) Passage of air is through dust filter and silica gel

ii) Moisture absorption indicated by a change in colour of the tinted crystal can easily observed from a distance

iii) Breather shall be mounted not less than 1400 mm above rail top level.

5.12 TERMINAL ARRANGEMENT**a) Porcelain Bushing**

- i) The minimum clearances in air between the phases and between the phase and earth potential of the porcelain bushings shall be in accordance with IS: 2026 - part V, 1994.
- ii) Bushing terminals shall be provided with suitable terminal connectors of approved type and size for ACSR as specified in the annexure.
- iii) All transformer bushings shall be of solid porcelain with plain sheds conforming to IS: 8603.
- iv) The removal of bushing shall be possible without disturbing the current transformers, secondary terminals and connectors or pipe work.

b) Cable Boxes and Disconnecting Chambers

- i) Wherever cable connections are specified, suitable air insulated type cable boxes of sufficient sizes shall be provided to accommodate cable termination. Cable boxes shall be designed and installed such that it shall be possible to move away the transformer without disturbing the cable termination leaving the cable box on external supports. The support for the cable box shall be of galvanized iron.
- ii) Cable boxes shall have terminal connectors of adequate size and bolt holes to receive cable lugs.
- iii) The contractor shall provide earthing terminals on the cable box to suit 50 x 8 mm GI flat.
- iv) All necessary cable terminating accessories such as supporting brackets, power cable lugs, hard ware etc. shall be provided by the bidder.
- v) Cable boxes shall have removable top cover and ample clearance shall be provided to enable either transformer or each cable to be subjected separately to high voltage test.
- vi) Cable boxes shall have degree of protection of IP-52 as per IS: 2147.

5.13 TERMINAL MARKING

The terminal marking and their physical position shall be in accordance with IS:2 026 .

5.14 TERMINATION ARRANGEMENT FOR NEUTRALS

- a) The transformer shall be solidly earthed at the secondary neutral.
- b) The neutral terminal brought on to a separate neutral bushing shall be connected to associated neutral grounding pit by a copper flat, which shall be supplied and installed by the bidder.

5.15 OFF CIRCUIT TAP CHANGE SWITCH

- a) The tap change switch shall be three phase, hand operated, for simultaneous switching of similar taps on the three phases by operating an-external handle.
- b) Arrangement shall be made for securing and pad locking the tap changer in each of the working positions, and it shall not be possible for setting or padlocking in any intermediate position. An indicating device shall be provided to show tap in use.
- c) The cranking device for manual operation shall be removable and suitable for operation by a man standing on ground level. The mechanism shall be complete with the following:
 - i) Mechanical operation indicator.
 - ii) Mechanical tap position indicator which shall be clearly visible from the transformer.
 - iii) Mechanical stops to prevent over cranking of the mechanism beyond extreme tap position.
 - iv) The manual operating mechanism shall be labelled to show the direction of operation for raising the secondary voltage and vice versa.

v) A warning plate indicating "The switch shall be operated only when the transformer has been de-energized" shall be fitted.

5.16 cooling tubes

The tubes shall be mounted on the tank.

5.17 BOLTS AND NUTS

All bolts and nuts exposed to weather shall be of hot dip galvanized or cadmium plate or zinc passivated steel. All bolts, nuts and washers in contact with non ferrous part which carry current shall be of phosphor bronze.

5.18 FITTINGS

The following fittings shall be provided with all the transformers:

- a) Rating and diagram plate.
- b) Terminal marking plate
- c) Two earthing terminals
- d) Lifting lugs
- e) Jacking lugs
- f) Drain valve with plug, 50mm size.
- g) Dehydrating breather
- h) Plain oil level indicator with minimum marking.
- i) Off load tap changing switch
- j) Oil filling hole with cover
- k) Conservator
- l) Explosion vent
- m) Skids and pulling eyes on both sides
- n) Rollers, Flat unidirectional limited to 1000 mm
- o) H.V. porcelain bushings with metal parts or H.V. cable box.
- p) Filter valve.
- q) Inspection cover.
- r) L.V.cable box.

5.19 SPARE PARTS:

- a) The suppliers shall provide the following mandatory spares for each of Transformer supplied at no extra cost.
 - 1. H.V. & L.V. Bushing & Studs –Each 2 Nos
 - 2. Bimetallic connector for H.V & L.V. Bushings – Each 2 sets
- b) Any fittings, accessories of apparatus which might not have been mentioned in the specification but which are usual and necessary in the equipment of similar nature and are recommended by the manufacturer for satisfactory operation are to be provided by the contractor without extra cost. All apparatus must be complete in all details whether mentioned in the specification or not.

6.0 Operating Conditions

- i) The transformers shall be capable of being loaded in accordance with IS: 6600 up to load of 150%. There shall be no limitation imposed by bushings, tap changer etc.

ii) The transformers shall be capable of being operated continuously without danger on any tapping at the rated KVA with voltage variation of + 10% corresponding to the voltage of the tapping.

iii) For consideration of specific loading the transformer shall be suitable for continuous operation for flux densities specified in the requirement.

b) Fault Conditions

i) The transformer and all accessories shall be capable for withstanding any external short circuit at bushing terminal without damage for two (2) seconds.

ii) The maximum flux density in any part of the cores and yoke at normal voltage and frequency shall not exceed 1.5 wb/m².

iii) Manufacturer shall also indicate 150 % over voltage withstand time.

7.0 INSPECTION TRANSFORMER ASSEMBLY AND TESTS:

a) The following tests shall be carried out in order to determine whether the transformer and its components comply with the specification and to provide necessary data. As many tests in the opinion of the purchaser as are possible shall be arranged by the manufacturer.

b) The transformer shall be completely assembled and tested as per ISS: 2026/1977 and any amendment thereof, at the factory. All the tests are to be carried out in the presence of any authorized representative of the Corporation/Third party as per direction of Engineer of Contract. Test shall be performed in compliance with standard practice and relevant ISS. The routine tests shall be carried out on transformer at the manufacturer's cost at their works/other institute of repute, before dispatch.

However it may be noted that no call for final inspection of the transformer shall be entertained if the transformer has not passed the stage inspection or its waiver has not been issued by DoWR. The supplier is required to place the call for stage inspection in advance as illustrated in subsequent clauses of technical specification.

c) **ROUTINE TESTS:**

Transformer routine tests shall include tests stated in latest issue of IS: 2026 (Part –1). These tests shall also include but shall not be limited to the following:

- i) Measurement of winding DC resistance.
- ii) Measurement of voltage rating on each tapping.
- iii) Check for polarity and voltage vector relationship.
- iv) Measurement of No Load loss and current at 90%, 100% and 110% of rated voltage.
- v) Measurement of percentage impedance on principal tap and extreme taps.
- vi) Load loss at principal tap measured at rated frequency by applying an approximately Sinusoidal supply to one winding sufficient to reduce rated current in the winding with the other winding short-circuited.
- vii) Measurement of insulation resistance.
- viii) Polarization index i.e Insulation Resistance for 10 minutes and one minute (R 10 mt / R 1 mt).
- viii) Induced over voltage withstand test.
- ix) Separate source voltage withstand test.

- x) Dielectric test on transformer oil shall also include testing of oil sample drawn from transformer out of the offered at the suppliers work for BDV of oil (fresh from storage of tank as well as from transformer).

- xi) Oil leakage test.

All tanks and oil filled compartments shall be tested for oil tightness by being completely filled with air/ oil of a viscosity not greater than that of insulating oil conforming to IS: 335 at an ambient temperature and subject to pressure equal to 0.7 atmosphere above atmospheric pressure measured at the base of tank. This pressure shall be sustain for a period of not less than 12 Hours for oil and one Hours for air during which time no leakage shall be occur.

d) TYPE TEST:

The offered equipment must be of proven design through successful type testing particularly Temperature rise Test/ Short circuit Test/ Lightning impulse withstand Test, as per IS:2026 or latest amendment thereof (during last 5 years counted from the date of agreement with EPC Developer) at CPRI, Bangalore/Bhopal or NTH, Ghaziabad or ERDA, Varodara,. The manufacturer shall carry out type tests in accordance with IS: 2026 on one piece of one rating. Before conducting the Temperature rise Test, short circuit test and Impulse test, the firm will offer for both stage inspections and final inspection of the transformer by through a 3rd party agency as well as EPC's authorized executives at the manufacturer's works. If the transformer complies with the specification and offered technical parameters, the transformer will be sealed by authorized engineer(s) of EPC Developer and thereafter the transformer can be transported to CPRI/ NABL unit for required type tests in presence of EPC Developer's authorized representative(s) who will verify the seal & allow for conducting the type tests. The type tests shall include:

(2) Vacuum Test:

Transformer tank at an internal vacuum limiting to one atmosphere but not more than the pressure of 3.33 KN./Sq.m. (25 mm of Hg.) for one Hour.

The permanent deflection of flat plates after vacuum has been released shall not exceed the value specified below without affecting the performance of the transformer:

Horizontal Length of flat plate (mm)	Permanent deflection
Up to & including 750	05
751 to 1250	6.5
1251 to 1750	08
1751 to 2000	9.0
2001 to 2250	11
2251 to 2500	12.5
2501 to 3000	16
Above 3000	19

(2) Pressure Test:

Transformer tank together with its radiators, conservators, vessels and other fittings shall be able to with stand a pressure corresponding to 0.7 atmosphere above atmospheric pressure measured at the base of the tank and will be maintained for one hour. The permanent

deflection of the flat plate after the excess pressure has been released shall not exceed the figures specified above.

(3) Short Circuit Test:

As per ISS: 2026/1977 and latest amendment thereof.

(4) IMPULSE VOLTAGE WITHSTANDS TEST LIGHTING IMPULSE TEST:

This test is to be carried out as per IS: 2026/1981(Part-III) Para 13 and latest amendments thereof on all limbs of HV and LV. The tapping position for each limb shall be selected as recommended in clause 6.3 of above IS.

(5) Measurement of acoustic noise level.

- e) The transformer having passed successfully through the type tests along with verification of losses by test house shall be considered as acceptable design. The physical dimensions of this transformer shall form the guidelines for subsequent supplies. In case of any variation in any dimension incorporated in the approved drawings, shall be finally got approved by the engineer of the Contract taking into consideration, the dimensions offered in GTP/drawings as per test reports and drawings finally approved by CPRI/BHEL/Govt. Test House after conduction of type test.

In case, it is found during the joint inspection of transformers(s) by the executive of EPC Agency and/or representative of the third party entrusted with the work of inspection and/or representative of the firm that the firm has supplied substandard material then also the above penal action shall be taken. If the representative of the third party and/or of supplier or both are not present at the time of above joint inspection, then DoWR has right to take the penal action, as mentioned above. In the event of cancellation of orders no compensation shall be given to the firm by EPC Agency with no liability to DOWR.

TOLERANCE:

However, no negative tolerance on all the parameters including physical of dimensions tank certificated by test house/ laboratories as mentioned in respect of the equipment which has been successfully type tested shall be allowed.

SPECIAL TEST:

Measurement of zero sequence impedance test on one transformer. Inspection shall be carried out only after routine test results are submitted to 'Engineer of the Contract' , giving serial number of transformer.

All the original type test reports including verification of load/No. load losses from CPRI/BHEL/Govt. Test House/ERDA Vadodara along with detailed drawing approved by CPRI/BHEL/Govt. Test House as approved by the purchaser shall be submitted after successful "Type Testing" to prove that the design as successfully type tested.

8.0 INSPECTION & TESTING OF TESTING INSTRUMENTS AND RAW MATERIALS AND STAGE INSPECTION:

The supplier shall offer the core, windings and tank of each transformer for inspection by a 3rd party agency as well as EPC Agency representative(s). During stage Inspection, all the measurements like diameter, window height, leg centre, stack width, stack thickness, thickness of laminations etc. for core assembly, conductor size, Insulation thickness, I.D., O.D, winding height, major and minor insulations for both H.V and L.V windings, length, breadth, height and thickness of plates of Transformer tank, the quality of fittings and

accessories will be taken / determined. The supplier can offer for final inspection of the transformers subject to clearance of the stage Inspection report by the DOWR.

All the measuring instruments i.e. Voltmeter, Avometer, CT, PT'S and other instruments used in inspection and testing shall be properly calibrated and sealed once in a year. Calibration Certification when demanded by the inspection officer shall be produced for verification purposes. In case of disputes regarding calibration of instruments, instruments shall be sealed and signed by the representative of suppliers and purchaser and will be sent to institution/lab. of repute or its own lab. for calibration at the cost of supplier. The result of such testing shall be binding on the supplier.

The purchaser reserves the right to depute his representative/agency for carrying out stage inspections at any stage of manufacturing process for checking quality of manufacturing and also the raw materials.

The contractor shall offer all reasonable facilities for such inspection. The contractor shall furnish detailed production schedule including different phase of material procurement, manufacture and fabrication to facilitate the purchaser for deputing his representative/agency for carrying out stage inspection.

The contractor shall inform the purchaser likely date of assembly of core and readiness of HT & LT coils enabling the purchaser to depute his officers for stage inspection or issuing waiver of stage inspection.

Records shall be maintained of all the tests carried by the supplier on transformer offered for inspection and test shall be produced when demanded by the inspection officer to satisfy that the transformer are being offered after carrying all the necessary tests by the supplier.

9.0 DRAWING/ INSTRUCTIONS BOOKS/ OPERATION & MAINTENANCE MANUAL ETC:

The Manufacturer shall submit following drawings:

- a) Outline dimensions drawings of transformers and accessories giving complete details of main components parts and transportation details showing dimension and weight of the each package. (Top, Front & side views). Off load tap changer equipment earthing details, top cover/flange fill arrangement.
- b) Name plate diagram with tap changing details and guaranteed maximum load and no-load losses without any plus tolerance.
- c) Systematic control and wiring diagram of all auxiliary equipment including marshalling Boxes with terminal number of various accessories.
- d) Bushing drawing, porcelain portion drawings and terminal connector drawing with their Electrical and mechanical characteristics in tabular form.
- e) Drawing giving the weight for foundation of transformer.
- f) Drawing of core and winding (including sectional view) along with the clamping Arrangement giving details viz. Core dia, weight, stacking HV/LV winding weight and size/ number of coils/limbs, inner dia, outer dia, axial length, clamping channel, Size of the rod dia meter, its nos. and length etc. Cores steps details to be shown separately and clearly indicating the clearance provided inside and outside the transformer.

The manufacturer shall supply 2 copies of instruction books/operation and maintenance manuals spare parts booklets along with descriptive literature and date of transformer construction, winding, bushing, heat exchanger, tap changing gear etc. to each consignee with each transformer and to DoWR.

All tests and inspection shall be made at the place of manufacturer unless otherwise specifically agreed upon by the manufacturer and the engineer of the contract at the time of the purchaser. The manufacturer shall offer the inspecting officer (s). Representing the Engineer of the Contract, all reasonable facilities without charge to satisfy him that the materials are being manufactured in accordance with this specification.

NOTE: Inspection shall be carried out only after routine test results are submitted to Engineer of the contract and Unique number of transformers are given.

SCHEDULE OF GUARANTEED TECHNICAL PARTICULARS FOR DISTRIBUTION TRANSFORMERS

1.	Name of Manufacturer	
2.	Type of Transformer	
3.	Rating	
a.	Rated output (MVA)	
b.	Rated Voltage of HV&LV (KV)	
c.	Rated Current of HV&LV (A)	
d.	No load Voltage ratio	
e.	No. of Phases	
f.	Rated frequency	
4.	Connections	
a.	High Voltage	
b.	Low Voltage	
c.	Vector Group Symbol	
5.	Cooling Arrangement	
a.	Type of cooling	
b.	Number of Cooling tubes / fins per radiator and number of radiators	
c.	Size of radiator fins	
d.	Thickness of sheet	
e.	Horizontal distance between radiators	
f.	Vertical distance between Core center line and radiator center line	
6.	Dimension of inside of tank (mm)	
a.	Length	
b.	Breadth	
c.	Height	
d.	Weight of tank without fitting	
7.	Thickness of transformer tank Plate (mm)	
a.	Sides	
b.	Bottom	
c.	Cover	
8.	Overall Dimension of Tank with Fittings (mm)	
a.	Length	
b.	Breadth	

c.	Height	
9.	Details of Oil	
a.	Standards of Oil	
b.	Quantity of Oil (Ltr. and Kg.)	
C	Quantity of extra oil (Ltr and Kg)	
10.	Details of Core	
a.	Material of core lamination & Grade	
b.	Thickness of core plates	
c.	Insulation of Core lamination	
d.	Window Height	
e.	Leg Center	
f.	Core Diameter (approx.) (mm)	
g.	Core cross sectional area (gross) (mm ²)	
h.	Core cross sectional area (net) (mm ²)	
i.	Maximum flux density in core at normal voltage, frequency and ratio	
j.	Weight of stamping in core and yoke separately in Kgs.	
	i) Core	
	ii) Yoke	
i.	Size and No. of clamping channels	
li	Weight of clamping channels with stiffeners	
k.	Size & number of tie rod (if used)	
l.	Size & number of core bolt	
(Note: Please enclose details of core-steps, its drawing and flux density, weight of core, fittings, copper, oil, Off Load Tap Changer separately).		
11.	Weight of transformer	
a.	Weight of core only	
b.	Weight of core assembly excluding HV & LV coils	
c.	Weight of complete core coil assembly	
d.	Value of Transformer Oil	
e.	Weight of Transformer oil	
f.	Weight of insulated conductor in HV	
g.	Weight of insulated conductor in LV	
h.	Weight of Tank and fittings (Kgs.) including tap changer.	
i.	Total weight of transformer with oil	
12.	Details of Winding	HV / LV
a.	Type of winding and material	
b.	Conductor Size (bare)	
c.	Cross sectional area (mm ²)	
i.	Gross	
ii.	Net	
d.	Type of insulation of conductor	
e.	Size of insulated conductor	

f.	Number of disc / coil per limb	
g.	No. of coils per disc	
h.	Internal dia of coil	
i.	Outer dia of coil	
j.	Axial length	
k.	Mean length of turns (mm)	
l.	No. of turns	
m.	Inter turn insulation	
n.	End turn insulation	
o.	Type of axial coil supports	
p.	Details of end clamping rings	
q.	Whether windings are inter leaved	
r.	Size of cooling ducts	
s.	Weight of bare conductor used in one leg (kg.)	
t.	Weight of insulated conductor used in one leg (kg.) (dry)	
u.	I ² R loss at 75°C (per phase)	
v.	Maximum current density in winding at CMR – Amp./Sq cm.	
W	Polarization index (ratio of Megger values at 600 sec to 60 sec for HV to earth and HV to LV)	Shall be greater than or equal to 1.5
u.	Resistance of winding (with 5% tolerance) a) at 20 °C (Ohms) : b) at 75 °C (Ohms)	
(Note: Enclose calculation of losses with complete details of factor assumed, core & winding details of drawing)		
13.	Thermal time constants – Hrs.	
14.	Terminal arrangement HV side	
15.	Terminal arrangement LV side	
16.	Regulation at full load at 75°C	
a.	At unity power factor	
b.	At 0.8 power factor (lagging)	
17.	Percentage efficiently at normal ratio, rated voltage and at 75°C average winding temp.	
		UPF
a.	Full Load	
b.	3/4 Full Load	
c.	1/2 Full Load	
d.	1/4 Full Load	
18.	No load current as percentage of full load current at rated volt. and frequency in %	
19.	Power factor and no load current at normal volt. and frequency in %	

20.	RMS value of symmetrical short time current rating as per ISS which the transformer can withstand and its duration	
a.	H.V. Winding	
b.	L.V. Winding	
21.	Maximum out of balance force in winding on short circuit at the terminals	
22.	Clearance between phases in Air (mm)	
a.	H.V. Side	
b.	L.V. Side	
c.	L.V. to Earth	
23.	Clearance in oil (mm)	
a.	Internal clearance between inner walls of Tank & core coil	
b.	On length side	
c.	On Breadth Side	
d.	Radial clearance between H.V. & L.V. Winding	
e.	Phase of phase clearance between H.V. Limb	
f.	Radial clearance of L.V. coil from core	
g.	Minimum clearance between LV Pole to earth	
h.	Horizontal duct between H.T. disc	
i.	End clearance of H.T. coil from Yoke (with angle shaped windings)	
j.	Minimum clearance between core & tank bottom	
k.	Angular ducts between LT & HT winding	
24.	Insulation Details	
a.	End spacing of L.V.	
b.	End spacing of H.V.	
c.	L.V. winding to core	
d.	Between HV & LV winding	
e.	Inter phase barrier	
f.	End phase barrier	
25.	Insulation Level	H.V.
a.	Separate source power frequency Volt. Withstand – KV.	
b.	Induced over voltage withstand – KV	
c.	1.2/50 μ s full wave lighting impulse withstand voltage-KV	
	i) Impulse	
	ii) Power frequency (Dry & Wet)	
d.	Voltage to earth for which the star point will be insulated – KV	
	i) Impulse	
	ii) Power frequency (Dry & Wet)	
26.	Performance reference Temp. (Deg. C)	
27.	Volts per coil of HV winding (Volts)	
28.	Approx. Volts per layer of HV winding (Volts)	

29.	Impedance voltage at rated full load and transformation	
30.	Percentage reactance Ratio at rated voltage & frequency at 75°C.	
31.	Percentage resistance at 75°C	
32.	Impedence voltage at principal tapping and at 75°C average winding temperature expressed as percentage of rated voltage between HV & LV winding - %	
33.	Permissible duration of over load following continuous running at normal rated load in an ambient Temp. of 50 Deg. C.	
a.	10% overload	
b.	20% overload	
c.	30% overload	
34.	Maximum temperature rise at full load (above max. average ambient Temp. of 50 °C.)	
a.	Of top oil by thermometer Deg. C.	
b.	Of winding by resistance method Deg. C.	
c.	By hot spot temperature indicator Deg. C.	
35.	Limit of hot spot temperature for which designed – Deg. C.	
36.	Temperature Gradient between winding and oil – Deg. C.	
37.	Maximum No. load loss at rated voltage on principal tapping at rated frequency (Guaranteed without any plus tolerance) (including 25% stray no load loss for considering in-consistencies of B-H characteristics of core material and workmanship).	
38.	Maximum load loss at rated current on principal tapping at 75°C. (Guaranteed without any plus tolerance) including 10% stray load loss)	
39.	Resistance voltage drop at rated current for principal tapping at 75°C average winding temperature as percent of rated voltage - %	
40.	Reactance voltage drop expressed as percent for rated voltage - %	
41.	Temperature indictors	<u>Oil Temp Ind.</u>
a.	Make and Type	
b.	Permissible setting ranges for alarm & trip.	
c.	No. of contacts	
d.	Current rating of each contact.	
42.	Gas and oil actuated relay description data & range of settings, schematic diagram etc.	
43.	Type of pressure relief device & pressure at which it operates.	
44.	Details of magnetic oil gauge	
45.	Weight of silica gel (Grm.)	

46.	Particular of Bushings	H.V. / LV
a.	Name of manufacturer	
b.	Type	
c.	Voltage rating – KV	
d.	Visible power frequency voltage discharge test – KV	
e.	Dry power frequency withstand voltage for one minute	
f.	Wet power frequency withstand voltage for 30 minutes	
g.	Dry standard lightning impulse with stand volt-KV	
h.	Creepage distance in air (mm) (protected and total)	
i.	Recommended Gap setting – mm	
j.	Weight of assembled bushing KG	
47.	Free space required at the top for removal of bushing – mm	
48.	Minimum clearance height for lifting core & windings from tank	
Note: Type tests Reports of bushings shall be submitted		
49.	Details of Off load tap changer	
a.	Make	
b.	Type	
c.	Rating	
	i) Rated voltage	
	ii) Rated current	
	iii) step voltage	
	iv) No. of steps.	
50.	Shipping details	
a.	Parts detached for transport	
b.	Approx. Weight of heaviest package – kg.	
c.	Approx. dimension of larges package-mm	
	i) Length	
	ii) Breadth	
	iii) Height	
51.	Type Testing	
a.	Whether the transformer of the offered design has been type tested during last 5 years from the date of opening of tender?	
b.	If yes, when and where was it type tested?	
c.	Is there any deviation in the technical specification of offered for 33/6.9 KV, power transformer?	
52.	Details of test reports	

Sl. No.	Name of Test	Date of Test	Whether test reports enclosed or not (Yes / No)	If yes no. of sheets.
1.	Temperature Rise Test			
2.	Vacuum Test			
3.	Pressure Test			
4.	Impulse Voltage with stand test (lightning Impulse Test)			
5.	Short Circuit Test			
6.	Thermal ability Test			
7.	Zero sequence Impedance Test			

CHAPTER – 20**TECHNICAL SPECIFICATION FOR 6 kV SURGE TYPE LIGHTNING ARRESTORS****a) SCOPE**

This specification provides for the manufacturing, testing and supply of 6 kV Surge type Lightning Arrestors suitable for outdoor application.

b) STANDARDS

The 6 kV Surge type Lightning Arrestors shall comply with the latest revision of IS: 3070 and with the relevant parts of standards mentioned below;

IS 4004: Application guide for non linear resistor type surge arrestors.

IS 5350: Dimensions for outdoor porcelain post insulators.

The equipment covered under this specification shall comply with all the latest applicable statutory rules, regulations, acts and safety codes in force. Nothing in this specification shall be construed as to relieve the supplier of the responsibility for correctness of the design and construction of the equipment. All the standards being followed shall be listed out in the bid. Where any foreign standard is being followed, the copy of the same shall be provided with the bid.

c) DESIGN CRITERIA

The 6 kV Surge type Lightning Arrestors shall be suitable for 6600V (-10% to +10%), 3 phase, 50 Hz (-5% to +3%) power supply. The arrestor shall be suitable for operation in a solid earthed neutral system. The arrestor shall be able to sustain power frequency spark over voltage up to 15 kV. The Lightning Arrestors shall withstand standard impulse withstand voltage of 22.5 kV.

Maximum residual voltage at nominal discharge current shall be 22.5 kV. The nominal discharge current carrying capacity has been specified in Annexure-I at the rated voltage and frequency.

d) CONSTRUCTIONAL FEATURES

The lightning arrestor shall be line type and gapless. The arrestors shall be composed of units of non-linear resistors made of Zinc oxide.

e) PERFORMANCE**Electrical Features**

The lightning arrestor shall ensure:

i) Continuous operation at rated voltage (6 kV & 50 Hz) while carrying out effectively and without damage the automatic extinction of the follow up current.

b) Continuous operation within variation for voltage between -10% +10%, and frequency variation between – 5 %, + 3 %.

c) The arrestors shall divert any switching surge in excess of basic insulation level at the relevant nominal system voltage and cut off follow-up current of power frequency.

7.0 TEST CERTIFICATE

The units shall be Type tested for insulation level, discharge current and residual voltage in accordance with relevant codes. The results of the test certificate shall also indicate the

identifications like manufacturer's name and the serial no. of the product which should also appear printed or embossed on the body.

The contractor shall supply at the time of execution the routine test certificates from the manufacturer indicating the type of tests conducted, the test results and the serial nos. of the lightning arrestor.

ANNEXURE – I

TECHNICAL PARAMETERS FOR 6 KV SURGE TYPE LIGHTNING ARRESTORS

Nominal System Voltage – 6.6 kV

Rated Voltage – 6 kV

Power frequency spark over voltage – 15 kV

1.2/50 Spark over voltage 2500 Amp – 22.5 kV (peak)

Maximum residual voltage

At nominal discharge current – 22.5 kV (peak)

Nominal discharge current – 10 kA

System – 3 Phase, 50 C/S, Neutral solidly earthed.

Type – Gapless.

Mounting – Bracket mounted on structure Other requirements

f) Grounding terminal ii) Post insulator conforming to IS: 5350.

Line terminals – Each terminal should be suitable to accept ACSR and it should be suitable both for vertical takeoff. Standards to conform – IS: 4004 & IS: 3070.

CHAPTER – 21**TECHNICAL SPECIFICATION FOR 6.6 KV INDOOR VACUUM CIRCUIT BREAKER****1.0 SCOPE**

This specification provides for the manufacturing, testing and supply of 6.6kV Vacuum Circuit Breaker and vacuum contactor panels suitable for indoor application.

6.6 KV switchgear (VCB, CT, PT& Disconnecter) must be type tested & the Dimensions of Type Tested equipments from the short listed approved vendors are only be accepted.

2.0 STANDARDS

The circuit breaker shall comply with the latest revision of IS: 13118 and with the relevant parts of standards mentioned below;

IS: 3156	Voltage transformers
IS: 2705	Current transformers
IS: 3043	Code of practices for earthing
IS: 6875	Control switches (switching devices for control and auxiliary circuits including contactor relays)
IS:10118	Code of practice for selection, installation and maintenance of Switchgear and Control gear
IS:11353	Guide for uniform system of marking and identification of conductors and apparatus terminals
IS:3427	HT indoor switchgear and control gear

The equipment covered under this specification shall comply with all the latest applicable statutory rules, regulations, acts and safety codes in force. Nothing in this specification shall be construed as to relieve the supplier of the responsibility for correctness of the design and construction of the equipment. All the standards being followed shall be listed out in the bid. Where any other standard is being followed, the copy of the same shall be provided with the bid. The equipment shall have Test Certificate for Type test from CPRI, Bangalore.

3.0 DESIGN CRITERIA

The Circuit Breaker shall be suitable for 6600V (+/- 10%), 3-phase, 50Hz (+3% to-5%) power supply.

All similar components shall be interchangeable and shall be of same type and rating for easy maintenance and low spare inventory.

The rated current carrying capacity shall be as specified in annexure-I at the rated voltage and frequency and the circuit breaker shall carry rated current continuously while complying with this specification. The breaking and making capacity of the circuit breaker shall be as specified in annexure-I.

4.0 CONSTRUCTIONAL DETAILS/GENERAL TECHNICAL REQUIREMENTS

4.1 The unit shall comprise of the panel, Vacuum Circuit Breaker unit (VCB) and Vacuum Contactor Panels.

4.2 Panel

4.2.1 The panels shall conform to IS: 3427.

4.2.2 The panels shall be of unitized construction having separate compartments for

Circuit breaker, vacuum contactors, bus bars, CT, PT and separate chamber for protective relays, metering and indicating instruments. The panels shall be extensible to form a multi-panel Switchboard.

- 4.2.3 The panels shall be fabricated from sheet steel of minimum thickness 3mm and 2 mm for load bearing sections and non load bearing sections respectively.
- 4.2.4 The panels shall have a separate cable box at the rear for outgoing cables.
- 4.2.5 An earth bus of continuous type shall earth all metallic non-current carrying parts in the panels and the VCB and contactor units.
- 4.2.6 The panels shall be suitable for ready installation on embedded MS channels flushed with the floor or for direct installation on a leveled floor through grouting holes.
- 4.2.7 The panel shall be dust and vermin proof with no access to ingress of moisture.
- 4.3 **The Vacuum Circuit Breaker unit**
- 4.3.1 The Breaker unit shall be of horizontal DRAW OUT construction.
- 4.3.2 The Breaker unit shall have two main components:
 - a) The trolley assembly
 - b) The cradle assembly

The trolley assembly made of steel plates shall be mounted on wheels. The trolley assembly shall be provided with:

- ❖ The pole assembly
- ❖ The operating mechanism

The pole assembly component of the trolley assembly shall have;

- i. The interrupter units having vacuum not less than 10⁻⁵ Torr.
- ii. The top terminals for interrupter units, separated by fire retardant type barriers.
- iii. The contacts of the breaker shall be silver plated copper or silver plated copper-chromium.

The operating mechanism shall consist of:

- Solenoid operating mechanism
- Control devices

The solenoid mechanism operating on the electro-magnetic principle shall close or open the interrupter. The driving force of the closing electro-magnet shall be imparted to the operating shaft with a trip free link mechanism.

There shall be a heavy duty plug-in type earth contact/change over switch which shall make before the insertion of trolley assembly and break after the withdrawal of the same.

The cradle assembly made of steel plates shall be mounted on chassis and shall accommodate the trolley assembly.

The cradle assembly shall consist of:

- a) Copper terminals to receive the breaker contact.
- b) Rails to guide the trolley assembly.
- c) Insulated safety shutter mechanism to make the shutter operation fully automatic depending on circuit breaker position.

4.4 **Operation of the Breaker**

The breaker shall be electrically operated locally and shall have indicating devices for ON/OFF/TRIP indication and operation counter shall be provided.

Terminal blocks for control cables shall also be provided for interfacing with other breakers if required.

5.0 PERFORMANCE

- 5.1 The design of the circuit breakers and accessories shall be in accordance with the latest standard practice and shall be such as to facilitate Inspection, clearing, repairs, maintenance and operation and shall ensure safety operations under situation of sudden variations of loads and voltages as may be required under local operating conditions.

5.2 Electrical Features

The breaker shall ensure:

- a) Continuous operation at rated current at specified ambient conditions.
- b) Continuous operation within variation for voltage between -10% +10%, and frequency variation between +3 to-5% .
- c) Temperature rise limited to the values given in IS: 13118 for test condition.
- d) The insulation levels shall conform to the values given in IS: 13118.
- e) Circuit breaker shall have to withstand apparent short circuit power of 25 kA (rms) for at least 3 second.

5.3 Mechanical Features

- a) The breaker shall be able to withstand the thermal and electromagnetic stress arising out of fault level of 25 kA for 3 second.
- b) Earthing of all metallic parts of trolley and cradle must be ensured in ISOLATED position.

6.0 PROTECTIONS AND INTERLOCKS

- 6.1 Combined IDMT type overload relay (50% to 200% of C.T. Secondary) and earth fault relay (10% to 40% of C.T. Secondary) shall be provided. High set (400% to 1600%) instantaneous element shall also be provided on at least two phases. Protective Class of C.T. with adequate ratio conforming to IS: 2705 shall be incorporated.
- 6.2 For incoming circuit breakers Overload IDMT over load relay, Earth Fault IDMT relay, Neutral displacement relay, Short circuit protection shall be provided. For outgoing circuit breakers Overload IDMT overload relay, Earth leakage and Short circuit protection shall be provided. For Capacitor control circuit breakers Overload IDMT overload relay, Earth Fault IDMT relay, Earth leakage and Short circuit, Over voltage unbalanced protection and Under voltage protection shall be provided.
- 6.3 The trip circuit shall also be operable from each of the following:
- A) Buchholz (gas operated) relay of transformer
 - b) Temperature relay of transformer Auxiliary contacts shall be provided for the above.
- 6.4 Electrical interlock shall be provided to prevent ON/OFF operation with other breakers, if required. Interlocks shall be provided to ensure that the trolley cannot be plugged in or out unless Vacuum Circuit Breaker is in off or open position. Vacuum Circuit Breaker shall not close unless it is fully plugged in.
- Interlock shall also ensure opening of the door with the breaker in isolated position only.
- 6.5 Protection against earth leakage shall also be provided for operation of the earth leakage relay in the range of 0.5 Amp to 2 Amp. Suitable C.B.C.T. for the same shall be provided.
- 6.6 Sufficient number of NO + NC auxiliary contacts shall be provided for the protections mentioned in para 6.2, 6.3 & 6.4.

7.0 METERING & MIMIC FACILITY

7.1 Following indications shall be provided :

- a) ON/OFF/TRIP
- b) Indication (Alarm/Lamp) on TRIP with reset button

7.2 Following Mimic display shall be provided:

- a) Trip on overload
- b) Trip on earth fault
- c) Trip on short circuit
- d) Trip for high temperature in transformer
- e) Trip for high gas pressure in transformer

7.3 Following measuring instruments shall be provided with all breakers except couplers:

- a) Voltmeter with Selector switch. 0-10 kV with measuring class P.T.
- b) Ammeter with Selector switch with measuring class C.T.
- c) P.F. meter.
- d) Frequency meter.
- e) KW meter.
- f) KWH meter. 0-99999999 Units.

7.4 Installation of Circuit Breaker unit and interfacing with other Circuit Breaker unit/Contactor panel shall be in scope of bidder. Suitable class of Current Transformer and Potential Transformer shall be provided.

8.0 NAME PLATE

The name plates of the circuit breaker and its operating device shall have marking as:

Manufacturer

Type designation and serial number

Rated voltage

Rated frequency

Rated normal current

Short circuit withstand capacity

Rated short circuit breaking current

Rated supply voltage of closing and opening devices

Rated supply frequency of closing and opening devices

Tender Document Ref:

Operating duty

Supply voltage of auxiliary circuits

Supply frequency of auxiliary circuits

Weights

Rated operating sequence

Year of manufacture

ANNEXURE - I**TECHNICAL PARAMETERS OF 6.6kV INDOOR VCB**

1 Installation: Indoor Panel

2 Numbers of Poles: 3

3 Service Voltage: 6600 V (-10% to 10%)

- 4 Rated current (A : As per requirement
 - 5 Making capacity: 62 kA (peak minimum)
 - 6 Frequency: 50 Hz (+3% to -5%)
 - 7 Symmetrical breaking capacity : 25 kA (rms minimum)
 - 8 Short time current for 3 Second: 25 kA (rms minimum)
 - 9 Operating duty: P1
 - 10 Operating Mechanism: Motor operated spring charged.
Trip free mechanism along with ON/OFF/TRIP Indication.
 - 10.1 Manual/Electrically operated: Manual and Electrical with closing and shunt trip coil.
 - 11 Tripping arrangement: AC shunt trip mechanism.
 - 12 Meters to be provided on all breakers except
Couplers: Ammeter, Voltmeter with selector switches, PF meter, KWH meter, KW meter.
 - 13 Protections to be provided: i) Short circuit
ii) Overload
iii) Earth Fault
iv) Earth leakage
v) Over Voltage
iv) Under voltage
 - 14 Indications on Control panel: ON, OFF, TRIP, LOCKOUT, CONTROL SUPPLY, SPRING CHARGED.
 - 15 Terminal arrangement:
15.1 Incoming: Conductor: Aluminium Type : PVCSWA/PVCDWA Size: Suitable size
15.2 Outgoing:
Conductor: Aluminium
Type: PVCSWA/PVCDWA
Size: Suitable size
 - 16 Control supply: 220 V DC.
 - 17 Control wiring: 1.5 mm², 660 V, PVC, Copper conductor 2.5 mm², 660 V, PVC, Copper conductor for C.T. secondary connection.
 - 18 Current Transformer: Of adequate class for measuring and protection with 5 A secondary.
 - 19 Use of breaker: Incomer/Coupler/Transformer Control/Capacitor Bank Control/ Spare
-

CHAPTER – 22**TECHNICAL SPECIFICATIONS FOR 6.6 KV A B SWITCH****1.0 SCOPE**

(i) This specification covers design, manufacturing, assembly, testing before supply, inspection, packing and delivery and other basic requirements in respect of outdoor type 12 kV rating Air Break Switch (A B Switch) for Distribution Transformer with accessories and auxiliary equipment required for their satisfactory operation.

(ii) The equipment offered shall be complete with all parts necessary for their effective and trouble free operation. Such parts shall be within the scope of supply irrespective of whether they are specifically indicated in the Bid Proposal sheet.

(iii) It is not the intent to specify, completely here in all the details of design and construction of the A B Switch. However, the A B Switch shall conform, in all respects to high standard of engineering, design and workmanship as listed in annexure I.

2.0 APPLICABLE STANDARD

(i) The A B Switch shall conform to the latest revisions, available at the time of placement of order of relevant standard, rules and codes listed in annexure-I.

(ii) Equipment meeting with the stipulations of equivalent IEC, ANSI, CSA, DIN standard, which ensure equal or better quality than the standards listed in annexure-I, shall also be acceptable. In such case the contractor should submit along with his offer, two copies of such standards in authentic English translation, if the language of the standard is other than English.

3.0 GENERAL TECHNICAL REQUIREMENTS**(i) Type of A B Switch**

The A B Switch shall be outdoor type suitable for horizontal mounting on the support structure. The A B switch shall be 3-phase 3-pin type gang operated and of rotating type with one post insulators per stack and single throw, double break characteristic. It would be complete with arcing horns, down pipe and operating mechanism.

(ii) Current Density

Current density to be adopted for all the parts of A B Switch and terminal connector shall not exceed the following limits:

- a. Hollow tube section -Copper 2.0 A/sqmm
- b. Flat section - Copper 1.6 A/sqmm
- c. Terminal connectors -Alum. 1.0 A/sqmm

(iii) Post Insulators

a. The Post insulator shall be with solid core insulators. Polycone insulators shall not be acceptable. The post insulator should conform to IS: 2544 latest issue. Each stack two such insulators placed one over other with original cementing.

b. The insulator shall be provided with completely galvanised steel base design for mounting on the support. The base and mounting arrangement of the insulator shall be such that the insulator shall be rigid and self-supporting and no guying or cross bracing between phases shall be necessary.

c. Insulator shall be made of homogeneous and vitreous porcelain of high mechanical & dielectric strength. It shall have sufficient mechanical strength to sustain electrical and

mechanical loading on account of wind load, short circuit stresses etc. Glazing of the porcelain shall be uniform brown or dark brown colour with a smooth surface arranged to shed away rain water. Porcelain and metal parts shall be assembled in such a way that any thermal differential expansion between the metal and porcelain through the range of temperature specified in this specification shall not loosen the parts or create undue internal stresses which may affect the mechanical or electrical strength or rigidity.

d. Cap of the insulator shall be of high grade malleable steel casting. It shall be machine faced and hot dip galvanized as per IS 3638, IS 2623. The cap shall have four number of tapped holes spaced on a pitch circle of diameter of 76 mm. to accommodate the terminal clamps of Bus bar.

(e) The insulator unit shall be assembled in suitable jig to ensure correct positioning of the top and bottom metal fittings relative to one another.

(iv) Operating Mechanism

a. Manual operating mechanism gang operated through hand-operated lever shall be provided for A B switch.

b. The operating mechanism shall provide quick, simple and effective operation. The design shall be such that one person shall be able to operate the A B Switch without undue efforts. AB Switch operating mechanism should be such that it should not operate by gravity, wind, short circuit, seismic acceleration, vibration, shock, accidental touching.

c. It shall make it possible to effect a smooth and fully controlled movement of the three blades simultaneously throughout the entire cycle of operation. Adjustment stop shall be provided at either end of the mechanism to stop the handle in the "ON" and "OFF" position. Pad locking arrangement for the handle in the "ON" and "OFF" position should be clearly indicated on the stand.

(v) Control Cabinet

(a) The control cabinet of each operating mechanism shall be made out of 12 SWG (2.64 mm thick) sheet steel. Control cabinet shall be provided with hinged door along with padlocking arrangement. 15mm thick neoprene or better type of gaskets shall be provided to ensure degree of protection at least IP55 as per IS 13947.

(vi) Gland Plates and Glands

A removable gland plate with double compression type brass cable glands shall be provided with each operating mechanism for terminating all cables.

(vii) Auxiliary Switch

a. Main switch operating mechanism shall be equipped with reliable auxiliary switch with 4 NO & 4 NC contacts exclusively for owner's interlocking and protection scheme.

b. The auxiliary switch and auxiliary shall be capable of carrying of 10 Amp current continuously.

c. Quick make and break (QMB) type auxiliary switch shall have snap action built in within the switch.

d. Auxiliary switches shall be actuated by a cam or similar arrangement directly mounted on the A B Switch shaft without any intermediate levers, linkages etc to ensure fool proof operation.

(viii) Terminal and Wiring

A B switch operating mechanism shall be provided with 1100 volt grade stud type terminal. Auxiliary switch shall be wired up to the terminal block. There shall be at least 20% extra

terminals. All wiring shall be carried out with 1100 V grade PVC insulated 2.5 sq. mm copper conductor maximum conductor temperature shall be as per IS: 3961.

(ix) Accessories

- i. Position indicator
- ii. Name plate (Complete details of the parameter)
- iii. Padlocking device
- iv. Status of the A B Switch shall not show as closed till its contacts are not closed properly.
- v. Status of the A B Switch shall not show as opened till its contacts are not opened at least 80% of the isolating distance.

(x) Earthing

- i. Flexible copper braid connections shall be provided between rotating earth blades and the frame which shall have a cross section of at least 50 sqmm and shall be tinned or suitably treated against corrosion.
- ii. The frame of each A B Switch shall be provided with two reliable earthing terminals for connecting to earth mat. The connection shall be such that it can carry specified short circuit current.

(xi) Design and Construction

- i. Contractor shall have to give full details of design, manufacturing, quality control etc of the equipment offered in respect of the following items.
 1. Contacts material, current density etc.
 2. Contact support and fixing arrangement on insulator.
 3. Bearings, housing of bearings, bushes etc.
 4. Base plates
 5. Down pipe, guides joints
 6. Operating mechanism, aux switch, size and thickness of box, degree of protection, gland plate, gland etc.
 7. Nuts, bolt and fasteners
 8. Inter locking devices.

Offers without the above information or with incomplete information may be rejected.

- ii. All live parts shall be designed to have smooth surfaces without any sharp points, edges and corona producing surfaces so as to eliminate corona at specified extinction voltage or at 1.1x Rated voltage if extinction voltage is not specified.

(xii) Fasteners

Nuts, bolts and washers of 5/8" and higher size shall be hot dip galvanized. The bolts used on tapped holes of insulator cap shall be galvanized by centrifuge process to avoid excess deposition of zinc on threads. Nuts, bolts and washers of less than 5/8" size shall be non-magnetic stainless steel.

(xiii) Contacts

Contacts shall be made out of hard drawn rolled/ extruded electrolytic grade copper. The contact assembly should be so robustly designed that while carrying the rated continuous current the temperature rise does not increase beyond 650C over and average ambient temperature of 400C and peak ambient temperature of 500C. Arcing contacts wherever provided shall close first and open last. The contacts shall be silver plated (10 to15 microns).

(xiv) Terminal Pad

It shall be made out of electrolytic copper heavily silver plated (15 microns). The terminal pads shall be suitable for connection to 40x40 mm terminal connector.

(xv) Mounting of Contacts

Fixed contacts shall be mounted on 6 mm thick 100x50 mm M.S. Galvanized channel welded to 10 mm thick M.S. plate with holes for fixing on insulators. Slots shall be provided for marginal adjustment of height of contacts.

(xvi) Moving Blades

Contact surface of moving blades shall be heavily silver plated to 15 microns thick. The surface shall be wiped during closing and opening operations to remove any oxide deposition on the contacts. The blades would be made of single length of rolled/extruded electrolyte grade copper of adequate size matching with the current carrying capacity. The blade shall be supported shall be steel angle on MS angle striping of adequate dimensions (40x40x6 mm).

(xvii) Fixed Contact Assembly

The fixed contact element shall be made of rolled/ extruded electrolyte grade copper flat and reverse loop type. The contact assembly shall be so robustly designed that while carrying the rated continuous current the temperature rise does not increase beyond 650C over and average ambient temperature of 400C. The fixed contact assembly shall be spring-loaded and of high pressure and self aligned type, head guide shall be provided so that proper rating of contact elements and detailed even when the blade is out of alignment by ¼ inch. It should be of robust design. The fixed contact assembly shall be designed in such that the passage of short circuit current for a period one second shall not cause any annealing of the contact. The various parts should be finished to ensure inter-changeability of similar component.

(xviii) Bearings

Rotating insulator shall be mounted on housing with bearings. Two numbers of bearings with at least 50 mm ID and 80 mm distance between the bearings shall be provided. The bearings shall be of reputed make and lubricated for lifetime. Other parts like bushes, joints springs etc shall be so designed that no lubrication shall be required during the service.

(xix) Down Pipe

The down pipes of A B Switch shall be of at 1.25% I.P.S. G.I. pipe and its length would be such that when the blades of the switch are at height of 20 ft, the operating handle is 3.5 ft from the ground level. Suitable guides shall be provided for intermediate positions of the down pipe.

(xx) Base

Each base of A B Switch shall be provided with a base fabricated from steel sections. The base shall be suitable for mounting on support structures. Fabrication, welding etc shall be done by suitable jig; templates and devices used for production of the base shall be furnished with the contractor.

(xxi) Supporting Structures / Arcing Horns / Phase**Coupling Bar**

a. The contractor shall quote unit prices for support structure for the A B Switch offered. These support structures shall be fabricated out of galvanized steel sections conforming to IS 1239.

b. The support structure shall be suitable for mounting operating mechanism and guides. It shall be designed to withstand short circuit forces, wind pressure, seismic forces etc. along with the operating forces, vibrations, shocks etc. at actual site conditions with adequate factor of safety.

c. The arcing horn shall be of 8 mm galvanized steel rod. One end of each arcing horn shall be soundly welded to a 25x6 mm steel flat which in turn shall be fitted to the switch using 5/16 inch dia galvanized bolts and nuts. Arcing horn shall be fitted against one another.

d. The phase coupling bar: The bar required for coupling the rotation of all the three phase would on 1 inch I.P.S. steel pipe in 9 ft length. The fixing arrangement for the phase coupling bar to the cranks and the rotating insulator stacks shall be such as to permit a smooth movement of coupling bar on operation of the switches without bending/looseness.

(xxii) Terminals & Connectors

a. Terminal: The terminal shall be made of rolled/ extruded electrolytic grade copper flat having cross section area equal to that of the blade. It shall be so constructed that an intimate contact with the contact element is ensured and provision is made to bolt with two numbers of 3/8 inch dia galvanized bolts and nuts, a cast aluminium connector suitable to take conductors up to the size of ACSR 150 mm² using number 3/8 inch dia bolts and nuts. The terminal shall be silver coated.

b. Connectors: The cast aluminium connectors shall be smooth and supplied for the each end of each phase of the switch. The design of the connector shall be such that at no place it's cross sectional area is less than the twice the cross sectional area of the copper blade. All the bolts should be galvanized.

(xxiii) Assembly

i. The disconnector shall be fully assembled at the works of the contractor and all operations of the fully assembled disconnector shall be checked at the manufacturer's works

(xxiv) Painting, Galvanizing and Climate Proofing

a. All interiors and exteriors of enclosures, cabinets and other metal parts shall be thoroughly cleaned to remove all rust, scales, corrosion, grease and other foreign materials. After cleaning two coats of zinc oxide primer shall be given by suitable stoving and air drying etc. Colour of the final paint shall be epoxy light gray.

b. Paint inside the metallic housing shall be of anti condensation type and the paint on outer surfaces shall be suitable for out door condition.

c. Galvanization shall be done after completion of the fabrication and should be capable of preventing corrosion in view of severe climatic conditions.

d. All ferrous part of the switch shall be hot dip galvanized as IS: 2629-1969 (as amended up to date). The steel pipe used shall be galvanized in accordance with IS: 4786-1968 (as amended up to date). **ANNEXURE-I**

(xxv) Tests

Type Tests: The A B Switch shall be type tested as per IS:1818-1972 (as amended up to date) for the following, for which the contractor shall submit the type test report along with the bid.

a. Impulse voltage dry test

b. Temperature rise test of the main contact.

c. Measurement of resistance of main contact in closure position.

d. Test to prove the capability of carrying the rated full load current continuously and short circuit for some second.

e. Mechanical endurance tests.

Routine Tests & Acceptance Test:

a. All acceptance and routine tests as stipulated in the relevant standards shall be carried out by the supplier/contractor in presence of owner representative.

b. Mechanical operation test (Routine test) shall be conducted on the complete A B switch.

c. Immediately after finalization of the Programme of type/acceptance/routine testing, the supplier/ contractor shall give three weeks advance intimation to the owner, to enable him to depute his representative for witnessing the tests.

(xxvi) Inspection

a. The owner may carry out the inspection at any stage of manufacture. The contractor shall grant free access to owner's representative at reasonable time when the work is in progress.

b. The owner reserves the right to insist for witnessing the acceptance / routine testing of the bought out times.

c. Inspection and acceptance of any equipment under this specification by the owner shall not relieve the supplier/contractor of his obligation of supplying equipments in accordance with the specification.

Annexure-I

List of the relevant standards:

a. Indian Standards: 1818, 9921, 2544, 13947, 4691, 325, 4722, 2629, 4759, 2633, 1573, 3033, 2016, 3961, 5561, 1554, 5578, 11353, 9920

b. IEC: 129, 168,

c. Indian Electricity Rules 1956

Only the latest versions of all these standards shall be followed.

Technical parameters:

Sl.No	Parameter	Unit	Requirement
1	Rated frequency	HZ	50
2	System neutral Earthing		Effectively earthed
3	No of phases	No	3
4	Tem. Rise	Deg.c	As per Standards IS/IEC
5	Safe duration of over load		
	a) 150% of rated current		
	b) 12% of rated current		
6	Rated voltage	Kv rms	12
7	Type of AB switch		DBCR
8	Rated normal current	Amps	400
9	Rated short time with stand current of MS for 3 sec	KA rms	25
10	Rated short circuit make current	KA peak	63
11	Basic Insulation Level		
	1) Lighting impulse with stand	KV peak	

	voltage		
	a) Pole to earth & between poles		75
	b) Across isolating distance		85
	2) Rated power frequency withstand voltage	KV rms	
	c) Pole to earth & between poles		28
	d) Across isolating distance		32
12	Minimum creepage distance	mm	300

Material Details:

Sl.No	Description	Material	Size
1	Base channel	MS Galvanized	75x40x6 mm
2	Base support channel	MS Galvanized	75x40x6 mm
3	Base for 4 th bearing	MS Galvanized	75x40x6 mm
4	Tandem pipe	GI Pipe	25 NB, Class B 3200 mm long
5	Down Pipe	GI Pipe	50 NB, Class B, 1900 mm long
6	Earthing Terminal		M16, Bolts with Nut
7	Support structure	MS Galvanised Pipe	114 mm CD x 12 SWG

Note: The dimensions/data shown above against material details are for reference of the contractor and indicative only.

CHAPTER – 23**TECHNICAL SPECIFICATION FOR CROSS-ARMS
(6.6 kV OVERHEAD LINES)****j) V' shape M.S. cross arm with clamps**

(ii) X-arms shall be made as per GAD – 001.

k) The cross arm shall be hot dipped galvanized generally conforming to IS – 2633/72.

(iv) The X-arm should not be welded/ jointed at any place except as specified.

(v) The clamps for the X-arm shall be of G.I. & shall be hot dipped galvanized generally conforming to IS – 2633/72.

(vi) The clamps shall be designed to fit for the specified PSC poles.

G.I. X-Arm for 90 degrees cut points

(i) It shall comprise of 75 x 40 x 6 mm 3.2 mtr. Long ISMC channels to be provided on poles for 90 degrees cut points.

(ii) The X-arm shall be hot dipped galvanized generally conforming to IS – 2633/72.

l) The clamps shall be designed to fit for the specified PSC poles.

m) The holes for the G.I. pin shall be spaced as per the relevant I.S. specifications for 11kV and LT circuits.

CHAPTER – 24

TECHNICAL SPECIFICATION FOR STAY SET

SCOPE:

This specification provides for manufacturing, testing, dispatch, supply and delivery of Stay Set for 6.6 kV. The stay set will consist of the following items:

- a. Stay wire
- b. Stay Insulator
- c. Turn Buckle
- d. Clamps
- e. Anchor rod & plate
- f. Stay pit anchor assembly

GI STAY WIRE

The specification for the GI stay wire shall be as follows.

(i) APPLICABLE STANDARDS

Except when they conflict with the specific requirements of this specification, the G.I. Stay Stranded Wires shall comply with the specific requirements of IS: 2141-1979, IS: 4826-1979 & IS: 6594-1974 or the latest versions thereof.

(ii) APPLICATION AND SIZES

- a) The G.I. stranded wires covered in this Specification are intended for use on the overhead power line poles, distribution transformer structures etc.
- b) The G.I. stranded wires shall be of 7/12SWG (7/2.5 mm) (11kV lines) and 7/14 SWG (7/2 mm) (LT lines) standard sizes.

(iii) MATERIAL

The wires shall be drawn from steel made by the open hearth basic oxygen or electric furnace process and of such quality that when drawn to the size of wire specified and coated with zinc, the finished strand and the individual wires shall be of uniform quality and have the properties and characteristics as specified in this specification. The wires shall not contain sulphur and phosphorus exceeding 0.060% each.

(iv) TENSILE GRADE

The wires shall be of tensile grade 4, having minimum tensile strength of 700 N/mm² conforming to IS: 2141.

(v) GENERAL REQUIREMENTS

- a. The outer wire of strands shall have a right-hand lay.
- b. The lay length of wire strands shall be 12 to 18 times the strand diameter.

(vi) MINIMUM BREAKING LOAD

The minimum-breaking load of the wires before and after stranding shall be as follows:

No. of wires & const	Wire dia (mm)	Min. breaking load of the standard wire(KN)before standing (KN)	Min. breaking load of single wire
7(6/1)	2.0	2.20	13.70
7(6/1)	2.5	3.44	21.4
7(6/1)	3.15	5.46	34.0
7(6/1)	4.0	8.8	54.9

(VII) CONSTRUCTION

- The galvanized stay wire shall be of 7-wire construction. The wires shall be so stranded together that when an evenly distributed pull is applied at the ends of completed strand, each wire shall take an equal share of the pull.
- Joints are permitted in the individual wires during stranding but such joints shall not be less than 15 meters apart in the finished strands.
- The wire shall be circular and free from scale, irregularities, imperfection, flaws, splits and other defects.

(viii) TOLERANCES

A tolerance of ($\pm$) 2.5% on the diameter of wires before stranding shall be permitted.

(ix) SAMPLING CRITERIA

The sampling criteria shall be in accordance with IS: 2141.

(x) TESTS ON WIRES BEFORE MANUFACTURE

The wires shall be subjected to the following tests in accordance with IS: 2141.

- Ductility Test
- Tolerance on Wire Diameter

(xi) TESTS ON COMPLETED STRAND

The completed strand shall be tested for the following tests in accordance with IS: 2141.

- Tensile and Elongation Test: the percentage elongation of the stranded wire shall not be less than 6%.
- Chemical analysis
- Galvanizing Test :

The Zinc Coating shall conform to "Heavy Coating" as laid down in IS:4826

(xii) MARKING

Each coil shall carry a metallic tag, securely attached to the inner part of the coil, bearing the following information:

- Manufacturers' name or trade mark
- Lot number and coil number
- Size
- Construction
- Tensile Designation
- Lay
- Coating

h) Length

i) Mass

j) ISI certification mark, if any

(xiii) **PACKING**

The wires shall be supplied in 75-100 Kg. coils. The packing should be done in accordance with the provisions of IS: 6594

CHAPTER – 25**DANGER NOTICE PLATES****1. SCOPE**

This Specification covers Danger Notice Plates to be displayed in accordance with rule No. 35 of Indian Electricity Rules, 1956.

2. APPLICABLE STANDARDS

Unless otherwise modified in this specification, the Danger Notice Plates shall comply with IS: 2551-1982 or the latest version thereof.

3. DIMENSIONS

- I. For display at 33 KV installations -250x200mm
- II. The corners of the plate shall be rounded off.
- III. The location of fixing holes: - that suit the requirements of the installations.

4. LETTERINGS

All letterings shall be centrally spaced. The size of letters in the words in each language and spacing between them shall be so chosen that these be uniformly written in the space earmarked for them.

5. LANGUAGES

5.1 Under Rule No. 35 of Indian Electricity Rules, 1956, the owner of every medium, high and extra high voltage installation is required to affix permanently in a conspicuous position a danger notice in Hindi or English and, in addition, in the local language(Odiya), with the sign of skull and bones.

5.2 In the specimen danger notice plate, adequate space has been provided for having the letterings in local language for the equivalent of ' Danger', '33000' and 'Volts'.

6. MATERIAL AND FINISH

The plate shall be made from mild steel sheet of at least 1.6mm thick and vitreous enameled white, with letters, figures and the conventional skull and cross-bones in signal red colour (refer IS:5-1978) on the front side. The rear side of the plate shall also be enameled.

7. TESTS

The following tests shall be carried out:

- i) Visual examination as per IS: 2551-1982
- ii) Dimensional check as per IS: 2551-1982
- i) Test for weather proofing as per IS: 8709-1977 (or its latest version)

Chapter-26
TECHNICAL SPECIFICATIONS FOR 415/240 V.
PORCELAIN INSULATORS AND INSULATOR FITTINGS

1.0 SCOPE:

This specification covers design, engineering, manufacture, assembly, stage testing, inspection & testing before supply and delivery at site of LT pin insulator, LT shackle insulators and insulator fittings for use on 415/240 V over head power lines to be constructed under this specification.

2.0 APPLICATION STANDARDS:

The insulators shall comply with IS: 1445-1977 and fittings with IS: 7935-1975 or the latest revisions thereof. In the event of the supply of insulators and fittings conforming to standards other than specified, the Contractor shall confirm in his bid that these standards are equivalent to those specified. In case of award, salient features of comparison between the standards proposed by the contractor and those specified in this document will be provided by the contractor to establish their equivalence.

3.0 PORCELAIN INSULATORS:**(i) General requirements:**

- a. The porcelain shall be sound, free from defects, thoroughly verified and smoothly glazed.
- b. The glaze, unless otherwise specified, shall be brown in colour. Except for the screw threads and parts on which the porcelain is supported during the firing, which may be left unglazed.
- c. The design of the insulator shall be such that stresses due to expansion and contraction in any part of the insulator shall not lead to its deterioration.
- d. The insulator shall be in one piece.

(ii) Type of insulators

- a. Pin insulator: Pin insulator is an insulator consisting of single piece of porcelain and indented to be mounted rigidly on a supporting structure by a pin, which passes up inside the insulator. The pin type insulator shall have a top groove and shall be threaded to take mild steel pin. The dimensions of pin insulator shall be as per REC standards.

(iii) Basic insulation level: The test voltages of the insulators shall be as under:

Type of Insulator	Wet One minute Power frequency with stand voltage [KV (rms)]	Power Frequency Puncture withstand voltage[KV (rms)]
Pin	10	60
Shackle	10	60

The withstand voltage in column 2 above is referred to the "Reference Atmospheric Conditions" as per IS: 1445.

- (iv) Mechanical Load: The insulators shall be suitable for minimum failing load specified as under:

Pin insulator KN	Shackle insulator KN
3.5	11.5 (Type 1)
-	16.0 (Type 2)

(v) Test: The insulators shall comply with the following tests as per IS: 1445.

- a. Type test: The following tests shall constitute the type tests;
 - a) Visual examination
 - b) Verification of dimensions
 - c) Wet power- frequency voltage withstand test
 - d) Temperature cycle test
 - e) Mechanical failing load test
 - f) Power- frequency puncture withstand test
 - g) Porosity test
- b. Acceptance test: The test samples shall be subjected to the following acceptance tests in the order indicated below;
 - a) Verification of dimensions
 - b) Temperature cycle test
 - c) Mechanical failing load test
 - d) Porosity test
- c. Routine test: The visual examination shall be carried out on each insulator. Any other test not mentioned above but included in the latest version of IS:1445 shall also be construed to be included in the above list of type, acceptance & routine tests.

(vi) Marking:

- a) Each insulator shall be legibly and indelibly marked to show the followings:
 - Name of the trade mark of the manufacturer
 - Year of manufacture
 - ISI certification mark

(vii) Packing: All insulators shall be packed in basket, crates or boxes as per manufacturer's standard practice but suitable to rough handling.

4.0 INSULATOR FITTINGS:

I. Pins

General requirements

- a. The pin shall be obtained by process of forging. They shall be good finish, free from flows and other defects. The finish of collar shall be such that sharp angle between the collar and the shackle is avoided.
- b. All ferrous pins, nuts and washers except those made of stainless steel, shall be galvanized. The threads of nuts shall be cut after galvanizing and shall be well oiled or greased.
- c. Dimensions: Pin shall have a stalk length of 135 mm, stalk length of 125 mm and minimum failing load of 2.9 KN. Dimensions shall be as per REC standards.

II. Shackle insulator Fittings

- a. All parts shall be of good finish and free from flaws and other defects. The edges on the outside of the fittings, such as holes etc. shall be rounded.
 - b. All ferrous fittings and the parts other than those of stainless steel shall be galvanized. Small fittings like spring washers, nuts etc. may be electro-plated with zinc.
- III. Strap type fittings shall consist of followings:
 - a. A pair of MS Strap
 - b. 2 nos MS bolts with hexagonal head and nuts
 - c. 2 nos. spring washers
 - d. Helically formed conductor dead-end fittings made of aluminum alloy or aluminum-clad steel conforming to the requirement specification No.25/1983.
- IV. U Clamps fittings shall be required. These would consist of:
 - a. MS “U” Clamps
 - b. 1. No. MS bolts and nut
 - c. 1 No spring washer
 - d. Helically formed distribution side tie made of aluminum alloy or aluminum- clad steel conforming to requirements of RE Specification No. 25/1983. [Note: “U” Clamp fittings are intended only for use on tangent locations]
- V. Tests: Insulator fittings shall comply with following tests as per IS:7935.
 - a. Type test: the following shall constitute the type test:
 - a) Visual examination
 - b) Verification of dimensions
 - c) Checking of threads on head
 - d) Galvanizing/electro plating test
 - e) Mechanical strength test (for pin insulator fitting only)
 - b. Acceptance tests: The following shall constitute the acceptance tests;
 - Checking of threads on the heads
 - Galvanizing test
 - c. Routine Tests: Visual examination test shall be carried out as routine tests. Any other test not mentioned above but included in the latest version of IS: 7935 shall also be construed to be included in the above list of type, acceptance & routine tests.
 - d. Packing: For packing of insulator pin & shackle fittings, double gunny bags or wooden cases, if deemed necessary, shall be employed. Helically formed fittings shall be packed in card board/wooden boxes. The gross wt of each packing shall not normally exceed 50 KG. All nuts shall be hand tightened over the bolts and screwed up to furthest point.
- VI. GUARANTEED TECHNICAL PARTICULARS: The bidders shall furnish this document with his bid.
