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**ODISHA DEDICATED AGRICULTURE & FISHERY
FEEDER PROJECT
(ODAFFP)**

PROJECT MANAGEMENT UNIT 33/11KV

VOL – II

Technical Specification

For

**Engineering, Supply, Erection and Commissioning of
11 kV dedicated Trunk Lines and Spur Lines from
Existing 33/11KV Sub-Stations**

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SCOPE OF WORK

1.0 SCOPE OF WORK:

1.1 Scope of Work for Sub-station & Line

Scope of work of the Contractor includes Engineering, Supply, Erection, Testing and Commissioning of all materials & equipment such as –

Sub-station:

- a) 33/11Kv 3.15MVA / 5MVA / 8MVA Power Transformer in the source Substation.
- b) Upgradation of Power Transformer in source Substations, where there is no space available for additional Power Transformer.
- c) 33/0.433 kV 100 kVA Station Transformer in source Substations.
- d) It is envisaged that Distribution Transformers of 25KVA, 63KVA & 100KVA capacity will be installed in some places. The detailed requirement is being work out. However, as per the tentative assessment, DISCOM wise requirement is furnished below:

Organinisation	25KVA	63KVA	100KVA	Total
CESU	200nos.	130nos.	240nos.	570nos.
NESCO	400nos.	180nos.	120nos.	700nos.
WESCO	140nos.	90nos.	100nos.	330nos.

The exact requirement will be uploaded later on through amendment. These Distribution Transformers shall be supplied, erected & commissioned as per the Technical Specifications

- e) 33kV Transformer Bay consisting of Four pole structure, Outdoor VCB, CT, Isolators, Surge Arrester, Relays in VCB Marshalling box or Relays in Control Relay Panel inside Control room.
- f) 11kV Transformer bay consisting of Four pole structure, Outdoor VCB, CT, Isolators, Surge Arrester, Relays in VCB Marshalling box or Relays in Control Relay Panel inside Control room.
- g) 11kV Metering unit on DP structure with Static Trivector Meter.
- h) Control cable, LT power Cable, Conductors, Insulators, Hardware fitting, Clamps & Connector
- i) Four pole structutre for 33 kV bay and also 11 kV Bay to be kept as spare bay with strung bus only.
- j) DP structure with 33 kV AB Switches & HG Fuse for Station Transformer and 11kV AB Switches & HG Fuse for Distribution Transformer
- k) LT Distribution Box with LT cable.
- l) Substation Structures
- m) Earthing
- n) RCC plus brick work Cable trench.
- o) PCC.
- p) Fixing of danger plate, Bay marking & colour coding

- q) Excavation of soil for foundation of the structures & transformers.
- r) Leveling of bay area including borrowed earth and antiweed treatment.

Line:-

- a) Preliminary and detail Survey of 11 kV Trunk and Spur lines.
- b) Preparation of Pole schedule
- c) Erection of PSC pole, DP and four pole structure with GI RSbJoist including civil works.
- d) Stringing of conductors by fixing insulators, hardware fittings and accessories.
- e) Erection of stay wires with insulator
- f) Earthing of poles.
- g) Fixing of number plates etc.

Important Note: In 33/11 KV source S/s, care is to be taken for construction of bays for matching with the existing system. The dismantling works if any involved are also to be taken care as per the direction of the Engineer in Charge.

- 1.2 The specification covers design, engineering, manufacture, assembly, type tests, inspection and testing at manufacturer's works, packing, forwarding and delivery F.O.R destination stores.
- 1.3 The scope is on the basis of a single/JV Bidder's responsibility, completely covering supply, erection and commissioning of all equipment specified under the accompanying Technical Specifications including other services. It will include the following:
 - a) A tentative BOQ has been made on Preliminary investigation . However, the Contractor will make preliminary survey, detailed survey and will supply the materials as per detailed survey.
 - b) Providing Engineering drawings of foundation details, structural details of both line & Sub-station work, where not provided in the tender.
 - c) Providing Equipment data, Operational manual.
 - d) Preparation of Cable Schedule (in shape of a booklet) for the Owner's approval.
 - e) Packing and transportation from the manufacturer's works to the site.
 - f) Loading, unloading and transportation as required.
 - g) Receipt, storage, preservation and conservation of equipment at the site including insurance.
 - h) Erection, testing and commissioning of all equipment.
 - i) Performance and Guarantee tests.
- 1.4 The scope of work shall also include all work incidentals for successful operation and commissioning and handing over of works whether specifically mentioned or not. In general, works are to be carried out by the Contractor in accordance with the stipulations in Conditions of Contract.
- 1.5 Bidders are requested to visit the site before participating the tender.

GENERAL TECHNICAL CLAUSES & DESIGN

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PART - A

GENERAL TECHNICAL CLAUSES

GENERAL TECHNICAL CLAUSES

1.0 GENERAL PARTICULARS OF SYSTEM

1.1 Bay Extension at source sub station:

- i. The 11 kV dedicated feeders for extending power supply to irrigation pumps and fishery farms will emanate from the existing 33/11 kV substations.
- ii. In some sub stations, new transformers will be installed and in others the transformers will be upgraded.
- iii. 33/0.433 kV Station Transformer will be provided in some Substations.
- iv. 33 kV transformer bay, 11 kV transformer bay where new transformer will be installed and 11 kV line feeder bays.
- v. Metering units with HT Trivector meter will be installed on the 11 kV trunk line feeder at the sub station for energy auditing.
- vi. One spare 11 kV bay with four pole structure and strung bus will be constructed in each source sub station.

1.2 11 kV Line :

- i. There will be two types of lines: Trunk lines and spur lines
- ii. Trunk lines shall be with 100 sq mm All Aluminium Alloy conductor (AAAC) and spur lines will be with 55 sq mm AAAC.
- iii. Both trunk lines and spur lines will be drawn on 10 mtr PSC pole (300 kg loading capacity) at straight line poles (0 degree to 10 degree angle deviation). In cyclone prone area they shall be of 400 kg loading capacity. At angle points with deviation angle (more than 10 degree and upto 60 degree deviation), Double Pole (DP) arrangement with GI RS joists shall be made & Four-Pole arrangement with GI RS joists shall be made for angle more than 60 degree upto 90 degree deviation.
- iv. In addition to the meter on the trunk line feeder at source sub station, HT Trivector meters with metering units shall be installed on spur lines and on spur line starting points for energy auditing.
- v. The foundation of PSC poles in straight line with deviation up to 10 degree shall be with PCC (1:2:4) and DP/Four pole foundations will be with RCC (1:1.5:3)

1.3 Transformer Capacity:

- i. The transformers to be installed will be of either 3.15 MVA or 5 MVA or 8 MVA 33/11kV capacity.
- ii. Station transformers shall be of 100 kVA, 33/0.433kV capacity.

1.4 Qualifying requirement of vendors;

The material offered shall be procured from short listed vendor at Chapter E-14 and shall have been successfully Type Tested during last five years on the date of bid opening. The Type Test reports shall be submitted along with the bid.

For other items which are not in the vendor list, the material offered shall be in accordance with the REC specifications and procured from a vendor who must have at least three years experience in manufacturing of the same. The materials shall have been successfully type tested during last five years on the date of bid opening. The front page of the type test report showing evidence of successful test with the signature of the bidder shall be submitted along with the bid. The type test reports shall be submitted within one month placement of LOA.

All materials shall be manufactured in India only.

2.0 Layout arrangement:

The bay layout in the source sub-stations shall be prepared by the contractor in line with the existing arrangement and shall be approved by the Engineer-in-Charge.

3.0 Soil data

Soil investigations in sub-stations and lines have not been made. The Contractor shall investigate the soil properties and soil bearing capacity as part of the scope of work. Bidder can do the soil investigation at its cost for bidding purpose.

4.0 Completeness and accuracy of information

The Contractor shall note that the information provided in the bidding document and relevant schedules/Annexures may not be complete or fully accurate. For his own interest the Contractor is advised to make site visits and fully satisfy himself regarding site conditions in all respects, and shall be fully responsible for the complete design and engineering of the sub-stations.

5.0 DRAWINGS ATTACHED WITH TENDER DOCUMENT

Some drawings and Technical Particulars provided in **Chapter E18 & Chapter E16** are a part of the specification. Bids shall be prepared by the Bidder based on information provided in the drawings and Technical Particulars/schedules. The bidder shall fill up his offered value in the column provided in the GTP. However this value shall not be inferior to the value which the OWNER has specified in the specification in different chapters.

The list of drawings and Technical Particulars are furnished at **Chapter E18 & Chapter E16 of the T.S** respectively.

6.0 COMPLIANCE WITH SPECIFICATION

In the event of there being any inconsistency between the provisions of the conditions of contract and the provisions of this Specification in respect of commercial requirements, the provisions of the conditions of contract shall take precedence for commercial matters and the provisions of this Specification shall take precedence in respect of technical matters.

In case of inconsistency between Technical specification & Bid Proposal sheet, quantities of various items as specified in the bid proposal sheet shall be considered for quoting however the work shall be executed as specified in the Technical specification. Only brief description is given in the BPS & the work shall be executed in line with the requirement given in the TS and payment will be made accordingly.

7.0 SPARES

a) General

The Contractor shall provide the mandatory spares detailed in the chapter **E15** with their price. Mandatory spares shall be supplied as part of the Works under this specification.

The spares shall include consumable items sufficient for an operational period of 5 (five) years after commissioning, as well as essential replacement parts to cover the event of a break-down which would affect the availability or safety of the equipment.

The Contractor shall ensure that sufficient spare parts and consumable items are available for his own use during commissioning of the plant. Spares ordered by the Owner shall not be used by the Contractor without the written consent of the Engg Incharge and any spares so used by the Contractor during the commissioning of the plant shall be replaced by the Contractor at the Contractor's expense.

Any spare Equipment, parts and tools shall be subject to the same specification, tests and conditions as similar material supplied under the Scope of Works of the Contract. They shall be interchangeable and suitable for use in place of the corresponding parts supplied with the plant and must be suitably marked and numbered for identification and prepared for storage by greasing or painting to prevent deterioration.

All spare Equipment or materials containing electrical insulation shall be packed and delivered in cases suitable for storing such parts or material over a period of years without deterioration. Such cases shall have affixed to both the underside and topside of the lid a list detailing its contents. The case will remain the property of the Owner.

8.0 TRAINING

In accordance with GCC , two days training shall be imparted on equipment installation, commissioning, operation maintenance at each source sub station.

8.1. Installation and commissioning techniques

The Owner's staff or its authorised representative will be present during the installation and commissioning period and it is essential that they be fully involved in any on-site corrections or modifications to equipment.

All training course notes and documentation shall be in the English language.

9.0 ERECTION AT SITE AND ACCOMMODATION

The Contractor shall provide, at his own cost and expense, all labour, plant and material necessary for unloading and erection at the Site and shall be entirely responsible for its efficient and correct operation.

The Contractor shall be responsible for arranging and providing all living accommodation services and amenities required by his employees.

9.1 SUPERVISION AND CHECKING OF WORK ON SITE

All work on site included in the Contract scope of works shall be supervised by a sufficient number of qualified representatives of the Contractor.

Before putting any plant or Equipment into operation the Contractor shall satisfy himself as to the correctness of all connections between the plant and Equipment supplied under this and other contracts. The Contractor shall advise the Engg Incharge in writing, giving seven days, when the plant or Equipment is ready for inspection or energisation.

10.0 COMPLIANCE WITH REGULATIONS

All Equipment and material supplied, and all work carried out shall comply in all respects with such of the requirements of all Regulations and Acts in force in India as are applicable to the Contract Works and with any other applicable regulations to which the Owner is subject.

The Contractor shall fully inform himself of the requirements of the local Laws, Regulations and rules in-force in the State of Orissa, especially with respect to local employment laws, licensing requirements, electrical safety rules and regulations, building regulations and planning procedures.

The Contractor shall be responsible for applying for all necessary licenses; including Electrical Contractors License, Workman's Permits and Certificates of Competency for Supervisors, and local Government approvals required for the contract works and for the payment of all necessary fees associated with such licenses and approvals.

Correspondence with the Electrical Inspector shall be conducted through the Engg Incharge, but the Contractor shall provide all necessary information, regarding the contract works, as may be required by the Electrical Inspector.

Additionally the Contractor shall also follow the minimum regulations on safety, employees' welfare, industrial relation etc. as stipulated under the relevant Acts and Rules.

11.0 INSURANCE

General

In accordance to the clause 69 of **the General Conditions of Contract (Erection)**, the following provisions will apply towards insurance.

Workmen's Compensation Insurance

This insurance shall protect the Contractor against all claims applicable under the Workmen's Compensation Act, 1948 (Government of India). This policy shall

also cover the Contractor against the claims for injury, disability, disease or death of his or his sub-contractor's employees, which for any reason are not covered under the Workman's Compensation Act, 1948.

Comprehensive auto mobile insurance

This insurance shall be in a such a form to protect the Contractor against all claims for injuries, disability, disease and death to members of public including the OWNER's men and damage to the property of others arising from the use of motor vehicles during on or off the Site operations, irrespective of the ownership of such vehicles. The minimum liability covered shall be as herein indicated:

- 1) Fatal Injury : Rs. 1,00,000/- each person
- 2) Property : Rs. 2,00,000/- each occurrence
- 3) Damage : Rs. 1,00,000/- each occurrence

* As per latest prevailing Govt. rules.

Comprehensive General Liability Insurance

This insurance shall protect the Contractor against all claims arising from injuries, disabilities, disease or death of members or public or damage to property of others, due to any act or omission on the part of the Contractor, its agents, its employees, its representatives and sub-contractors or from riots, strikes and civil commotion.

The hazards to be covered will pertain to all works and areas where the Contractor, its sub-contractors, agents and employees have to perform work pursuant to the Contracts.

The above are only an illustrative list of insurance covers normally required and it will be the responsibility of the Contractor to maintain all necessary insurance coverage to the extent both in time and amount to take care of all its liabilities either direct or indirect, in pursuance of the Contract.

PART – B

**GENERAL TECHNICAL CLAUSES
FOR DESIGN**

GENERAL TECHNICAL CLAUSES FOR DESIGN

1.0 DESIGN AND STANDARDISATION

All Equipment shall be designed to ensure satisfactory operation in all atmospheric conditions prevailing at the Site(s) and during such sudden variation of load and voltage as may be met with under working conditions on the system, including those due to faulty synchronising and short circuit.

All outdoor Equipment and fittings shall be designed so that water cannot collect at any point. Grease lubricators shall be fitted with nipples and where necessary for accessibility, the nipples shall be placed at the end of extension piping.

Kiosks, cubicles and similar enclosed compartments shall be adequately ventilated to restrict condensation. All contactor or relay coils and other parts shall be suitably protected against corrosion, birds, insects All Equipment shall be designed to obviate the risk of accidental short circuit due to animals, mites, rodents or micro-organisms.

2.0 QUALITY ASSURANCE

The quality assurance arrangements shall conform to the relevant requirements of ISO 9001 or ISO 9002 as appropriate.

The systems and procedures which the Contractor will use to ensure that the Works comply with the Contract requirements shall be defined in the Contractor's Quality Plan for the Works.

The Contractor shall operate systems which implement the following:

Hold Point "A stage in the material procurement or workmanship process beyond which work shall not proceed without the documented approval of designated individuals or organisations."

The Engg. Incharge's written approval is required to authorise work to progress beyond the Hold Points indicated in approved Quality Plans.

Notification Point "A stage in material procurement or workmanship process for which advance notice of the activity is required to facilitate witness."

If the Engg. Incharge or his authorised person does not attend after receiving documented notification in accordance with the agreed procedures and within the notice period, then work may proceed.

The following will be the hold points in the contract

- i) Sub-structure (Foundation concreting in substation and line)
- ii) Stringing of conductor
- iii) Acceptance Tests of materials to be supplied in Manufactures premises
- iv) Stage inspection of transformers
- v) Testing and Commissioning of sub station bay and line

2.1 Quality plans

The Contractor shall draw up for each section of the work Manufacturing Quality Plans (MQP) and Field Quality Plan (FQP), which shall be submitted to the Engg. Incharge for approval at least two weeks prior to commencement of the particular

section. Each Quality Plan shall set out the activities in a logical sequence and, unless advised otherwise, shall include the following:

- a) An outline of the proposed work and program sequence
- b) The duties and responsibilities assigned to staff ensuring quality of work for Contract
- c) Hold and Notification points
- d) The inspection of materials and components on receipt
- e) Reference to the Contractor's work procedures appropriate to each activity
- f) Inspection during fabrication/construction
- g) Final inspection and test

Non-conforming product

The Contractor shall retain responsibility for the disposition of non-conforming items.

2.2 Monitoring of quality arrangements

During the course of the Contract, the Engg. Incharge will monitor the implementation of the Quality Assurance arrangements. Monitoring will be by surveillance of the activities at work locations and/or by formal audits of the adherence of the Contractor to the systems and procedures which constitute his Quality Assurance arrangements. Corrective actions shall be agreed and implemented in respect of any deficiencies

The Contractor shall provide facilities, including access to , which may be required by the Engg. Incharge for monitoring activities.

3.0 HEALTH, SAFETY AND ENVIRONMENT (HSE) PLAN

3.1 General

Within one month of award of contract the Contractor shall produce an HSE Plan for the contract and submit for the approval of the Engg. Incharge. The HSE Plan is described in the following sections.

The primary objective of the HSE Plan is for the contractor to demonstrate that he has the capability to carry out the contract work in a cost effective manner, giving due consideration to the Health, Safety and Environmental management of both his own employees, those of the Owner and anyone who may be affected by his activities.

3.2 General structure of HSE Plan

The HSE Plan shall conform to the following general structure:

- a) Contractors Policy Statement
- b) Health
- c) First Aid
- d) Occupational health
- e) Safety
- f) Motivation and communication
- g) Emergency response
- h) Safety function
- i) Accident investigating and reporting
- j) Personal protective equipment
- k) Environment

l) Waste management

4.0 PROGRESS REPORTING

The Contractor shall submit for approval, within three weeks of the issue of letter of award, an outline of the engineering, material procurement, site mobilisation, man and machine deployment, delivery, erection, testing, commissioning, and handing over programme. Within a further period of two weeks, the Contractor shall provide a detailed programme of all these activities in a form to be agreed by the Owner. The Contractor shall submit monthly progress reports not later than the fifth day of the following month. The reports shall show clearly and accurately the position of all activities associated with engineering, material procurement, works tests, shipping, site erection, testing and commissioning with regard to the agreed contract programme. The An outline of the completion schedule of different activities prepared by the OWNER is enclosed at **Annexure-XVI** of Volume-I.

In addition to the routine monthly progress report the Contractor shall also submit to the Engg. Incharge by the 25th day of every month, a man hour schedule for the following month, detailing the man hours scheduled for that month, skill-wise and area-wise.

The preferred format for presentation of programmes is the latest version of MS Project. The programmes and monthly updates shall be submitted on CD.

The position on material procurement shall give the date and details of orders placed and indicate the delivery date quoted by the manufacturer. If any delivery date has an adverse affect on the contract programme the Contractor shall state the remedial action taken to ensure that delays do not occur.

Any delays which may affect any milestone or final completion dates shall be detailed by the Contractor who shall state the action taken to effect contract completion in accordance with the contract programme.

The contractor shall provide two copies of the progress report to the Engg. Incharge .

5.0 STANDARDS

Except where otherwise specified or implied, the Contract Works shall comply with the latest edition of the relevant Indian Standards, International Electro technical Commission (IEC) standards and any other standards mentioned in this Specification. The Contractor may submit for approval, equipment or materials conforming to these specifications.- In case of conflict the order of precedence shall be (1) IS, (2) IEC (3) Other specification/ISO which are specifically mentioned in this specification.

Reference to a particular standard or recommendation in this Specification does not relieve the Contractor of the necessity of providing the Contract Works complying with other relevant standards or recommendations.

The contractor shall furnish a copy of all standards (IEC/IS/other specifications and ISO mentioned in this specification) within 15 days of LOA

6.0 LANGUAGE AND SYSTEM OF UNITS

The English language shall be used in all written communications between the Owner and the Contractor with respect to the services to be rendered and with

respect to all documents and drawings procured or prepared by the Contractor pertaining to the work, unless otherwise agreed by the Owner.

It is required that danger plates, equipment designation labels or plates, instruction notices on plant and general substation notices be written in English, Hindi and Oriya. Control switch and lamp labels, indicator lamp and annunciator inscriptions shall be in English only.

The Contractor must furnish a schedule giving the English, Hindi and Oriya version of all labels, notices, etc., for approval.

The design features of all equipment shall be based on the SI system of units.

7.0 CORRESPONDENCE, DRAWINGS, APPROVAL PROCEDURE AND SAMPLES

7.1 Correspondence

All correspondence shall be addressed to the Project Manager, Project Management Unit-33/11kV, OPTCL.

7.2 Drawings and samples

Within 15 days of contract commencement the Contractor shall submit, for approval by the Engg. Incharge a schedule of the drawings to be produced detailing which are to be submitted for "Approval" and which are to be submitted "For Information Only". The schedule shall also provide a programme of drawing submission, for approval by the Engg. Incharge that ensures that all drawings and calculations are submitted within-two months

All drawings submitted by the Contractor shall be in sufficient detail to indicate the type, size, arrangement, material description, Bill of Materials, weight of each component, break-up for packing and shipment, the external connections, fixing arrangement, and the dimensions, required for installation and interconnections with other equipment and materials, clearances and spaces required for installation and interconnections between various portions of equipment and any other information specifically requested in the specification.

All dimensions marked on drawings shall be considered correct although measurement by scale may differ from general arrangement drawings. Detailed drawings shall be worked to where they differ from general arrangement drawings.

All detail drawings submitted for approval shall be to scale not less than 1 : 20. All important dimensions shall be given and the material of which each part is to be constructed shall be indicated on the drawings.

All documents, drawings and samples shall be submitted in accordance with the provisions of this Specification and shall become the property of the Owner.

All drawings and calculations, submitted to the Engg. Incharge shall be on international standard size paper, A0, A1, A2, A3 or A4.

All such drawings and calculations shall be provided with a contract title block and shall be assigned a unique project drawing number; the contract title block and project numbering system shall be agreed with the Engg. Incharge .

All drawings for approval shall have the OPTCL-LOGO and the name of the Owner.

Technical drawings must be shown, in such a form that the information necessary to construct an installation or part of an installation must be understandable by the technicians/skilled workmen responsible for construction and supervision. The drawings must therefore conform to following standards.

For presentation of design drawings and circuit documents IEC Publication 617 or equivalent standards for graphical symbols are to be followed.

Script sizes and thickness of scripts and lines be selected so that if reduced by two stages the alphanumeric characters and lines are still perfectly legible so as to microfilm them .

7.3 Approval procedure

The Contractor shall submit all drawings and samples for approval in sufficient time to permit modifications to be made if such are deemed necessary, and the drawings and samples to be re-submitted without delaying the initial deliveries or completion of the Contract Works. The following schedule shall be adhered for submission, approval, re-submission and final distribution drawings/ documents.

Initial submission:	All drawings, designs and documents requiring approval of Engg. Incharge - not later than 45 days from award of contract.
Approval /comments of 1st submission:	Within 15 days of receipt.
Re-submission where required:	Within 7 days of receipt including postal time both ways.
Approval/comments of re-submission:	Within 7 days of receipt.
Submission of distribution copies:	Within 15 days of approval.

Three copies of all drawings shall be submitted for approval and three copies for any subsequent revision. The Engg. Incharge reserves the right to request any additional information that may be considered necessary in order to fully review the drawings. Drawings for approval shall be submitted as paper prints and shall bear the approved contract references. Submittal should where possible be staggered to facilitate maintenance of the above schedule.

If the Engg. Incharge is satisfied with the drawing, one copy will be returned to the Contractor marked with “**Approved**” stamp. If the Engg. Incharge is not totally satisfied with the drawing, then “**Approved subject to comment**” status will be given to it and a comment sheet will be sent to the Contractor. If the drawing does not comply with the requirements of the specification then it will be given “**Not Approved**” status and a comment sheet will be sent to the Contractor. In both the latter cases the Contractor will have to modify the drawing, update the revision column and resubmit for final approval.

Following approval copies of final drawings will be required as given below.

- a) Hard Copies on paper (Blue print or Xerox) : 20 copies
- b) Computer CD ROM : 1 copy

Any drawing or document submitted for information only should be indicated as such by the Contractor. Drawings submitted for information only will not be returned to the Contractor unless the Engg. Incharge considers that such drawings do need to be approved, in which case they will be returned suitably stamped with comments.

Drawings, samples and models submitted by the Contractor and approved by the Engg. Incharge shall not be departed from without the instruction in writing of the Engg. Incharge.

The Contractor shall be responsible for any discrepancies or errors in or omissions from the drawings, whether such drawings have been approved or not by the Engg. Incharge . Approval given by the Engg. Incharge to any drawing or sample shall neither relieve the Contractor from his liability to complete the Contract Works in accordance with this Specification and the conditions of contract nor exonerate him from any of his guarantees.

7.4 Final as-built drawings

After completion of work on site all drawings shall be revised where necessary to show the equipment as installed and three copies submitted duly signed by site-in-charge. Following approval, twenty prints shall then be provided as required by the Engg. Incharge and shall be of sufficient detail to enable all parts to be identified. The contractor shall also submit, where possible, digitally stored copies of all as-built drawings on disc or CD-ROM in a format compatible with the Owner's drawing system.

7.5 Operation and Maintenance Manuals

Six months prior to the contractual completion date for each substation site the Contractor shall forward to the Engg. Incharge, two copies of the Operation and Maintenance Manual unique to the substation site being handed over.

After approval by the Engg. Incharge the Contractor shall deliver ten (10) copies of the complete manual.

The Taking Over Certificate **will not be issued** until the required number of approved copies of the manuals have been provided by the Contractor.

The manuals shall be as complete and as specific as possible and shall incorporate documentation that is specific to the materials and equipment used on the contract. Because the nature of the work varies from site to site the manuals will have to be tailored to the specific needs of each site.

All precautions and warnings relative to the safety of life and equipment shall be included in the manuals.

The manuals should also show exploded views wherever required, Mass and size of parts and quantities of oil

8.0 GENERAL REQUIREMENTS

8.1 Bolts and nuts

All bolts, studs, screw threads, threads, bolt heads and nuts shall comply with the Indian Standard.

Except for small wiring, current carrying terminal bolts or studs, for mechanical reasons, shall not be less than 6 mm in diameter.

All nuts and pins shall be adequately locked.

Wherever possible bolts shall be fitted in such a manner that in the event of failure of locking resulting in the nuts working loose and falling off, the bolt will remain in position.

All bolts, nuts and washers placed in outdoor positions shall be treated to prevent corrosion, by hot dip galvanising or electro galvanising to service condition. Appropriate precautions shall be taken to prevent electrolytic action between dissimilar metals.

Where bolts are used on external horizontal surfaces where water can collect, methods of preventing the ingress of moisture to the threads shall be provided.

Each bolt or stud shall project at least one thread but not more than three threads through its nut, except when otherwise approved for terminal board studs or relay stems. If bolts and nuts are placed so that they are inaccessible by means of ordinary spanners, special spanners shall be provided.

The length of the screwed portion of the bolts shall be such that no screw thread may form part of a shear plane between members.

Taper washers shall be provided where necessary.

Protective washers of suitable material shall be provided front and back on the securing screws.

8.2 Galvanising.

8.2.1 General

All machining, drilling, welding, engraving, scribing or other manufacturing activities which would damage the final surface treatment shall be completed before the specified surface treatment is carried out.

8.2.2 Galvanising

All metal surfaces shall be subjected to treatment for anti-corrosion protection. All ferrous surfaces for external use shall be hot dip galvanised. High tensile steel nuts, bolts and spring washers shall be electro galvanised to service condition. All steel conductors including those used for earthing and grounding (above ground level) **shall also be galvanised according to IS 2629.**

All galvanising shall be applied by the hot dip process and shall comply with IS 2629, IS 2633, IS 4759, IS 1367 or IS 6745.

All welds shall be de-scaled, all machining carried out and all parts shall be adequately cleaned prior to galvanising. The preparation for galvanising and the galvanising itself shall not adversely affect the mechanical properties of the coated material.

The threads of all galvanised bolts and screwed rods shall be cleared of spelter by spinning or brushing.. All nuts shall be galvanised with the exception of the threads which shall be oiled. Surfaces which are in contact with oil shall not be galvanised or cadmium plated.

Partial immersion of the work will not be permitted and the galvanising tank must therefore be sufficiently large to permit galvanising to be carried out by one immersion.

Galvanising of wires shall be applied by the hot dip process and shall meet the requirements of IS 2141.

The minimum weight of the zinc coating shall be **610 gm/sq.m** and minimum **thickness of coating shall be 86 microns** for all items thicker than 5 mm. For items of less than 5 mm thickness requirement of coating thickness shall be as per BS 729. For surface which shall be embedded in concrete, the zinc coating shall be a minimum of **800 gm/sq.m**.

The galvanised surfaces shall consist of a continuous and uniform thick coating of zinc, firmly adhering to the surface of steel. The finished surface shall be clean and smooth and shall be free from defects such as discoloured patches, bare spots, unevenness of coating, spelter which is loosely attached to the steel globules, spiky deposits, blistered surface, flaking or peeling off, etc. The presence of any of these defects noticed on visual or microscopic inspection shall render the material liable to rejection.

After galvanising no drilling or welding shall be performed on the galvanised parts of the equipment excepting that nuts may be threaded after galvanising. Sodium dichromate treatment shall be provided to avoid formation of white rust after hot dip galvanisation.

The galvanised steel shall be subjected to **six one minute dips** in copper sulphate solution as **per IS 2633**.

Sharp edges with radii less than 2.5 mm shall be able to withstand four immersions of the Standard Preece test. All other coatings shall withstand six immersions. The **following galvanising tests** should essentially be performed as per relevant Indian Standards

- a) Coating thickness
- b) Uniformity of zinc
- c) Adhesion test
- d) Mass of zinc coating

Galvanised material must be transported properly to ensure that galvanised surfaces are not damaged during transit. Application of zinc rich paint at site shall not be allowed.

8.3 Cleaning, painting and tropicalisation

8.3.1 General

All paints shall be applied in strict accordance with the paint manufacturer's instructions.

All painting shall be carried out on dry and clean surfaces and under suitable atmospheric and other conditions in accordance with the paint manufacturer's recommendations.

An alternative method of coating equipment such as with epoxy resin-based coating powders will be permitted, subject to the approval of the Engg. Incharge and such powders shall comply with the requirements of IEC 455. The Contractor shall provide full details of the coating process to the Engg. Incharge for approval.

It is the responsibility of the Contractor to ensure that the quality of paints used shall withstand the tropical heat and extremes of weather conditions specified in the schedules. The paint shall not peel off, wrinkle, be removed by wind, storm and handling on site and the surface finish shall neither rust nor fade during the service life of the equipment.

The colours of paints for external and internal surfaces shall be in accordance with the approved colour schemes.

8.3.2 Works painting processes

All steelworks, plant supporting steelworks and metalwork, except galvanised surfaces or where otherwise specified, ISO standard. All sheet steel work shall be degreased, pickled, phosphated in accordance with the IS 6005 "Code of Practice for phosphating iron and sheet steel". All surfaces shall then be painted with one coat of epoxy zinc rich primer, two pack type, to a film thickness of 50 microns. This primer shall be applied preferably by airless spray and within twenty minutes but not exceeding one hour of shot blasting.

All rough surfaces of coatings shall be filled with an approved two pack filler and rubbed down to a smooth surface.

The interior surfaces of all steel tanks and oil filled chambers shall be shot blasted in accordance ISO, and painted within a period of preferably twenty minutes, but not exceeding one hour with an oil resisting coating of a type and make to the approval of the Engg. Incharge.

The interior surfaces of mechanism chambers, boxes and kiosks, after preparation, cleaning and priming as required above, shall be painted with one coat zinc chromate primer, one coat phenolic based undercoating, followed by one coat phenolic based finishing paint to a light or white colour. For equipment for outdoor use this shall be followed by a final coat of anti-condensation paint of a type and make to the approval of the Engg. Incharge to a light or white colour. A minimum overall paint film thickness of 150 microns shall be maintained throughout.

All steelworks and metalwork, except where otherwise specified, after preparation and priming as required above shall be painted with one coat metallic zinc primer and two coats of micaceous iron oxide paint followed by two coats of either phenolic based or enamel hard gloss finished coloured paint to the approval to an overall minimum paint film thickness of 150 microns.

Galvanised surfaces shall not be painted in the works.

All nuts, bolts, washers etc., which may be fitted after fabrication of the plant shall be painted as described above after fabrication.

The painted metal works shall be subjected to paint qualification test as per IEEE-Std 37.21 -1985 clause 5.2.5.

8.3.3 Site Painting

After erection at site, the interior surfaces of mechanism chambers and kiosks shall be thoroughly examined, and any deteriorated or mechanically damaged surfaces of such shall be made good to the full Specification described above.

After installation/erection at site all surfaces of steelworks and metalwork shall be thoroughly washed down. Any deteriorated or otherwise faulty paint-work removed down to bare metal and made good to the full Specification described above, then painted one further coat of phenolic based undercoating and one coat phenolic based hard gloss finishing paint to provide an overall minimum paint film thickness of 200 microns.

Any nuts, bolts, washers, etc., which have been removed during site erection, or which may be required to be removed for maintenance purposes shall be restored to their original condition.

All paint work shall be left clean and perfect on completion of the works.

8.3.4 Colour Schemes

The Contractor shall propose a colour scheme for the sub-station for the approval of Engg. Incharge. The decision of Engg. Incharge shall be final. The scheme shall include:

- a) Finishing colour of indoor equipment
- b) Finishing colour of outdoor equipment
- c) Finish colour of all cubicles
- d) Finishing colour of various auxiliary system equipment including piping.
- e) Finishing colour of various building items.

All steel structures, plates etc. shall be painted with non-corrosive paint on a suitable primer. It may be noted that normally all electrical equipment of the Owners switchyard are painted with shade 631 of IS:5 and Owner will prefer to follow the same for this project also. All indoor cubicles shall be of same colour scheme. For other miscellaneous items colour scheme will be subject to the approval of the Engg. Incharge.

Table 10.3.4. Recommended colour schemes

Sl. No.	Equipment	Application Environment			
		Indoor		Outdoor	
		Colour	Code IS:5	Colour	Code IS:5
33/11 kV Class Equipment					
1	Transformers	-	-	Light grey	631

2	Marshalling boxes, CTs, PT's, CVT's, Surge counter casings, junction boxes etc.	Light Admiralty grey	697	Light Admiralty grey	697
3	Control and Relay Panels, PLCC cabinets, RTU panel etc.	Smoke grey	692	-	-
4	Porcelain parts i.e. insulators	Dark brown	412	Dark brown	412
5	All structures/ metallic parts exposed to atmosphere	Hot dip galvanised			
33kV Class equipment					
6	Switchgear cubicles	Smoke grey	692	Light grey	631
7	Control and relay panels	Smoke grey	692	-	-
	LT switchgear				
8	LT switchgear exterior	Smoke grey	692	Light grey	631
9	ACDB/ MCC	Smoke grey	692	Light grey	631
10	DCDB	Smoke grey	692	—	—
11	LT bus duct in side enclosure	Matt Paint		—	—
12	LT bus duct outside enclosure	Smoke grey	692	—	—
13	Motors	Smoke grey	692	Light grey	631
14	Diesel generator engine	Smoke grey	692	—	—
15	Diesel generator	Smoke grey	692	—	—
16	LT transformers	Smoke grey	692	Light grey	631
17	Battery charger	Smoke grey	692	—	—
18	Mimic diagram 33kV 11kV 415V	Sky blue Signal red Canary yellow Middle brown	101 537 309 411	- - - -	- - - -
	Miscellaneous				
19	Control modules and console inserts	Smoke grey	692	Light grey	631
20	Lighting package equipment outside	Light grey	631	Light grey	631
21	Lighting package equipment inside	Glossy white		Glossy white	
22	Water pipes	sea green	217	sea green	217
23	Air pipes	Sky blue	101	Sky blue	101
24	Transformer oil pipes	Light brown	410	Light brown	410

25	Fire Installations	Fire red	536	Fire red	536
26	Insulating oil/ gas treatment plant	Gulf red	473	Gulf red	473

The agriculture feeder line poles shall be marked with green strip painting of 0.5 mtr width around the pole at a height of 2 mtr above ground level. Similar marking shall be provided on Fishery feeder line poles with brown colour.

8.4 Provision for exposure to hot and humid climate

Outdoor equipment supplied under the Specification shall be suitable for service and storage under tropical conditions of high temperature, high humidity, heavy rainfall and environment favourable to the growth of fungi and mildew. The indoor equipments located in non air-conditioned areas shall also be of same type.

8.4.1 Anti-condensation Provisions:

Space heaters where provided shall be suitable for continuous operation at 240V supply voltage. On-off switch and fuse shall be provided.

One or more adequately rated permanently or thermostatically connected heaters shall be supplied to prevent condensation in any compartment. The heaters shall be installed in the lower portion of the compartment and electrical connections shall be made from below the heaters to minimise deterioration of supply wire insulation. The heaters shall be suitable to maintain the compartment temperature at approximately 10⁰C, above the outside air temperature to prevent condensation. This shall be demonstrated by tests.

8.4.2 Fungistatic treatment

Besides the space heaters, special moisture and **fungus resistant varnish shall be applied** to parts which may be subjected or predisposed to the formation of fungi due to the presence or deposit of nutrient substances.

8.4.3 Ventilating specifications

In order to ensure adequate ventilation, compartments shall have ventilation openings provided with **fine wire mesh of brass** or galvanised steel **to prevent the entry of insects** and to reduce to a minimum the entry of dirt and dust. Outdoor compartment openings shall be provided with shutter type blinds.

8.4.4 Labels and plates

All Equipment shall be clearly labeled indicating, where necessary, its purpose and service positions. Each phase of alternating current and each pole of direct current equipment and connections shall be coloured in an approved manner to distinguish phase or polarity.

The material of all labels and the dimensions, legend, and method of printing shall be to approval. The surface of indoor labels shall have a matt or satin finish to avoid dazzle from reflected light.

Colours shall be permanent and free from fading. Labels mounted on black surfaces shall have white lettering. **‘Danger’ plates shall have red lettering on a white background.**

All labels and plates for outdoor use shall be of non corroding material. Where the use of enameled iron plates is approved, the whole surface including the back and

edges, shall be properly covered and resistant to corrosion. Protective washers of suitable material shall be provided front and back on the securing screws.

Labels shall be engraved in Hindi, English and Oriya. Name plates shall be white with black engraved lettering and shall carry all the applicable information specified in the applicable items of the Standards.

Any other relevant information which may be required for groups of smaller items for which this is not possible e.g. switch bays etc. a common name plate in Oriya with the title and special instructions on it shall be provided.

No scratching, corrections or changes will be allowed on name plates.

All equipment mounted on front and rear sides as well as equipment mounted inside the panels shall be provided with individual name plates with equipment designation engraved.

On the top of each panel on front as well as rear sides large name plates with bold size lettering shall be provided for circuit/ feeder/ cubicle box designation.

All front mounted equipment shall be also provided, at the rear, with individual name plates engraved with tag numbers corresponding to the one shown in the panel internal wiring to facilitate tracing of the wiring. The name plates shall be mounted directly by the side of the respective equipment wiring.

Name plates of cubicles and panels may be made of non rusting metal or 3 ply lamicaid. These name plates may be black with white engraved lettering.

The name plate inscription and size of name plates and letters shall be submitted to the Engg. Incharge for approval.

The name plates of the Equipment shall include, at least, the information listed below, together with any other relevant information specified in the applicable standards:

- a) Concise descriptive title of the equipment
- b) Rating and circuit diagrams
- c) Manufacturer's name, trade-mark, model type, serial number
- d) Instruction book number
- e) Year of manufacture
- f) Special instructions, if any, about storage, transportation, handling etc.

Each measuring 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 manufacturers name, type, serial number and electrical rating data.

Danger plates and plates for phase colours shall be provided as per requirement. The Contractor shall devise a system to designate equipment and sub-systems. The nameplates/labels displaying these designations shall be installed at appropriate locations. Whenever motion or flow of fluids is involved, plates showing direction of motion or flow shall also be provided.

8.5 Padlocks

For each item of plant the Contractor shall provide a padlockable handle and a non-ferrous padlock with different key changes in order to prevent access to control

cabinets, cubicles and relay panels. The Contractor shall provide two keys for each lock and a master key for each substation.

Cabinets for the accommodation of padlocks and keys, whilst not in use, shall be provided and shall be suitably labeled so that keys will be readily identifiable.

8.6 Earthing

Metal parts of all equipment other than those forming part of an electrical circuit shall be connected directly to the main earth system via two separate conductors of adequate capacity at two different points.

All main members of structural steelworks shall be earthed by galvanised iron flat connections bonded by welding or bolting to the steelworks.

Connections to Equipment and structures shall be made clear of ground level, preferably to a vertical face and protected as appropriate against electrolytic corrosion. They shall be made between clean surfaces and of sufficient size and pressure to carry the rated short circuit current without damage.

Earth bars installed directly into the ground should normally be laid bare and the trench back-filled with a fine top soil. Where the soil is of a hostile nature, special precautions must be taken to protect the earth bar, the method used being subject to the agreement of the Engg. Incharge.

Joints in earth bars shall be welded and then coated with a suitable anti-corrosion protection treatment.

Facilities shall be provided on the earth bar run between equipment and the base of structures, comprising a looped strip, so as to permit the attachment of portable earth connections for maintenance purposes.

The cross sectional area of the earth bar and connections shall be such that the current density is not greater than **100 A/mm²** for a **3** second fault duration.

8.7 Lubrication

Bearings which require lubrication either with oil or grease shall be fitted with nipples.

9.0 PRODUCTION PROCESS REQUIREMENTS

9.1 Castings

9.1.1 General

All castings shall be true to pattern, free from defects and of uniform quality and condition. The surfaces of castings which do not undergo machining, shall be free from foundry irregularities. The castings shall be subject to NDT, chemical, mechanical and metallographic tests. Details of the same shall be furnished to Engg. Incharge for review/approval. Magnetic particle inspection (MPI) test, wherever applicable, shall be carried out in longitudinal and transverse direction to detect radial and axial cracks.

9.2 Welding

All welding shall be in accordance with the corresponding Indian standards.

10.0 WIRING, CABLING AND CABLE INSTALLATION

10.1 Cubicle wiring

Panels shall be complete with interconnecting wiring between all electrical devices in the panels. External connections shall be achieved through terminal blocks. Where panels are required to be located adjacent to each other all inter panel wiring and connections between the panels shall be carried out internally. The Contractor shall furnish a detailed drawing of such inter panel wiring. The Contractor shall ensure the completeness and correctness of the internal wiring and the proper functioning of the connected equipment.

All wiring shall be carried out with **1.1 kV** grade, **PVC** insulated, single core, stranded copper wires. The PVC shall have oxygen index not less than '**29**' and Temperature index not less than **25°C**. The wires shall have annealed copper conductors of adequate size comprise not less than three strands

The minimum cross sectional area of the stranded copper conductor used for internal wiring shall be as follows:

- a) All circuits excepting CT circuits and energy metering circuit of VT 2.5 sq.mm
 - b) All CT circuits and metering circuit of VT 2.5 sq. mm
- All internal wiring shall be supported, neatly arranged, readily accessible and connected to equipment terminals and terminal blocks. Wiring gutters and troughs shall be used for this purpose.

Cubicle connections shall be insulated with PVC to IEC 227. Wires shall not be jointed or teed between terminal points.

Bus wires shall be fully insulated and run separately from one another. 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 panel suite. Longitudinal troughs extending throughout the full length of panel shall be preferred for inter panel wiring.

All inter connecting wires between adjacent panels shall be brought to a separate set of terminal blocks located near the slots of holes meant for the passage of the inter connecting wires. Interconnection of adjacent panels on site shall be straightforward and simple. The bus wires for this purpose shall be bunched properly inside each panel.

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. Numbers 6 and 9 shall not be included for ferrules purposes unless the ferrules have numbers underscored to enable differentiation. (i.e. 6 and 9). Fuses and links shall be provided to enable all circuits in a cubicle, except a lighting circuit, to be isolated from the bus wires.

The DC trip and AC voltage supplies and wiring to main protective gear shall be segregated from those for back-up protection and also from protective Equipment for special purposes. Each such group shall be fed through separate fuses from the bus wires. There shall not be more than one set of supplies to the Equipment comprising

each group. All wires associated with the tripping circuits shall be provided with red ferrules marked "**Trip**".

It shall be possible to work on small wiring for maintenance or test purposes without making a switchboard dead.

The insulation material shall be suitably coloured in order to distinguish between the relevant phases of the circuit.

When connections rated at 380 volt and above are taken through junction boxes they shall be adequately screened and "**DANGER**" notices shall be affixed to the outsides of junction boxes or marshalling kiosk.

Where connections to other equipment and supervisory equipment are required the connections shall be grouped together.

10.2 **LV power cabling**

LV AC cable terminals shall be provided with adequately sized, hot pressed, cast or crimp type lugs. Where sweating sockets are provided they shall be without additional clamping or pinch bolts. Where crimp type lugs are provided they shall be applied with the correct tool and the crimping tool shall be checked regularly for correct calibration. Bi-metallic joints between the terminals and lugs shall be provided where necessary.

Terminals shall be marked with the phase colour in a clear and permanent manner.

A removable gland plate shall be provided by the Contractor. The Contractor shall be responsible for drilling the cable gland plate.

Armoured cables shall be provided with suitable glands for terminating the cable armour and shall be provided with an earthing ring and lug to facilitate connection of the gland to the earth bar.

10.3 **Multi-core cables and conduit wiring**

External multi-core cabling between items of main and ancillary equipment shall form part of the Contract Works and shall consist of un-armoured multi-core cable with stranded copper conductors PVC insulated and PVC over sheathed complying with the requirements of IEC 227 and 228 as applicable.

Multi-core cable for instrumentation and control purposes shall be supplied with 2.5 mm² stranded copper cores. Multi-core cables for CT and VT circuits shall be supplied with two by 2.5 mm² stranded copper cores and the cores shall be identified by the phase colour.

Where conduit is used the runs shall be laid with suitable falls and the lowest parts of the run shall be external to the equipment. All conduit runs shall be adequately drained and ventilated. Conduits shall not be run at or below ground level.

Multi-core cable tails shall be so bound that each wire may be traced to its cable without difficulty. All multi-core cables shall be provided with 20 % spare cores and the spare cores shall be numbered and terminated at a terminal block in the cubicle.

Where cables are terminated in a junction box and the connections to a relay or control cubicle are continued in conduit, the spare cores shall be taken through the conduit and terminated in the cubicle. The dc trip and ac voltage circuits shall be segregated from each other as shall the circuits to main protective gear be segregated from those for back-up protection.

The screens of screened pairs of multi-core cables shall be earthed at one end of the cable only. The position of the earthing connections shall be shown clearly on the diagram.

All wires on panels and all multi-core cable cores shall be crimped with the correct size of crimp and crimping tool and will have ferrules which bear the same number at both ends. At those points of interconnection between the wiring carried out by separate contractors where a change of number cannot be avoided double ferrules shall be provided on each wire. The change of numbering shall be shown on the

appropriate diagram of the equipment. The same ferrule number shall not be used on wires in different circuits on the same panels.

The Contractor shall provide a two (2) metre loop of spare cable at both ends of all multi-core cable runs and shall leave sufficient lengths of tails at each end of the multi-core cables to connect up to the terminal boards. The Contractor shall also strip, insulate, ring through and tag the tails and shall also seal the cable boxes. The Contractor shall be responsible for re-checking the individual cores and for the final connecting up and fitting of numbered ferrules within all equipment provided on this contract.

The drilling of gland plates, supply and fitting of compression glands and connecting up of power cables included in the Contract scope of work shall be carried out under this contract.

10.4 Laying and installing of cables

10.4.1 General

For cable laying the following shall apply:

- c) Switchyard area - In concrete cable troughs (cable trench having cable racks with cable trays)

10.4.2 Laying of cable

Cables shall be laid in concrete troughs provided under this contract or drawn into pipes or ducts or on cable racks or directly buried as may be required by the Engg. Incharge. Concrete troughs shall be designed so that the cables are supported on cable support systems and the supports shall be arranged so as to allow the segregation of power, control (including CT and VT circuits) and communications cables onto different layers of cable supports. All cable supports shall be earthed in accordance with IS 3043. The minimum vertical separation between layers of cable tray shall be not less than 300 mm.

For auxiliary cables the top of the slab or tile shall be at a depth not less than 300 mm below the surface of the ground and there shall be a layer of fine well packed riddled earth 75 mm thick in between the cable and the bottom of the trench and between the top of the cable and the underside of the slab.

The Contractor shall be responsible for the proper laying of all cables in the ground. Where cables in the same trench are laid over each other, they shall be separated by not less than 75 mm of riddled earth. The riddled earth used for this purpose shall have been passed through a screen having a 12 mm square mesh.

Where cables pass under roadways they shall be laid in pipes at a depth not less than 800 mm below the surface.

The Contractor shall be responsible for the excavation of trenches which shall include all pumping and baling required and the provision of all necessary labour, plant, tools, water, additional soil, fuel or motor power for such purposes.

Cables in trenches will be inspected by the Engg. Incharge before the trenches are backfilled.

The running of communications and power cables along the same route shall be avoided as far as possible. Where this is not possible they shall be segregated, the one group from the other. Power and communication cables shall be laid in separate tiers. For other than directly buried cables the order of laying of various cables shall be as follows:

- d) Power cables on top tiers.
- e) Control/ instrumentation and other service cables in bottom tiers.

10.4.3 Cable tags and markers

Each cable and conduit run shall be tagged with numbers that appear in the cable and conduit schedule.

The tag shall be of aluminium with the number punched on it and securely attached to the cable conduit by not less than two turns of 20 SWG GI wire conforming to IS 280. Cable tags shall be of rectangular shape for power cables and of circular shape for control cables.

Location of cables laid directly in the ground shall be clearly indicated with cable marker made of galvanised iron plate.

Location of buried cable joints shall be indicated with a cable marker having an additional inscription "**Cable joint**".

Cable markers shall project 150 mm above ground and shall be spaced at an interval of 30 meters and at every change in direction. They shall be located on both sides of road and drain crossings.

Cable tags shall be provided on all cables at each end (just before entering the equipment enclosure), on both sides of a wall or floor crossing, on each duct, conduit entry and at every twenty meters (20 m) in cable tray/trench runs. Cable tags shall be provided inside switchgear, motor control centres, control and relay panels etc.. and wherever required for cable identification when a number of cables enter together through a gland plate.

The price of cable tags and markers shall be included in the installation rates for cables/conduits quoted by the Bidder.

10.4.4 Cable supports and cable tray mounting arrangements in control room

The control room will normally be provided with embedded steel inserts on concrete floors/walls for the purpose of cabling in the control room. The supports shall be secured by welding to these inserts or available building steel structures. However, in cases where no such embedded steel inserts are available, the same shall have to be secured to the supports on walls or floors by suitable anchoring .

10.4.5 Cable support structure in switchyard cable trenches

The contractor shall fabricate and install cable support structures in cable trenches. These supports shall be provided at 750 mm spacing along the run of cable trenches.

Cable supports and cable racks shall be fabricated from standard structural steel members, channels, angles and flats of required size. The fabrication, welding and erection of these structures shall conform to the relevant clauses of this Specification, in addition to the specification given herein.

10.5 Termination of cables and wires

Where cables leave the Equipment in an upward direction the cable boxes shall be provided with a barrier joint to prevent leakage of cable oil or compound into the Equipment. Where cable cores are liable to contact with oil or oil vapour the insulation shall be unaffected by oil.

PVC sheathed cables shall be terminated by compression glands complying with BS 6121 (or equivalent).

Auxiliary PVC insulated cables shall be terminated with compression type glands, clamps or armour clamps complete with all the necessary fittings.

Colours shall be marked on the cable box, cable tail ends and single core cables at all connecting points and/or any positions the Engg. Incharge may determine. Cable boxes shall be provided with suitable labels indicating the purpose of the supply where such supply is not obvious or where the Engg. Incharge may determine.

All cables shall be identified and shall have phase colours marked at their termination.

All incoming and outgoing connections shall be terminated at a terminal block. Direct termination into auxiliary switches will not be accepted.

10.6 DEGREES OF PROTECTION

Degrees of protection shall be provided in accordance with IEC 144 and IEC 529 and be as follows:

- f) For outdoor applications, IP 55.
- g) For indoor applications where purpose built accommodation is provided, e.g. switch and control and relay rooms in auxiliary plant buildings, IP 41.
- h) Where dust can adversely affect equipment within the enclosure, this equipment should be separately housed with a degree of protection of IP 51.
- i) For indoor applications where the equipment is housed in the same building as that enclosing water and steam operated equipment, the degrees of protection stated in the previous paragraph shall be up-rated to IP 44 and IP 54 respectively.
Where more severe environments exist, e.g. steam and oil vapour or other deleterious chemical environments, special measures will be necessary and the degree of protection required will be specified separately.
The Contractor shall submit a schedule for providing the degree protection to various control boxes, junction boxes etc. for the Engg. In charge's approval.

10.7 SUPPLY VOLTAGE

All incoming supplies of greater than 125 V to earth shall have their termination shrouded by a suitable insulating material.

The auxiliary supply voltages on site shall be as follows:

Nominal Voltage V	Variation	Frequency Hz or DC	Phase	Wires	Neutral Connection
430	±10%	50±5%	3	4	Solidly earthed
240	±10%	50±5%	1	2	Solidly earthed
24 V	10%	DC	DC	2	Isolated 2 wires

10.8. ERECTION CONDITIONS

10.8.1 General

The following shall supplement the conditions already contained in the other parts of these specifications and documents and shall govern that portion of the work on this Contract to be performed at Site.

10.8.2 Regulation of local authorities and statutes

The Contractor shall comply with all the rules and regulations of local authorities during the performance of his field activities. He shall also comply with the Minimum Wages Act, 1948 and the payment of Wages Act (both of the Government of India and Govt of Orissa) and the rules made thereunder in respect of any employee or workman employed or engaged by him or his Sub-Contractor.

All registration and statutory inspection fees, if any, in respect of his work pursuant to this Contract shall be to the account of the Contractor. However, any registration, statutory inspection fees lawfully payable under the provisions of the statutory laws and its amendments from time to time during erection in respect of the substation

ultimately to be owned by the OWNER, shall be to the account of the OWNER. Should any such inspection or registration need to be re-arranged due to the fault of the Contractor or his Sub-Contractor, the additional fees to such inspection and/or registration shall be borne by the Contractor.

The Contractor shall ensure that he obtains, from the Government of Orissa, an Electrical Contractor's Licence and a supervisory certificate of the appropriate grade to allow him to execute the electrical works included in the Contract. The Contractor shall ensure that all workmen possess Workman Permits, issued by the Government of Orissa, for engagement in the Contract Works.

10.8.3 Inspection, testing and inspection certificates

The Engineer-In-Charge shall have the right to re-inspect any equipment though previously inspected and approved by him at the Contractor's works, before and after the same are erected at Site. If by the above inspection, the Engineer-In-Charge rejects any equipment, the Contractor shall make good for such rejections either by replacement or modifications/repairs as may be necessary to the satisfaction of the Engineer-In-Charge, free of cost. Such replacement will also include the replacements or re-execution of such of those works of other Contractors and/or agencies, which might have got damaged or affected by the replacements or re-work done to the Contractor's work. The Engg. Incharge shall have the right to re-inspect any equipment though previously inspected approved by him at the Contractor's works, before and after the same are erected at Site.

10.9 Contractor's field operation

10.9.1 General

The Contractor shall inform the Engg. Incharge in advance of field activity plans and schedules for carrying-out each part of the works. Any review of such plans or schedules or methods of work by the Engg. Incharge shall not relieve the Contractor of any of his responsibilities towards the field activities. Progress Report

Progress reports shall be provided by the Contractor to the Engg. Incharge in accordance with the relevant parts of this specification. Appropriate photographs shall accompany the monthly progress reports.

10.10 Facilities to be provided by the contractor

10.10.1 Unloading

Contractor shall make his own arrangement for unloading the equipment at site.

10.10.2 Tools, tackle and scaffoldings

The Contractor shall provide all the construction equipment tools, tackle and scaffoldings required for offloading, storage, pre-assembly, erection, testing and commissioning of the equipment covered under the Contract. He shall submit a list of all such materials to the Engg. Incharge before the commencement of pre-assembly at Site. These tools and tackles shall not be removed from the Site without the written permission of the Engg. Incharge.

10.11 First-Aid and general hygiene

The Contractor shall provide necessary first-aid facilities for all his employees, representatives and workmen working at the site. At all times at least ten percent of all Contractors personnel assigned to the worksite shall be shall be trained in administering first-aid.

The labour colony, offices and residential areas of the Contractor's employees and workmen shall be kept clean and neat to the entire satisfaction of the Engg. Incharge. Proper sanitary arrangements shall be provided by the Contractor in work-areas, offices and residential areas of the Contractor.

Waste oil shall be disposed of in a manner acceptable to the Engg. Incharge . Under no circumstances shall waste oil be dumped into uncontrolled drains.

10.12 Security

The Contractor shall have total responsibility for all equipment and material in his custody, stored, loose, semi-assembled and/or erected by him at Site. The Contractor shall make suitable security arrangements including employment of security personnel to ensure the protection of all materials, equipment and works from theft, fire, pilferage and any other damages and loss.

10.13 Materials handling and storage

All the equipment furnished under the Contract and arriving at Site shall be promptly received, unloaded and transported and stored in the stores by the Contractor.

Contractor shall be responsible for examining the complete shipment and notifying the Engg. Incharge immediately of any damage, shortage, discrepancy etc. for the purpose of Engg. In charge's information only. The Contractor shall submit to the Engg. Incharge every week a report detailing all the receipts during the weeks. However, the Contractor shall be solely responsible for any shortages or damages during transit, handling, storage and erection of the equipment at Site. Any demurrage, wharfage and other such charges claimed by the transporters, railways etc. shall be to the account of the Contractor.

The Contractor shall maintain an accurate and exhaustive record detailing all equipment received by him for the purpose of erection and keep such record open for the inspection of the Engg. Incharge.

All equipment shall be handled carefully to prevent any damage or loss. All equipment stored shall be properly protected to prevent damage. Equipment from the store shall be moved to the actual location at an appropriate time so as to avoid damage of such equipment at Site.

All the materials stored in the open or dusty location shall be covered with suitable weather-proof and flameproof covering material.

The Contractor shall be responsible for making suitable indoor facilities for the storage of all equipment which requires to be kept indoors.

11.0 CONSTRUCTION MANAGEMENT

11.1 General

Time is the essence of the Contract and the Contractor shall be responsible for performance of his Works in accordance with the specified construction schedule. If at any time the Contractor is falling behind the schedule, he shall take necessary action to make good for such delays by increasing his work force or by working overtime to accelerate the progress of the work and to comply with schedule and shall communicate such actions in writing to the Engg. Incharge, providing evidence that his action will compensate for the delay. The Contractor shall not be allowed any extra compensation for such action.

11.2 Field office records

The Contractor shall maintain at his Site office up-to-date copies of all drawings, specifications and other supplementary data complete with all the latest revisions thereto. The Contractor shall also maintain in addition the continuous record of all changes to the above contract documents, drawings, specifications, supplementary data, etc. effected at the field. On completion of his total assignment under the Contract, such drawings and engineering data shall be submitted to the Engg. Incharge in the required number of copies.

11.3 Protection of property and Contractor's liability

The Contractor will ensure provision of necessary safety equipment such as barriers, sign-boards, warning light and alarms, personal protective equipment etc. to provide adequate protection to persons and property. The Contractor shall be responsible for giving reasonable notice to the Engg. Incharge and the owners of public or private property and utilities when such property and utilities are likely to be damaged or injured during the performance of his works, and shall make all necessary arrangements with such owners, related to removal and/or replacement or protection of such property and utilities.

12.0 CODE REQUIREMENTS

The erection requirements and procedures to be followed during the installation of the equipment shall be in accordance with the relevant Indian/International Standards/Regulations, ASME codes, accepted good engineering practice, drawings and other applicable Indian codes and laws and regulations.

13.0 OWNER'S SUPERVISION

To eliminate delays and avoid disputes and litigation, it is agreed between the Parties to the Contracts that all matters and questions shall be referred to the OWNER and without prejudice the Contractor shall proceed to comply with the OWNER's decision.

The work shall be performed under the direction and supervision of the Engg. Incharge. The scope of the duties of the Engg. Incharge, pursuant to the contract, will include but not be limited to the following:

- j) Interpretation of all the terms and conditions of these documents and specifications.
- k) Review and interpretation of all the Contractors drawing, engineering data etc.
- l) Witness or authorise his representative to witness tests and trials either at the manufacturer's works or at site, or at any place where work is performed under the Contract.
- m) Inspect, accept or reject any equipment, material and work under Contract.
- n) Issue certificate of acceptance and/or progressive payment and final payment certificates.
- o) Review and suggest modification and improvements in completion schedules from time to time.
- p) Supervise the Quality Assurance program implementation at all stages of the Works.

14.0 TESTING AND INSPECTION

The Contractor shall carry out the tests stated in accordance with the conditions of this Specification, without extra charge for such additional tests as in the opinion of the Engg. Incharge are necessary to determine that the Contract Works comply with this Specification. The tests shall be carried out generally in accordance with the relevant IEC's or IS or equivalent standards. The specific details of testing and inspection are given in the appropriate section of this Specification.

The Contractor shall submit Type Test Reports for all equipment being supplied by him for the Engg. Incharge's approval. The Engg. Incharge may also give instruction to carry out Type Tests, routine tests or acceptance tests. Type Test Charges shall be paid as per the rates indicated in the Price Schedules.

All materials used shall be subjected to such routine tests as are customary in the manufacture of the types of plant included in the Contract Works. These materials shall withstand satisfactorily all such tests.

All tests shall be carried out to the satisfaction of the Engg. Incharge, in his presence, at such reasonable times as he may require, unless agreed otherwise. Not less than three weeks notice of all tests shall be given to the Engg. Incharge in order that he may be represented if he so desires. As many tests as possible shall be arranged together. Six copies of the Contractor's test reports and test sheets shall be supplied to the Engg. Incharge for approval.

Measuring Equipment shall be approved by the Engg. Incharge and if required shall be calibrated at the expense of the Contractor at an approved laboratory.

The Contractor shall be responsible for the proper testing of the work completed or plant or materials supplied by a sub-contractor to the same extent as if the work, plant or materials were completed or supplied by the Contractor himself.

All Equipment, instruments and connections required for the above tests shall be provided by the Contractor, but the Engg. Incharge may permit the use for the tests on site, any instruments and Equipment which may be provided permanently on site as part of the contract works conditional upon the Contractor accepting liability for any damage which may be sustained by such equipment during the test.

The contractor shall supply suitable test pieces of all materials as required by the Engg. Incharge. If required by the Engg. Incharge, test specimens shall be prepared for check testing and forwarded at the expense of the Contractor to an independent testing authority selected by the Engg. Incharge.

Any costs incurred by the OWNER in connection with inspection and re-testing as a result of a failure of the subject under test, or damage during transport, or erection on site before take-over by the OWNER, shall be to the account of the Contractor.

No inspection or lack of inspection or passing by the Engg. Incharge of work, plant or materials, whether carried out or supplied by the Contractor or sub-contractor, shall relieve the Contractor from his liability to complete the Contract Works in accordance with the Contract or exonerate him from any of his guarantees.

15.0 FIRE PRECAUTIONS

All Equipment, connections and cabling shall be designed and arranged to minimise the risk of fire and any damage which might be caused in the event of fire. When cabling is carried out as part of this Contract the Contractor shall be responsible for sealing all holes in floors, walls, roofs etc. through which the cabling may pass.

The work procedures that are to be used during the erection shall be those which minimise fire hazards to the maximum extent practicable. Combustible materials, combustible waste and rubbish shall be collected and removed from the site at least once each day. Fuels, oils and volatile or flammable materials shall be stored away from the construction site and equipment and material stores in appropriate safe containers.

All Contractor's supervisory personnel and at least ten percent all of workers shall be trained for fire-fighting and shall be assigned specific fire protection duties. At least ten percent of all personnel assigned to site at any one time shall be trained for fire fighting.

The contractor shall provide sufficient fire protection equipment of the types and sizes for the ware-houses, office temporary structures, labour colony area etc. Access to such fire protection equipment shall be easy and kept open at all time.

SYSTEM PARAMETERS & CLIMATIC CONDITIONS

1.0. SYSTEM PARAMETERS

Sl. No	Description of Technical Parameter	Unit	Data	
1	Nominal system voltage	kV _{rms}	33 kV	11 kV
2	Maximum system voltage	kV _{rms}	36 kV	12 kV
3	Power frequency with stand voltage	kV _{rms}	70 kV	28 kV
4	Lightning impulse withstand voltage 1) Line to earth 2) Across isolating gap	KV p (for 1.2 / 50 ⁰ C)	170kVp 195kVp	75 kVp 85 kVp
5	One minute power frequency withstand value Dry Wet	kV _{rms} kV _{rms}	95 75	35 35
6	System frequency	Hz	50	
7	Variation in frequency	%	2.5	
8	Continuous current rating (out door equipment)	Amp	1250	1250
9	Continuous current rating (Indoor Equipment)	Amp	630	630
10	Continuous current rating (Indoor Bus Bar)	Amp	800	800
11	Symmetrical short circuit current	kA	25kA	
12	Duration of short circuit fault current	Second	3	
13	Dynamic short circuit current rating	kAp	62.5kA	
14	Conductor spacing for AIS layouts Phase to ground Phase to phase	meters meters	3.7 1.5	2.8 0.76
15	Design ambient temperatures	°C	50	
16	Pollution level as per IEC-815 and 71		III	
17	Maximum fault clearing time	ms	not exceeding □ 150ms	
18	Safety clearances 1. Section clearance a) Ground clearances(between ground and bottom most part of energised object)	metres metres	4 4	3 3

	b) Horizontal clearance between the fence and energised object	metres	As per I.E. Rules	As per I.E. Rules
	c) Horizontal clearance between the road centre line and energised part of the nearby equipment	metres	As per I.E. Rules	As per I.E. Rules
19	Bay width	metres	5.5	4.0
20	Height of bus equipment interconnection from ground	metres	4	3.5
21	Height of strung busbar	metres	5.5	4.0

2.0 CLIMATIC CONDITIONS

The service conditions shall be as follows:

1. Maximum altitude above sea level 1,000m
2. Maximum ambient air temperature 50°C
3. Maximum daily average ambient air temperature 35°C
4. minimum ambient air temperature 0°C
5. maximum temperature attainable by an object exposed to the sun 60°C
6. maximum yearly weighted average ambient temperature 32°C
7. maximum relative humidity 100%
8. average number of thunderstorm days per annum (isokeraunic level) 70
9. average number of rainy days per annum 120
10. average annual rainfall 150cm
11. wind pressures as per IS 802 (Part I/ Sec. I) : 1995

Environmentally, the region where the work will take place includes coastal areas, subject to high relative humidity, which can give rise to condensation. Onshore winds will frequently be salt laden. On occasions, the combination of salt and condensation may create pollution conditions for outdoor insulators.

Therefore, outdoor material and equipment shall be designed and protected for use in exposed, heavily polluted, salty, corrosive and humid coastal atmosphere.

**TECHINICAL SPECIFICATIONS
FOR 3.15 / 5.00 / 8.00 MVA,
33/11KV ONAN
POWER TRANSFORMERS**

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OF
POWER TRANSFORMERS

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TECHINICAL SPECIFICATION FOR 33/11KV ONAN POWER

TRANSFORMERS

1.0 SCOPE

1.1 This Specification provides for design, manufacture, assembly, stage inspection, final inspection and testing before despatch, packing and delivery at destination Sub-station by road transport, transit insurance, unloading at site of **3.15 / 5.00 / 8.00 MVA, 33/11kV Power Transformers**, complete with all fittings, accessories, associated equipment, Spares, 10% extra Transformer Oil, required for its satisfactory operation.

The material offered shall be procured from short listed vendor at **E-14** and shall have been successfully Type Tested during last five years on the date of bid opening. The Type Test reports shall be submitted along with the bid.

The Transformer shall be of outdoor type with On Load In-Tank type Tap Changer.

3.15 MVA -	OFF Load Tap Changer
5.00 MVA -	OFF Load Tap Changer
8.00 MVA -	ON Load Tank type Tap Changer (with RTCC Panel)

1.2 **The core shall be constructed from high grade, non-aging Cold Rolled Grain Oriented (CRGO) Silicon Steel laminations conforming to HIB grade with lamination thickness not more than 0.23mm to 0.27mm or better quoted grade Core. The maximum flux density in any part of the core and yoke at normal voltage and frequency shall not be more than 1.5 Tesla. The Bidder shall provide saturation curve of the core material, proposed to be used. Laminations of different grade(s) and different thickness (s) are not allowed to be used in any manner or under any circumstances.**

1.3 The Power Transformer shall conform in all respects to highest standards of engineering, design, workmanship based on this specification and the latest revisions of relevant standards at the time of offer. OPTCL shall have the power to reject any work or material, which, in his judgment, is not in full accordance therewith. The Transformer(s) offered, shall be complete with all components, necessary for their effective and trouble free operation. Such components shall be deemed to be within the scope of supply, irrespective of whether those are specifically brought out in this specification and / or in the commercial order or not.

OPTCL reserves the right to reject the transformer(s)-

- i) if on testing the No-load and load- losses exceed the stipulated values as per this Technical Specification
- ii) if the temperature rise in oil and / or winding exceeds the value as per this Technical Specification

iii) if impedance value differs from the guaranteed value including tolerance as per this specification

iii) On Inspection and testing, if any of the technical data does not comply to this specification, bid offer and approved drawings etc.

1.4 The offered rating transformer should have been tested for 'Short Circuit withstand capability test' and 'Impulse test' in an NABL accredited Government Laboratory as per relevant IS/IEC and the Type Test certificates in complete shape shall be accompanied with the bid offer.

2.0 TECHNICAL REQUIREMENTS OF POWER TRANSFORMER

1	Rated MVA of Transformer (ONAN rating)	3.15MVA 5.00MVA 8.00MVA
2	No. of Phases	3
3	Type of Installation	Outdoor
4	Frequency	50 Hz ($\pm 5\%$)
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	11 kV
8	Highest continuous system Voltage	
	a) Maximum system Voltage ratio (HV / LV)	36 kV/ 12 kV
	b) Rated Voltage ratio (HV / LV)	33 kV/ 11 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 earthing	Neutral of LV side to be solidly earthed.
15	Percentage impedance voltage on Normal tap and MVA base at 75°C corresponding to HV/ LV rating and applicable tolerances :	% Impedance for 3.15MVA- 6.25%, 5MVA-7.15% and for 8MVA - 8.35% (Tolerance +10%) (No negative tolerance will be allowed)
16	Intended regular cyclic overloading of windings	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	On-Load In-tank Type tap changer hanger for 8 MVA and OFF load in 3.15 and 5 MVA transformer
	Range of taping	+ 5% to – 15% in 9 equal steps of

		2.5% each on HV winding
19	Neutral terminal to be brought out	On LV side only
20	Over Voltage operating capability and duration	112.5 % of rated voltage (continuous)
21	Maximum Flux Density in any part of the core and yoke at rated MVA, rated voltage i.e 33kV / 11kV and system frequency of 50 Hz	1.5 Tesla
22	Insulation levels for windings :-	33 kV 11 kV
	a) 1.2 / 50 microsecond wave shape Impulse withstand (KVP)	170 95
	b) Power frequency voltage withstand (KVrms)	70 28
23	Type of winding insulation	
	a) HV winding	Uniform
	b) LV winding	Uniform
24	Withstand time for three phase short circuit	2 Seconds
25	Noise level at rated voltage and frequency	As per NEMA Publication No. TR-1.
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) Hot Spot Temperature rise	54° C
27	Minimum clearances in air (mm) :-	Phase to Phase Phase to ground
	a) HV	400 320
	b) LV	280 140
28	Terminals :-	
	a) HV winding line end	36kV oil filled communicating type porcelain bushings (Antifog type)
	b) LV winding	12kV porcelain type of bushings (Antifog type)
29	Insulation level of Bushing :-	HV LV
	a) Lightning Impulse withstand (KVP)	170 95
	b) 1 Minute Power Frequency withstand voltage (KV-rms)	70 28
	c) Creepage distance (mm) (minimum)	900 300
30	Material of 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 type
34	Temperature Indicator	

	a) Oil	One number
	b) Winding	One number
35	Maximum permissible no load loss at rated voltage and rated frequency.	3.15MVA-3.0 KW (Maximum) 5.0MVA- 3.6. KW (Maximum) 8.0MVA- 4.5KW (Maximum)
36	Maximum permissible load loss at rated current,at normal tap and at 75° C	3.15MVA-17.0 KW (Maximum) 5.0MVA- 21.0. KW (Maximum) 8.0MVA- 38.0KW (Maximum)
37	Paper Covering thickness of HV Winding Conductor	0.6 mm(minimum)
38	Paper Covering thickness of LV Winding Conductor	0.5 mm(minimum)
39	Clearances:-	
	a) Gap between HV Coil to the inside of the tank on the longer side	65 mm(minimum)
	b) Gap between HV Coil to the inside of the tank on the width side (LV Side)	65 mm(minimum)
	c) Gap between HV Coil to the inside of the tank on the width side (HV Side to accommodate delta and tapping leads)	115 mm(minimum)
	d) Gap between Core yoke to tank bottom	55 mm(minimum)
	e) Yoke insulation at top and bottom	130 mm(minimum)
	f) Phase to Phase clearance between HV Limbs	20 mm(minimum)
	g) Radial Clearance between LV and HV Coil	20 mm(minimum)
	h) Radial Clearance between Core to LV Coil	12.5 mm(minimum)
40	The difference of Ampere Turns at each location shall not be more than 5 % at all percentages of tappings	
41	Winding to winding clearance should have minimum 20% of sum of pressboard Cylinder/Barrier.	
42	Tap changing gear:-	
(i)	Type-	In Tank,High Speed Resistor Type
(ii)	Provided on	HV Side
(iii)	Tap range	-15% to +5%
(iv)	Tap Step	2.5% of 33kV
(v)	Minimum Rated current	For 3.15MVA-100A,5MVA-150A &8MVA-200A
(vi)	Minimum Rated short circuit current	3KA
(vii)	Automatic control required	YES
(viii)	Remote Control Panel required	YES
(ix)	Marshalling kiosk required	YES

43.	Minimum Air core reactance of HV winding	20%
44.	Type of oil preservation	Air-cell type

2.1 MARSHALLING BOX

A metal enclosed, weather, vermin and dust proof marshalling box fitted with required glands, locks, glass door, terminal Board, heater with switch, illumination lamp with switch etc. shall be provided with each transformer to accommodate temperature indicators, terminal blocks etc. It shall have degree of protection of IP 55 or better as per IS: 2147.

2.2 PERFORMANCE

- i) Transformer shall be capable of withstanding for two seconds without damage to any external short circuit.
- ii) The maximum flux density in any part of the core and yoke at rated MVA, Voltage and frequency, shall be 1.5 Tesla (maximum).
- iii) Transformer shall under exceptional circumstances due to sudden disconnection of the load, be capable of operating at the voltage approximately 25% above normal rated voltage for a period of not exceeding one minute and 40% above normal for a period of 5 seconds.
- iv) The transformer may be operated continuously without danger on any particular tapping at the rated MVA \pm 12.5% of the voltage corresponding to the tapping.
- v) The thermal ability to withstand short circuit shall be demonstrated by calculation.
- vi) Transformer shall be capable of withstanding thermal and mechanical stress caused by any symmetrical and asymmetrical faults on any winding. The Bidder shall submit the necessary Short Circuit Force Calculation with the offer.

2.3 DRAWINGS/ DOCUMENTS INCORPORATING THE FOLLOWING PARTICULARS SHALL BE SUBMITTED WITH THE BID

- a) General outline drawing showing shipping dimensions and overall dimensions, net weights and shipping weights, quality of insulating oil, spacing of wheels in either direction of motion, location of coolers, marshalling box and tap changers etc.
- b) Assembly drawings of core, windings etc. and weights of main components / parts.
- c) Height of center line on HV and LV connectors of transformers from the

rail top level.

- d) Dimensions of the largest part to be transported.
- e) GA drawings / details of various types of bushing
- f) Tap changing and Name Plate diagram
- g) Type test certificates of the quoted rating transformer.
- h) Illustrative & descriptive literature of the Transformer.
- i) The drawings and Type Test certificates of On-Load Tap Changer
- j) Maintenance and Operating Instructions.
- k) The Type Test certificates in complete shape for 'Lightning Impulse' and 'Short Circuit' Test and Temperature Rise Test

2.4 MISCELLANEOUS

- i) Padlocks along with duplicate keys as asked for various valves, marshalling box etc. shall be supplied by the contractor, wherever locking arrangement is provided.
- ii) Foundation bolts for wheel locking devices of Transformer shall be supplied by the Contractor.

2.5 DELIVERY

The full quantity of the equipments shall be delivered as per the delivery schedule appended to this specification.

2.6 SCHEDULES

Any Schedule, if any, annexed to the specification shall be duly filled by the bidder separately.

2.7 NAME PLATE

Transformer rating plate shall contain the information as given in clause 15 of IS-2026 (part-I). The details on rating plate shall be finalized during the detailed engineering. Further, each transformer shall have inscription of DISTCOM's name which will be intimated by OPTCL to the firm before hand.

The name plate shall also include

- (i) The short circuit rating
- (ii) Measured no load current and no load losses at rated voltage and rated frequency
- (iii) Measured load losses at 75⁰ C (Normal Tap only)
- (iv) D.C resistance of each winding at 75⁰ C.

3.0 SYSTEM CONDITIONS

The equipment shall be suitable for installation in supply systems of the following characteristics.

		33 kV	11 kV
1	Frequency	50 Hz \pm 5%	50 Hz \pm 5%
2	Nominal system voltages	33 kV	11 kV
3	Maximum system voltages	36.3 kV	12 kV
4	Nominal short circuit level	AS per IS:2026	
5	Insulation levels (1.2/50 μ sec impulse withstand voltage)	170 kV (peak)	95kV (peak)
6	Power frequency with one minute withstand (wet & dry) voltage	70 kV(rms)	28 kV(rms)
7	Neutral earthing arrangements	-	Solidly earthed

4.0 CODES & STANDARDS

4.1 The design, material, fabrication, manufacture, inspection, testing before dispatch and performance of power transformers at site shall comply with all currently applicable statutory regulations and safety codes in the locality where the equipment will be installed. The equipment shall also conform to the latest applicable standards and codes of practice. Nothing in this specification shall be construed to relieve the Contractor of this responsibility.

4.2 The equipment and materials covered by this specification shall conform to the latest applicable provision of the following standards.

1	IS: 5	Colour for ready mixed paints & Enamels
2	IS: 325	Three Phase Induction Motors
3	IS: 335	New insulating oil for transformers, switch gears
4	IS: 1271	Classification of insulating materials for electrical machinery and apparatus in relation to their stability in services
5	IS: 2026(Part I to IV	Power Transformer

6	IS: 2071	Method of high voltage testing
7	IS: 2099	High voltage porcelain bushings
8	IS: 2147	Degree of protection
9	IS: 2705	Current Transformers
10	IS: 3202	Code of practice for climate proofing of electrical equipment
11	IS: 3347	Dimensions for porcelain Transformer Bushings
12	IS: 3637	Gas operated relays
13	IS: 3639	Fittings and accessories for power Transformers
14	IS: 5561	Electric Power Connectors
15	IS: 6600/BS:CP' 10:0	Guide for loading of oil immersed Transformers
16	IS: 10028	Code of practice for selection, installation and maintenance of transformers, Part I. II and III
17	IS 1002/1981 (Part – III)	Maintenance of Transformer
18	C.B.I.P. Publication	Manual on Transformers

If the standard is not quoted for any item, it shall be presumed that the latest version of Indian Standard shall be applicable to that item.

The equipment complying other internationally accepted standards, may also be considered if they ensure performance superior to the Indian Standards.

4.3 DRAWINGS

- a) The contractor shall furnish, within fifteen days after issuing of Letter of Award. Six copies each of the following drawings/documents incorporating the transformer rating for approval.
 - i) Detailed overall general arrangement drawing showing front and side elevations and plan of the transformer and all accessories including radiators and external features with details of dimensions, spacing of wheels in either direction of motion, net weights and shipping weights, crane lift for un-tanking, size of lugs and eyes, bushing lifting dimensions, clearances between HV and L.V terminals and ground, quantity of insulating oil etc.
 - ii) Assembly drawings of core and winding and weights of main components / parts. In the Core-Coil assembly drawing, the following dimensions should be clearly mentioned:-

Core:- Window Height, Leg Centre, Core diameter, Grade & thickness of Core material, gross & net Core Cross-Sectional area, Watt loss per kg at the quoted flux density, VA per kg at the quoted flux density.

HV & LV Windings:- Conductor Size (both bare and insulated), Inside and Outside diameters, axial heights, type of windings, No. of spacers with sizes, No. of discs, No. of turns/disc, gap between discs, clearance from top and bottom yoke, gap between windings, Size of the conductor for delta connection etc.

- iii) Foundation plan showing loading on each wheel land jacking points with respect to Centre line of transformer.
- iv) GA drawings details of bushing and terminal connectors.
- v) Name plate drawing with terminal marking and connection diagrams.
- vi) Wheel locking arrangement drawing.
- vii) Transportation dimensions drawings.
- viii) Magnetization characteristic curves of PS class neutral and phase side current transformers, if applicable.
- ix) Interconnection diagrams.
- x) Over fluxing withstand time characteristic of transformer.
- xi) GA drawing of marshalling box.
- xii) Control scheme/wiring diagram of marshalling box.
- xiii) Technical leaflets of major components and fittings.
- xiiv) As built drawings of schematics, wiring diagram etc.
- xv) Setting of oil temperature indicator, winding temperature indicator.
- xvi) Completed technical data sheets.
- xvii) Detail Drawings, Type Test Certificates including write-up of On-Load tap changing gear and its required accessories/equipments, wiring diagrams etc. as per this specification.
- xviii) HV conductor bushing.
- xix) Bushing Assembly.
 - xx) Bi-metallic connector suitable for connection to 100 sq. mm up to 232 Sq.mm AAAC Conductor.
- xxi) GA of LV cable Box.
- xxii) Radiator type assembly
- xxiii) Specific loss(watt/Kg. vs.Flux density),VA/Kg.vs.Flux density &B-H Graph for the offered HIB or better core material,to be used for the offered transformer

- b) All drawings, documents, technical data sheets and test certificates, results and calculations shall be furnished.
 - c) Ampere –Turns Calculation at various locations and tapping positions of both LV and HV windings.
- 4.4 Any approval given to the detailed drawings by the OPTCL shall not relieve the contractor of the responsibility for correctness of the drawing and in the manufacture of the equipment. The approval given by the OPTCL shall be general with overall responsibility with contractor.

5.0 GENERAL CONSTRUCTIONAL FEATURES

- 5.1 All material used shall be of best quality and of the class most suitable for working under the conditions specified and shall withstand the variations of temperature and atmospheric conditions without distortion or deterioration or the setting up of undue stresses which may impair suitability of the various parts for the work which they have to perform.
- 5.2 Similar parts particularly removable ones shall be interchangeable.
- 5.3 Pipes and pipe fittings, screws, studs, nuts and bolts used for external Connections shall be as per the relevant standards. Steel bolts and nuts exposed to atmosphere shall be galvanized.
- 5.4 Nuts, bolts and pins used inside the transformers and tap changer compartments shall be provided with lock washer or locknuts.
- 5.5 Exposed parts shall not have pockets where water can collect.
- 5.6 Internal design of transformer shall ensure that air is not trapped in any location.
- 5.7 Material in contact with oil shall be such as not to contribute to the formation of acid in oil. Surface in contact with oil shall not be galvanized or cadmium plated.
- 5.8 Labels, indelibly marked, shall be provided for all identifiable accessories like Relays, switches current transformers etc. All label plates shall be of in corrodible material.
- 5.9 All internal connections and fastenings shall be capable of operating under overloads and over-excitation, allowed as per specified stands without injury.
- 5.10 Transformer and accessories shall be designed to facilitate proper operation, inspection, maintenance and repairs.
- 5.11 No patching, plugging, shimming or other such means of overcoming defects, discrepancies or errors will be accepted.

5.12 Schematic Drawing of the wiring, including external cables shall be put under the prospane sheet on the inside door of the transformer marshalling box.

5.13 Painting

Particular attention shall be paid to the following:

- a) Proper storage to avoid exposure as well as extremes of temperature.
- b) Surface preparation prior to painting.
- c) Mixing and thinning
- d) Application of paints and the recommended limit on time intervals between coats.
- e) Shelf life for storage.

5.13.1.1 All paints, when applied in normal full coat, shall be free from runs, sags, wrinkles, patchiness, brush marks or other defects.

5.13.1.2 All primers shall be well marked into the surface, particularly in areas where painting is evident, and the first priming coat shall be applied as soon as possible after cleaning. The paint shall be applied by airless spray according to the manufacturer's recommendations. However, wherever airless spray is not possible, conventional spray be used with prior approval of OPTCL.

5.13.1.3 The supplier shall, prior to painting protect nameplates, lettering gauges, sight glasses, light fittings and similar such items.

5.13.2 Cleaning and Surface Preparation

5.13.2.1 After all machining, forming and welding has been completed, all steel work surfaces shall be thoroughly cleaned of rust, scale, welding slag or spatter and other contamination prior to any painting.

5.13.2.2 Steel surfaces shall be prepared by Sand/Shot blast cleaning and Chemical cleaning by Seven tank process including Phosphating to the appropriate quality. The surface shall be treated by phosphating and dried in accordance with IS 6005 (Code of practices for phosphating of Iron and Steel). Immediately after Phosphating, surface shall be given two coats of high quality Zinc Chromate Primer.

5.13.2.3 The pressure and Volume of the compressed air supply for the blast cleaning shall meet the work requirements and shall be sufficiently free from all water contamination prior to any painting.

5.13.2.4 Chipping, scraping and steel wire brushing using manual or power driven tools cannot remove firmly adherent mill-scale and shall only be used where blast cleaning is impractical.

5.13.3 Protective Coating

As soon as all items have been cleaned and within four hours of the subsequent drying, they shall be given suitable anticorrosion protection.

5.13.4 Paint Material

Followings are the type of paints that may be suitably used for the items to be painted at shop and supply of matching paint to site:

- i) Heat resistant paint (Hot oil proof) for inside surface.
- ii) For external surfaces one coat of Thermo Setting Paint or 2 coats of Zinc chromate followed by 2 coats of POLYURETHANE . The color of the finishing coats shall be dark admiral grey conforming to No.632 or IS 5:1961.

5.13.5 Painting Procedure

- 5.13.5.1 All painting shall be carried out in conformity with both specifications and with the paint manufacture's recommendations. All paints in any one particular system. Whether shop or site applied, shall originate from one paint manufacturer.
- 5.13.5.2 Particular attention shall be paid to the manufacture's instructions on storage, mixing, thinning and pot life. The paint shall only be applied in the manner detailed by the manufacturer e.g. brush, roller, conventional or airless spray and shall be applied under the manufacturer's recommended conditions. Minimum and maximum time intervals between coats shall be closely followed.
- 5.13.5.3 All prepared steel surfaces should be primed before visible re-rusting occurs or within 4 hours whichever is sooner. Chemical treated steel surfaces shall be primed as soon as the surface is dry and while the surface is warm.
- 5.13.5.4 Where the quality of film is impaired by excess film thickness,(wrinkling, mud cracking or general softness) the supplier shall remove the unsatisfactory paint coatings and apply another. As a general rule, dry film thickness should not exceed the specified minimum dry film thickness by more than 25% . In all instances, where two or more coats of the same paints are specified, such coatings may or may not be of contrasting colors.
- 5.13.5.5 Paint applied to items that are not to be painted, shall be removed at supplier's expense, leaving the surface clean, un-stained and undamaged.

5.13.6 Damages to Paints Work

5.13.6.1 Any damage occurring to any part of the painting scheme shall be made good to the same standard of corrosion protection and appearance as that originally employed.

5.13.6.2 Any damaged paint work shall be made as follows:

- a) The damaged area, together with an area extending 25mm around its boundary, shall be cleaned down to bare metal.
- b) A priming coat shall immediately applied, followed by a full paint finish equal to that originally applied and extending 50mm around the perimeter of the originally damaged.

5.13.6.3 The repainted surface shall present a smooth surface. This shall be obtained by carefully chamfering the paint edges before & after priming.

5.13.7 Dry Film Thickness

5.13.7.1 To the maximum extent practicable, the coats shall be applied as a continuous film of uniform thickness and free of pores. Over-spray, skips, runs, sags and drips should be avoided. The different coats may or may not be same color.

5.13.7.2 Each coat of paint shall allowed to hardened before the next is applied as per manufacture's recommendations.

5.13.7.3 Particular attention must be paid to full film thickness at edges.

5.13.7.4 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	Total Dry film thickness(Min)
1.	Liquid Paint			
	a) Zinc Chromate(Primer)	Out side	02	45 micron
	b) POLYURETHANE (Finish Coat)	Out side	02	35 micron
	c) Hot Oil	inside	01	35 micron

6.0 DETAILED DESCRIPTION

6.1 Tank

- 6.1.1 The Transformer tank and cover shall be fabricated from high grade low carbon plate steel of tested quality. The tank shall be of welded construction. The transformer Tank shall be of rectangular Shape design(No elliptical shape design is allowed).
- 6.1.2 Tank shall be designed to permit lifting by crane or jacks of the complete transformer assembly filled with oil. Suitable lugs and bossed shall be provided for this purpose.
- 6.1.3 All beams, flanges, lifting lugs, braces and permanent parts attached to the tank shall be welded and where practicable, they shall be double welded.
- 6.1.4 The main tank body of the transformer, excluding tap changing compartments and radiators ,shall be capable of withstanding pressure of 760mm of Hg. **The side Tank wall shall be of 6mm thickness (minimum) for 3.15MVA and 8mm(minimum) for 5MVA & 8MVA . The bottom and Top Plate of the Tank shall be of 8mm thickness (minimum) for 3.15MVA,10mm(minimum) for 5MVA &12mm.(minimum) for 8MVA.**
- 6.1.5 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.
- 6.1.6 Gaskets of nitrile rubber or equivalent shall be used to ensure perfect oil tightness.
- All gaskets shall be closed design (without open ends) and shall be of one piece only. Rubber gaskets used for flange type connections of the various oil compartments, shall be laid in grooves or in groove-equivalent sections on bolt sides of the gasket, throughout their total length. Care shall be taken to secure uniformly distributed mechanical strength over the gaskets and retains throughout the total length. Gaskets of neoprene and / or any kind of impregnated / bonded core or cork only which can easily be damaged by over-pressing are not acceptable. Use of hemp as gasket material is also not acceptable.
- 6.1.7 Suitable guides shall be provided for positioning the various parts during assemble or dismantling. Adequate space shall be provided between the cores and windings and the bottom of the tank for collection of any sediment.

6.2 Tank Cover

The transformer top shall be provided with a detachable tank cover with bolted flanged gasket joint. Lifting lugs shall be provided for removing the cover. The surface of the cover shall be suitable sloped so that it does not retain rain water.

6.3 UNDER CARRIAGE

- 6.3.1 The transformer tank shall be supported on steel structure with detachable plain rollers completely filled with oil. Suitable channels for movement of roller with transformer shall be space accordingly, rollers wheels shall be provided with suitable rollers bearings, which will resist rust and corrosion and shall be equipped with fittings for lubrication. It shall be possible to swivel the wheels in two directions, at right angle to or parallel to the main axis of the transformers.

6.4 CORE

- 6.4.1 Stage inspection for core construction shall be carried out by the Purchaser.
- 6.4.2 Each lamination shall be insulated such that it will not deteriorate due to mechanical pressure and the action of hot transformer oil.
- 6.4.3 The core shall be constructed from high grade, non-aging Cold Rolled Grain Oriented (CRGO) silicon steel laminations conforming to HIB grade or better grade with lamination thickness not more than 0.23mm to 0.27mm. The maximum flux density in any part of the cores and yoke at normal voltage and frequency shall not be more than 1.5 Tesla. The Bidder shall provide saturation curve of the core material, proposed to be used. Laminations of different grade(s) and different thickness (s) are not allowed to be used in any manner or under any circumstances.
- 6.4.4 The bidder should offer the core for inspection starting from the destination port to enable OPTCL for deputing inspecting officers for detail verification as given below and approval by the OPTCL during the manufacturing stage. Bidder's call notice for the purpose should be accompanied with the following documents as applicable as a proof towards use of prime core material:
- The core coils, if found suitable, are to be sealed with proper seals which shall be opened in presence of the inspecting officers during core- cutting at the manufacturer's or it's sub-vendor's premises as per approved design drawing.
- a) Purchase Order No. & Date.
 - b) Invoice of the supplier
 - c) Mills test certificate
 - d) Packing list

- e) Bill of lading
- f) Bill of entry certificate to customs

Core material shall be directly procured either from the manufacturer or through their accredited marketing organization of repute, but not through any agent.

6.4.4 (B) 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) Purchase Order No. & Date ;
- b) No. of packed coils with Package Nos.
- c) Gross Weight.
- d) Net Weight :
- e) Port of loading.
- f) Port of Discharge ;
- g) Name of the Ocean Vessel :
- h) Grade & Thickness of Core Material :
- i) Any other information as mentioned on the body of packed coils.

6.4.4 (C) For those bidders, who have no in-house core-cutting facility, they should mention the names of at least three sub-vendors to whom they intend to assign their core-cutting. Such sub-vendors should have been approved by other Electricity Board / Electrical Utilities and accredited by some internationally recognized certification body like ISO- 9000 etc. to ensure that a minimum quality parameters & tolerance are maintained. The experience, the details of core-cutting facilities finishing & testing facilities etc. as available which such sub-vendors should be clearly out-lined in the bid

6.4.4 (D) On award of Contract the TM is to assign the core-cutting to such sub-vendors for which approval is to be given by the OPTCL.

6.4.5 The laminations shall be free of all burrs and sharp projections. Each sheet shall have an insulting coating resistant to the action of hot oil.

6.4.6 The insulation structure for the core to bolts and core to clamp plates, shall be such as to withstand 2000 V DC voltage for one minute.

6.4.7 The completed core and coil shall be so assembled that the axis and the plane of the outer surface of the core assemble shall not deviate from the vertical plane by more than 25mm.

6.4.8 All steel sections used for supporting the core shall be thoroughly shot or sand blasted, after cutting, drilling and welding.

- 6.4.9 The finally assembled core with all the clamping structures shall be free from deformation and shall not vibrate during operation.
- 6.4.10 The core clamping structure shall be designed to minimize eddy current loss.
- 6.4.11 The framework and clamping arrangements shall be securely earthed.
- 6.4.12 The core shall be carefully assembled and rigidly clamped to ensure adequate mechanical strength.
- 6.4.13 Oil ducts shall be provided, where necessary, to ensure adequate cooling inside the core. The welding structure and major insulation shall not obstruct the free flow of oil through such ducts.
- 6.4.14 The design of magnetic circuit shall be such as to avoid static discharges, development of short circuit paths within itself or to the earth clamping structure and production of flux component at right angle to the plane of the lamination, which may cause local heating. The supporting framework of the cores shall be so designed as to avoid the presence of pockets, which would prevent complete emptying of the tank through the drain valve or cause trapping of air during filling.
- 6.4.15 The construction is to be of boltless core type. The core shall be provided with lugs suitable for lifting the complete core and coil assembly. The core and coil assembly shall be so fixed in the tank that shifting will not occur during transport or short circuits.
- 6.4.16 The temperature gradient between core & surrounding oil shall be maintained less than 20 deg. Centigrade. The manufacturer shall demonstrate this either through test (procedure to be mutually agreed) or by calculation.

6.5 INTERNAL EARTHING

- 6.5.1 All internal metal parts of the transformer, with the exception of individual laminations and their individual clamping plates shall be earthed.
- 6.5.2 The top clamping structure shall be connected to the tank by a copper strap. The bottom clamping structure shall be earthed by one or more the following methods:
- a) By connection through vertical tie-rods to the top structure.
 - b) By direct metal to metal contact with the tank base.
 - c) By a connection to the structure on the same side of the core as the main earth connection to the tank.
- 6.5.3 The magnetic circuit shall be connected to the clamping structure at one point only and this shall be brought out of the top cover of the transformer tank

through a suitably rated insulator. A disconnecting link shall be provided on transformer tank to facilitate disconnections from ground for IR measurement purpose.

- 6.5.4 Coil clamping rings of metal at earth potential shall be connected to the adjacent core clamping structure on the same side as the main earth connections.

6.6 WINDING:-

- 6.6.1 Winding shall be subjected to a shrinking and seasoning process, so that no further shrinkage occurs during service. Adjustable devices shall be provided for taking up possible shrinkage in service.
- 6.6.2 All low voltage windings for use in the circular coil concentric winding shall be wound on a performed insulating cylinder for mechanical protection of the winding in handling and placing around the core.
- 6.6.3 Winding shall not contain sharp bends which might damage the insulation or produce high dielectric stresses. No strip conductor wound on edge shall have width exceeding six times the thickness.
- 6.6.4 Materials used in the insulation and assembly of the windings shall be insoluble, non catalytic and chemically inactive in the hot transformer oil and shall not soften or the otherwise affected under the operating conditions.
- 6.6.5 Varnish application on coil windings may be given only for mechanical protection and not for improvement in dielectric properties. In no case varnish or other adhesive be used which will seal the coil and prevent evacuation of air and moisture and impregnation by oil.
- 6.6.6 Winding and connections shall be braced to withstand shocks during transport or short circuit.
- 6.6.7 Permanent current carrying joints in the windings and leads shall be welded or brazed. Clamping bolts for current carrying parts inside oil shall be made of oil resistant material which shall not be affected by acidity in the oil steel bolts, if used, shall be suitably treated.
- 6.6.8 Terminals of all windings shall be brought out of the tank through bushings for external connections.
- 6.6.8.1 The completed core and coil assemble shall be dried in vacuum at not more than 0.5mm of mercury absolute pressure and shall be immediately impregnated with oil after the drying process to ensure the elimination of air and moisture within the insulation. Vacuum may be applied in either vacuum over or in the transformer tank.
- 6.6.8.2 The winding shall be so designed that all coil assemblies of identical voltage ratings shall be interchangeable and field repairs to the winding can be made readily without special equipment. The coils shall have high dielectric strength.
- 6.6.8.3 Coils shall be made of continuous smooth high grade electrolytic copper conductor, shaped and braced to provide for expansion and contraction due to temperature changes.

- 6.6.8.4 Adequate barriers shall be provided between coils and core and between high and low voltage coil. End turn shall have additional protection against abnormal line disturbances.
- 6.6.8.5 The insulation of winding shall be designed to withstand voltage stress arising from surge in transmission lines due to atmospheric or transient conditions caused by switching etc.
- 6.6.8.6 Tapping shall not be brought out from inside the coil or from intermediate turns and shall be so arranged as to preserve as far as possible magnetic balance of transformer at all voltage ratios.
- 6.6.8.7 Magnitude of impulse surges transferred from HV to LV windings by electro magnetic induction and capacitance coupling shall be limited to BIL of LV winding.
- 6.6.8.8 The current density adopted in all winding shall not exceed 2.4 A/mm^2 .
The total net conductor area should be arrived after deducting the area ,lost due to rounding off the sharp edges of the conductor , which is given below:-

0.21 mm ² up to a depth of 1.6 mm
0.36 mm ² mm up to a depth of 2.24 mm
0.55 mm ² up to a depth of 3.25 mm
0.86 mm ² above 3.25 mm

- 6.6.8.9 The finally compressed shrunk height of both HV and LV windings should be equal.

6.7 INSULATING OIL

- 6.7.1 The insulating oil for the transformer shall be of EHV grade, generally conforming to IS: 335. No inhibitors shall be used in the oil.
- 6.7.2 The quantity of oil required for the first filling of the transformer and its full specification shall be stated in the bid. The bidder shall quote the price of transformer complete with all fittings, accessories and new transformer oil required for first filling plus 10% extra oil. The extra quantity of oil shall be supplied in non-returnable drums along with the oil required for the radiator banks.
- 6.7.3 The design and materials used in the construction of the transformer shall be such as to reduce the risk of the development of acidity in the oil.
- 6.7.4 Transformer Oil-The contractor shall ensure that the Transformer oil furnished conforms to IS:335 including amendment,if any.

6.8 VALVES:-

- i) Valves shall be of forged carbon steel upto 50mm size and of gun mental or of cast iron bodies with gun metal fittings for sizes above 50mm. They shall be of full way type with screwed ends and shall be opened by

turning counter clockwise when facing the hand wheel. There shall be no oil leakage when the valves are in closed position.

ii) Each valve shall be provided with an indicator to show the open and closed positions and shall be provided with facility for padlocking in either open or closed position. All screwed valves shall be furnished with pipe plugs for protection. Padlocks with duplicate keys shall be supplied along with the valves.

iii) All valves except screwed valves shall be provided with flanges having machined faced drilled to suit the applicable requirements, Oil tight blanking plates shall be provided for each connection for use when any radiator is detached and for all valves opening to atmosphere. If any special radiator valve tools are required the contractor shall supply the same.

i) Each transformer shall be provided with following valves on the tank:

- a) Drain valve so located as to completely drain the tank & to be provided with locking arrangement.
- b) Two filter valves on diagonally opposite corners of 50mm size & to be provided with locking arrangement.
- c) Oil sampling valves not less than 8mm at top and bottom of main tank & to be provided with locking arrangement.
- d) One 15mm air release plug.
- e) Valves between radiators and tank.

Drain and filter valves shall be suitable for applying vacuum as specified in this specification.

6.9 ACCESSORIES:-

6.9.1 Bushing

- i) All porcelain used in bushings shall be homogeneous, non-porous, uniformly glazed to brown colour and free from blisters, burns and other defects.
- ii) Stress due to expansion and contraction in any part of the bushing shall not lead to deterioration.
- iii) Bushing shall be designed and tested to comply with the applicable standards.
- iv) Bushing rated for 400A and above shall have non-ferrous flanges and hardware.

- v) Fittings made of steel or malleable iron shall be galvanized
- vi) Bushing shall be so located on the transformers that full flashover strength will be utilized. Minimum clearances as required for the BIL shall be realized between live parts and live parts to earthed structures.
- vii) All applicable routine and type tests certificates of the bushings shall be furnished for approval.
- viii) Bushing shall be supplied with bi-metallic terminal connector/ clamp/ washers suitable for fixing to bush terminal and the OPTCL's specified conductors. The connector/clamp shall be rated to carry the bushing rated current without exceeding a temperature rise of 50° C over an ambient of 50°C. The connector/clamp shall be designed to be corona free at the maximum rated line to ground voltage.
- ix) Bushing of identical voltage rating shall be interchangeable.
- x) The insulation class of high voltage neutral bushing shall be properly coordinated with the insulation class of the neutral of the low voltage winding.
- xi) Each bushing shall be so coordinated with the transformer insulation that all flashover will occur outside the tank.

6.9.2 Protection & Measuring Devices:-

i) Oil Conservator Tank

- a) A conservator, complete with drain valve shall be provided in such a position, so as not to obstruct the electrical connections to the Transformer. The capacity of the conservator between highest and lowest visible levels shall be minimum of 7.5% of the total cold oil volume in the Transformer.
- b) The conservator tank shall be bolted on its support of mounting to allow for its removal for cleaning/ repairing purposes.
- c) The conservator shall be fitted with magnetic oil level gauge with low level electrically insulated alarm contact.
- d) The silica gel breather shall have minimum quantity of silica gel as 1kg for every 3500Ltrs. of oil in the Tank. The container for the dehydrating agent shall be of transparent plastic of best quality, to be approved by OPTCL.

ii) Pressure Relief Device.

The pressure relief device provided shall be of sufficient size for rapid release of any pressure that may be generated in the tank and which may

result in damage of the equipment. The device shall operate at a static pressure of less than the hydraulic test pressure of transformer tank. It shall be mounted direct on the tank. A pair of electrically insulated contact shall be provided for alarm and tripping.

iii) **Buchholz Relay**

A double float type Buchholz relay shall be provided., Any gas evolved in the transformer shall collect in this relay. The relay shall be provided with a test cock suitable for a flexible pipe connection for checking its operation. A copper tube shall be connected from the gas collector to a valve located about 1200 mm above ground level to facilitate sampling with the transformer in service. The device shall be provided with two electrically independent potential free contacts, one for alarm on gas accumulation and the other for tripping on sudden rise of pressure.

iv) **Temperature Indicator**

a) **Oil Temperature Indicator (OTI)**

The transformers shall be provided with a mercury contact type thermometer with 150 mm dial for top oil temperature indication. The thermometer shall have adjustable, electrically independent potential free alarm and trip contacts. Maximum reading pointer and resetting device shall be mounted in the local control panel. A temperature sensing element suitably located in a pocket on top oil shall be furnished. This shall be connected to the OTI by means of capillary tubing. Accuracy class of OTI shall be $\pm 1\%$ or better. One No electrical contact capable of operating at 5 A ac at 230 volt supply.

b) **Winding Temperature indicator(WTI)**

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

- i) Temperature sensing element.
- ii) Image Coil.
- iii) Mercury contacts.
- iv) Auxiliary CTS, If required to match the image coil, shall be furnished and mounted in the local control panel.
- v) 150mm dial local indicating instrument with maximum reading pointer mounted in local panel and with adjustable electrically independent ungrounded contacts, besides that required for control of cooling

equipment, one for high winding temperature alarm and on for trip.

vi) Calibration device.

vii) Two number electrical contact each capable of operating at 5 A ac at 230 Volt supply.

7.9.3 Oil Preservation Equipment

6.9.3. :-

The oil preservation shall be diaphragm type oil sealing in conservator to prevent oxidation and contamination of oil due to contact with atmospheric moisture.

The conservator shall be fitted with a dehydrating filter breather. It shall be so designed that.

i) Passage of air is through a dust filter & Silica gel.

ii) Silica gel is isolated from atmosphere by an oil seal.

iii) Moisture absorption indicated by a change in colour of the crystals of the silica gel can be easily observed from a distance.

iv) Breather is mounted not more than 1400 mm above rail top level.

6.10 **MARSHALLING BOX:-**

i) Sheet steel, weather, vermin and dust proof marshalling box fitted with required glands, locks, glass door, terminal Board, heater with switch, illumination lamp with switch, watertight hinged and padlocked door of a suitable construction shall be provided with each transformer to accommodate temperature indicators, terminal blocks etc. 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.

ii) The schematic diagram of the circuitry inside the marshalling box be prepared and fixed inside the door under a suitable sheet.

iii) The marshalling box shall accommodate the following equipment:

a) Temperature indicators.

b) Space for accommodating Control & Protection equipment in future for the cooling fan (for ONAF type cooling, may be provided in future).

c) Terminal blocks and gland plates for incoming and outgoing cables.

All the above equipments except c) shall be mounted on panels and back of panel wiring shall be used for inter-connection. The temperature indicators shall be so mounted that the dials are not more than 1600 mm from the ground level and the door (s) of the compartment(s) shall be provided with glazed window of adequate size. The transformer shall be erected on a plinth which shall be 2.5 feet above ground level.

iii) To prevent internal condensation, a metal clad heater with thermostat shall be provided. The heater shall be controlled by a MCB of suitable rating mounted in the box. The ventilation louvers, suitably padded with felt, shall also be provided. The louvers shall be provided with suitable felt pads to prevent ingress of dust.

iv) 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.

v) The control connection, wiring etc. shall be as per Clause 3.15 of this

6.11 TAPCHANGER

6.11.1 ON-LOAD TAP-CHANGERS WITH REMOTE TAP CHANGE CONTROL

Each transformer shall be provided with an “In-Tank” Type on-load tap-changer connected to the high voltage winding. The on-load tap-changer shall be capable of withstanding the voltages described earlier and shall comply with the requirements of IEC-60214, latest revision. Its tapping range, number of steps and tap positions shall be as specified.

On Load Tap Changer shall be sourced from reputed manufacturer(s) and it should be type tested as per relevant IEC60214 as given below and test methods shall be in full conformance to the procedures indicated in IEC60214

Sl.No.	IEC Reference	Test Description
1.	Cl.5.2.1	Temperature rise of contacts.
2.	Cl.5.2.2	Switching Tests
3.	Cl.5.2.3	Short-circuit current Test.
4.	Cl.5.2.4	Short-circuit current Test. .
5.	Cl.5.2.5	Mechanical tests.
6.	Cl.5.2.6	Dielectric Tests

OLTC manufacturer shall conduct the following routine tests fully in compliance with IEC 60214 on every unit, as given below, before dispatch to assure the quality of the OLTC.OPTCL at its sole discretion may test-witness and inspect

the Tap-Changers at the works of the OLTC manufacturer.

The following are the routine tests, to be carried out on each OLTC:-

Sl.No.	IEC Reference	Test Description
1.	CI.5.3.1	Mechanical Test.
2.	CI.5.3.2	Sequence test
3.	CI.5.3.3	Auxiliary circuits Insulation tests
4.	CI.5.3.4	Pressure test
5.	CI.5.3.4	Vacuum test

All the test reports shall be submitted to OPTCL for approval.

Adequate access for personnel shall be provided for inspection and maintenance. The guaranteed interval between maintenance periods for the diverter switch shall be 10 years or 50,000 operations. It shall not be possible for oil in the diverter switch compartment to come in contact with the oil in the main transformer tank.

The tap-changer shall be driven by a motor operated mechanism incorporating a stored energy device which shall ensure that once a change of tap begins it is completed and so shall ensure that the mechanism does not fail in an intermediate position on loss of the supply voltage to the motor. The motor shall be rated for 400/230V, 50 Hz and shall operate satisfactorily at any voltage between 85% and 110% of rated voltage.

A tap-changer mechanism box with hinged door and mounted on the transformer tank at a convenient height shall contain all electrical and mechanical parts associated locally with control of the tap-changer. Remote tap-changer controls shall also be provided at a transformer control panel (one per transformer, to be supplied under this contract) in the control room.

Facilities for electrical raise and lower operation (Control switch or push button) as well as mechanical operation shall be provided as the tap-change mechanism box. An interlock shall be provided which shall interrupt the electric supply to the drive motor when the manual mechanical operating device is engaged. The motor drive control shall be such that on initiation of a tap-change operation by means of a control switch or push-button the tap-changer shall complete its movement from one service position to an adjacent one irrespective of whether or not the control switch or push button has been operated continuously during the running time or motor drive. Another

operation shall only be possible when the previous operation has been completed, the control switch or push button has been released and the control system is again in the rest position.

The tap-changer arrangement shall be such that a command to raise tap-numbers shall result in an increase in the secondary voltage with constant voltage applied to the high voltage winding.

An under and over voltage monitoring relay fed with line voltage from the owner's voltage transformers on the low voltage side of the transformer and capable of being set in a continuously variable range from 90% to 115% normal voltage (110V) shall be used to give visual and audible signals at the remote tap change control panel if the LV voltage lies above or below preset values.

Limit switches shall be provided to prevent over-running of the tap-change mechanism. These shall be directly connected in the motor circuit. In addition mechanical end stops shall be fitted to prevent over-running of the mechanism under any conditions. A counter shall be provided to indicate the number of tap-change operations that have been taken place.

A mechanical tap-position indicator shall be provided and it shall be visible from ground level through a window in the door of the mechanism box. Position transmitter e.g. dial switches shall be provided to:

- a. Signal tap position to the control cabinet in the control room.
- b. Signal "out of step" under parallel operating conditions.

A Remote/Local switch shall be provided at the mechanism box to select either remote or local operation. When this switch is turned to the Remote position control shall be passed to the control cabinet in the control room. It should be possible to use only one control, i.e. Local or Remote.

It shall be possible to operate a transformer tap-changer independently or in parallel with the tap-changers of other similar transformers in the same substation in either a "master" or "follower" mode. In addition, when operating independently or in parallel in the master mode, it shall be possible to have manual operation by means of control switch, push button or, (in future) automatic operation by means of an automatic voltage regulating relay. Contacts shall be provided for future SCADA control of the tap-changer and for reporting of the tap position and mode of control to the SCADA system. The paralleling scheme shall use the in- step principle and shall have provision for

operating singly or in parallel in any combination. It shall be possible for any transformer in a group to be selected as either the master or follower for that group when operating in parallel. Each transformer control panel shall therefore have a manual/automatic control switch or push buttons, independent/master/follower control switch or push buttons as well as “raise” and lower” control switches or push buttons. Interlock shall be provided to avoid independent operation when the transformers are running in parallel. There should not be any out-of-step during such operation.

The control scheme shall be capable of extension to cater for the total number of transformers to be installed in any future development of the substation. The control mode selected shall be indicated on the front of the control cabinet.

Each transformer shall have a miniature circuit breaker (MCB) on the AC distribution cabinet through which the 400/230V, 50 Hz supply to its tap-changer and temperature controls is passed. Separate MCB's shall be provided at the mechanism box for protection of the motor and control circuits. The control circuits shall operate at 110V single phase, to be supplied from a transformer having a ratio of 230/55-0-55 V, with the center point earthed through a removable link mounted in the marshalling box or tap-changer mechanism box.

Each tap-changer mechanism box shall be fitted with an anti-condensation space heater (230V AC) controlled by a humidistat with variable range. A lamp for illumination purposes controlled by a door switch shall be provided. Solar gain can give rise to high temperature within a mechanism box. Adequate ventilation shall be provided to ensure that all equipment contained therein shall operate satisfactorily under these conditions.

A terminal block with terminals rated for 10 A continuous current, 650V grade of moulded insulating materials shall be provided for panel wiring and external connection.

Ten percent spare terminals shall be provided in each mechanism box.

The tap changer mechanism box shall be outdoor, weatherproof type, dust, vermin and damp proof with a degree of protection of IP54 of IEC 529 or IS 13947 equivalent.

6.11.2 **Transformer Tap Change Control Panel:-**

The indoor panel suitable for installation in the owner's control room mentioned above shall contain.

- Raise and Lower push buttons or switch.
- Independent / master / follower selector switch.
- Remote tap position indicator.
- Necessary audible & visual alarms.
- Out of step relay with two spare contacts (2 NO + 2 NC)

In addition to the above the Transformer tap change control panel shall have an audible and visual annunciation system for the following trips and alarms.

Oil temperature alarm
Oil temperature trip
Winding temperature alarm
Winding temperature trip
Buchholz alarm
Buchholz trip
Surge relay trip(OLTC gear)
Low oil level alarm
Tap changer out-of-step alarm
Failure of D.C supply alarm

Two spare windows shall be supplied on each panel

Indicating lamps shall be panel mounted type with rear terminal connections. Lamps shall be provided with series connected resistors preferably built within the lamp assembly. Lamps shall have screwed translucent lamp covers to diffuse light and shall be continuously rated for 120 percent of the 24 volt DC supply from a power pack having desired capacity. The 'DC supply failure' lamp shall operate from the AC supply and be rated for 230 Volt AC. The wattage of the lamps shall be not more than five watts. Bulbs and lenses shall be interchangeable and easily replaceable from the front of the panel. The Annunciation scheme with facia windows and alarm bells shall work as follows.

Annunciation scheme functions

Incident	Alarm Bell	Facia Window
Fault occurrence	Ringling	Light flashing
Sound cancel	Off	Light flashing

Acknowledge	Off	Steady light
Fault cleared and reset	Off	Clear
Lamp test	Off	Steady

Any new annunciation operating after the operation of the 'sound cancel' shall cause audible and visual alarm even if the process of acknowledging the previous alarm is going on or has yet to be carried out. Resetting facilities for the flasher and audible alarm circuits of the annunciator shall be provided, and provision shall be made for switching off the entire annunciation system. Two spare windows shall be provided.

The control and relay panel shall be metal clad, dust, moisture, rodent and vermin proof with degree of protection not less than IP 41 specified in IEC :529/ IS : 13947. Panels shall have folded construction and be of unit type. Each panel shall be a free standing structure, independent floor mounting type and shall be manufactured from cold rolled sheet steel of thickness not less than 2.5 mm. There shall be sufficient reinforcement to provide level surfaces, resistance to vibration and rigidity during transportation, installation and service. The panel shall be painted as specified in the clause on "painting" in the specification.

Design, material selection and workmanship shall be such as to result in neat appearance inside and outside with no welds, rivets or bolt ends apparent from outside, with all exterior surfaces even and smooth. The equipment on the front of the panel shall be matched to give neat uniform appearance.

All doors and removable covers shall be gasketed all round with neoprene bonded gaskets, Ventilating louvers shall be provided with screens and filters. The screen shall be made of non corroding metal like brass or galvanized iron wire mesh.

The transformer tap change control panel shall be supplied with all necessary internal wiring, terminal blocks, relays and alarms to provide the above listed alarm and trip functions.

Panel wiring shall be suitably bunched and clamped for neat appearance. The

conductors used for wiring purpose shall be PVC insulated 650 Volt grade semi-flexible heat resistant, flame retardant and vermin proof electrolytic copper cable conforming to IEC : 227 or IS : 1554. The wiring shall be securely supported and taken through PVC troughs. All panel wiring shall be capable of withstanding a voltage of 2 KV AC 50 Hz for one minute.

Terminal blocks of brass studs rated for 10 amps continuous current, 650 volt DC grade covered by moulded insulating materials with adequate electrical clearance 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 the ends. The arrangement can be horizontal or vertical as per standard practice adopted by the manufacturer. All terminals must be numbered and wire terminations provided with numbered ferrules for identification. All numbering and marking including those in wiring diagrams shall follow the guidelines provided in IS : 11353. Ten percent spare terminals shall be provided.

A separate removable gland plate shall be provided at the bottom of each panel for entry of PVC insulated control and auxiliary power cables in the cabinet. At least five electroplated brass cable glands of approved sizes with shrouds shall be provided in the gland plate for these cables. Provision shall be made for earthing of the cable armours in the glands.

6.11.3 OFF LOAD TAP CHANGER (For 3.15 and 5 MVA transformers)

- i The transformers shall be provided with Off-load Taps.
- ii The Transformer with off-load tap changing gear shall have taps ranging from +5% to -10% in 7 equal steps of 2.5% each on HV winding for voltage variation.
- iii The tap changing switch shall be located in a convenient position so that it can be operated from ground level. The switch handle shall be provided with locking arrangement along with tap position indication, thus enabling the switch to be locked in position.

6.12

FITTINGS AND ACCESSORIES:-

The following fittings and accessories shall be provided on the transformers:

- i) Conservator with isolating valves, oil filling hole with cap and drain valve. The

conservator vessel shall be filled with constant oil pressure diaphragm oil sealing system.

- ii) Magnetic type oil level gauge (150 mm dia) with low oil level alarm contacts.
- iii) Prismatic/ toughened glass oil level gauge.
- iv) Silica gel breather with oil seal and connecting pipe complete with first fill of activated silica gel or Alumina mounted at a level of 1300 mm above ground level.
- v) A double float type Buchholz relay with isolating valve. Bleeding pipe and a testing cock, the test cock shall be suitable for a flexible (pipe connection for checking its operation). A 5mm dia. Copper pipe shall be connected from the relay test cock to a valve located at a suitable height above ground level to facilitate sampling of gas with the transformer in service. Interconnection between gas collection box and relay shall also be provided. The device shall be provided with two electrically independent ungrounded contacts, one for alarm on gas accumulation and the other for tripping on sudden oil surge. These contacts shall be wired upto transformer marshalling box. The relay shall be provided with shut off valve on the conservator side as well as on the tank side.
- vi) Pressure relief devices (including pressure relief valve) and necessary air equalizer connection between this and the conservator with necessary alarm and trip contacts.
- vii) Air release plugs in the top cover.
- viii) Inspection cover, access holes with bolted covers for access to inner ends of bushing etc.
- ix) Winding temperature (hot spot) indicating device for local mounting complete in all respects. Winding temperature indicator shall have three set of contacts to operate at different settings :
 - a) To provide winding temperature high alarm
 - b) To provide temperature too high trip
- x) Dial thermometer with pocket for oil temperature indicator with one set of alarm and one set of trip contacts and maximum reading pointer.
- xi) Lifting eyes or lugs for the top cover, core and coils and for the complete transformer.
- xii) Jacking pads
- xiii) Haulage lugs.

- xiv) Protected type mercury / alcohol in glass thermometer and a pocket to house the same.
- xv) Top and bottom filter valves on diagonally opposite ends with pad locking arrangement on both valves.
- xvi) Top and bottom sampling valves.
- xvii) Drain valve with pad locking arrangement
- xviii) Rating and connection diagram plate.
- xix) Two numbers tank earthing terminals with associated nuts and bolts for connections to purchaser's grounding strip.
- xx) Bi-directional flagged rollers with locking and bolting device.
- xxi) Marshalling Box (MB)
- xxii) Shut off valve on both sides of flexible pipe connections between radiator bank and transformer tank.
- xxiii) Cooling Accessories :
 - a) Requisite number of radiators provided with :-
 - One shut off valve on top
 - One shut off valve at bottom
 - Air release device on top
 - Drain and sampling device at bottom
 - Lifting lugs.
 - b) Air release device and oil drain plug on oil pipe connectors :
- xxiv) Terminal marking plates for Current Transformer and Main Transformer
- xxv) On- Load Tap Changer
- xxvi) Oil Preservation Equipment
- xxvii) Oil Temperature indicator

- Note :**
- (i) The fittings listed above are indicative and any other fittings which are generally required for satisfactory operation of the transformer are deemed to be included in the quoted price of the transformer.
 - (ii) The contacts of various devices required for alarm and trip shall be potential free and shall be adequately rated for continuous, making and

breaking current duties as specified.

- vi) The following fittings and accessories shall be provided on the transformers:
- i) Conservator with isolating valves, oil filling hole with cap and drain valve. The conservator vessel shall be filled with constant oil pressure diaphragm oil sealing system.
 - ii) Magnetic type oil level gauge (150 mm dia) with low oil level alarm contacts.
 - iii) Prismatic/ toughened glass oil level gauge.
 - iv) Silica gel breather with oil seal and connecting pipe complete with first fill of activated silica gel or Alumina mounted at a level of 1300 mm above ground level.
 - v) A double float type Buchholz relay with isolating valve. Bleeding pipe and a testing cock, the test cock shall be suitable for a flexible (pipe connection for checking its operation). A 5mm dia. Copper pipe shall be connected from the relay test cock to a valve located at a suitable height above ground level to facilitate sampling of gas with the transformer in service. Interconnection between gas collection box and relay shall also be provided. The device shall be provided with two electrically independent ungrounded contacts, one for alarm on gas accumulation and the other for tripping on sudden oil surge. These contacts shall be wired upto transformer marshalling box. The relay shall be provided with shut off valve on the conservator side as well as on the tank side.
 - vi) Pressure relief devices (including pressure relief valve) and necessary air equalizer connection between this and the conservator with necessary alarm and trip contacts.
 - vii) Air release plugs in the top cover.
 - viii) Inspection cover, access holes with bolted covers for access to inner ends of bushing etc.
 - ix) Winding temperature (hot spot) indicating device for local mounting complete in all respects. Winding temperature indicator shall have two set of contacts to operate at different settings :
 - a) To provide winding temperature high alarm
 - b) To provide temperature too high trip
 - x) Dial thermometer with pocket for oil temperature indicator with one set of alarm and one set of trip contacts and maximum reading pointer.

- xi) Lifting eyes or lugs for the top cover, core and coils and for the complete transformer.
- xii) Jacking pads
- xiii) Haulage lugs.
- xiv) Protected type mercury / alcohol in glass thermometer and a pocket to house the same.
- xv) Top and bottom filter valves on diagonally opposite ends with pad locking arrangement on both valves.
- xvi) Top and bottom sampling valves.
- xvii) Drain valve with pad locking arrangement
- xviii) Rating and connection diagram plate.
- xix) Two numbers tank earthing terminals with associated nuts and bolts for connections to grounding strip of the S/s.
- xx) Bi-directional flagged rollers with locking and bolting device.
- xxi) Marshalling Box (MB)
- xxii) Shut off valve on both sides of flexible pipe connections between radiator bank and transformer tank.
- xxiii) Cooling Accessories:
 - a) Requisite number of radiators provided with :-
 - One shut off valve on top
 - One shut off valve at bottom
 - Air release device on top
 - Drain and sampling device at bottom
 - Lifting lugs.
 - b) Air release device and oil drain plug on oil pipe connectors :
- xxiv) Terminal marking plates for Current Transformer and Main Transformer
- xxv) On-Load Tap Changing Gear with all necessary equipments and control mechanism for both local and remote operation
- xxvi) Oil Preservation Equipment
- xxvii) Oil Temperature indicator

Note : (i) The fittings listed above are indicative and any other fittings which are generally required for satisfactory operation of the transformer including tap-changing by On-Load Tap changing Gear are deemed to be included in the quoted price of the transformer.

(ii) The contacts of various devices required for alarm and trip shall be potential free and shall be adequately rated for continuous, making and breaking current duties as specified.

6.13 CONTROL CONNECTIONS AND INSTRUMENT AND WIRING TERMINAL BOARD AND FUSES:-

- i) Normally no fuses shall be used anywhere instead of fuses MCB's (both in AC & DC circuits) shall be used. Only in cases where a MCB cannot replace a fuse due to system requirements, a HRC fuse can be accepted.
- ii) All wiring connections, terminal boards, fuses MCB's and links shall be suitable for tropical atmosphere. Any wiring liable to be in contact with oil shall have oil resisting insulation and the bare ends of stranded wire shall be sweated together to prevent seepage of oil along the wire.
- iii) Panel connections shall be neatly and squarely fixed to the panel. All instruments and panel wiring shall be run in PVC or non-rusting metal cleats of the compression type. All wiring to a panel shall be taken from suitable terminal boards.
- iv) Where conduits are used, the runs shall be laid with suitable falls, and the lowest parts of the run shall be external to the boxes. All conduit runs shall be adequately drained and ventilated. Conduits shall not be run at or below ground level.
- v) When 400 volt connections are taken through junction boxes or marshalling boxes, they shall be adequately screened and 400 volts Danger Notice must be affixed to the outside of the junction boxes or marshalling box. Proper colour code for Red, Yellow, Blue wires shall be followed.
- vi) All box wiring shall be in accordance with relevant ISS. All wiring shall be of stranded copper (48 strands) of 1100 Volt grade and size not less than 2.5 sq.mm
- vii) All wires on panels and all multi-core cables shall have ferrules, for easy identifications, which bear the same number at both ends, as indicated in the relevant drawing.
- viii) At those points of interconnection between the wiring carried out by

separate contractors, where a change of number cannot be avoided double ferrules shall be provided on each wire. The change of numbering shall be shown on the appropriate diagram of the equipment.

- ix) The same ferrule number shall not be used on wires in different circuits on the same panels.
- x) Ferrules shall be of white insulating material and shall be provided with glossy finish to prevent the adhesion of dirt. They shall be clearly and durably marked in black and shall not be affected by dampness or oil.
- xi) Stranded wires shall be terminated with tinned Ross Courtney terminals, claw washers or crimped tubular lugs. Separate washers shall be suited to the size of the wire terminated. Wiring shall, in general, be accommodated on the sides of the box and the wires for each circuit shall be separately grouped. Back of panel wiring shall be arranged so that access to the connecting items of relays and other apparatus is not impeded.
- xii) All circuits, in which the voltage exceeds 125 volts, shall be kept physically separated from the remaining wiring. The function of each circuit shall be marked on the associated terminal boards.
- xiii) Where apparatus is mounted on panels, all metal cases shall be separately earthed by means of stranded (48 No.) copper wire of strip having a cross section of not less than 2 sq. mm where strip is used, the joints shall be sweated. The copper wire shall have green colour insulation for earth connections.
- xiv) All wiring diagram for control and relay panel shall preferably be drawn as viewed from the back and shall show the terminal boards arranged as in services.
- xv) Terminal block rows should be spaced adequately not less than 100 mm apart to permit convenient access to external cables and terminations.
- xvi) Terminal blocks shall be placed with respect to the cable gland (at a minimum distance of 200 mm) as to permit satisfactory arrangement of multicore cable tails .
- xvii) Terminal blocks shall have pairs of terminals for incoming and outgoing wires. Insulating barriers shall be provided between adjacent connections. The height of the barriers and the spacing between terminals shall be such as to give adequate protection while allowing easy access to terminals. The terminals shall be adequately protected with insulating dust proof covers. No live metal shall be exposed at the back of the terminal

boards. CT terminals shall have shorting facilities. The terminals for CTs should have provision to insert banana plugs and with isolating links.

- xviii) All interconnecting wiring, as per the final approved scheme between accessories of transformer and marshalling box is included in the scope of this specification and shall be done by the Transformer supplier.
- xix) The schematic diagram shall be drawn and fixed under a transparent prospane sheet on the inner side of the marshalling box cover.
- xx) To avoid condensation in the Marshalling Box, a space heater shall be provided with an MCB and thermostat.
- xxi) Suitable MV, CFL light shall be provided in the Marshalling Box for lightning purpose.

6.14 RADIO INTERFERENCE AND NOISE LEVEL:-

Transformers shall be designed with particular care to suppress at least the third and fifth harmonic voltages so as to minimise interference with communication circuits. Transformer noise level when energised at normal voltage and frequency shall be as per NEMA stipulations.

7.0 INSPECTION AND TESTING

- (i) The Contractor shall carry out a comprehensive inspection and testing programme during manufacture of the transformer. An indicative in inspection is given under Clause No. 4.1. This is, however, not intended to form a comprehensive programme as it is contractor's responsibility to draw up and carry out such a programme duly approved by the OPTCL.
- (ii) The contractor shall carry out type tests and routine tests on the transformers.
- (iii) Only one no of transformer of each rating will be subjected to type tests as per relevant IEC/IS in CPRI presence of authorized engineer(s) of OPTCL. The charges for conducting each of type tests shall be included in the bid price and no separate type test charges shall be paid.
- (iv) The pre-shipment checks shall also be carried out by the contractor.
- (v) The requirements on site tests are as listed in the specifications.
- (vi) Certified test report and oscillograms shall be furnished to the OPTCL for evaluation as per the schedule of distribution of documents. The Contractor shall also evaluate the test results and rectify the defects in the equipment based on his and the OPTCL's evaluations of the tests without any extra charges to OPTCL. Manufacturer's Test Certificates in respect of all associated auxiliary and ancillary equipment shall be furnished.

- (vii) The bidder shall state in his proposal the testing facilities available at his works. In case full testing facilities are not available, the bidder shall state the method proposed to be adopted so as to ascertain the transformer characteristics corresponding to full capacity.
- (viii) OPTCL at its discretion may use its power analyser or the power analyser of authorized testing agency for determination of no load loss, no load current, load loss and % Impedance at the works of the manufacturer and the concerned stores/Testing Laboratory of OPTCL/Any other Government approved laboratory.

7.1 INSPECTION

i) Tank and Conservator

- a) Inspection of major weld.
- b) Crack detection of major strength weld seams by dye penetration test.
- c) Check correct dimensions between wheels, demonstrate turning of wheels, through 900 and further dimensional check.
- d) Leakage test of the conservator.

ii) Core

- a) Sample testing of core materials for checking specific loss, properties, magnetization characteristics and thickness.
- b) Check on the quality of varnish if used on the stampings.
- c) Check on the amount of burrs.
- d) Visual and dimensional check during assembly stage.
- e) Check on completed core for measurement of iron loss, determination of maximum flux density. (Determination of gross and net cross sectional area of the core & no. of turns/Phase.)
- f) Visual and dimensional checks for straightness and roundness of core, thickness of limbs and suitability of clamps.
- g) High voltage DC test (2 KV for one minute) between core and clamps.

iii) Insulating Material

- a) Sample check for physical properties of materials.
- b) Check for dielectric strength
- c) Check for the reaction of hot oil on insulating materials.

iv) Winding

- a) Sample check on winding conductor for mechanical and electrical conductivity.

- b) Visual and dimensional checks on conductor for scratches, dent mark etc.
- c) Sample check on insulating paper for PH value, electric strength.
- d) Check for the bonding of the insulating paper with conductor.
- e) Check and ensure that physical condition of all materials taken for windings is satisfactory and free of dust.
- f) Check for absence of short circuit between parallel strands.

v) **Checks Before Drying Process**

- a) Check condition of insulation on the conductor and between the windings.
- b) Check insulation distance between high voltage connections, between high voltage connection cables and earth and other live parts.
- c) Check insulating distances between low voltage connections and earth and other parts.
- d) Insulating test for core earthing.

vi) **Check During Drying Process**

- a) Measurement and recording of temperature and drying time during vacuum treatment.
- b) Check for completeness of drying

vii) **Assembled Transformer**

- a) Check completed transformer against approved outline drawing, provision for all fittings, finish level etc.
- b) Jacking test on the assembled Transformer.

viii) **Oil**

All standard tests in accordance with IS: 335 shall be carried out on Transformer oil sample before filling in the transformer.

ix) **Test Report for bought out items**

The contractor shall submit the test reports for all bought out / sub contracted items for approval.

- a) Buchholz relay
- b) Sudden pressure rise relay on Main Tank
- c) Winding temperature indicators (for TX capacity 5 MVA)
- d) Oil temperature indicators
- e) Bushings

- f) Bushing current transformers in neutral (If Provided)
- g) Marshalling box
- h) Off Load Tap changer for MVA Transformer
- i) Any other item required to complete the works.
- j) Porcelain, bushings, bushing current transformers, wherever provided, winding coolers, control devices, insulating oil and other associated equipment shall be tested by the contractor in accordance with relevant IS . If such requirement is purchased by the contractor on a sub-contract, he shall have them tested to comply with these requirements.

7.2 FACTORY TESTS

- i) All standards routine tests in accordance IS: 2026 with dielectric tests corresponding as per latest amendments to IS: 2026 shall be carried out.
- ii) All auxiliary equipment shall be tested as per the relevant IS. Test certificates shall be submitted for bought out items.
- iii) High voltage withstand test shall be performed on auxiliary equipment and wiring after complete assembly.
- iv) Following additional routine tests shall also be carried out on each transformer:
 - a) Magnetic Circuit Test
Each core shall be tested for 1 minute at 2000 Volt DC
 - b) Oil leakage test on transformer

7.2.1 Type Tests:-

The transformer shall be subjected to the following type tests particularly Short circuit and Impulse withstand tests at CPRI. Before conducting the short circuit test and Impulse test, the firm will offer for both stage inspection and final inspection of the transformer by OPTCL at the manufacturer's works. If the transformer complies to the specification and offered technical parameters, the transformer will be sealed by authorized engineer(s) of OPTCL and thereafter the transformer can be transported to CPRI for required type tests in presence of OPTCL's authorized representative(s) who will verify the seal & allow for conducting the type tests.

The Type Tests shall include:-

- (1) Tan delta measurement and capacitance of each winding to earth (with all other windings earthed) & between all windings connected together to

earth.

- (2) Measurement of Zero sequence impedance.
- (3) Temperature Rise Test
- (4) Short Circuit Test
- (5) Tank Vacuum test
- (6) Tank Pressure Test
- (7) Lightning impulse withstand test for line and neutral terminal.
- (8) Measurement of acoustic noise level.

7.2.2 STAGE INSPECTION:-

The supplier shall offer the core, windings and tank of each transformer for inspection by the OPTCL's 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 OPTCL. No. of turns is to be determined by wrapping known No. of turns across LV winding and determining the turns ratio by ratio meter.

7.2.3 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) Voltage ratio on each tapping and check of voltage vector relationship.
- (iii) Impedance voltage at all tapings.
- (iv) Magnetic circuit test as per relevant ISS or CBIP manual or latest standard being followed.
- (v) Measurement of Load losses at normal tap and extreme taps.
- (vi) No load losses and no load current at rated voltage and rated frequency, also at 25% to 121 % of rated voltage in steps.

- (vii) Absorption index i.e insulation resistance for 15 seconds and 60 seconds (R_{60} / R_{15}) and 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) Tan delta measurement and capacitance of each winding to earth (with all other windings earthed) & between all windings connected together to earth.
- (xi) Measurement of zero sequence impedance
- (xii) Tests on On- Load tap changer (fully assembled on transformer) as per IEC : 214/ 1976 and BS: 4571/ 1970.
- (xii) Auxiliary circuit tests
- (xiv) Oil BDV tests
- (xv) Measurement of neutral unbalance current which shall not exceed 2% of the full rated current of the transformer.
- (xvi) Magnetic balance test
- (xvii) Leakage test.

Six (6) set of certified test reports and oscillographs shall be submitted for evaluation prior to dispatch of the equipment. The contractor shall also evaluate the test results and shall correct any defect indicated by his and OPTCL's evaluation of the tests without charge to the OPTCL.

7.2.4 TANK TESTS

a) Oil leakage Test :

The tank and oil filled compartments shall be tested for oil tightness completely filled with air or oil of viscosity not greater than that of insulating oil conforming to IS : 335 at the ambient temperature and applying a pressure equal to the normal pressure plus 35 KN/ m² measured at the base of the tank. The pressure shall be maintained for a period of not less than 12 hours of oil and one hour for air and during that time no leak shall occur.

b) Pressure Test

Where required by the OPTCL, one transformer tank of each size together with its radiator, conservator vessel and other fittings shall be subjected to a pressure corresponding to twice the normal head of oil or to the normal

pressure plus 35 KN / m² whichever is lower, measured at the base of the tank and maintained for one hour.

c) Vacuum Test

One transformer tank of each size shall be subjected to the vacuum pressure of 60 mm of mercury. The tanks designed for full vacuum shall be tested at an internal pressure of 3.33 KN/m² (25 mm of mercury) for one hour. The permanent deflection of flat plates after the vacuum has been released shall not exceed the value specified in C.B.I.P. Manual on Transformers (Revised 1999) without affecting the performance of the transformer.

7.2.5 PRE-SHIPMENT CHECK AT MANUFACTURERS WORKS

- i) Check for proper packing and preservation of accessories like radiators, bushings, explosions vent, dehydrating breather, rollers, buchholz relay, control cubicle connecting pipes and conservator etc.
- ii) Check for proper provision of bracing to arrest the movement of core and winding assembly inside the tank.
- iii) Gas tightness test to conform tightness.

7.2.6 INSPECTION AND TESTING AT SITE

The Engineer authorized from OPTCL along with the contractor's site engineer shall carry out detailed inspection covering areas right from the receipt of material up to commissioning stage. An indicative program of inspection as envisaged by the Engineer is given below.

7.2.7 Receipt and Storage Checks

- i) Check and record conditions of each package visible parts of the transformers etc for any damage.
- ii) Visual check of core and coils before filling up with oil and also check condition of core and winding in general.

7.2.8 Installation Checks

- i) Inspection and performance testing of accessories like tap changers etc.
- ii) Check choking of the tubes of radiators
- iii) Test on oil samples taken from main tank top and bottom and cooling system. Samples should be taken only after the oil has been allowed to settle for 24 hours.

- iv) Check the whole assembly for tightness, general appearance etc.
- v) Oil leakage tests.

7.2.9 Pre-Commissioning Tests

After the transformer is installed, the following pre-commissioning tests and checks shall be done before putting the transformer in service.

- i) Dry out test
- ii) Megger Test
- iii) DC Resistance measurement of windings
- iv) Ratio test on all taps
- v) Phase relationship test (Vector grouping test)
- vi) Buchholz relay alarm & surge operation test
- vii) Low oil level (in conservator) alarm
- viii) Temperature Indicators
- ix) Marshalling kiosk
- x) Protective relays
- xi) Magnetising current
- xii) Tests on OLTC

7.2.10 The following additional checks shall be made :

- i) All oil valves are in correct position closed or opened as required
- ii) All air pocket are cleared.
- iii) Thermometer pockets are filled with oil.
- iv) Oil is at correct level in the bushing, conservator, diverter switch & tank etc.
- v) Earthing connections are made.
- vi) Colour of Silica gel is blue.
- vii) Bushing arcing horn is set correctly and gap distance is recorded.
- Viii) C T polarity and ratio is correct.

8.0 PERFORMANCE

The performance of the transformer shall be measured on the following aspects.

- i) The transformer shall be capable of being operated without danger on any tapping at the rated KVA with voltage variations and $\pm 10\%$ corresponding to the voltage of the tapping
- ii) Radio interference and Noise Level
- iii) The transformer shall be designed with particular attention to the suppression of third and fifth harmonics so as to minimize interference with communication circuits.

8.1 FAULT CONDITIONS

- a) The transformer shall be capable of withstanding for two(2) seconds without damages any external short circuit to earth
- b) Transformer shall be capable of withstanding thermal and mechanical stresses conveyed by symmetrical or asymmetrical faults on any winding. This shall be demonstrated through calculation as per IS : 2026.
- c) Transformer shall accept, without injurious heating, combined voltage and frequency fluctuation which produce the 125% over fluxing condition for one minute and 140% for 5 seconds.

Certified test report and oscillograms shall be furnished to the OPTCL for evaluation as per the schedule of distribution of documents. The Contractor shall also evaluate the test results and rectify the defects in the equipment based on his and the OPTCL's evaluations of the tests without any extra charges to the OPTCL. Manufacturer's Test Certificates in respect of all associated auxiliary and ancillary equipment shall be furnished.

The bidder shall state in his proposal the testing facilities available at his works. In case full testing facilities are not available, the bidder shall state the method proposed to be adopted so as to ascertain the transformer characteristics corresponding to full capacity testing.

9.0 LOSSES:-

Sl.No	Transformer Rating	Maximum No-Load Loss in KW at rated voltage & frequency	Maximum Load Loss in KW at 75 ⁰ C at normal tap position & rated frequency
1	33/11 KV, 3.15 MVA	3.0	17

2	33/11 KV, 5 MVA	3.6	21
3	33/11 KV, 8 MVA	4.5	38
	TOTAL		66

N.B : There shall be no positive tolerance to above losses. Capitalization of losses shall not be factored in the comparative statement for selection of vendors.

10.0 SPARE PARTS:-

- 10.1 In case the manufacturer goes out of production of spare parts, then he shall make available the drawings of spare parts and specification of materials at no extra cost to the OPTCL to fabricate or procure spare parts from other sources.

Mandatory 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

11.0 INSTRUCTION MANUAL:-

- 11.1 Eight sets of the instruction manuals shall be supplied at least four (4) weeks before the actual dispatch of equipment. The manuals shall be in bound volumes and shall contain all the drawings and information required for erection, operation and maintenance of the transformer. The manuals shall include amongst other, the following particular:

Marked erection prints identifying the components, parts of the transformer as dispatched with assembly drawings.

- a) Detailed dimensions, assembly and description of all auxiliaries.
- b) Detailed views of the core and winding assembly, winding connections and tapings tap changer construction etc. These drawings are required for carrying out overhauling operation at site.
- c) Salient technical particulars of the transformer.
- d) Copies of all final approved drawings.
- e) Detailed O&M instructions with periodical check lists and Performa etc.

11.2 COMPLETENESS OF EQUIPMENT:-

All fittings and accessories, which may not be specifically mentioned in the specification but which are necessary for the satisfactory operation of the

transformer, shall be deemed to be included in the specification and shall be furnished by the supplier without any extra charge. The equipment shall be complete in all details whether such details are mentioned in the specification or not, without any financial liability to the OPTCL under any circumstances.

11.3 TOOLS AND TACKLES:-

All the necessary tools and tackles required for normal operation & maintenance of the transformers shall be supplied by the Contractor.

12.0 COMMISSIONING:-

The equipments shall be commissioned as per CBIP manual, IS: 10028 and manufacturer's recommendations. All the related drawings and manuals shall be pre-requisite for release of final payment.

13.0 General Technical Particulars is furnished at Chapter E14 of the Technical Specification.

TECHNICAL SPECIFICATION

FOR

SUPPLY OF 100KVA, 33/0.433kV STATION

TRANSFORMER (BEE STANDARD)

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OF
100KVA, 33/0.433kV STATION TRANSFORMER

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TECHNICAL SPECIFICATION FOR OUTDOOR TYPE 100 KVA, 33/.433KV STATION TRANSFORMER

1.0 SCOPE:

1.1 This specification covers design, engineering, manufacture, assembly, stage testing, inspection and testing before supply and delivery at site of oil immersed, naturally cooled 3 phase **100 KVA, 33kV/0.433KV** Station Transformer for Outdoor use.

1.2 It is not the intent to specify completely herein all the details of the design and construction of equipment. However, the equipment shall conform in all respects to high standards of engineering, design and workmanship and shall be capable of performing in continuous commercial operation, in a manner acceptable to the owner, who will interpret the meanings of drawings and specification and shall have the power to reject any work or material which, in his judgment is not in accordance therewith. The offered equipment shall be complete with all components necessary for their effective and trouble free operation. Such components shall be deemed to be within the scope of bidder's supply irrespective of whether those are specifically brought out in this specification and / or the commercial order or not.

1.3 The transformer and accessories shall be designed to facilitate operation, inspection, maintenance and repairs. The design shall incorporate every precaution and provision for the safety of equipment as well as staff engaged in operation and maintenance of equipment.

1.4 All outdoor apparatus, including bushing insulators with their mountings, shall be designed so as to avoid any accumulation of water.

2.0 STANDARD RATINGS:

2.1. **100 KVA, 33/0.433 kV** Station Transformers.

3.0 STANDARDS:

3.1 The materials shall conform in all respects to the relevant Indian / International Standards, with latest amendments thereof unless otherwise specified herein. Some of them are listed below:

Indian Standard	Title	International and Internationally recognized standards
IS - 2026	Specification for Power Transformers	IEC 76
IS - 12444	Specification for Copper wire rod	ASTM B - 49
IS - 335	Specification for Transformer Oil	BS 148, D - 1473, D - 1533-1934 IEC Pub 296
IS - 5	Specification for colors for ready mixed paints	
IS - 104	Ready mixed paint, brushing zinc chromate, priming	
IS - 2099	Specification for high voltage porcelain bushing	
IS - 649	Testing for steel sheets and strips and magnetic circuits	
IS - 4257	Dimensions for clamping arrangement for bushings	
IS - 7421	Specification for Low Voltage bushings	
IS - 3347	Specification for Outdoor Bushings	DIN 42531 to 33
IS - 5484	Specification for Al Wire rods	ASTM B - 233
IS - 9335	Specification for Insulating Kraft Paper	IEC 554
IS - 1576	Specification for Insulating Press Board	IEC 641
IS - 6600	Guide for loading of oil Immersed Transformers	IEC 76
IS – 2362	Determination of water content in oil for porcelain bushing of transformer	
IS – 6160	Rectangular Electrical conductor for electrical machines	
IS - 5561	Electrical power connector	
IS – 6103	Testing of specific resistance of electrical insulating liquids	
IS – 6262	Method of test for power factor and dielectric constant of electrical insulating liquids	
IS – 6792	Determination of electrical strength of insulating oil	
IS - 10028	Installation and maintenance of transformers	

3.2 Material conforming to other internationally accepted standards, which ensure equal or better quality than the standards mentioned above, would also be acceptable. In case the bidders who wish to offer material conforming to other standards, the bidders shall clearly bring out the salient points of difference between the standards adopted and the specific standards in relevant schedule. Four copies of such standards with authentic English translations shall be furnished along with the offer.

4.0 CLIMATIC CONDITIONS:

Please refer **Chapter E3** of Technical Specification on climatic conditions.

NOTE:-

The equipment shall generally be for use in moderately hot and humid tropical climate, conducive to rust and fungus growth .

5.0 PRICIPAL PARAMETERS:

- 5.1 The transformers shall be suitable for Outdoor installation with 3-phase, 50 Hz, 33kV system in which the neutral is effectively earthed and they should be suitable for service with **fluctuations in supply voltage up to $\pm 12.5\%$**
- 5.2 The transformers shall conform to the following specific parameters:

Sl. No.	Item	33 kV Station Transformers
1	System voltage (max)	36 kV
2	Rated voltage HV	33 kV
3	Rated voltage LV	0.433KV
4	Frequency	50Hz $\pm 5\%$
5	No. of Phases	Three
6	Connection HV	Delta
7	Connection LV	Star (Neutral Brought out)
8	Vector group	Dyn – 11
9	Type of cooling	ONAN

Audible sound levels (decibels) at rated voltage and frequency for liquid immersed transformers shall be as below (NEMA Standards):

kVA rating	Audible sound levels (decibels)
100 KVA	51

6.0 TECHNICAL REQUIREMENTS:

6.1 CORE MATERIAL – CRGO

- 6.1.1 The core shall be stack / wound type of high grade cold rolled grain oriented annealed steel lamination having low loss and good grain properties, coated with hot oil proof insulation, bolted together and to the frames firmly to prevent vibration or noise. The core shall be stress relieved by annealing under inert atmosphere if required. The complete design of core must ensure permanency of the core loss with continuous working of the transformers. The values of the maximum flux density allowed in the design and grade of lamination used shall be clearly stated in the offer
- 6.1.2 The bidder should offer the core for inspection and approval by the Owner during manufacturing stage.
- 6.1.3 The transformers core shall be suitable for over fluxing (due to combined effect of voltage and frequency) up to 12.5% without injurious heating at full load conditions and shall not get saturated. The bidder shall **furnish necessary design data** in support of this situation.
- 6.1.4 **No-load current shall not exceed 3% of full load current and will be measured by energizing the transformer at 433 volts, 50 Hz on the secondary. Increase of voltage of 433 volts by 12.5% shall not increase the no-load current by 6% (maximum) of full load current.**
- 6.1.5 **Flux density within the core should not exceed 1.6 web/sq meter at rated voltage & rated frequency.**

7.0 WINDINGS:

7.1 Material:

- 7.1.1 HV and LV windings shall be wound from Supper Enamel covered / Double Paper covered copper conductor .
- 7.1.2 LV winding shall be such that neutral formation will be at top.
- 7.1.3 The winding construction of single HV coil wound over LV coil is preferable.
- 7.1.4 Inter layer insulation shall be Nomex / Epoxy dotted Kraft Paper.
- 7.1.5 Proper bounding of inter layer insulation with the conductor shall be ensured. Test for bounding strength shall be conducted.
- 7.1.6 Dimensions of winding coils are very critical. Dimensional tolerances for winding coils shall be within limits as specified in Guaranteed technical .
- 7.1.7 Current density for HV and LV winding should not be more than 2.8 Ampere per sq mm at rated current & normal tap.
- 7.1.8 The core / coil assembly shall be securely held in position to avoid any movement under short circuit conditions.
- 7.1.9 Joints in the winding shall be avoided. However, if jointing is necessary the joints shall be properly brazed and the resistance of the joints shall be less than that of parent conductor. In case of foil windings, welding of leads to foil can be done within the winding.

8.0 TAPS:

- 8.1 **Tappings shall be provided, on the higher voltage winding for variation of Low voltage within range of (-) 5.0 % to (+) 7.5% in steps of 2.5%.**
- 8.2 Tap changing shall be carried out by means of an **externally operated self position switch and when the transformer is in de-energised condition.** Switch position No. 1 shall correspond to the maximum plus tapping. Each tap change shall result in variation of 2.5% in voltage. Provision shall be made for locking the tapping switch handle in position. Suitable aluminium anodized plate shall be fixed for tap changing switch to know the position number of tap.

9.0 OIL:

- 9.1 The insulating oil shall comply with the requirements of IS335 or BS 148. **Use of recycled oil is not acceptable.** The specific resistance of the oil shall not be less than 2.5×10^{12} ohm-cm at 27°C when tested as per IS 6103.
- 9.2 Oil shall be filtered and tested for break down voltage (BDV) and moisture content before filling.
- 9.3 The oil shall be filled under vacuum.
- 9.4 The design and all materials processes used in the manufacture of the transformer, shall be such as to reduce the total risk of the development of acidity in the oil.

10.0 INSULATION LEVELS:

Sl. No.	Voltage (kV)	Impulse Voltage (kV Peak)	Power Frequency Voltage (kV)
1	0.433	-	3
2	33	170	70

11.0 LOSSES:

11.1 The bidder shall guarantee individually the **no-load loss and load loss without any positive tolerance**. The bidder shall also guarantee the total losses at 50% and 100% load condition (at rated voltage and frequency and at 75°C).

11.2 The following maximum allowable losses at rated voltage and frequency and at 75°C shall be taken:

Voltage Rating	Rating (kVA)	Max. Losses at 50% loading (Watts)	Max. Losses at 100% loading (Watts)
33000/433 - 250 V	100	560	1820

Bids with higher losses than the above specified values would be treated as non-responsive. However, the manufacturer can offer losses less than above.

12.0 TOLERANCES:

12.1 **No positive tolerance** shall be allowed on the maximum losses displayed on the label for both 50% and 100% loading values.

13.0 PERCENTAGE IMPEDANCE:

13.1 The value of percentage impedance of transformer at 75 °C at normal tap shall be **5.0% (Minimum)**. **No negative tolerances is allowed.**

14.0 TEMPERATURE RISE

The temperature rise over ambient shall not exceed the limits given below:

14.1 Top Oil temperature rise measured by Tthermometer : 35 °C

14.2 Winding temperature rise measured by resistance method : 40 °C

NOTE : Bids not meeting the above limits of temperature rise will be treated as non-responsive.

14.3 The transformer shall be capable of giving continuous rated output without exceeding the specified temperature rise. Bidder shall submit the calculation sheet in this regard.

15.0 PENALTY FOR NON PERFORMANCE:

- 15.1 During testing at supplier's works **if it is found that the actual measured losses are more than the values quoted by the bidder, the purchaser shall reject the transformer and he shall also have the right to reject the complete lot.**
- 15.2 Purchaser shall **reject the entire lot during the test at supplier's works, if the temperature rise exceeds the specified values.**
- 15.3 Purchaser shall reject any transformer during the test at supplier's works, **if the impedance values differ from the guaranteed values including tolerance.**

16.0 INSULATION MATERIAL:

- i) Electrical grade insulation epoxy dotted Kraft Paper / Nomex and pressboard of standard make or any other superior material subject to approval of the purchaser shall be used.
- ii) All spacers, axial wedges / runners used in windings shall be made of pre-compressed Pressboard-solid, conforming to type B 3.1 of IEC 641-3-2. In case of cross-over coil winding of HV all spacers shall be properly sheared and dovetail punched to ensure proper locking. All axial wedges / runners shall be properly milled to dovetail shape so that they pass through the designed spacers freely. Insulation shearing, cutting, milling and punching operations shall be carried out in such a way, that there should not be any burr and dimensional variations

17.0 TANK

- 17.1 The internal clearance of tank shall be such, that it shall facilitate easy lifting of core with coils from the tank without dismantling LV bushings.
- 17.2 All joints of tank and fittings shall be oil tight and no bulging should occur during service.
- 17.3 Inside of tank shall be painted with varnish / hot oil resistant paint.
- 17.4 The top cover of the tank shall be slightly sloping to drain rain water.
- 17.5 The tank plate and the lifting lugs shall be of such strength that the complete transformer filled with oil may be lifted by means of lifting shackle.
- 17.6 Manufacturer should carry out all welding operations as per the relevant ASME standards and submit a copy of the welding procedure and welder performance qualification certificates to the customer.

17.0.A PLAIN TANK:

- a) The transformer tank shall be of robust construction rectangular / octagonal / round / elliptical in shape and shall be built up of electrically tested welded mild steel plates of thickness of 6 mm for the bottom & top and not less than 4 mm for the sides . Tolerances as per IS 1852 shall be applicable.
- b) In case of rectangular tanks the corners shall be fully welded at the corners from inside and outside of the tank to withstand a pressure of 0.8 kg/cm² for 30 minutes.

- c) Under operating conditions the pressure generated inside the tank should not exceed 0.4 kg/sq.cm positive or negative.
- d) The tank shall be reinforced by welded flats on all the outside walls on the edge of the tank.
- e) Permanent deflection: The permanent deflection, when the tank without oil is subjected to a vacuum of 525 mm of mercury for rectangular tank and 760 mm of mercury for round tank, shall not be more than the values as given below:

Horizontal length of flat plate in mm	Permanent deflection in mm
Upto and including 750	5.0
751 to 1250	6.5
1251 to 1750	8.0
1751 to 2000	9.5
2001 to 2250	11.0
2251 to 2500	12.0
2501 to 3000	16.0
Above 3000	19.0

- f) **The tank shall further be capable of withstanding a pressure of 0.8 kg/sq.cm (g) and a vacuum of 0.7 kg/sq.cm (g) without any deformation.**
- g) The radiators can be tube or fin type or pressed steel type to achieve the desired cooling to limit specified temperature rise.

18.0 CONSERVATOR:

- 18.1 The Conservator shall be provided on Transformers for plain tank .
- 18.2 When a conservator is provided, oil gauge and the plain or dehydrating breathing device shall be fitted to the conservator which shall also be provided with a drain plug and a filling hole [32 mm (1¼")] normal size thread with cover.
- 18.3 The dehydrating agent shall be silica gel. The moisture absorption shall be indicated by a change in the colour of the silica gel crystals which should be easily visible from a distance. Volume of breather shall be suitable for 1kg of Silica gel conforming to IS 3410 .
- 18.4 The capacity of a Conservator tank shall be designed keeping in view the total quantity of oil and its contraction and expansion due to temperature variation. The total volume of conservator shall be such as to contain 10% quantity of the oil. Normally 3% quantity the oil shall be contained in the conservator.
- 18.5 The cover of main tank shall be provided with an air release plug to enable air trapped within to be released, unless the conservator is so located as to eliminate the possibility of air being trapped within the main tank.
- 18.6 The inside diameter of the pipe connecting the conservator to the main tank should be within 20 to 50 mm and it should be projected into the conservator so that its end is approximately 20 mm above the bottom of the conservator so as to create a sump for collection of impurities. The minimum oil level (corresponding to 0°C) should be above the sump level.

19.0 SURFACE PREPARATION AND PAINTING:

19.1 GENERAL

19.1.1 All paints, when applied in a normal full coat, shall be free from runs, sags, wrinkles, patchiness, brush marks or other defects.

19.1.2 All primers shall be well marked into the surface, particularly in areas where painting is evident and the first priming coat shall be applied as soon as possible after cleaning. The paint shall be applied by airless spray according to manufacturer's recommendations. However, where ever airless spray is no possible, conventional spray be used with prior approval of purchaser.

19.2 CLEANING AND SURFACE PREPARATION:

19.2.1 After all machining, forming and welding has been completed, all steel work surfaces shall be thoroughly cleaned of rust, scale, welding slag or spatter and other contamination prior to any painting.

19.2.2 Steel surfaces shall be prepared by shot blast cleaning (IS9954) to grade Sq. 2.5 of ISO 8501-1 or chemical cleaning including phosphating of the appropriate quality (IS 3618).

19.2.3 Chipping scraping and steel wire brushing using manual or power driven tools cannot remove firmly adherent mill-scale. These methods shall only be used where blast cleaning is impractical. Manufacturer to clearly explain such areas in his technical offer.

19.3 PROTECTIVE COATING:

19.3.1 As soon as all items have been cleaned and within four hours of the subsequent drying, they shall be given suitable anti-corrosion protection.

19.4 PAINT MATERIAL:

19.4.1 Following are the types of paint which may be suitably used for the items to be painted at shop and supply of matching paint to site :Heat resistant paint (Hot oil proof) for inside surface.

19.4.2 For external surfaces one coat of thermo setting powder paint or one coat of epoxy primer followed by two coats of synthetic enamel / polyurethane base paint. These paints can be either air drying or stoving.

19.4.3 Also paint as above with one coat of high build Micaceous iron oxide (MIO) as an intermediate coat may be used.

19.5 PAINTING PROCEDURE:

19.5.1 All prepared steel surfaces should be primed before visible re-rusting occurs or within 4 hours, whichever is sooner. Chemical treated steel surfaces shall be primed as soon as the surface is dry and while the surface is still warm.

19.5.2 Where the quality of film is impaired by excess film thickness (wrinkling, mud cracking or general softness) the supplier shall remove the unsatisfactory paint coating and apply another coating. As a general rule, dry film thickness should not exceed the specified minimum dry film thickness by more than 25%.

19.6 DAMAGED PAINTWORK:

19.6.1 Any damage occurring to any part of a painting scheme shall be made good to the same standard of corrosion protection and appearance as that was originally applied.

19.6.2 Any damaged paint work shall be made good as follows:

- A. The damaged area, together with an area extending 25 mm around its boundary, shall be cleaned down to bare metal.
- B. A priming coat shall be immediately applied, followed by a full paint finish equal to that originally applied and extending 50 mm around the perimeter of the original damage.
- C. The repainted surface shall present a smooth surface. This shall be obtained by carefully chamfering the paint edges before and after priming .

19.7 DRY FILM THICKNESS:

19.7.1 To the maximum extent practicable the coats shall be applied as a continuous film of uniform thickness and free of pores. Over spray, skips, runs, sags and drips should be avoided. The different coats may or may not be of the same colour.

19.7.2 Each coat of paint shall be allowed to harden before the next is applied as per manufacturer's recommendation.

19.7.3 Particular attention must be paid to full film thickness at the edges.

19.7.4 The requirements for the dry film thickness (DFT) of paint and the materials to be used shall be as given below:

Sl.No.	Paint type	Area to be painted	No. of coats	Total dry film thickness (min.) (microns)
1.	Thermo setting powder Paint	Inside	01	30
		outside	01	60
2.	Liquid paint	Outside	01	30
	i.Epoxy (primer)			
	ii P.U. Paint (Finish coat)	outside	02	25 each
	iii Hot oil paint / Varnish	inside	01	35/10

19.8 TESTS FOR PAINTED SURFACE:

19.8.1 The painted surface shall be tested for paint thickness.

19.8.2 The painted surface shall pass the cross hatch adhesion test and impact test as acceptance tests and Salt spray test and Hardness test as type test as per the relevant ASTM standards.

Note: Supplier shall guarantee the painting performance requirement for a period of not less than 5 years.

20.0 BUSHINGS:

20.1 The bushings shall conform to the relevant standards specified and shall be of Outdoor type. The bushing rods and nuts shall be made of brass material 12 mm diameter for both HT and LT bushings. The tests as per latest IS 2099 and IS 7421 shall be conducted on the Transformer bushings.

20.2 For 33 kV, 33 kV class bushings; for 0.433 kV, 1.1 kV class bushings shall be used.

20.3 Bushing can be of porcelain /epoxy material. Polymer insulator bushings conforming with relevant IEC can also be used.

20.4 Bushing of plain shades as per IS 3347 shall be mounted on the side of the tank and not on top cover.

20.5 Dimensions of the bushings of the voltage class shall conform to the Standards specified and dimension of clamping arrangement shall be as per IS 4257.

20.6 Minimum external phase to phase and phase to earth clearances of bushing terminals shall be as follows:

Voltage	Clearance	
	Phase to Phase	Phase to earth
33 kV	350 mm	320 mm
LV	75 mm	40 mm

The clearances in case of Cable Box shall be as below:

Voltage	Clearance	
	Phase to Phase	Phase to earth
33 kV	351 mm	222 mm
LV	45 mm	20 mm

20.7 Arcing horns shall be provided on HV bushings.

20.8 Brazing of all inter connections, jumpers from winding to bushing shall have cross section larger than the winding conductor. All the Brazes shall be qualified as per ASME, section – IX.

20.9 The bushings shall be of reputed make supplied by those manufacturers who are having manufacturing and testing facilities for insulators.

- 20.10 The terminal arrangement shall not require a separate oil chamber not connected to oil in the main tank.

21.0 TERMINAL CONNECTORS:

The HV bushing stems shall be provided with suitable terminal connectors suitable as per IS 5082 so as to connect the jumper without disturbing the bushing stem. Connectors shall be with eye bolts so as to receive conductor for HV. Terminal connectors shall be type tested as per IS 5561. The terminal arrangement for 433volts side shall be such as to suit 3 ½ X300 mm² armoured PVC cable .

22.0 TERMINAL MARKINGS:

High voltage phase windings shall be marked both in the terminal boards inside the tank and one the outside with capital letter 1U, 1V, 1W and low voltage winding for the same phase marked by corresponding small letter 2u, 2v, 2w. The neutral point terminal shall be indicated by the letter 2n. Neutral is to be brought out and connected to local grounding terminal by an earthing strip.

23.0 FITTINGS:

The following standard fittings shall be provided:

- a. Rating and terminal marking plates, non-detachable.
- b. Earthing terminals with lugs – 2 Nos.
- c. Lifting lugs for main tank and top cover.
- d. Terminal connectors on the HV / LV bushings (For bare terminations only)
- e. Thermometer pocket with cap – 1 No.
- f. Air release device
- g. HV bushings – 3 Nos.,
- h. LV bushings – 4 Nos.
- i. Pulling lugs.
- j. Stiffener
- k. Radiators – No. and length may be mentioned
(as per heat dissipation calculations) / corrugations.
- l. Arcing horns on HT side 3 nos.
- m. Prismatic oil level gauge.
- n. Drain cum sampling valve.
- o. Top filter valve.
- p. Oil filling hole having p. 1- ¼” thread with plug and drain plug on the conservator.
- q. Silica gel breather.
- r. Base channel 100 mm x 50 mm, 460 mm long with holes to make them suitable for fixing on a platform or plinth.
- s. 4 Nos. rollers
- t. Pressure relief device or explosion vent.

24.0 FASTENERS:

All bolts, studs screw threads, pipe threads, bolt heads and nuts shall comply with the appropriate Indian Standards for metric threads, or the technical equivalent.

Bolts or studs shall not be less than 6 mm in diameter except when used for small wiring terminals.

All nuts and pins shall be adequately locked.

Wherever possible bolts shall be fitted in such a manner that in the event of failure of locking resulting in the nuts working loose and falling off, the bolt will remain in position.

All ferrous bolts, nuts and washers placed in outdoor positions shall be treated to prevent corrosion, by hot dip galvanizing, except high tensile steel bolts and spring washers which shall be electro-galvanized / plated. Appropriate precautions shall be taken to prevent electrolytic action between dissimilar metals.

Each bolt or stud shall project at least one thread but not more than three threads through the nut, except when otherwise approved for terminal board studs or relay stems. If bolts and nuts are placed so that they are accessible by means of ordinary spanners, special spanners shall be provided.

The length of the screwed portion of the bolts shall be such that no screw thread may form part of a shear plane between members.

Taper washers shall be provided where necessary.

Protective washers of suitable material shall be provided front and back of the securing screws.

25.0 OVERLOAD CAPACITY:

The transformers shall be suitable for loading as per IS 6600.

26.0 TESTS:

26.1 The Type tests as indicated at clause-28 below should have been conducted on a Transformer of **same design** during the **last five years on the date of opening of techno-commercial bids**. The bidder shall furnish type test reports during detailed Engineering & drawing approval.

26.2 **The test certificates for all routine and type tests for the transformers and also for the bushings and transformer oil shall be submitted** reports during detailed Engineering & drawing approval.

26.3 The procedure for testing shall be in accordance with IS 1180/2026 as the case may be except for temperature rise test.

26.4 Before dispatch each of the completely assembled transformers shall be subjected to the routine tests at the manufacturer's works.

26.0A. ROUTINE TESTS:

- 26.1A Ratio, polarity, phase sequence , vector group & magnetic balance test.
- 26.2A No Load current and losses at service voltage and normal frequency.
- 26.3A Load losses at rated current and normal frequency.
- 26.4A Impedance voltage test.
- 26.4A Resistance of windings at each tap, cold (at or near the test bed temperature).
- 26.5A Insulation resistance at 60second,600 second & Polarisation Index (P.I i.e ratio of Insulation Resistance taken at 600seconds & at 60 seconds shall not be less than 1.5)
- 26.6A Induced over voltage withstand test.
- 26.7A Separate source voltage withstand test.
- 26.8A Neutral current measurement – The value of zero sequence current in the neutral of the star winding shall not be more than 2% of the full load current.
- 26.9A Oil samples (one sample per lot) to comply with IS 1866.
- 26.10A Measurement of no load losses and magnetizing current at rated frequency and 90%, 100% and 112.5% rated voltage.
- 26.11A Pressure & vacuum test for checking the deflection & oil leakage test.

26.0 B. TYPE TESTS :

Following type test reports are also to be furnished during detailed Engineering & drawing approval. If not furnished than the same will not be accepted for further processing & liable for rejection.

- 26.1B Temperature rise test for determining the maximum temperature rise after continuous full load run. The ambient temperature and time of test should be stated in the test certificate.
- 26.2B Impulse voltage test: with chopped wave of IS 2026 part – III .
- 26.3B Short circuit withstand test: Thermal and dynamic ability.
- 26.4B Air Pressure Test: As per IS – 1180.
- 26.5B Un-balanced current test: The value of unbalanced current indicated by the ammeter shall not be more than 2% of the full load current.
- 26.6B Noise-level measurement.
- 26.7B Measurement of zero-phase sequence impedance.

26.8B Measurement of Harmonics of no-load current.

26.9B Transformer tank shall be subjected to specified vacuum. The tank designed for vacuum shall be tested at an internal pressure of 0.35 kg per sq cm absolute (250 mm of Hg) for one hour. The permanent deflection of flat plates after the vacuum has been released shall not exceed the values specified below:

Horizontal length of flat plate (in mm)	Permanent deflection (in mm)
Upto and including 750	5.0
751 to 1250	6.5
1251 to 1750	8.0
1751 to 2000	9.5
2001 to 2250	11.0
2251 to 2500	12.0
2501 to 3000	16.0
Above 3000	19.0

26.10B Transformer tank together with its radiator and other fittings shall be subjected to pressure corresponding to twice the normal pressure or 0.35 kg / sq.cm whichever is lower, measured at the base of the tank and maintained for an hour. The permanent deflection of the flat plates after the excess pressure has been released, shall not exceed the figures for vacuum test.

27.0 Pressure relief device test:

The pressure relief device shall be subject to increasing fluid pressure. It shall operate before reaching the test pressure as specified in the above class. The operating pressure shall be recorded. The device shall seal-off after the excess pressure has been released.

28.0 Short Circuit Test and Impulse Voltage Withstand Tests:

The purchaser intends to procure Transformers designed and successfully tested for short circuit and impulse test. In case the transformers proposed for supply against the order are not exactly as per the tested design, the supplier shall be required to carry out the short circuit test and impulse voltage withstand test **at their own cost in the presence of the representative of the purchaser.**

28.1 The supply shall be accepted only after such test is done successfully, as it confirms on successful withstand of short circuit and healthiness of the active parts thereafter on un-tanking after a short circuit test.

28.2 Apart from dynamic ability test, the transformers shall also be required to withstand thermal ability test or thermal withstand ability will have to be established by way of calculations.

28.3 It may also be noted that the owner reserves the right to conduct short circuit test and impulse voltage withstand test in accordance with the IS, afresh on each ordered rating at owner cost, even if the transformers of the same rating and similar design are already tested. This test shall be carried

out on a transformer to be selected by the owner either at the manufacturer's works when they are offered in a lot for supply or randomly from the supplies already made to purchaser's stores. The findings and conclusions of these tests shall be binding on the supplier.

28.4 The front page of the Type test certificates duly signed by the bidder for the tests carried out on prototype of same specifications shall be scanned & uploaded **along with the bid**. The detail type tested certificates shall be submitted during contract of agreement. The owner may select the transformer for type tests randomly.

29.0 ACCEPTANCE TEST:

29.1 **All transformers** shall be subjected to the stage inspection, routine & acceptance test as indicated above in presence of owner's representative at the place of manufacture before dispatch without any extra charges. The testing shall be carried out in accordance with IS:1180 and IS:2026.

29.2 Checking of weights, dimensions, fitting and accessories, tank sheet thickness, oil quality, material, finish and workmanship as per GTP and contract drawings.

29.3 Physical verification of core coil assembly and measurement of flux density of one unit of each rating, in every inspection with reference to short circuit test report.

29.4 **Temperature rise test on one unit of the total ordered quantity.-** This test shall be carried out as per IS.

29.5 The pressure & vacuum test on the tank on one unit/lot randomly selected to be carried out as per SI No. 28.8 & 28.9.

29.0A TESTS AT SITE:

The owner reserves the right to conduct all tests on transformer after arrival at site and the manufacturer shall guarantee test certificate figures under actual service conditions.

30.0 INSPECTION:

30.1 In respect of raw material such as core stampings, winding conductors, insulating paper and oil, supplier shall use materials manufactured / supplied by standard manufacturers and furnish the manufacturers' test certificate as well as the proof of purchase from these manufacturers (excise gate pass) for information of the owner. The bidder shall furnish following documents along with their offer in respect of the raw materials:

- (a) Invoice of supplier.
- (b) Mill's certificate.
- (c) Packing list.
- (d) Bill of landing.
- (e) Bill of entry certificate by custom.

31.0 INSPECTION AND TESTING OF TRANSFORMER OIL:

- 31.1 To ascertain the quality of the transformer oil, the original manufacturer's tests report should be submitted at the time of inspection. Arrangements should also be made for testing of transformer oil, after taking out the sample from the manufactured transformers and tested in the presence of purchaser's representative.
- 31.2 To ensure about the quality of transformers, the inspection shall be carried out by the owner's representative at following two stages:-
- 31.2.1 On line anytime during receipt of raw material and manufacture / assembly whenever the purchaser desires.
- 31.2.2 At finished stage i.e. transformers are fully assembled and are ready for dispatch.
- 31.2.3 All tests and inspection shall be carried out at the place of manufacture unless otherwise specifically agreed upon by the manufacturer and purchaser at the time of purchase. The manufacturer shall offer the Inspector representing the Purchaser all reasonable facilities, without charges, to satisfy him that the material is being supplied in accordance with this specification. this will include Stage Inspection during manufacturing stage as well as Active Part Inspection during Acceptance Tests.
- 31.2.4 The manufacturer shall provide all services to establish and maintain quality of workmanship in his works and that of his sub-contractors to ensure the mechanical / electrical performance of components, compliance with drawings, identification and acceptability of al materials, parts and equipment as per latest quality standards of ISO 9000.
- 31.2.5 Owner shall have every right to appoint a third party inspection to carryout the inspection process.
- 31.2.6 The purchaser has the right to have the test carried out at his own cost by an independent agency wherever there is a dispute regarding the quality supplied. Purchaser has right to test 1% of the supply selected either from the stores or field to check the quality of the product. In case of any deviation Owner **have every right to reject the entire lot or penalize the manufacturer, which may lead to blacklisting, among other things.**

32.0 GUARANTEED TECHNICAL PARTICULARS:-

The tenderer shall furnish the guaranteed technical particulars duly filled in the format **at Chapter-E16** along with the tender.

33.0 DOCUMENTATION:

- 33.1 The bidder shall furnish along with the bid the dimensional drawings of the items offered indicating all the fittings.
- 33.2 Dimensional tolerances.

33.3 Weight of individual components and total weight.

33.4 An outline drawing front (both primary and secondary sides) and end-elevation and plan of the tank and terminal gear, wherein the principal dimensions shall be given.

33.5 Typical general arrangement drawings of the windings with the details of the insulation at each point and core construction of transformer.

33.6 Typical general arrangement drawing showing both primary and secondary sides and end-elevation and plan of the transformer.

34.0 PACKING AND FORWARDING:

34.1 The packing shall be done as per the manufacturer's standard practice. However, it should be ensured that the packing is such that, the material would not get damaged during transit by Rail / Road / Sea.

34.2 The marking on each package shall be as per the relevant IS.

35.0 DEVIATION:

35.1 The bidders are not allowed to deviate from the principal requirements of the Specifications. However, the bidder is required to submit with his bid in the relevant schedule a detailed list of all deviations without any ambiguity. In the absence of a deviation list in the deviation schedules, it is understood that such bid conforms to the bid specification and no post-bid negotiations shall take place in this regard.

35.2 The discrepancies, if any, between the specification and the catalogues and / or literatures submitted as part of the offer by the bidders, shall not be considered and representations in this regard shall not be entertained.

35.3 If it is observed that there are deviations in the offer in guaranteed technical particulars other than those specified in the deviation schedules then such deviations shall be treated as deviations.

35.4 All the tables shall be prepared by vendor and are to be enclosed with the bid.

ANNEXURE-I

**PROFOREMA FOR PRE-DELIVERY INSPECTION OF
STATION TRANSFORMERS**

1.	Name of the firm.	
2.	Details of offer made	
	(i) Order No. and Date.	
	(ii) Rating.	
	(iii) Quantity.	
	(iv) Sl. No. of transformer.	
3.	Date of stage inspection clearance.	
4.	Reference of stage inspection clearance.	
5.	Quantity offered and inspected against the order prior to this lot.	

ANNEXURE-II

ROUTINE/ ACCEPTANCE TESTS TO BE CARRIED OUT(Clause-27,29 above & ISS)

Sl. No.	PARTICULARS	OBSERVATIONS.
1.	(a) Ratio Test	AB/an
		BC/bn
		CA/Cn
	(b) Polarity Test, Vector Group, Phase Sequence	
	c) Magnetic Balance	
2.	No load loss measurement	
		W1
		W2
		W3
	TOTAL	
	Multiplying Factor	
	CT	
	Watt meter	
	Total x MF	
	NET LOSS	

3.	Load loss measurement	
		W1
		W2
		W3
	Total	
	Multiplying Factors:	
	CT	
	Watt meter	
	PT	
	Total x MF	
	Loss at ambient temperature (watt)	
	Loss at 75° C (with calculation sheet)(watt)	
4.	Winding Resistance:	
	H.V. (In Ohms)	
	(a) At ambient temperature of ° C	A-B
		B-C
		C-A
	(b) Resistance at 75° C	A-B
		B-C
		C-A

Sl. No.	PARTICULARS	OBSERVATIONS.
	L.V. (In Ohms)	
	(a) At ambient temperature of ° C	a-b
		b-c
		c-a
	(b) Per Phase Resistance at 75° C	a-n
		b-n
		c-n
5.	Insulation Resistance (M ohm)	HV-LV
	60sec,600sec , Polarisation Index(P.I)	HV-E
		LV-E
6.	Separate Source voltage withstand test voltage	
	HV	70 kV for 60 secs.
	LV	3 kV for 60 secs
7.	Induce over-voltage withstand test at double voltage and double frequency.	100 Hz, 866 volts For 60 seconds.
8.	No load current at	
	90% volts	
	100% Volts	
	110% volts	
9.	Unbalance current	
10.	Vector group test	Diagram and readings be shown in separate sheets.
11.	Percentage Impedance at 75° C(Please furnish calculation sheet)	
12.	Transformer oil test (Break down voltage)	
13.	Oil leakage test	
14.	Heat run test	To be carried out once against the order.

15.	Bushing clearance (mm)	HV	LV
	(a) Phase to Phase		
	(b) Phase to Earth		
16.	Comments on compliance by the firm on the modifications done as per stage inspection clearance letter issued.		
17.	Whether fittings of the order have been verified		
18.	Whether aluminium die cast silicagel breather with tin container is fitted on the transformers offered.		
19.	Whether engraving of Sl.No. and Name of firm on core clamping channel, side wall and top cover of tank has been verified.		
20.	Whether MS Plate of size 125 x125mm welded on with side of stiffner.		
21.	Whether engraving of name of firm, Sl.No. and Rating of transformer, Order No. and date and Date of Despatch on MS Plate.		
22.	Copy of calibration certificate of metering equipments be enclosed.		

Note:- If the owner's Inspecting officer wants to note & incorporate any other readings pertaining to the above tests then the same shall have to be incorporated in the test report by the supplier. Also if the inspecting officer decides to carry out any other low voltage tests to know the soundness of the transformer then the same shall have to be carried out by the supplier.

Note : Please ensure that complete details have been filled in the proforma and no column has been left blank.

**TECHINICAL SPECIFICATIONS
OF
3 STAR RATED DISTRIBUTION TRANSFORMERS
(25 KVA, 63 KVA, 100 KVA 11/0.433 KV)**

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OF
25,63 & 100KVA, 11/0.433 3STAR RATED DISTRIBUTION TRANSFORMER

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TECHNICAL SPECIFICATION OF
25,63 & 100 KVA, 11/0.433 3STAR RATED DISTRIBUTION TRANSFORMER

1 . 0 S C O P E

1.1 The specification covers the design, engineering, manufacture, stage inspection, testing, pre-delivery inspection, supply, delivery, loading, unloading and performance requirements of 11/0.433 KV non-sealed type aluminum wound BEE specified 3 Star Distribution Transformers for outdoor use in the networks of CESU, NESCO, WESCO & SOUTHCO. The transformers shall be double wound, three phase, CRGO M3 Grade (0.23mm) or better, oil immersed with ONAN cooling with Oil filled up to maximum permissible level. The ratings required under this specification **are 25 KVA, 63 KVA & 100 KVA with Aluminum windings.**

1.2 The equipment offered should have been successfully type tested within five years from date of tender and the designs should have been in satisfactory operation for a period not less than three years as on the date of bid opening. Compliance shall be demonstrated by submitting with the bid, (i) authenticated copies of the type test reports and (ii) performance certificates from the users, specifically from Central Govt./ State Govt. or their undertakings.

1.3 The scope of supply should also include the provision of type test. Owner reserves the right to waive type tests as indicated in the section on Quality Assurance, Inspection and Testing in this specification.

1.4 The transformer shall conform in all respects to 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 material, which, in his judgment, is not in full accordance therewith.

2 . 0 C O D E S & S T A N D A R D S

2.1 Except where modified by this specification, the Transformers shall be designed, manufactured and tested in accordance with the latest editions of the following standards. The Bidder may propose alternative standards, provided it is demonstrated that they give a degree of quality and performance equivalent to or better than the referenced standards. Whether to accept or reject any alternative standard shall be adjudged by the owner. The Bidder shall furnish a copy of the alternative standard proposed along with the bid. If the alternative standard is in a language other than English, an English translation shall be submitted with the standard. In the case of conflict the order of precedence shall be 1) IEC or ISO Standards, 2) Indian Standards, 3) other alternative standards.

IEC/ISO	Indian Standard	Subject
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IEC 71		Insulation Coordination
IEC 76	IS 2026	Power Transformers.
	IS 1180	Outdoor Three Phase Distribution Transformers up to 500KVA, 11/ 0.4 KV, Non- Sealed Type.
IEC 137	IS 2099	Bushing for Alternating Voltages above 1000V.
IEC 156		Method of determining Electric Strength of Insulating Oils.
IEC 296 for	IS 335	Specification for Unused Mineral Insulating Oils Transformers and Switchgear.
	IS 6792	Method of determination of electric strength of Insulating oils.
IEC 354	IS 6600	Loading Guide for oil immersed Transformers
IEC 437		Radio Influence Voltage Measurement.
IEC 551 Levels.		Determination of Transformer and Reactor Sound
IEC 616		Terminal and Tapping markings for power transformers.
IEC 722 of		Guide to the Lightning and Switching impulse testing Power Transformers and Reactors.
ISO 1460/BS 729		Galvanizing

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 complying with other relevant standards or recommendations.

3.0 SERVICE CONDITIONS

The service conditions shall be as follows:

maximum altitude above sea level	1,000m
maximum ambient air temperature	50° C
maximum daily average ambient air temperature	40° C
minimum ambient air temperature	-5° C
maximum temperature attainable by an object exposed to the sun	60 ° C
maximum yearly weighted 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	1500 mm
maximum wind pressure	260Kg / m ²

Environmentally, the region where the equipment will be installed includes coastal areas, subject to high relative humidity, which can give rise to condensation. Onshore winds will frequently be salt laden. On occasions, the combination of salt and condensation may create pollution conditions for outdoor insulators.

Therefore, outdoor material and equipment shall be designed and protected for use in exposed, heavily polluted, salty, corrosive, tropical and humid coastal atmosphere.

4.0 SYSTEM CONDITIONS:

The equipment shall be suitable for installation in supply systems of the following characteristics.

♦	Frequency		50 Hz ± 5%
♦	Nominal system voltages	11 KV System	11 KV
		LV System	433/250 V
♦	Maximum system voltages	11 KV System	12 KV
		LV System	476 V
♦	Minimum LV voltage	(NEC)	392V
♦	Nominal short circuit apparent power of	11kV System	500MVA (IS:2026)
	The system		
♦	Insulation levels:		
	1.2/50μ sec impulse withstand	11kV System	95KV peak(As per BEE, Clause No. 10)
♦	Power frequency one minute withstand	11kV System	28KV(rms)
	(wet and dry)	LV System	3KV (rms)
♦	Neutral earthing arrangements:	LV System	Solidly earthed

5.0 TECHNICAL SPECIFIC TECHNICAL REQUIREMENTS

1	Rated KVA (ONAN rating)	25KVA. 63 KVA, 100 KVA 11/0.433 KV
2	No. of phases	3
3	Type of installation	Outdoor
4	Frequency	50 Hz (± 5%)
5	Cooling medium	Insulating Oil (ONAN)
6	Type of mounting	On Channels.
7	Rated voltage	
	a) High voltage winding	11 KV
	b) Low voltage winding	0.433 KV
8	Highest continuous system voltage	
	a)Maximum system voltage ratio (HV / LV)	12 KV / 0.476 KV
	b) Rated voltage ratio (HV / LV)	11 KV / 0.433 KV
9	No. of windings	Two winding Transformers
10	Type of cooling	ONAN (Oil natural / Air natural)
11	KVA Rating corresponding to	100%
	ONAN cooling system	
12	Method of connection:	
	HV:	Delta
	LV:	Star
13	Connection symbol	Dyn 11
14	System earthing	Neutral of LV side to be solidly
15	Percentage impedance voltage on normal tap and KVA base at 75 ⁰ C corresponding to HV/ LV rating and	% Impedance +Tolerance % 4.5 + 10% (No negative tolerance will be allowed) As per IEC —76-1, Clause 4.2
16	Intended regular cyclic overloading of windings	
17	Anticipated unbalanced loading	Around 10%
	Anticipated continuous loading of windings (HV / LV)	110 % of rated current
18	a) Type of tap changer	NA
	b) Range of taping	No Tap
19	Neutral terminal to be brought out	On LV side only
20	Over Voltage operating capability and duration	112.5 % of rated voltage (continuous)

21	Maximum Flux Density in any part of the core and yoke at rated KVA, rated voltage i.e 11 KV / 0.433 KV and system frequency of 50 HZ	1.5 Tesla	
22	Insulation levels for windings :-		
	a) 1.2 / 50 microsecond wave shape Impulse withstand (KVP)	HV: 95	LV: N.A.
	b) Power frequency voltage withstand (KVrms)	HV: 28	LV: 03
23	Type of winding insulation		
	a) HV winding	Uniform	
	b) LV winding	Uniform	
24	Withstand time for three phase short circuit	2 Seconds	
25	Noise level at rated voltage and frequency	As per NEMA Publication No. TR-1.	
26	Permissible 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 HV clearances in air (mm) :-		
	a) Phase to Phase	280	
	b) Phase to ground	140	
28	Bushings & Terminals		
	a) HV winding line end	12 KV oil filled porcelain communicating	
	b) LV winding	0.4 KV porcelain type of bushing (Antifog type)	

29	Insulation level of bushing Lightning Impulse withstand (KVP)	HV 95	LV Not applicable
	b) 1 Minute Power Frequency withstand voltage (KV —	28	3
	c) Creepage distance (mm) (minimum)	25 mm/ KV	
30	Material of HV & LV Conductor	EC grade Aluminum	
31	Maximum current density for HV and LV winding for rated	1.6 Amp/ mm ²	
32	Polarisation index i.e. ratio of megger values at 600 sec. to 60 sec for 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 type	
34	Transformer	Max. Losses at 50%	Max. Losses at 100%
	rating	load (Watts).	load (Watts).
	25 KVA	210	695
	63 KVA	380	1250
	100 KVA	520	1800

6.0 TYPE OF TRANSFORMER

- 6.1 The Transformers shall be of core type construction, double wound, three phase, oil immersed, 11/0.433KV, 50 Hz with natural oil and air cooling (ONAN) to be used as step down transformers for out door use. The design of the tank, fittings, bushings, etc shall be such that it will not be necessary to keep the Transformer energised to prevent deterioration as the transformers may be held in reserve, outdoors, for many years.

7.0 PERFORMANCE , CAPACITY AND SHORT CIRCUIT RATINGS

7.1 The following ratings are covered under this specification

- 25 KVA, 11/0.433 KV, Aluminum wound
- 63 KVA, 11/0.433 KV, Aluminum wound
- 100 KVA, 11/0.433 KV, Aluminum wound

7.2 The Transformer shall be capable of supplying a continuous load equal to its KVA rating, under the following conditions :

- ♦ continuous steady load;
- ♦ design at maximum ambient air temperature of 50°C;
- ♦ 40°C average winding temperature rise and 35°C top oil temperature rise for conventional breathing transformers.

7.3 The transformer may be overloaded during emergency up to 150% of its continuous rating in accordance with IEC Publication 354 or IS: 6600. Bushings and other current-carrying parts shall also be designed for this condition.

7.4 The transformer shall be capable of withstanding for two seconds without damage to any external short circuit, with the short circuit MVA available at the terminals of either winding with rated voltage on the other winding. If short circuit tests have been carried out on the particular design of transformer offered, the test results shall be supplied with the bid.

7.5 The thermal ability to withstand short circuit shall be demonstrated by calculation. The Transformer shall be capable of withstanding the thermal and dynamic effects of short circuits, as specified in IEC 76-5 or IS: 2026: Ability to withstand short circuits.

The maximum flux density in any part of the core and yoke at rated KVA Voltage and frequency shall not exceed 1.5 Tesla.

8.0 VOLTAGE RATIO & TAPPING RANGE

8.1 The transformers shall have the following ratio :-

- ♦ the nominal voltage ratio shall be 11,000/ 433 V for 25 KVA, 63 KVA, 100 KVA 11/0.4KV transformers;

- ♦ Tolerance on the voltage ratio shall be $\pm 0.5\%$.
- ♦ for transformers up to 100 KVA, 11/0.4 KV no tap changer is required.

8.2 The bidder shall state in the technical schedule, the percentage regulation at full load, power factor 1.0 and at full load, power factor 0.85 lagging.

Transformers shall be suitable for parallel operation with each other.

9.0 PERCENTAGE IMPEDANCE

9.1 The Percentage of Impedance at 75°C shall be 4.5 % for 25 KVA, 63 KVA & 100 KVA Transformers. No negative tolerance on percentage Impedance is allowed.

10.0 LOSSES

The load losses shall not exceed the values given below: -

KVA Rating	Maximum losses at 50% loading (Watts)	Maximum losses at 100% loading (Watts)
25 KVA	210	695
63 KVA	380	1250
100 KVA	520	1800

10.1 The above losses are maximum allowable and there should not be any positive tolerance.

10.2 The offered transformer(s) should have been type-tested at CPRI/ NABL Accredited laboratory. The bid shall be accompanied with type-test reports (short circuit test and Impulse test) conducted at Central Power Research Institute / NABL Accredited laboratory for the offered transformers within five years from date of tender. The short circuit test report(s) must contain the measured no load loss and load loss, determined by CPRI/ NABL Accredited laboratory.

In case of any doubts, Owner reserves the right to verify the original type test reports of CPRI/ NABL Accredited laboratory

or ask the supplier to conduct the type tests at CPRI/ NABL Accredited laboratory at his (supplier's) cost for re-confirmation of the test results particularly no load losses, load losses and percentage impedance.

- 10.3 If the bidder quotes lower values of losses than the CPRI's measured losses, he has to prove the same by conducting the Impulse & short Circuit tests at CPRI/ NABL Accredited laboratory along with measurement of no load losses and load losses at his own cost in presence of Owner's authorized representative without any financial liability to owner.
- 10.4 However, if the loss figures will exceed the stipulated values as per specification, the Transformer(s) shall be out rightly rejected.

11.0 VECTOR GROUP

- 11.1 The Transformers shall be connected delta-star, in accordance with vector group reference Dyn11 of IEC - 76/ IS - 2026.
- 11.2 The LV neutral shall be brought out to a terminal bushing, which shall be identical to the phase bushings in all respects.

12.0 LOSSES

- 12.1 Transformers would be out rightly rejected if losses exceed the values indicated at clause-10 above.

13.0 FLUX DENSITY

The flux density at rated voltage & rated frequency shall not exceed. 1.5 Tesla. The Transformer must be capable of operating at 10% over voltage and at frequency of 48.5 Hz without saturation.

14.0 INSULATION LEVELS

The insulation levels as defined in IEC 76-C/ IS: 2026

Insulation levels and dielectric test shall apply as per Table 2:

Table 2 : Transformer insulation level

	HV Winding	LV Winding
Basic Impulse voltage Level (Kvp) (1.2/50 micro. sec. Wave)	95	Not Applicable
Power Frequency voltage withstand level, Wet and Dry (KV)	28	3

Bushings and terminals shall be adequate for the winding insulation tests and shall flash over externally before puncture or internal failure can occur.

15.0 NOISE LEVEL

The average noise level of the transformers shall not exceed 51db. The measurement shall be carried out in accordance with IEC 551 at a distance of 300mm from the envelope of the Transformer.

16.0 RADIO INFLUENCE VOLTAGE

The maximum radio influence voltage shall be 25011 V, measured as specified in IEC 437.

17.0 CORE AND WINDINGS

- 17.1 Core
- 17.1.1 Stage level inspection for core construction shall be carried out by the owner.
- 17.1.2 Each lamination shall be insulated such that it will not deteriorate due to mechanical pressure and the action of hot transformer oil.
- 17.1.3 The core shall be constructed from high grade, non-ageing, **Cold Rolled Grain Oriented (CRGO) silicon steel of M3 Grade (0.23mm) or HIB grade laminations only.** No other core materials shall be entertained. Bidders are requested to note that only PRIME CORE M3 Grade (0.23mm) materials HIB grade are to be used. In no case, second grade core material is to be used. The purchaser at his discretion, may select samples from the core laminations and get the same tested in CPRI/ NABL Accredited laboratory to prove the quality of the core material.

- 17.1.4 For the above purpose, the supplier shall have to offer every batch of core laminations received from his Sub-Vendor along with Invoice of the sub-vendor, Mills test certificate, packing list, Bill of landing, Bill of entry certificate to customs etc. towards proof of prime core materials for verification by the Purchaser's representative without any cost to the Owner. Besides, the contractor must mention in his bid about the type of CRGO / Amorphous laminations to be utilized for the offered transformers along with a copy of the specific core loss curve at different flux densities.
- 17.1.5 Core materials should be directly procured either from the manufacturer or through their accredited marketing organization of repute, but not through any agent.
- The core and winding shall be capable of withstanding shocks during transport, installation and service. Provision shall be made to prevent movement of the core and windings relative to the tank during these conditions and also during short circuits.
- 17.1.6 The design shall avoid the presence of pockets which would prevent the complete emptying of the tank through the drain valve. The core material offered in the tender to be checked for its correctness before core coil assembly. For this, the tendered must ask for core and coil inspection before its tanking.
- 17.1.7
- 17.1.8 The laminations shall be free of all burrs and sharp projections. Each sheet shall have an insulting coating resistant to the action of hot oil.
- 17.1.9 The insulation structure for the core to bolts and core to clamp plates shall be such as to withstand 2000 V DC voltage for one minute.
- 17.1.10 The completed core and coil shall be so assembled that the axis and the plane of the outer surface of the core assemble shall not deviate from the vertical plane by more than 25mm.
- 17.1.11 All steel sections used for supporting the core shall be thoroughly shot or

sand blasted, after cutting, drilling and welding.

The finally assembled core with all the clamping structures shall be free from deformation and shall not vibrate during operation.

- 17.1.12 The core clamping structure shall be designed to minimize eddy current loss.
- 17.1.13 The framework and clamping arrangements shall be securely earthed.
- 17.1.14 The core shall be carefully assembled and rigidly clamped to ensure adequate mechanical strength.
- 17.1.15 Oil ducts shall be provided, where necessary, to ensure adequate cooling inside the core. The welding structure and major insulation shall not obstruct the free flow of oil through such ducts.
- 17.1.16 The design of magnetic circuit shall be such as to avoid static discharges, development of short circuit paths within itself or to the earth clamping structure and production of flux component at right angle to the plane of the lamination, which may cause local heating. The supporting framework of the cores shall be so designed as to avoid the presence of pockets, which would prevent complete emptying of the tank through the drain valve or cause trapping of air during filling.

- The construction is to be of boltless core type. The core shall be provided with lugs suitable for lifting the complete core and coil assembly. The core and coil assembly shall be so fixed in the tank that shifting will not occur during transport or short circuits.
- 17.1.17

17.2 INTERNAL EARTHING

- 17.2.1 All internal metal parts of the transformer, with the exception of individual laminations and their individual clamping plates shall be earthed.

The top clamping structure shall be connected to the tank by a copper strap.

- 17.2.2 The bottom clamping structure shall be earthed by one or more the following methods:
 - a) By connection through vertical tie-rods to the top structure.
 - b) By direct metal to metal contact with the tank base.
 - c) By a connection to the structure on the same side of the core as the main earth connection to the tank.

- 17.2.3 The magnetic circuit shall be connected to the clamping structure at one

point only and this shall be brought out of the top cover of the transformer tank through a suitably rated insulator. A disconnecting link shall be provided on transformer tank to facilitate disconnections from ground for IR measurement purpose.

- 17.2.4 Coil clamping rings of metal at earth potential shall be connected to the adjacent core clamping structure on the same side as the main earth connections.

17.3 **Windings**

- 17.3.1 Winding shall be subjected to a shrinking and seasoning process, so that no
- 17.3.2 further shrinkage occurs during service. Adjustable devices shall be provided for taking up possible shrinkage in service.

All low voltage windings for use in the circular coil concentric winding shall be wound on a performed insulating cylinder for mechanical protection of the

and placing around the core. Winding shall not contain sharp bends which might damage the insulation or produce high dielectric stresses. No strip conductor wound on edge shall have width exceeding six times the thickness.

17.3.3

The winding insulation shall be free from insulating compounds which are liable to soften, ooze out, shrink or collapse. It shall be non catalytic and chemically inert in hot transformer oil during normal service.

The stacks of windings are to receive adequate shrinkage treatment.

The windings and connections are to be braced to withstand shocks during transport switching, short circuit or other transient conditions.

17.3.6

Permanent current carrying joints in the windings and leads shall be welded or brazed. Clamping bolts for current carrying parts inside oil shall be made of oil resistant material which shall not be affected by acidity in the oil steel bolts, if used, shall be suitably treated.

17.3.9

Terminals of all windings shall be brought out of the tank through bushings for external connections.

17.3.10

The windings shall be uniformly insulated and the L.V neutral points shall be insulated for full voltage.

The completed core and coil assemble shall be dried in vacuum at not more than 0.5mm of mercury absolute pressure and shall be immediately impregnated with oil after the drying process to ensure the elimination of air and moisture within the insulation. Vacuum may be applied in either vacuum over or in the transformer tank.

The winding shall be so designed that all coil assemblies of identical voltage ratings shall be interchangeable and field repairs to the winding can be made readily without special equipment. The coils shall have high dielectric strength.

17.3.12

Coils shall be made of continuous smooth high grade electrolytic copper or aluminium conductor, shaped and braced to provide for expansion and contraction due to temperature changes.

Adequate barriers shall be provided between coils and core and between high and low voltage coil. End turn shall have additional protection against abnormal line disturbances.

The insulation of winding shall be designed to withstand voltage stress arising

from surge in transmission lines due to atmospheric or transient conditions caused by switching etc

17.3.15 Tapping shall not be brought out from inside the coil or from intermediate turns and shall be so arranged as to preserve as far as possible magnetic balance of transformer at all voltage ratios.

17.3.16

17.3.17 Magnitude of impulse surges transferred from HV to LV windings by electro magnetic induction and capacitance coupling shall be limited to BIL of LV winding.

The winding conductor shall be of Aluminum. The current density shall not exceed 1.6 Amp/ mm² for aluminium at normal full load current.

180 BUSHINGS AND TERMINATIONS

181 Bushings

18.1.1 Bushings shall be of the outdoor type and easily replaceable. Cemented in types will not be accepted. They shall be sufficiently robust to withstand normal transport and erection hazards and shall confirm to TEC 137 /TS 3347 and 2099.

18.1.2

All bushings shall have a minimum creepage distance of 25 mm /KV and shall have a continuous rating of 200% of the transformer rating. The protected creepage distance shall not be less than 50% of the total.

The following minimum 11 KV clearance shall be provided:

	External (Air) for 11 KV
Phase to phase	255 mm
Phase to earth	140 mm

- 18.1.3 The 11 KV bushings of transformers shall be provided with a bi-metallic terminal connector or suitable device to receive 35 —100 mm² AAAC or ACSR conductor directly without any bi-metallic action. The dia of HT bushing stud should not be less than 12.5 mm.
- 18.1.4 The secondary bushings of transformers shall be fitted with non ferrous threaded terminals of dia not less than 20 mm. With the exception of brass the terminals shall be protected from atmospheric deterioration by suitable tinning or by some other approved coating.

18.1.5 The terminals are to be supplied with one 16mm bolt, one conic spring washer, one matching flat washer, one nut and one lock nut for each hole in the terminal plate.

18.2 Bushing Labels

18.2.1 The HV bushings shall be labeled U, V and W and the LV bushing u, v, w and n. Marking letters shall be at least 12 mm high. The means of marking shall be either,

- ♦ engraved metal plate; or
- ♦ etched anodized aluminum.

Phase identification by adhesive stickers shall not be acceptable.

18.2.2 If labeling is to be carried out on the tank, it is preferred that one plate be used rather than individual markings for each phase, in order to prevent incorrect phase markings. Labels shall conform to the requirements of the section on labels in this specification.

18.3 Earthing Terminals

All transformers shall be provided with two earthing terminals conforming to relevant Standards and M12 ISO metric bolt and nut which shall be non ferrous. It shall include a spring washer and lock washer.

18.4 LIGHTNING ARRESTORS

9 KV, 5KA metal oxide lightning arresters of reputed make conforming to IS=3070 Part=III, one number per phase shall be provided.(Under the HV bushing with GI earth strip 25x4 mm connected to the body of the transformer with robust clamping arrangement). Lightning arrestors with polymer insulators in conformance with relevant IEC can also be used.

19.0 TANK FABRICATION

19.1 All transformer sizes, the tank shall be of bolted type construction in accordance with IS1180 (Part 2).

- The tank shall be at atmospheric pressure at an internal temperature of 10⁰ C;

- The tank shall be designed for an internal pressure of 100 Kg/ m² at 50⁰ C ambient conditions. It shall be capable of withstanding an unlimited number of 24 hours cyclic variations of internal pressure from atmospheric to this value.
- The tendered shall state the top oil temperature at which the tank internal pressure shall reach the value of 100 kN/ m² and the value of steady load which will result in this top oil temperature with an ambient temperature of 45⁰ C.
- Adequate space shall be provided at the bottom of the tank for collection of sediments.

19.2 Transformer tanks of all types shall be designed so that the completed transformer can be lifted and transported without permanent deformation or oil leakage. Stiffeners provided on all the four side walls for rigidity should be so designed that there is no accumulation of water.

19.3 The Tank shall be of rectangular shape with round edges fabricated from tested quality mild steel plates with minimum thickness of 3.15 mm. for the side walls while top cover and the bottom plate of the tank shall have a minimum thickness of 5 mm. The transformer tank and the top cover shall be designed in such a manner as to leave no external pockets in which water can log, or any internal pocket where air/ gas can accumulate.

Edge of Top cover should be bend downwards so as to avoid water through cover plate gasket. The width of the bend plate shall be 25mm minimum.

19.4 All sealing washers / gaskets shall be made of oil and heat resistant neoprene rubber or neoprene bonded cork seals suitable for temperature as stipulated in this specification. Surfaces at gasketed joints shall be such that an even face is presented to gasket, thereby eliminating the necessity for the gasket to take up surface irregularities.

19.5 All pipes, radiators, stiffeners or corrugations which are welded to the tank wall shall be welded externally and shall be double welded wherever possible. All welds shall be stress relieved.

19.6 The transformer tank shall be complete with all accessories, lifting lugs etc. and shall be designed to allow the complete transformer filled with oil to be lifted by crane or jacks without risk of any damage and can be transported by Rail/ Road without straining any joints and without causing any leakage of oil.

19.7 Provision of Cable End Box with suitable gland.

19.8 The height of the tank shall be such that minimum vertical clearance up to the top cover plate of 80mm is achieved from the top of the yoke.

20.0 PRESSURE RELIEF DEVICE

Transformers shall be fitted with a pressure relief device in the form of explosion Vent.

The tendered shall state the pressure at which it is designed to operate.

21.0 OIL LEVEL GAUGE

A suitable oil level gauge (Magnetic type of dia 1⁰⁰ mm) shall be fitted on the transformers and so located that it can be easily read from ground level. The gauge fitted with the conservator shall be graduated for temperatures of 5° C, 3° C and +98° C.

22.0 CONSERVATORS AND BREATHERS

All the transformers shall be provided with a conservator tank.

22.1 The conservator tank shall be so designed and located as to eliminate any trapping of air in the transformer or pipe work. It shall be inclined at an angle of about 5 degrees to the horizontal towards the drain plug and the pipe connecting the main tank to the conservator should project about 2° mm above the bottom of the conservator so as to create a sump for the collection of impurities. Minimum oil level corresponding to 5° C shall be well above the sump level.

22.2 All transformers shall be fitted with a silica gel breather of weatherproof design at a convenient height with oil seal at the bottom, draw in plug and filling holes with covers to isolate the silica gel from the atmosphere. The breather pipe should be connected at top of the conservator tank with two bends at right angles. The cover of the main tank and bushings turrets shall be provided with air release plug to enable the trapped air to be released.

23.0 FITTINGS AND ACCESSORIES

23.1 The following standard fittings and accessories shall be provided :

- ◆ Rating, diagram and terminal marking plate.
- ◆ Two earthing terminals.
- ◆ Lifting lugs/ platform lugs.
- ◆ Pressure relief device or explosion vent.
- ◆ Silica gel breather.
- ◆ A magnetic oil level gauge 1⁰⁰ mm dia for all transformers indicating three position (3) of oil - minimum. 5° C, 3° C and 98° C.
- ◆ Top filter valve with locking arrangement.
- ◆ Bottom filter valve with locking arrangement.
- ◆ Air release plugs at transformer top cover, bushing turrets etc.
- ◆ Set of Radiators.
- ◆ Conservator Tank

Bi-metallic terminals on the bushings for connection with over head ACSR/ AAAC conductor. The Specification and brief details of the salient features of these terminals should be stated.

24.0 TRANSFORMER OIL

The transformers shall be supplied complete with first filling of transformer oil upto maximum permissible level. The quantity of oil required for the first filling of the transformer and its full specification shall be stated in the bid. The complete first filling shall be of new oil free from inhibitors and additives up to maximum permissible level for the supplied Transformer. The bidder shall quote the price of transformer including the cost of Transformer Oil required for initial filling.

The insulating oil for the transformer shall be of EHV grade, generally conforming to IEC: 296/ BS: 148/ REC: 39/ 1993 or latest version of IS: 335/ 1983 whichever is more stringent. No inhibitors shall be used in the oil. The dielectric strength of the oil shall not be less than 60 KV at 2.5 mm. gap when tested in accordance with IS: 6792/ 1972. If an anti-oxidant inhibitor is recommended, its use shall be subject to the purchaser's approval.

The design and materials used in the construction of the transformer shall be such as to reduce the risk of the development of acidity in the oil.

The contractor shall warrant that oil furnished is in accordance with the following specifications.

S.N	Characteristic	Requirement	Method of Test
01	Appearance	The oil shall be clear & transparent & free from suspended matter or sediment	A representative sample of oil shall be examined in a 100 mm thick layer at ambient temp.
02	Density at 20 ⁰ C	0.89 g/cm ³ Max.	IS:1448
03	Kinematic Viscosity at 27 deg. C Max	27 CST	IS:1448

04	Interfacial tension at 27deg.C Min.	0.03 N/m	IS: 6104
05	Flash Point	136 ⁰ C	IS:1448
06	Pour Point Max.	-6 ⁰ C	IS:1448
07	Naturalization Value (Total Acidity) Max.	0.03 mg KOH/gm	IS:335
08	Electric strength Breakdown (voltage) Min.	72.5 KV	IS: 6792
09	Dielectric dissipation factor tan delta at 90 ⁰ C	0.03 Max	IS: 6262
10	Min specific resistance (resistively) at 90	35X10 ¹² ohm cm (min.)	IS:6103
11	Oxidation stability		
12	Neutralization value after oxidation	0.40mg KOH/g	
13	Total sludge after oxidation	0.10% by weight max.	
14	Presence of oxidation Inhibitor	The oil shall not contain anti-oxidant Additives.	IS:335
15	Water content Max:	Less than 25ppm	IS:2362

26.0 RATING AND CONNECTION PLATE

Each transformer shall be provided with a rating plate of weatherproof material showing the following items indelibly marked :

- ♦ type of transformer
- ♦ standard to which it is manufactured (preferably IEC 76)
- ♦ manufacturer's name
- ♦ transformer serial number
- ♦ year of manufacture
- ♦ rated frequency in Hz (50)
- ♦ rated voltages in KV (11/0.433)

- ♦ number of phases (3)
- ♦ rated power in KVA
- ♦ type of cooling (ONAN)
- ♦ rated currents in A
- ♦ vector group symbol (Dyn1 1)
- ♦ 1.2/501.ts wave impulse voltage withstand level in KVp
- ♦ power frequency withstand voltage in KV impedance voltage at rated current and frequency in percentage at 75⁰ C at normal tap
- ♦ Measured load loss in KW at rated current and at 75⁰ C at normal tap
- ♦ Measured no-load loss in KW at rated voltage and rated frequency continuous ambient temperature at which ratings apply in 0C
- ♦ top oil and winding temperature rise at rated load in 0C
- ♦ winding connection diagram
- ♦ Total weight in kg with complete oil filled.
- ♦ total weight of the transformer with out oil
- ♦ Volume of oil in litres.
- ♦ weight of core and windings in kg; and
- ♦ name of the purchaser
- ♦ DISCOM, GoO, CAPEX Programme.

The rating plate shall conform to the requirements of the section of Labels in this specification.

27.0 BASE MOUNTING ARRANGEMENT

The under base of all transformers up to 100 KVA capacity shall be provided with two 75x40 mm channels, 460 mm long with holes of 14 mm dia at a centre to centre distance of 415 mm to make them suitable for fixing on a platform or plinth.

- 27 (a) PUNCHINGS: Non=erasable Punching and embossing of Volume of oil in litres, name of the Owner-----, Name of the Supplier — M/s - -----, Year of Manufacture, Guarantee Period (i.e. 2 years from the date of

installation)and Sl. No. of each transformer is to be made on top core channel, top cover, side walls and name plates of transformers.

27 (b) 3 STAR LEVEL: In addition to above, the supplied Distribution Transformers must contain 3 Star Level with style and information provided by the Bureau of Energy Efficiency (B.E.E), Ministry of Power, Government of India.

28.0 PAINTING

28.1 All paints shall be applied in accordance with the paint manufacturer's recommendations. Particular attention shall be paid to the following:

28.2a) Proper storage to avoid exposure as well as extremes of temperature.

b) Surface preparation prior to painting.

c) Mixing and thinning

d) Application of paints and the recommended limit on time intervals between coats.

e) Shelf life for storage.

28.3 All paints, when applied in normal full coat, shall be free from runs, sags, wrinkles, patchiness brush marks or other defects.

28.3.1 All primers shall be well marked into the surface, particularly in areas where painting is evident, and the first priming coat shall be applied as soon as possible after cleaning. The paint shall be applied by airless spray according to the manufacturer's recommendations. However, wherever airless spray is not possible, conventional spray be used with prior approval of purchaser.

28.3.2 The supplier shall, prior to painting protect nameplates, lettering gauges, sight glasses, light fittings and similar such items.

28.4 Cleaning and Surface Preparation

28.4.1 After all machining, forming and welding has been completed, all steel work surfaces shall be thoroughly cleaned of rust, scale, welding slag or spatter and other contamination prior to any painting.

28.4.2 Steel surfaces shall be prepared by Sand/Shot blast cleaning or Chemical cleaning by Seven tank process including Phosphating to the appropriate quality.

28.4.3 The pressure and Volume of the compressed air supply for the blast cleaning shall meet the work requirements and shall be sufficiently free from all water contamination prior to any painting.

28.4.4 Chipping, scraping and steel wire brushing using manual or power driven tools cannot remove firmly adherent mill-scale and shall only be used where blast

cleaning is impractical.

28.5 Protective Coating

28.5.1 As soon as all items have been cleaned and within four hours of the subsequent drying, they shall be given suitable anticorrosion protection.

28.6 Paint Material

Followings are the type of paints that may be suitably used for the items to be painted at shop and supply of matching paint to site:

- i) Heat resistant paint (Hot oil proof) for inside surface.
- ii) For external surfaces one coat of Thermo Setting Paint or 2 coats of Zinc chromate followed by 2 coats of P.O (Poly-urethane) paint. The color of the finishing coats shall be dark admiral gray.

28.7 Painting Procedure

28.7.1 All painting shall be carried out in conformity with both specifications and with the paint manufacture's recommendations. All paints in any one particular system. Whether shop or site applied, shall originate from one paint manufacturer.

28.7.2 Particular attention shall be paid to the manufacture's instructions on storage, mixing, thinning and pot life. The paint shall only be applied in the manner detailed by the manufacturer e.g. brush, roller, conventional or airless spray and shall be applied under the manufacturer's recommended conditions. Minimum and maximum time intervals between coats shall be closely followed.

28.7.3 All prepared steel surfaces should be primed before visible re-rusting occurs or within 4 hours whichever is sooner. Chemical treated steel surfaces shall be primed as soon as the surface is dry and while the surface is warm.

28.7.4 Where the quality of film is impaired by excess film thickness, (wrinkling, mud cracking or general softness) the supplier shall remove the unsatisfactory paint coatings and apply another. As a general rule, dry film thickness should not exceed the specified minimum dry film thickness by more than 25%. In all instances, where two or more coats of the same paints are specifies, such coatings may or may not be of contrasting colors.

28.7.5 Paint applied to items that are not be painted, shall be removed at supplier's expense, leaving the surface clean, un-stained and undamaged.

28.8 Damages to Paints Work

Any damage occurring to any part of the painting scheme shall be made good to the same standard of corrosion protection and appearance as that originally employed.

Any damaged paint work shall be made as follows:

a) The damaged area, together with an area extending 25mm around its boundary, shall be cleaned down to bare metal.

b) A priming coat shall immediately applied, followed by a full paint finish equal to that originally applied and extending 50mm around the perimeter of the originally damaged.

The repainted surface shall present a smooth surface. This shall be obtained by carefully chamfering the paint edges before & after priming.

28.9 Dry Film Thickness

To the maximum extent practicable, the coats shall be applied as a continuous film of uniform thickness and free of pores. Over-spray, skips, runs, sags and drips should be avoided. The different coats may or may not be same color.

Each coat of paint shall be allowed to harden before the next is applied as per manufacture's recommendations. Particular attention must be paid to full film thickness at edges.

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	Total Dry film thickness(Min)
1.	Liquid paint			
	a) Zinc Chromate (Primer)	Out side	01	30 micron
	b) P.U. Paint Coat)	Out side	02	45 each
	c)Hot Oil paint	inside	01	35/10 micron

The colour of the finishing coat shall be Sky Blue/ Dark Admiral Gray/ Deep Green or any other colour as decided by the Purchaser

29.0 SEALING GASKETS

All sealing washers / gaskets shall be made of oil and heat-resistant Nitrile/ Neoprene rubber/ synthetic rubber bonded cork type RC-70C gaskets. Gaskets made of natural rubber or cork sheet are not permissible.

30.0 SUPRESSION OF HARMONICS

The transformer shall be designed with attention to the suppression of harmonic voltage especially the third and fifth.

31.0 TESTS

31.1 Routine Tests

Routine tests shall be carried out on all transformers and the tests shall be conducted in accordance with relevant National/ International Standards. No sampling is allowed. In addition, tank tests in accordance with IS: 1180 shall be carried out.

The following routine measurements and tests shall be carried out in presence of Purchaser's authorized representative(s):

- a) Measurement of winding resistance.
- b) Voltage ratio measurement and check of polarity and vector group.
Bushing positions shall have permanent markings at this stage of production;
- c) measurement of impedance voltages/ short circuit impedance at rated current and frequency
- d) measurement of load loss at full load and 75⁰C;
- e) measurement of neutral unbalance current;
- f) Temperature rise test on one transformer of each rating and measurement of hot resistance.
- g) measurement of no-load loss and no-load currents at full, 50%, 75%, 90%, 110%, 112.5% and 120% of rated voltages;
- h) induced over voltage withstand test at 22KV for 60 sec on the HV windings;
- i) power frequency voltage withstand tests on HV and LV windings;
- j) magnetic balance test
- k) Polarization Index test P.I. value shall be not less than 1.5. P.I. = IR at 600 sec / IR at 60 sec.
- l) oil leakage test : The criterion of leakage shall be discoloration by oil of whitewash applied externally to suspected parts at an oil temperature of 90⁰C or other method, as approved by the Purchaser;
- m) Pressure test on transformer tank on one unit for each rating.
Bushings and oil shall be subject to the following routine tests.
- n) bushing routine test: in accordance with IEC 137/IS 3347;
- o) Oil dielectric and moisture content test: conforming to IEC 156 or IS 335.

Routine test certificates shall include in addition to the test results, the purchaser's order number, the transformer serial number, outline drawing number and transformer KVA rating.

Any other applicable tests shall be conducted at the discretion of the Purchaser without any extra cost to Purchaser.

31.2 Type Tests

31.2.1 The measurements and tests should be carried out in accordance with the standard specified in each case as indicated in the following table if the same tests were not conducted earlier at CPRI or any NABL accredited Laboratory on the transformers of the offered design.

Table 6: Transformer type tests

Type Test	Standard
Temperature Rise Test	IEC 76/IS 2026/IS6600
Impulse Voltage Withstand Test, including Full Waves and Chopped Waves as listed below	IEC 76/IS 2026
Noise Level Measurement	IEC 551
Short Circuit Test	IEC 76 / IS 2026

In accordance with IEC 76-3 the following sequence of impulses should have been/ should be applied;

- one full wave at 50% BIL;
- one full wave at 100% BIL;
- one chopped wave at 50% BIL
- two chopped waves at 100% BIL and
- two full waves at 100% BIL.

31.2.2 If the type test report(s) submitted by the bidder do not fulfill the criteria, as stipulated in this technical specification/ Bidder's offer, the relevant type test(s) has/ have to be conducted by the Bidder at his own cost in CPRI/ NABL accredited laboratory in the presence of purchasers representative(s) without any financial liability to purchaser in the event of order placed on him.

31.2.3 Even if the Type test report(s) confirm(s) the Owner's specification, the Purchaser at his discretion may ask the Supplier to repeat any or all specified type tests at CPRI/ NABL accredited laboratory on sample(s),

selected at random by the purchaser's representative(s) out of the offered quantity (first lot i.e. minimum one third of the total ordered quantity). The type test(s) are to be test-witnessed by the Purchaser's representative(s). For such type of repetition of type tests, the Bidder may quote Type

Test Charges in the enclosed Price Schedule or conduct the tests free of cost.31.2.4 The supplier shall furnish calculations in accordance with IS: 2°26 to demonstrate the Thermal ability of the transformers to withstand Short Circuit forces.

31.3 CHALLENGE TESTING:

The manufacturer can also request challenge testing for any test based on the specification and measurement of no load losses, load losses & impedance at 75°C. The challenger would request for testing with testing fees. The challenge test fees are proposed to be at least three times the cost of testing. This is likely to deter unnecessary challenges. The challenger would have the opportunity to select the sample from the store and any such challenge should be made within the guarantee period. The party challenged, challenger and the utility could witness the challenge testing.

The challenge testing would cover the following tests:

1. Measurement of magnetizing current & No Load losses at rated voltage & frequency.
2. Load Losses at more than 5°% loading to determine the Full Load losses & percentage impedance at 75°C and neutral unbalance current.
3. Temperature Rise Test.

The challenge test could be conducted at NABL Laboratory like CPRI. If the values are within the limits the product gets confirmed else not confirmed. No positive tolerances in losses are permitted. If the product is not confirmed the manufacturer would pay the challenge fee and the challenger would get the fee refunded. However as a redressal system the challenged would be allowed to ask for fresh

testing of two or more samples from the store and the same be tested in NABL Laboratory or CPRI in presence of the party challenged, challenger and the utility.

If any one of the above two samples does not confirm the test, then the product is said to have failed the test. In such cases the manufacturer will be declared as unsuccessful manufacturer for the said product with wide publicity and would not be allowed to compete in tenders of the purchaser for a period of at least three years and heavy penalty would be imposed.

31.4 TEST VOLTAGE

Transformers shall be capable of withstanding the Power frequency and Impulse test voltage as described below:

Nominal system voltage	Highest System voltage	Impulse Test voltage	Power frequency test voltage
433 V (rms)			3 KV (rms)
11 KV (rms)	12 KV (rms)	95 KV (Peak)	28 KV (rms)

32.0 COMPLIANCE WITH SPECIFICATION

The transformers shall comply in all respects with the requirements of this specification. However, any minor departure from the provisions of the specification shall be disclosed at the time of tendering in the Non Compliance Schedule as in Annexure-3, Section- V of this document.

33.0 COMPLIANCE WITH REGULATIONS

All the equipment shall comply in all respects with the Indian Regulations and acts in force. The equipment and connections shall be designed and arranged to minimize the risk of fire and any damage which might be caused in the event of fire.

34.0 INSPECTION AND TESTING

34.1 The Purchaser shall have free entry at all times, while work on the contract is being performed, to all parts of the manufacturer's works which concern the processing of the equipment ordered. The manufacturer shall afford the Purchaser without charge, all reasonable facilities to assure that the equipment being furnished is in accordance with this specification. After approval of Drawings by the Purchaser, the manufacturer shall manufacture a Prototype Model as per the Approved Drawing and offer the same for inspection. The Inspection of the Prototype Model shall be carried out as per the Format prescribed at Clause 41, Section-IV of our Tender Specification. The Supplier shall offer the core, windings and tanks of each transformer for inspection by the Owner's representative(s). During stage inspection of the Prototype Model, 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 HV and LV windings, length, breadth, height and thickness of plates of transformer tanks, the quality of fittings and accessories will be taken/ determined.

The Inspection Report for the Tests conducted by our Authorized Inspectors in presence of the manufacturer's representative, for the Prototype Model offered for inspection with suggested modifications, if any shall be submitted to the undersigned for approval.

After Inspection, the Prototype Model shall be kept sealed, in the premises of the manufacturer till the completion of delivery of final consignment, for future reference during subsequent Inspections.

The Supplier can offer for final inspection of the transformers subject to clearance of the stage inspection report by the Purchaser.

- 34.2 The equipment shall successfully pass all the type tests and routine tests mentioned in the above Clauses and those listed in the most recent edition of the standards given in Clause 2, of this specification.
- 34.3 The Owner reserves the right to reject an item of equipment if the test results do not comply with the values specified or with the data given in the technical data schedule.
- 34.4 Routine tests shall be carried out by the Supplier at no extra charge at their works. Adequate facility with calibrated testing equipment must be provided by the manufacturer free of cost to carry out the tests. Type test certificates must be furnished along with the tender for reference of the Owner.
- 34.5 The Purchaser will witness all required tests. In order to facilitate this, the Supplier shall give the Purchaser a minimum of two weeks notice as mentioned in clause-7(ii) of General Terms and Condition of Contract (GTCC) that the materials are ready for testing. If the Purchaser does not indicate his intention to participate in the testing, the manufacturer may proceed with the tests only after receipt of written confirmation to this effect from the Purchaser and shall furnish the results thereof to the Purchaser consequent upon such testing.
- 34.6 Full details of the proposed methods of testing, including connection diagrams, shall be submitted to the Purchaser by the Supplier for approval, at least one month before testing.

All costs in connection with the testing, including any necessary re-testing, shall be borne by the Supplier who shall provide the Purchaser with all the test facilities which the latter may require, free of charge. The Purchaser shall have the right to select the samples for test and shall also have the right to assure that the testing apparatus is duly calibrated and correct. Measuring apparatus for routine tests shall be calibrated at the expense of the Supplier at an approved laboratory and shall be approved by the Purchaser.

34.7 The supplier shall submit to the Purchaser five signed copies of the test certificates, giving the results of the tests as required. No materials shall be dispatched until the test certificates have been received by the Purchaser and the Supplier has been informed that they are acceptable.

The test certificates must show the actual values obtained from the tests, in the units used in this specification, and not merely confirm that the requirements have been met.

In the case of components for which specific type tests or routine tests are not given in this specification or in the quoted standards in Clause 2, of this specification, The Supplier shall include a list of the tests normally required for these components. All materials used in the Contract shall withstand and shall be certified to have satisfactorily passed such tests.

34.8 The Purchaser at his discretion may re-confirm the Routine Test Results, particularly no load losses, load losses and percentage impedance in his own laboratory or laboratory of his choice.

No inspection or lack of inspection or passing by the Purchaser's Representative of equipment or materials whether supplied by the Supplier or sub-supplier, shall relieve the Supplier from his liability to complete the contract works in accordance with the contract or exonerate him from any of his guarantees.

However in case of future discrepancy, if any, after acceptance of equipments, observed at any stage during guarantee period, the matter may be referred to Bureau of Energy Efficiency (B.E.E) for random testing of equipments supplied. In such cases the observation of B.E.E shall be binding to both parties.

35.0 GUARANTEE

The supplier shall guarantee the following:

- ♦ Quality and strength of materials used;
- ♦ Satisfactory operation during the guarantee period of two years (24 months) from the date of commissioning, or 30 months from the date of acceptance of the equipment by the Purchaser following delivery, whichever is earlier;
- ♦ Performance figures as supplied by the tendered in the schedule of guaranteed particulars;
- ♦ The offered surface treatment shall protect the treated metal from corrosion for a period of not less than five years from the date of delivery.

36.0 PACKING AND SHIPPING

36.1 Packing

The equipment and any supporting structures are to be transported adequately sealed against water ingress. All accessories and spares shall be packed and securely clamped against movement in robust, wooden, non returnable packing cases to ensure safe transit in rough terrain, cross country road conditions and in heavy rains from the manufacturer's works to the work sites/ earmarked destinations.

36.1.1 All accessories shall be carefully packed so that they are fully protected during transport and handling operations and in storage. Internal surfaces of loose accessories shall be sealed by means of gaskets and blanking off plates. All parts liable to rust shall receive an anti-rusting coat and shall be suitably protected. It shall be the responsibility of the Supplier to make good any damage caused through insufficient packing.

Each packing case shall be indelibly marked, on two adjacent sides and on the top, with the following:

- ◆ Individual serial number;
- ◆ Purchaser's name;
- ◆ Contract number;
- ◆ Destination;
- ◆ A colour coded marking to indicate destination;
- ◆ Supplier's name;
- ◆ Name and address of supplier's agent in Orissa;
- ◆ Description and numbers of contents;
- ◆ Manufacturer's name;
- ◆ Country of origin;
- ◆ Case measurements;
- ◆ Gross and net weight in kilograms: and
- ◆ All necessary slinging and stacking instructions.

36.1.2 Each crate or container shall be marked clearly on the outside of the case to show TOP and BOTTOM positions with appropriate signs to indicate where the mass is

bearing and the correct positions for slings. All component parts which are separately transported shall have permanent identification marks to facilitate correct matching and assembly at site. Welded parts shall be marked before welding. Six copies of each packing list shall be sent to the Purchaser prior to dispatching the equipment.

36.2 Transportation

The Supplier shall be responsible for the transport of all plant and equipment supplied by them and for the transport of all goods to the various specified destinations including all road clearance, offloading, warehousing and insurance.

The Supplier shall inform himself fully as to all relevant transport facilities and requirements and loading gauges and ensure that the equipment as packed for transport conform to these limitations. The Supplier shall also be responsible for verifying the access facilities specified.

The Supplier shall be responsible for the transportation of all loads associated with the contract works and shall take all reasonable steps to prevent any highways or bridges from being damaged by his traffic and shall select routes, choose and use vehicles and restrict and distribute loads so that the risk of damage shall be avoided. The Supplier shall immediately report to the Purchaser any claims made against the Supplier arising out of alleged damage to a highway or bridge.

All transport accessories, such as riding lugs, jacking pads or blanking off plates shall become the property of the Purchaser. All items of equipment shall be securely clamped against movement to ensure safe transit from the manufacturer's facilities to the specified destinations.

The Supplier shall advise the storage requirements for any plant and equipment that may be delivered to the Purchaser's stores. The Supplier shall be required to accept responsibility for the advice given in so far as these arrangements may have a bearing on the behavior of the equipment in subsequent service.

37.0 Hazardous substances

The Supplier shall submit safety data sheets for all hazardous substances used with the equipment. The Supplier shall give an assurance that there are no other substances classified as hazardous in the equipment supplied. No oil shall be supplied or used at any stage of manufacture or test without a certificate acceptable to the Purchaser that it has a PCB content of less than 2 mg/ kg. The Supplier shall accept responsibility for the disposal of such hazardous substances, should any be found.

The Supplier shall also be responsible for any injuries resulting from hazardous substances due to non compliance with these requirements.

38.0 SUBMITTALS

38.1 Submittals required with the bid

The following shall be required with each copy of the bid :

- Completed technical data schedule;
- Descriptive literature giving full technical details of equipment offered;
- Outline dimensions drawing for each major component, general arrangement drawing showing component layout and general schematic diagram;
- Type test certificates (short circuit withstand test and impulse test) of the offered

transformers conducted at CPRI/ or any NABL Accredited laboratory without which tender will be out rightly rejected.

- Sample routine test reports;

Detailed reference list of customers already using equipment offered along with performance certificates of such equipment, during the last 3 (three) years with particular emphasis on units of similar design and rating;

- Details of manufacturer's quality assurance standards and programme and ISO 9000 series or equivalent national certification;
- Deviations from this specification. Only deviations approved in writing before award of contract shall be accepted;
- List of recommended spare parts and consumable items for five year of operation with prices and spare parts catalogue with price list for future requirements.

38.2 Submittals required after contract award

38.2.1 Programme

Five copies of the programme for production and testing

38.2.2 Technical Particulars

Within 30 days of contract award five bound folders with records of the technical particulars relating to the equipment. Each folder shall contain the following information:

- ◆ General description of the equipment and all components, including brochures;
- ◆ Technical data schedule, with approved revision;
- ◆ Calculations to substantiate choice of electrical, structural, mechanical component size/ ratings;
- ◆ Detailed dimension drawing for all components, general arrangement drawing showing detailed component layout and detailed schematic and wiring drawings for all components; along with core-coil assembly drawings, showing details of core such as grade, thickness, window height, leg centre, diameter, step width, step thickness and details of windings such as I.D., O.D , thickness ,

Conductor size, No. of turns, major and minor insulations, winding height etc.

- ◆ Detailed loading drawing to enable the Purchaser to design and construct foundations for the transformer;
- ◆ Statement drawing attention to all exposed points in the equipment at which copper / aluminum or aluminum alloy parts are in contact with or in close proximity to other metals and stating clearly what protection is employed to prevent corrosion at each point;
- ◆ Detailed installation and commissioning instructions;
- ◆ At the final hold point for Purchaser approval prior to delivery of the equipment the following shall be submitted ;
- ◆ Inspection and test reports carried out in the manufacturer's works
- ◆ Operation and maintenance instructions as well as trouble shooting charts.

38.2.3 Operation and Maintenance Instructions

A copy of installation and commissioning instructions and of the operation and maintenance instructions and trouble shooting charts shall be supplied with each transformer.

38.3 Drawings

38.3.1 Within 15 days of award of contract, the Supplier shall submit 4 complete sets of drawings as detailed below describing equipment in details. These drawings would be duly approved by the Purchaser after due securitization and approval will be communicated within 15 days of receipt of these drawings. After the drawings are approved and communicated to the supplier, he would supply ten complete sets of final drawings.

38.3.2 All detail drawings submitted for approval shall be to scale not less than 1:20. All important dimensions shall be given and the material of which each part is to be constructed shall be indicated on the drawings. All documents and drawings

shall be submitted in accordance with the provisions of this specification and shall become the property of the Purchaser.

38.3.3 All drawings and calculations, submitted to the Purchaser, shall be on international standard size paper, either AO, A1, A2, A3 or A4. All such drawings and calculations shall be provided with a contract title block, which shall include the name of the Purchaser and shall be assigned an unique project drawing number; the contract title block and project numbering system shall be agreed with the Purchaser.

38.3.4 Script sizes and thickness of scripts and lines be selected so that if reduced by two stages the alphanumeric characters and lines are still perfectly legible so as to facilitate microfilming.

38.3.5 For presentation of design drawings and circuit documents IEC Publication 617 or equivalent standards for graphical symbols are to be followed. The drawing approval will be communicated within 15 days from the receipt of drawings from the Bidder and for any delay in furnishing the drawings, if delivery period will be delayed, no extension of delivery time will be granted due to this.

38.3.6 The following drawings for each item are to be submitted as part of this Contract.

- a. Out line dimensional drawings of transformers and accessories
- b. Assembly drawings and weights of main component parts.
- c. Transportation drawings showing dimensions and weights of each package.
- d. Drawings giving the weights for foundations each .
- e. Drawing showing details such as clamping arrangements of core, core

assembly showing oil duct section of HT and LT coils with conductor size showing insulation arrangements of windings and their reinforcement to withstand short circuit stresses, in side tank dimensions showing core assembly. Details of core and windings, as enumerated at Cl. No. 33.2.2 of this part of Specification shall be indicated in the above drawings.

- f. Schematic diagram showing the flow of oil in the cooling system as well as each limb and winding. Longitudinal and cross- sectional views showing the duct sizes, cooling pipe etc. for transformer/ heat exchanger, drawn to scale shall be furnished.
- g. Large Scale drawings of high and low tension winding of the transformers showing the nature and arrangements of insulation and terminal connection.
- h. Name plate drawing showing details as per Cl. 23 of Part-2 of Technical Specification.

Test reports

39.0 FASTENERS

- 39.1 All bolts, studs, screw threads, pipe threads, bolt heads and nuts shall comply with the appropriate Indian Standards for metric threads, or the technical equivalent.
- 39.2 Bolts or studs shall not be less than 6 mm in diameter except when used for small wiring terminals. All nuts and pins shall be adequately locked.
- 39.3 Wherever possible, bolts shall be fitted in such a manner that in the event of failure of locking resulting in the nuts working loose and falling off, the bolt will remain in position.

39.4 All ferrous bolts, nuts and washers placed in outdoor positions shall be of anti-corrosive materials except high tensile steel bolts and spring washers which shall be electrogalvanized to service condition stated elsewhere in the Specification. Appropriate precautions shall be taken to prevent electrolytic action between dissimilar metals where bolts are used on external horizontal surfaces and where water can collect, methods of preventing the ingress of moisture to the threads shall be provided. Each bolt or stud shall project at least one thread but not more than three threads through the nut, except when otherwise approved for terminal board studs or relay stems. If bolts nuts are placed so that they are inaccessible by means of ordinary spanners, special spanners shall be provided. The length of the screwed portion of the bolts shall be such that no screw thread may form part of a shear place between members. Taper washers shall be provided where necessary. Protective washers of suitable material shall be provided front and back on the securing screws.

40.0 LABELS

40.1 All apparatus shall be clearly labelled indicating, where necessary, its purpose and service positions. The material of all labels and plates, their dimensions, legend and the method of printing shall be subject to approval of the Purchaser. The surfaces of all labels and plates shall have a mat or satin finish to avoid dazzle from reflected light. Colours shall be permanent and free from fading. Labels mounted on black surfaces shall have white lettering. Danger plates shall have white lettering on a red background. All labels and plates for outdoor use shall be of in-corrodible material. Where the use of enameled iron plates is approved, the whole surface including the back and edges, shall be properly covered and resistant to corrosion. They shall be engraved in English. Name plates shall be white with black engraved lettering and shall carry all the applicable information specified in the applicable items of the Standards. No scratching, corrections or changes will be allowed on name plates.

40.2 Name plates shall be provided of white background with black engraved lettering carrying all the applicable information specified in the standards and other details as

required by the Purchaser. The name plate inscription and the size and lettering shall be submitted to the Purchaser for approval.

41. 0 PROFORMA FOR STAGE INSPECTION OF DISTRIBUTION TRANSFORMERS

(A) GENERAL INFORMATION:

1. Name of Firm :
2. Order No and Date :
3. Rating —wise quantity offered :

4. Details of offer

- (a) Rating
- (b) Quantity
- (c) Serial Numbers

5. Details of last stage inspected lot :

- (a) Total quantity inspected
- (b) Serial Numbers
- (c) Date of stage inspection
- (d) Quantity offered for final inspection of

6.

- (A) Inspection of BEE 3 Star Level/ Embossing / Punching requirement: whether satisfies the Specification: deviation if any to be mentioned:

- (B) AVAILABILITY OF MATERIAL FOR
OFFERED QUANTITY: Details to be filled in

- (C) POSITION OF MANUFACTURING STAGE :
OF THE OFFERED QUANTITY

- (a) Complete tanked assembly
- (b) Core and coil assembly ready
- (c) Core assembled
- (d) Coils ready for assembly

(i) HV Coils

(ii) LV Coils

NOTE:

(i) A quantity if more than 100 no's shall not be entertained for stage inspection

(ii) The stage inspection shall be carried out in case:-

(a) At Least 25% quantity offered has been tanked and

(b) Core coil assembly of further at least 30% of the quantity offered has been completed.

(iii) Quantity offered for stage inspection should be offered for final inspection within 15 days from the date of issuance of clearance for stage inspection, otherwise stage inspection already cleared shall be liable for cancellation.

Sl.No	Particulars	As Offered					As observed				Deviation and Remarks			
D	INSPECTION OF													
(i)	Core material													
1	Manufacturer's Characteristic Certificate in respect of grade of													
2	Remarks regarding Rusting and smoothness of core													
	Whether laminations used for top and bottom yoke are in													
(ii)	Core Construction:													
1	No of steps													
2	Dimension of Steps													
	Step No. 1	2	3	4	5	6	7	8	9	10	11	12		
	As Offered													
	W mm													
	T mm													
	As found													
	W mm													
	T mm													
3	Core Dia (mm)													

4	Total Cross Section area of core			
5	Effective cross Sectional area of core			
6	Clamping			
	Channel Size			
	Bolt size and No			
	Tie Rods			

(iv)	Painting			
	Channels			
	Tie Rods			
(c)	Bolts			
7	Whether top yoke is cut for LV connection			
8	If yes, at 7 above, whether Reinforcement is			
9	Size of support Channels provided for Core base and bottom yoke (Single Piece of channels are only acceptable)			
10	Thickness of insulation provided between core base and support channel			
11	Core length (leg center to leg centre)			
12	Window height			
13	Core height			
14	Core weight only (without channel etc.)			
(E)	INSPECTION OF WINDING			
(I)	Winding material			
1	Material used for			

3 Material used for top and bottom yoke and insulation

II Type and thickness of material used: (mm)

	(a) HV Winding			
	(b) LV Winding			
2	Grade of material for			
	(a) HV Winding			
	(b) LV Winding			
3	Test certificate of manufacturer (enclosed copy) for			
	(a) HV			
	(b) LV			
(II)	CONSTRUCTIONAL DETAILS			
1	Size of Cross Sectional area of conductor for:			
	(a) HV Winding			
	(b) LV Winding			
2	Type of insulation for conductor			
	(a) HV Winding			
	(b) LV Winding			
3	Diameter of wire used for delta formation (mm)			
4	Diameter of coils in:			
a	LV Winding			
	Internal dia (mm)			
	Outer dia (mm)			
b	HV Winding			
	Internal dia (mm)			
	Outer dia (mm)			
5	Current Density of winding material			

	(a) HV			
	(b) LV			
6	Whether neutral formation on top			
7	HV Coils/ Phase			
a)	Number			
b)	Turns/ coil			
c)	Total turns			
8	LV Coils/ Phase			
a)	Number			
b)	Turns/coil			
c)	Total turns			
9	Method of HV Coil Joints			
10	Total weight of coils of			
	(a) HV Winding (Kg)			
	(b) LV Winding (Kg)			
F	INSULATION MATERIALS:			
(I)	MATERIAL			
1	Craft paper			
a)	Make			
b)	Thickness (mm)			
c)	Test certificate of manufacturer (enclosed copy)			
2	Press Board			
a)	Make			
	Thickness (mm)			
	Test certificate of manufacturer (enclosed copy)			
a)	Between core and LV			
b)	Spacers			
c)	Interlayer			

d)	Between HV & LV winding			
e)	Between phases			
	End insulation			
G	CLEARANCES			
(I)	Related to core and winding			
1	LV to Core (Radial)			
2	Between HV and LV (Radial)			
3	(i) Phase to phase between HV			
	(ii) Whether two Nos Press Board each of minimum 1 mm ;thick provided			
4	Thickness of locking spacers between LV coils (mm)			
5	Axial wedges between HV and LV coils / phase (Nos)			
6	No. of radial spacers per phase between HV coils			
7	Size of duct between LV and HV winding (mm)			
(II)	Between core-coil assembly and tank: (mm)			
1	Between winding and body			
	a) Tank lengthwise			
	b) Tank breadth wise			

2	Clearance between top cover and top yoke upto 100 KVA and between top cover and top most live part of tap changing switch for 200 KVA and above.			
H	TANK			

1	Constructional details:			
	1) Rectangular shape			
	2) Thickness of side wall (mm)			
	3) Thickness of top and bottom plate			
	4) Provision of slopping top cover towards HV			
	5) Tank internal			
	(a) Length			
	(b) Breadth			
	(c) Height			
	(i) On LV side			
	(ii) On LV side			
(II)	General Details			
	1) Inside painted by varnish/ oil corrosion resistant paint (please specify which type of coating done)			
	2) Gasket between top cover and tank			
	(i) Material			
	(ii) Thickness(mm)			
	(iii) Joint over laps			

	3) Reinforcement of welded angle (Specify size and No. of angle			
	4) Provision of lifting			
	a) Numbers			
	b) Whether lugs of 8 mm thick MS plate			
	c) Whether reinforced by welded plates edge wise below the lug up to re-enforcing angle of the tank done			
	5) Pulling lug of MS			
	a) Nos			
	b) Thickness (mm).			
	c) Whether provided on breadth side or length side			
	6) Provision of air release plug			
	7) Provision of galvanized GI Nuts Bolts with 1 No Plain and 1 No spring washer			
	8) Deformation of length wise side wall of tank when subject to:			
	a) Vacuum of (-) 0.7 Kg/sq cm for 30 minutes			
	b) Pressure of 0.8 Kg/sq cm for 30			
(I)	RADIATORS			
	1. Fin radiators of 1.25 mm thick			
	a) Dimension of each fin (L x B x T)			

	b) Fins per radiators			
	c) Total No. of radiators			
	2. Verification of manufacturer's test certificate regarding Heat dissipation (excluding Top and Bottom) in w/sq m			
	3. Verification of position of radiator with respect to bushing			
(J)	CONSERVATOR			
	1. Dimensions (L x D) (in mm)			
	2. Volume (m3)			
	3. Inside dia of Conservator			
	4. Whether conservator outlet pipe is projected approx.20 mm inside the conservator tank			
	5. Whether arrangement made so that oil does not fall on the active			
	6. Whether die cast metal oil level gauge indicator having three positions at (- 5° C, 30° C and 98 ° C is provided.			
	7. Whether drain plug and filling hole with cover is provided			
	8. Inner side of the conservator tank painted with.			

(K)	BREATHER			
	1. Whether Die cast Aluminum body breather for silica gel provided			
	2. Make			
	3. Capacity			
(L)	TERMINALS			
1	Material whether of Brass Rods/ Tinned			
	a) HV			
	b) LV			
2	Size (dia in mm)			
	a) HV			
	b) LV			
3	Method of Star connection formed on LV side of 6mm thick (Should use Al./ Cu. Flat bolted/ brazed with crimped lugs on winding alternatively for 63 and 100 KVA rating brazed is done covered with tubular sleeve duly crimped)			
4	Method of Connection of LV of winding to LV bushing (end of winding should be crimped with lugs(Al/Cu) and bolted with bushing			

5	Method of Connection of HV winding to HV bushing (Copper joint should be done by using silver brazing alloy and for Aluminum, brazing rod or with tubular connector			
6	Whether SRB P tube/ insulated paper used for formation of Delta on HV			
7	Whether Empire sleeves used on the portion of HV winding joining to HV bushing			
8	Whether neutral formation is covered with cotton tape			
(M)	BUSHING			
1	Whether HV bushing mounted			

2	Whether sheet metal pocket used for mounting bushing (nine are not			
	a) HV			
	b) LV			
3	Whether arrangement for studs for fitting of HV bushing are in diamond shape (so			
	4. Position of mounting of LV			
	5. Bushing Clearance: (mm)			
	a) LV to Earth			
	b) HV to Earth			

	c) Between LV			
	d) Between HV			
(N)	TANK BASE CHANNEL/ROLLE			
1	Size of channels(mm)			
2	Whether channels welded across the length of the tank			
3	Size and type of roller (mm)			
(O)	OIL			
1	Name of Supplier			
2	Break down voltage of oil:(KV)			
	i) Filled in tanked			
	In storage tank (to be tested by Inspecting			
	3. Supplier's test certificate			
(P)	ENGRAVIN G / PUNCHING			
	1. Engraving of Sl. No and name of			
	i) On bottom of clamping channel of core-coil assembly			
	ii) On side wall and top cover of tank along with date of dispatch. / Guarantee Period			
	iii) 3 Star Level: Whether contains 3 Star Level with style prescribed by the B.E.E.			

(Q)	i) MS plate of size 125 x 125 mm welded on width side			
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	ii) Following details engraved (as per			
	(a) Serial Number			
	(b) Name of Firm			
	(c) Order No. and Date			
	(d) Rating			
	(e) Name of Inspecting Officer			
	(f) Designation			
	(g) Date of dispatch			
(R)	NAME PLATE DETAILS			
	Whether Name Plate is as per approved			
(S)	Colour of Transformer			
	1. Tank body with light blue colour			
	2. Conservator with white colour			
(T)	CHECKING OF TESTING FACILITIES			
	(Calibration certificate also to be checked for its validity)			
	TESTS			
	1. No Load Current			
	2. No Load Loss			
	3. % Impedance			
	4. Load Losses			
	5. Insulation Resistance Test			
	6. Vector Group Test (phase			
	7. Ratio and Polarity test			

	8. Transformer oil Test (Break down			
	9. Magnetic Balance			
	10. Measurement of winding resistance (HV and LV both)			
	11. Induced over voltage withstand test (Double voltage and			
	12. Separate source power frequency withstand test at 28 KV for HV and 3 KV for LV (one minute)			
	13. Air Pressure/ Oil leakage Test			
	14. Vacuum Test			
	15. Unbalanced current test			
	16. Temperature rise(Heat Run) test			
(U)	We have specifically checked the following and found the same as per G.T.P./ deviations observed as mentioned against each.			
	i) Rustlessness of CRGO laminations			
	ii) Core Steps			
	iii) Core Area			
	iv) Core Weight			
	v) Winding cross section area			
	a) LV			
	b) HV			
	vi) Weight of windings			

	vii) Clearance between winding and wall of tank (mm)			
	a) Length-wise			
	b) Breadth- wise			
	viii) Clearance between top of yoke top most live part of tap changer to tank cover			
	ix) Details of Neutral formation			
	x) Connections to bushings			
	a) LV			
	b) HV			
	xi) Slope of tank top			
	xii) Position of mounting of bushings			

COMPANY INSPECTING OFFICER

FIRMS

REPRESENTATIVE

DATE OF INSPECTION

42.0 Loss Capitalization :

As loss level is fixed in case of Star Rating Transformers, i.e, 25 KVA, 63 KVA & 100 KVA, there is no requirement of application of loss capitalization.

GUARANTEED TECHNICAL PARTICULARS FOR 25 KVA/ 63 KVA/ 100 KVA /,11/0.4KV, 3-PHASE STAR RATED DISTRIBUTION TRANSFORMERS I s furnished at **Chapter E-16** .

TECHNICAL SPECIFICATION FOR 11KV & 33KV VACCUM CIRCUIT BREAKERS (OUT DOOR TYPE)

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OF
36 KV & 12KV VACCUM CIRCUIT BREAKERS
(OUT DOOR TYPE)

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PART - A

36 KV VACCUM CIRCUIT BREAKERS (OUT DOOR TYPE)

TECHNICAL SPECIFICATION FOR 36 K.V. VACCUM CIRCUIT BREAKERS (OUTDOOR TYPE)

1.0. SCOPE:

36kV, 1430MVA Vaccum Circuit Breakers are intended to be purchased for outdoor installation at different source Sub-stations. Some of the Sub-stations for which equipment

are tendered are situated in coastal areas where saline climate prevails. The base structure of the circuit breakers must be galvanized.

1.1. POWER SUPPLY TO AUXILIARIES :

A.C. supply to auxiliaries will be 3 phase, 3 wire, 430 volt or three or single phase 250 volts at 50 C/s. The voltage variation will be within 10% and the frequency variation $\pm 5\%$.

1.2. 33 kV CIRCUIT BREAKERS TYPE AND RATING :

The circuit breaker shall have the following ratings :

Sl. No.	Description in details	Required value
1.	Number of poles	: 3 (One unit with three phase making and breaking).
2.	Frequency.	: 50 C/s.
3.	Nominal system voltage	: 33 KV rms.
4.	Highest system voltage	: 36.0 KV rms.
5.	Basic insulation level	: 170 KVP
6.	Power frequency test	
	Voltage (wet).	: 75 KV (rms.)
7.	Nominal Current.	: 1250 Amps rms.
7a.	First pole to clear factor	: 1.5
8.	Breaking capacity.	
	(a) Symmetrical	: 25 KA/1430 MVA.
	(b) Asymmetrical	: 33 KA Peak
9.	Making capacity	: 62.5 KA Peak.
10.	Continuous current rating	: 1250 Amps (RMS)
11.	Operating Duty	: 0-0.3 Sec-CO-3 Min-CO.
12.	(a) Break time	: 3 Cycles
	(b) Make time	: 5 Cycles
	(c) Minimum reclosing time	: 15 Cycle.
	(d) Minimum dead time for reclosing	: 15 Cycle
13.	Dry one minute power frequency withstand test voltage	
	a) Between line terminal	: 75 KV rms.
	b) Between line and body	: 75 KV rms.
14.	Impulse withstand test voltage;	
	a) Between terminal with C.B. open.	: 170 KV (Peak)
	b) Between body & terminal	: 170 KV (Peak)
15.	Insulator or bushing	
	a) Dry one minute power Frequency voltage,	: 75 KV
	b) Wet one minute power Frequency withstand Voltage.	: 75 KV
	c) Creepage distance	: 580 mm (Minimum)
16.	Short time current rating for 3 seconds	: Not less than 25 KA for 3 seconds.

17. Control circuit voltage : 24V D.C

2.0 STANDARDS :

The circuit breakers shall comply with the requirements of latest issue of IEC-62271-100, IEC-60694/IS12729:2004, IS-13118:1991.

3.0 TECHNICAL DETAILS

3.1 GENERAL :

- a) The circuit breakers shall be of Vacuum type. The breakers shall be supplied as a complete unit with all accessories and equipment in place and all internal wiring installed and terminated in the mechanism.
- b) The circuit breakers shall provide rapid and smooth interruption of current under all conditions, completely suppressing all undesirable phenomena even under the most severe and persistent short circuit conditions or when interrupting small leading or lagging reactive current. The details of any device incorporated to limit or control the rate of rise of restricting voltages across the circuit breaker contacts shall be stated. **The over voltages caused by the circuit breaker switching on inductive or capacitive load shall not exceed, 2.5 times the normal phase to neutral voltage.** The total break time for the circuit breakers throughout the range of their operating duty shall be stated in the tender and guaranteed.

4.0 CONSTRUCTIONAL FEATURES :

Each circuit breaker shall comprise 3 identical poles complete with a gang operated mechanism for specified duty. All these poles of the C.B. shall be linked together electrically & mechanically for specified duty.

a) CONTROL CUBICLE :

A common control cubicle shall be made to house electrical controls, monitoring devices and all other accessories. The cubicle shall be of gasketed weather proof construction, fabricated from sheet **Aluminum alloy sheet having minimum 3 mm thick. The operating mechanism shall be strong,rigid and not subject to rebound.**

The cubicle shall have front access door with lock and keys and removable gland plate at the bottom for owner's cable entry. Thermostat controlled space heater, internal illumination lamp, 5A 3Pin socket with individual on/off switches shall be provided in the cubicle.

5.0 MOUNTING :

All joints shall be welded so as to have adequate mechanical strength. The breaker porcelain shall be capable of withstanding all pressure resulting from any performance of the breaker.

The circuit breaker shall be supplied complete with the necessary lifting tools, foundation bolts and other accessories.

6.0 TEMPERATURE RISE :

The maximum temperature attained by any part of the equipment when in-service at site under continuous full load conditions and exposed to direct rays of sun shall not exceed the permissible limits fixed by approved specifications. When the standards

specifies the limits of temperature rise these shall not exceed when corrected for the difference between ambient temperature at site and the ambient temperature specified.

7.0 INSULATION OF THE CIRCUIT BREAKERS :

The insulation to ground, the insulation between open contacts, the insulation between phases of the completely assembled circuit breakers, should be capable of withstanding satisfactorily die-electric test voltages corresponding to basic insulation level specified in the GTP.

8.1 The clearance in open air shall be as follows, unless the apparatus is impulse tested after complete assembly.

- i) Minimum clearance between phase : 505 mm
- ii) Phase to Earth : 305 mm
- iii) Minimum clearance between live : 1400 mm
Parts and grounded objects.
- iv) Minimum ground clearance to live : 3700 mm
part.

8.0 BUSHING AND INSULATIONS :

The basic insulation level of the insulating porcelains shall be as specified in GTP and shall be suitable for installation in contaminated atmospheres. The porcelains used shall be homogenous and free from cavities and other flaws. They shall be designed to have ample insulation, mechanical strength and rigidity for satisfactory operation under conditions specified above. The puncture strength of the bushings shall be greater than the flashover value. The bushings shall be entirely free from radio disturbance when operating at a voltage 10% above rated voltage and also be free from external corona.

Adequate means shall be provided to accommodate conductor expansion and there should not be any undue stressing of any part due to temperature change.

9.0 OPERATION MECHANISM :

- 9.1 The operating mechanism shall spring operated type. In case of spring operating mechanism it shall be of motor operated having provision of hand operated spring charging type of by local/remote electric control under normal operation. The mechanism shall be trip from electrically and mechanically. All working parts in the mechanisms shall be corrosion resistant material and all bearings which require greasing shall be equipped with pressure grease fittings. The mechanism shall be strong, positive, quick in action and shall be removable without disturbing the other parts of the circuit breakers. The mechanisms of breaker shall be such that the failure of any spring will not prevent tripping.
- 9.2 The operating mechanism along with its accessories shall be mounted in a weather proof cabinet with hinged doors located near the breakers. A local control switch and the breaker position indicator shall be provided in the cabinet. The circuit breakers shall also be provided with means for manual operation for maintenance purposes.

9.3 The control circuits shall be designed to operate on **24 V D.C.** It shall be possible to adopt to work on other voltages by simply changing the operating coils. The closing and operating coils shall be designed to operate satisfactorily at any control voltage from 70% to 115% of the normal rated voltage. A heater shall be provided in the cabinet to prevent moisture condensation.

9.4 Necessary cable glands for the cables of the operating mechanism shall be provided.

9.5 **The Motor to be used for spring charging shall be of Universal type and suitable for AC and DC supply (24 V DC).**

10.0 TERMINAL CONNECTORS :

Terminal connectors suitable for the AAAC conductor size 148 Sq mm shall be supplied.

11.0 AUXILIARY SWITCHES :

Spare 10 Nos N/O (normally open) & 10 Nos N/C (normally closed) of auxiliary switches (contacts) shall be provided on each circuit breaker for use in the remote indication and control scheme of the circuit breaker and for providing safety interlocking etc. Special contact for use with trip coil and single short reclosing operation which permits relative adjustment with respect to the travel of the moving contact of the circuit breaker shall also be provided.

12.0 COMPLETENESS OF EQUIPMENT :

Any fittings, accessories or apparatus which may not have been specifically mentioned in those specification but which are usual or necessary in the equipment of similar plant shall be deemed to be included in the contract and shall be supplied by the contractor without extra charges. All plant and equipment shall be complete in all details whether such details are mentioned in the specification or not. The detail bill of materials list to be furnished along with the tender.

13.0 TEST :

13.1 Type test : -

All the equipment offered shall have been fully type tested as per the relevant standards. In case the equipment of the type and design offered, has already been type tested in CPRI / NABL . Approved test Laboratory, the Contractor shall furnish one sets of type test reports along with the offer. These tests **must not have been conducted earlier than five years from the date of opening of bids.** All the test reports should be submitted during detailed Engg & approval of drawings for verification by the Owner.

The first Page of Type test Report showing the bidder of successfully test.

Type Tests:--(As per IEC-62271-100)

- 1) Dielectric Test (LI Voltage, PF Voltage Withstand(Dry&Wet)& etc)
- 2) RIV Test
- 3) Measurement of resistance of the main circuit

- 4) Temperature rise Test
- 5) Basic short circuit duty test ,Short Time withstand current & Peak withstand current Test
- 6) Mechanical Operation Test, Mechanical endurance test
- 7) Out of phase / Short Circuit making & Breaking Test
- 8) Capacitive Current, Switching Test ,
 - a) cable charging current Test
 - b) Single capacitor Bank current switching test
- 9) Test to verify degree of protection

13.2 Routine Tests:-

- 1) Dielectric Tests on the main Circuit ,auxiliary & control circuits
- 2) Measurement of resistance of the main circuit.
- 3) Design & Visual Checks(Dimensions,clearances&etc)
- 4) Mechanical operation Test

13.3 Acceptance and Routine Tests.

All acceptance and routine tests as stipulated in the relevant standards & above shall be carried out by the supplier in presence of owner's representative.

Immediately after finalization of the programme of **acceptance /routine testing**, the supplier shall give twenty days advance intimation to the purchaser, along with the shop routine test certificate and valid calibration certificates of the equipments/instruments calibrated in a govt. approved test house, to be used during testing for scrutiny, to enable him to depute his representative for witnessing the tests.

14.0 DOCUMENTATION :

All drawings of the VCB shall be furnished to the owner along with the GTP, Type test reports for verification. All dimensions and data shall be in S.I. Units.

List of drawings and documents.

The Contractor shall furnish four sets of following drawings along with his offer.

- (a) General outline and assembly drawings of the equipment.
- (b) Graphs showing the performance of equipments
- (c) Sectional views showing :-
 - i) General Constructional features.
 - ii) The materials/gaskets/sealing used.
 - iii) method of connections.
 - iv) Porcelain used and its dimensions along with the mechanical and electrical characteristics.
- (d) Arrangement of terminal's and details of connection studs provided.
- e) Name Plate.
- f) Schematic drawing :-
- g) Type test reports in case the equipment has already been type tested.
- h) Test reports, literature, pamphlets of the bought out items, and raw material.

The manufacturing of the equipments shall be in accordance with the approved drawings and no deviation shall be permitted without the the written approval of the Owner.

17.0 PACKING AND FORWARDING

The Contractor shall be responsible for any damage to the equipment during transit, due to improper and inadequate packing. Any material found short inside the packing cases shall be supplied by the Contractor without any extra cost.

Each consignment shall be accompanied with a detailed packing list containing the following information.

a) Name of the consignee.

- (i) Details of consignment.
- (ii) Destination
- (iii) Total weight of consignment.
- (iv) Sign showing upper/lower side of the crate.
- (v) Handling and unpacking instructions.
- (vi) Bill of material indicating contents of each package.

The supplier shall ensure that the packing list and bill of material are approved by the purchaser before dispatch. Average no. of dust storm days per annum 20

TOPOGRAPHICAL AND METEOROLOGICAL SITE CONDITIONS

Location of installations	State of Orissa
Altitude	1000 m
Maximum Temperature	60°C
Minimum Temperature	0°C
Maximum daily average temperature	35°C
Maximum humidity 100%	
Pollution level	Heavy
Airborne contamination, if any	Highly Polluted
Seismic withstand factor	0.3 g
Maximum wind pressure	260 kg/m ²
Wind velocity	50m/sec

PART - B

12 KV VACCUM CIRCUIT BREAKERS (OUT DOOR TYPE)

TECHNICAL SPECIFICATION FOR 11KV OUTDOOR VACUUM CIRCUIT BREAKER

1.0 SCOPE

1.1 This specification covers design, engineering, manufacture, testing, inspection before dispatch, packing, forwarding, transportation, insurance during transit, delivery to site of 11KV outdoor Vacuum circuit Breaker for use in the 33/11KV primary substations under DISCOMS.

1.2 Vacuum circuit breakers must be manufactured and shall have been type tested at CPRI/NABL accredited testing laboratory located in India only within five years as on the date of bid opening and in satisfactory operation for a period not less than three years. The Bidders 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, without which Bid will be outright rejected.

1.3The type tests shall have been done at any of the CPRI/ NABL accredited testing laboratory within last 5 Years.

1.4 The Dimension of Type Tested VCBs can only be accepted.

1.5 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.

1.6The 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 purchaser shall have the power to reject any work or materials, which, in his judgment, is not in full accordance therewith.

2.0 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.

IEC/ISO/BS	IS	Subject
IEC:56 IEC: 62271-100 & 200		High voltage alternating current circuit breakers general requirement.
IEC:694	IS : 12729	Common clauses of high voltage switch-gear and control gear standards (for voltage exceeding 1000 V).
IEC:60	IS : 9135	High Voltage testing techniques.
I E C:427	IS:13516	Method of synthetic testing of HV .A.C circuit breakers.
IEC: 1233		HV. AC. Circuit breakers- inductive load switching.
IEC: 17A/CD:474		HV. AC. Circuit breakers- capacitive switching.

IEC:529	IS: 13947	Degree of protection provided by enclosure.
IEC:137	IS: 2099	Insulating bushing for A.C. voltages above 1000V
IEC:233	IS : 5621	Hollow insulators for use in electrical equipment & testing.
IEC:273	IS: 5350	Characteristics of indoor and outdoor post insulators for systems with nominal voltages greater than 1000V.
IEC:815	IS: 13134	Guide for selection of insulators in respect of polluted conditions.
IEC: 34	IS : 996	A.O motors
ISO:1460 BS:729	IS:2629	Hot dip galvanizing
	IS:2633	Method of testing uniformity of zinc coated articles.
	IS: 5	Colour for ready mixed paints and enamels
	IS: 6005	Code of practice for phosphating of iron and steel.
IEC: 227	IS:1554	P.V.C Insulated cables for voltages up to and including 1100 Volt.
IEC:269	IS:13703	Low voltage fuses for voltages not exceeding 1000volt.
ISO:800	IS:1300	Phenolic moulding materials.
	IS:13118	Guide for uniform marking and identification of conductors and apparatus terminals.
IEC: 185	IS: 2705	Current transformers.
IEC: 296	IS: 335	Specification for unused insulating oil for transformer and switchgear.
IEC:186	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.

3.0 REQUIREMENTS

The circuit breakers to be supplied against this specification shall be used in 11kV feeder and all in transformer bay in 33/11KV 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.

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	11 KV
4	Highest system voltage	12KV
5	Rated normal current at 50°C	
i)	For Bus-bar of Circuit Breaker	800A
ii)	For Interrupter	1250A
iii)	For Outgoing Feeders & Transformer	1250A
6	Rated short circuit breaking current (rms) for 3 Sec	25KA
7	Rated short circuit making current (peak)	63KA
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	28KV
ii)	Impulse withstand voltage to earth with 1.2/50gsec, wave of +ve and —ve polarity (Peak)	75KV
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	24V D.C
17	Minimum creepage distance (mm)	350
18	Minimum protected creepage distance (mm)	280

4.0 11KV OUTDOOR VCB:

4.1 GENERAL TECHNICAL REQUIREMENTS

The vacuum circuit breaker VCBs complete with all materials and accessories shall be suitable for outdoor installations with vacuum as interrupting media incorporating separate interrupters of 1250 A rating for each phase mounted on single frame. There shall be a common drive mechanism actuating the interrupters, which must work in synchronism.

- 4.2 It is not the intent to specify completely herein all details of the design and construction of equipments. However, the equipment shall conform in all respects to high standards of engineering, design and workmanship and shall be capable of performing in continuous commercial operation up to the Bidder's guarantee in a manner acceptable to the purchaser, who will interpret the meanings of drawings and specifications and shall have the power to reject any work or material which in his judgment is not in accordance therewith. The offered equipment shall be complete with all components necessary for its effective and trouble free operation along with associated equipments, interlocks, protection schemes etc. Such components shall be deemed to be within the scope of supply, irrespective of whether those are specially brought out in this specification and/ or the commercial order or not.

5.0 DESIGN CRITERIA

- 5.1 The equipment will be used in high voltage system having characteristics as listed in the specification. The equipment will be installed outdoor in a hot, humid and tropical atmosphere. All equipment, accessories and wiring shall have tropical protection, involving special treatment of metal and insulation against fungus, insects and corrosion.**permissible limits as stipulated in the relevant standards. The safety clearances of all live parts of the equipment shall be as per relevant standards.**
- 5.2 The maximum temperature in any part of the equipment at specified rating shall not exceed the
- 5.3 The equipment shall be capable of withstanding the dynamic and thermal stresses of listed short circuit current without any damage or deterioration.

6.0 CONSTRUCTIONAL FEATURE

- 6.1** The circuit breaker shall be triple pole fixed type. The VCB shall be vermin proof and dust tight. The switchgears and Control gears shall be complete with all necessary supporting frame works, Nuts and bolts etc. for securing the same to the floor.
- 6.2** The operating mechanism shall operate (close/open) all the three phases simultaneously. The operating mechanism link etc. should be accessible for maintenance. The circuit breakers and its operating mechanism shall be fully interlocked to prevent mal-operation. All the breakers shall be supplied with necessary clamps and connectors suitable for appropriate current ratings. Rigid type bimetallic/ Al. alloy terminal connector of 1250 Amps.

- 6.3** The VCB shall have an arrangement for emergency shunt tripping from remote

Place in addition to arrangement for local, emergency tripping (Mechanical). The VCB shall also have a system to check. The "Trip circuit healthy check". Necessary trip and closing coils shall be provided for operation of the breakers. The circuit breaker VCB shall be electrically and mechanically trip free under various conditions.

7.0 MAIN CONTACTS

- 7.1** The main contacts shall have adequate area and contact pressure for carrying rated continuous and short time current without excessive heating liable to cause pitting and welding.

- 7.1.1** The breakers may be provided with silver plated contacts,

- 7.1.2** If necessary, to meet the requirement of IS:13118/ **IEC 61172 — 100 & 200** where higher temperature rise is permitted with silver plated contacts. The quantity of silver shall be such that after carrying out one tenth of total number of operations specified for mechanical endurance tests, there is still continuous layer of silver on contacts.

7.2 NUMBER & TYPE OF SPARE, AUXILIARY CONTACTS/SWITCHES:

- 7.2.1** Adequate number of spare auxiliary switches/ contacts both of normally open & normally close type but not less than four each shall be provided on the circuit breaker for use in the indication and controlling scheme of circuit breakers.

8.0 INTERLOCK

- 8.1** All electrical and mechanical interlocks which are necessary for safe and satisfactory operation of the circuit breaker shall be provided.

9.0 OPERATING MECHANISM

Characteristics of Operating mechanism of circuit breaker and associated equipments:
Method of operation: The circuit breaker shall be equipped with power operated -34- mechanism to operate all three phases simultaneously using 220/240 V AC Motor operated spring closing mechanism. It shall be electrically and mechanically trip free under various conditions. VCB shall also be provided with hand operated spring charging closing mechanism. Operation counter and mechanically ON- OFF indicator shall be provided.

10.0 VACUUM CIRCUIT BREAKER

The three phase Vacuum Circuit Breaker will have three Vacuum interrupters (one interrupter per phase) mounted on same carriage. The interrupters shall be air insulated inside support insulators. Each interrupter shall have fixed and moving contacts in sealed envelopes having Vacuum below 10^{-6} torr. The metallic bellow shall permit axial movement of moving contract and act as vacuum seal. The contacts shall have requisite mechanical strength and good electrical and thermal conductivity and shall be made of copper chromium alloy. Complete literature of vacuum bottles shall be furnished with the tender.

11.0 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.

11.1. 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.

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.

11.2 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.

11.3 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.

11.4 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.

11.5 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.

11.6 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.

12.0 OPERATING MECHANISM

12.1 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 or IS:13118. 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.

12.2 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.

12.3 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.

13.0 AUXILIARY POWER SUPPLY

The operating mechanism shall be suitable to operate with the following auxiliary power supplies.

- a) 230V, 50Hz Single phase For spring charging motor A.C
- b) DC supply 24 Volts-For close and open coils, indication & Alarm
- c) (Power pack input supply: 230V & 110V AC and Output: 24V DC)

The DC supply shall be from a Power Pack. The Input to Power Pack is 110V from PT and 230V from main supply. The power pack should be capable for minimum 3 Trippings even if input to power pack is failed.

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 From 115% to 85% of normal and frequency variation
- DC supply: Voltage From 120% to 70% of normal voltage

14.0 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.

15.0 PROTECTION AND METERING

- Inter-tripping for simultaneous tripping other circuit breaker.

16.0 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.

17.0 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 - 150mm
- Phase to earth 120mm
- Ground clearance for live part **2800**

18.0 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.

19.0 TESTS

19.1 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 tests reports should 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:

19.2 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.

19.3 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.

19.4 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.

19.5 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.

19.6 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.

19.7 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.

19.8 TEST AT SITE

The purchaser reserves the right to conduct all tests on 12 KV circuit breakers after arrival at site and the contractor shall guarantee test certificate figures under actual service conditions.

20.0 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.

21.0 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:56 or IS:13118. 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.

22.0 Mandatory Spare Parts for 11KV Outdoor VCB

The supplier should provide the mandatory spares as per **Price Schedule-VIIA Substation** free of cost without any extra price for these spares parts. However, where part quantity has been offered spare parts will be varied proportionately.

22.0 MAKE AND TYPE OF BOUGHT OUT ITEMS:

22.1 The make of all bought out items shall be acceptable if it is of "ISI Marked" or type for which the bidder shall furnish attested Photostat copies of ISI certificate/ type test report not earlier than three years for the respective make offered along with the tender.

22.2 Make/ type of each relay, indicating instruments, integrating instruments, control switch for Circuit Breaker/ Trip Transfer selector switch for voltmeter/ Ammeter, Semaphore Indicator, indicating lamps, annunciater, Push Button, AC Hooter, Heater, Link Type, Test Terminal Block for testing of TVM, CFL Tube, 2/3 Pin Socket with

switch etc. shall be clearly and invariably indicated GTP (Guaranteed Technical Particulars), bill of materials and unit price list Only specific make accessories shall be indicated. The word "EQUIVALENT/REPUTED MAKE" will not be taken for consideration.

- 22.3** Other standard accessories which are not specifically mentioned but are required to be supplied with circuit breaker VCB of similar type and rating for efficient and trouble- free operation.

**TECHNICAL SPECIFICATION
FOR
CURRENT TRANSFORMERS (OUT DOOR)**

33KV CT (OUT DOOR)

a) RATIO-400-200 /1-1-1A

11KV CT (OUT DOOR)

a) RATIO-400-200 /1-1-1A

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PART - A

33KV CT (OUT DOOR)

a) RATIO-400-200 /1-1-1A

TECHNICAL SPECIFICATION FOR 33KV CURRENT TRANSFORMERS (Ratio: 400-200/1-1-1) WITH METERING CORES OF ACCURACY CLASS 0.2

1.0 SCOPE :

1.1. The specification covers the design, manufacture, assembly, inspection and testing at the manufacture's work, packing and delivery F.O.R. (destination) of the outdoor mounted dead tank type, single phase, single unit type Current Transformers for protection and metering services in 33kV solidly grounded system.

1.2. The current transformers shall be of the outdoor type, single phase, 50 C/S, oil immersed, self cooled, hermetically sealed and suitable for operating in the tropical conditions with maximum ambient temperature up to 50⁰C. The CTs should be suitable for use in the areas subject to heavy lightning storms and highly polluted conditions.

1.3. Followings are the list of documents constituting this specification.

[i]	Technical specification(TS)	
[ii]	Technical Requirements & General Requirement	E16
[iii]	Calibration Status of testing equipments and meters / Instruments	E16
Note :	E16 to be filled up by the Bidder	

1.4 The Current Transformer shall conform in all respects to high standards of engineering, design, workmanship and latest revisions of relevant standards at the time of offer and Owner shall have the power to reject any work or material which in his judgment is not in full accordance therewith.

1.5 Bidders are required to quote for 0.2 accuracy class of Metering cores with the following data / information etc.

- [a] Guaranteed Technical particulars.
- [b] Technical literatures, brochures and drawings as per this specification.
- [c] Type Test Reports.
- [d] List of orders, executed and User's certificates, failing submission of the above particulars with the offer, the tender may not be considered for evaluation.

2.0 STANDARDS

2.1 Except to the extent modified in the specification, the CTs shall conform to the latest editions and amendments of the standards listed hereunder.

Sl. No.	Standard Ref. No.	Title
1	IEC-44	Instrument transformer-measurement of PDS
2.	IEC-60	High Voltage Testing Technique.
3.	IEC-171	Insulation co-ordination
4.	IEC-185	Current Transformers.
5.	IEC-270	Partial Discharge Measurement
6.	IEC-8263	Method for RIV Test on High Voltage Insulators.
7.	IS-335	Insulating oil for Transformers

8.	IS:2071	Method of High Voltage Testing
9.	IS:2099	High Voltage porcelain Bushings
10.	IS:2147	Degree of Protection Provided by Enclosures for Low Voltage Switchgear and Control.
11.	IS:2165	Insulation Co-ordination for equipment of 100KV and above
12.	IS:2705 [Part-I to IV)	Current Transformers
13.	IS:3347	Dimensions of Porcelain Transformer Bushing
14.	IS:5621	Specification for Large Hollow Porcelain for use in Electrical installation.
15.	IS:4201	Application guide for CTS
16.		Indian Electricity Rules, 1956
17.	<i>IS:13072 –of1991</i>	<i>SF6 Gas (for 220kv SF6 gas filled CTs only)</i>
18.	<i>IEC:60376</i>	<i>SF6 Gas(for 220kv SF6 gas filled CTs only)</i>

- 2.2 Current Transformers with the requirements of other authoritative standards, which ensure equal or better quality than the standards, mentioned above, shall also be acceptable, where the equipment, offered by the supplier conforms to other standards, salient points of difference between the standards adopted and specified standards shall be brought out in the offer. 4 (four) copies of the reference standards in English language shall be furnished along with the offer.
- 2.3 The supplier is to furnish the latest edition of the standards as mentioned above from SI.1 to SI.15 with their amendments, if any, at their own cost, if required by the Owner.
- 2.4 All the above along with amendments thereof shall be read and interpreted together. However, in case of a contradiction between the Technical Specification and any other volume, the provisions of this specification will prevail.

3.0 CLIMATIC & SERVICE CONDITIONS :

Please refer **chapter E3** of Technical Specification on climatic conditions.

3.1 EARTHQUAKE INCIDENCE

The current Transformers are to be designed to withstand earthquakes of an intensity equivalent to seismic acceleration of 0.3g in the horizontal direction and 0.15g in the vertical direction, where 'g' stands for acceleration due to gravity.

- 3.2 The current Transformers covered under this specification shall be suitable for outdoor installation.

4.0 GENERAL TECHNICAL REQUIREMENTS :

- 4.1 The C.T. shall be of dead tank design and shall be so constructed that it can be easily transported to site within the allowable limitation and in horizontal position if the

transport limitations so demand. For compensation of variation in the oil volume due to ambient variation, nitrogen cushion / metal bellows shall be used. Rubber diaphragms shall not be permitted for this purpose.

- 4.2 The C.T. secondary terminals shall be brought out in a weather proof terminal box. The terminal box shall be provided with removable gland plate and gland (s) suitable for 1100 volts grade PVC insulated, PVC sheathed, multicore 4 Sq. mm stranded copper conductor cable. The terminal blocks shall be stud-type and provided with ferrules indelibly marked or numbered. The terminals shall be rated for not less than 10 Amps. The terminal box shall be dust and vermin proof. Suitable arrangements shall be made for drying of air inside the secondary terminal box. The dimensions of the terminal box and its openings shall be adequate to enable easy access and working space with the use of normal tools.
- 4.3 Polarity shall be indelibly marked on each primary and secondary terminal. Facility shall be provided for short-circuiting and grounding of the C.T. secondary terminals inside the terminal box.
- 4.4 The C.T. shall be provided with non-corrosive, legible name plate with the information, specified in the relevant standards, duly engraved/punched on it.
- 4.5 The current Transformer shall be vacuum filled with oil after processing and thereafter hermetically sealed to eliminate breathing and to prevent air and moisture from entering the tanks. Oil filling and / or sampling cocks, if provided to facilitate factory processing should be properly sealed before despatching the C.T., The method adopted for hermetic sealing shall be described in the offer.
- 4.6 The castings of base, collar etc. shall be die cast and tested before assembly to detect cracks and voids, if any.
- 4.7 The instrument security factor of metering core shall be low enough and not greater than '5'. This shall be demonstrated on all the ratios of the metering core in accordance with procedure, specified in IEC-185 OR IS: 2705. In case the instrument security factor of 5 or less is not possible to be achieved on higher ratios, auxiliary CTs of ratio 1/1 and 0.2 accuracy class shall be deemed to be included in the supplier's scope of supply. This shall also be specifically brought out by the supplier in his offer. However, all parameters, specified shall have to be met treating auxiliary CT/ reactor as an integral part of the current Transformer. The auxiliary CTs/reactor shall be inbuilt construction of the CTs.
- 4.8 Current transformers' guaranteed burdens and accuracy class are to be intended as simultaneous for all cores.

4.9 For 36kV Current Transformers, characteristics shall be such as to provide satisfactory performance for burdens ranging from 25% to 100% of rated burden over a range of 5% to 120% of rated current in case of Metering Core and up to accuracy limit factor / knee point voltage in case of Protection Core.

4.10 Current Transformers shall be designed so as to achieve the minimum risk of explosion in service. The Bidder shall bring out in his offer, the measures taken to achieve this.

5.0 PRIMARY WINDING

5.1 Primary winding may be either ring type or hair pin type or the type, which has been type tested. For 33kV class CTs, the rated extended primary current shall be 120% on all cores of the CTs, specified in tables.

5.1.1 The primary windings of current transformers shall be constructed of high purity, annealed, high conductivity electrolytic Copper meeting to the requirements of IEC 28/IS: 2705.

5.2 SECONDARY WINDINGS:

Suitably insulated copper wire of electrolytic grade shall be used for secondary windings. Type of insulation, used shall be described in the offer. The secondary taps shall be adequately reinforced to withstand handling without damage.

The rating of the Current Transformer's secondary winding shall be 1 (one) Amp. The secondary terminals shall be brought out in a compartment for easy access.

5.3 PRIMARY TERMINALS

The primary terminals shall be heavily tinned electrolytic Copper of 99.9% conductivity. The minimum thickness of tinning shall be 1.5 microns.

5.4 SECONDARY TERMINALS

5.4.1 Secondary terminal studs shall be provided with at least three nuts and adequate plain and spring washers for fixing the leads. The studs, nuts and washers shall be of brass, duly nickel plated. The minimum outside diameter of the stud shall be 6 mm. The length of at least 15 mm shall be available on the studs for inserting the leads. The horizontal spacing between the centers of the adjacent studs shall be at least 1.5 times the outside circum-dia of the nuts.

5.4.2 The current transformer shall be provided with suitable test tap for measurement of capacitance, tan delta as well as partial discharges. Provision shall be made on a screw cap for solid and secured earthing of the test tap connection, when not in use. A suitable caution plate shall be provided duly fixed on the cover of the secondary terminal box indicating the purpose of the test tap and the necessity of its solid earthing as per prescribed method before energising the Current Transformer.

5.4.3 The secondary terminals shall be provided with shorting arrangements.

5.5 CORE

Each core of the Current Transformer shall be of torroidal shape. Core laminations shall be of Cold Rolled Grain Oriented silicon steel or other equivalent alloys of low hysteresis and eddy current losses, high permeability to ensure high accuracy at both normal and over-current conditions. The cores used for protection shall produce undistorted secondary current under transient conditions at all ratios, with specified Current Transformer parameters. The core material, thickness of lamination, the relevant graphs showing the characteristics of the core material shall be submitted along with the offer.

5.6 TANK

- 5.6.1 Both expansion chambers and the tanks of the Current Transformers shall be made up of high quality steel, which should be able to withstand full vacuums and pressure occurring during transit and thermal and mechanical stresses resulting from maximum short circuit current during operation. The tanks along with all ferrous parts shall be galvanised as per relevant standard.
- 5.6.2 The metal tanks shall have bare minimum number of welded joints so as to minimise possible locations of oil leakage. Welding in horizontal plane is to be avoided as welding at this location may give way due to vibrations during transport resulting in oil leakage. Supplier has to obtain specific approval from purchaser for any horizontal welding used in the bottom tank.

5.6.3

5.7 SECONDARY TERMINAL BOX :

- 5.7.1 Secondary Terminal Boxes shall be weather proof with a rating not less than IP 55
- 5.7.2 All secondary terminals shall be brought out in a compartment on one side of each current transformer for easy access.
- 5.7.3 The exterior of this terminal box shall be of aluminium alloy sheet of minimum 3 mm thickness.
- 5.7.4 A terminal board which shall have arrangement for series / parallel connection and arrangement for shorting of secondary terminals shall be provided. For 33kV CTs, at least one of the ratios should be achieved through secondary tapping(s) i.e. primary re-connection is allowed for two ratios whereas third ratio is to be achieved by provision of secondary tapping or alternatively all the stipulated ratios may be achieved through secondary tappings. Series parallel connection or by secondary tapping.
- 5.7.5 The terminal box shall be provided with a removable cable gland plate at bottom for mounting cable glands for 1.1kV PVC sheathed 3 nos. of 4x 4 Sq. mm stranded copper conductor cables.
- 5.7.6 The terminal box shall be provided with a door in front so as to have easy access of secondary terminals. The door shall have a sealing / locking arrangement and shall be suitable to prevent penetration of moisture and rain water.

5.7.7 All terminals shall be clearly marked with identification number to facilitate connection to external wiring.

5.7.8 The secondary box of the CT's also of high quality steel materials with galvanizing as per standard IS.

5.7.9

PORCELAIN HOUSING

5.7.9.1 The housing shall be made up of homogeneous, vitreous porcelain of high mechanical and dielectric strength, Glazing of porcelain shall be of uniform brown or dark brown colour with a smooth surface, arranged to shed away rain water or condensed water particles (fog.) The details of location and type of joint, if provided on the porcelain, shall be furnished by the Bidder along with the offer.

5.7.9.2 The bushings of the Current Transformers shall conform to the latest edition of IS: 2099. The hollow porcelain insulator shall conform to the latest edition of IS: 5621.

5.7.9.3 The insulators shall be cemented with Portland cement to the flanges resulting in high mechanical, tensile and breaking strength.

5.7.9.4 The bushings shall have ample insulation, mechanical strength and rigidity for the condition under which they shall be used and shall be designed to prevent accumulation of explosive gases and provide adequate oil circulation to remove the internal heat.

5.7.9.5 Cast metal end caps for the bushings shall be of high strength, hot dip galvanized malleable iron. They shall have smooth surface to prevent discharge taking place between the metal parts and porcelain as a result of ionisation.

5.7.9.6 The insulation of bushings shall be coordinated with that of the current transformer such that the flashover, if any, will occur only external to the Current Transformer.

5.7.9.7 Oil level gauge and convenient means of filling, sampling and draining of oil should be provided.

5.7.10 End shields should be provided for distribution of stresses.

5.7.11 Corona shields for bushings, if required should be provided.

5.8 INSULATING MEDIUM (OIL TYPE)

The quantity of insulating oil for the filling and the complete specification of the insulating oil shall be stated. The oil shall comply in all respects with the provisions of latest edition of IS: 335. The Current Transformers shall be supplied, filled with purified oil completely.

5.8.1 PREVENTION OF OIL LEAKAGE AND ENTRY OF MOISTURE:

The supplier shall ensure that the sealing of the Current Transformer is properly achieved. In this connection, the arrangement provided by the supplier at various locations including the following ones shall be described, supported by sectional drawings.

- (a) locations of emergence of primary and secondary terminals.
- (b) Interface between porcelain housing and metal tank/s
- (c) Cover of the secondary terminal box.

- 5.8.2 Nuts and bolts or screws, used for fixation of the interfacing porcelain bushings for taking out terminals shall be provided on flanges, cemented to the bushings and not on the porcelain.
- 5.8.3 For gasketed joints, wherever used, nitrile butyl rubber gaskets shall be used. The gasket shall be fitted in properly machined groove with adequate space for accommodating the gasket under compression.

5.9 FITTINGS AND ACCESSORIES :

Fittings and accessories, listed below shall be supplied with each Current Transformer. Any fitting, required essential other than those listed below shall also be supplied along with each Current Transformer without any extra cost to the purchaser:

- (a) Oil level gauge.
- (b) Oil filling hole and cap.
- (c) Pressure relieving device.
- (d) Phase terminal connectors.
- (e) Lifting lugs for core and windings, bushings and complete Current Transformers.
- (f) Tank earthing pads /terminals with necessary nuts, bolts and washers for connecting to earth strip.
- (g) Name / Rating plate.

5.9.1 (A) OIL LEVEL GAUGE :

An oil level gauge shall be provided to indicate the oil level in the Current Transformer. This gauge shall be mounted in such a way that the oil level can be seen from ground level. If metal bellow is used, a ground glass window shall be provided to monitor the position of the metal bellow. The metal bellow shall be tested in accordance with relevant standards. The details shall be to the approval of the Owner.

5.9.2 PRESSURE RELIEVING DEVICE :

Each Current Transformer shall be provided with a pressure relieving device so as to protect bushing of the Current Transformer even under unfavorable conditions.

(A) OIL DRAIN COCK:

An oil drain cock along with a stop cock shall be provided in the bottom flange so as to permit taking of oil samples for testing, if required.

5.9.3 EARTHING :

Metal tank of each Current Transformer shall be provided with two separate earthing terminals for bolted connection to 50mm X 6 mm flat, to be provided by the Owner for connection to station earth-mat.

5.9.4 LIFTING ARRANGEMENT :

The Current Transformer shall be provided with suitable lifting arrangement to lift the entire unit. The lifting arrangement shall be clearly shown in the general arrangement drawing. Lifting arrangement (lifting eye) shall be positioned in such a way so as to avoid any damage to the porcelain housing or the tanks during lifting

for installation / transport. Necessary string guides shall be offered which shall be of removable type.

5.9.5 NAME PLATE & MARKING :

- 5.9.5.1 The Current Transformer shall be provided with non-corrosive, legible name plate with the information specified in relevant standards, duly engraved/punched on it.
- 5.9.5.2 A schematic drawing indicating the connections shall be provided in the interior of the Terminal box.

5.9.6 TERMINAL CONNECTORS :

All the Current Transformers shall be provided with bimetallic solder less clamp type, rigid type terminal connectors, suitable for

- (i) **33KV C.T. – AAAC 148 Sq mm conductor.**

Each terminal connector shall be of universal type, suitable for both horizontal and vertical connections to the transmission line conductors / station bus bars.

- 5.9.6.1 Terminal connectors shall be manufactured and tested as per IS: 5561.
- 5.9.6.2 All castings shall be free from blow holes, surface blisters, cracks and cavities. All sharp edges and corners shall be blurred and rounded off.
- 5.9.6.3 No part of a clamp shall be less than 10mm thick.
- 5.9.6.4 All ferrous parts shall be hot-dip galvanised conforming to relevant standard.
- 5.9.6.5 For bimetallic connectors, copper alloy linear of minimum thickness of 2 mm shall be cast integral with aluminium body.
- 5.9.6.6 All current carrying parts shall be designed and manufactured to have minimum contact resistance.
- 5.9.6.7 Connectors shall be designed to be corona free in accordance with the requirements, stipulated in IS: 5561.

6.0 TEST:

6.1 TYPE TESTS & SPECIAL TESTS:-

The current transformers, offered should have been subjected to the following type tests and Special Tests in Government approved test laboratory. The bidder shall furnish four sets of type test and Special Tests reports along with the offer for 0.2 accuracy class CTs. These tests should not have been conducted earlier than five years from the date of opening of the bid. For any change in the design/type already type tested and the design/type offered against this specification, the Owner reserves the right to demand repetition of some or all type & special tests without any extra cost to OPTCL in the presence of Owner's representative(s).

- (a) Lightning Impulse Voltage Test.
- (b) High Voltage power frequency wet withstands voltage Test.
- (c) Short time current test.
- (d) Temperature rise test.

- (e) Determination of errors or other characteristics according to the requirements of the appropriate designation and accuracy class as per individual parts of IS: 2705.
- (f) Instrument Security Factor Test.
- (g) IP-55 Test on Secondary Terminal Box.

N.B:

- Lightning Impulse Test, switching Impulse Voltage test and High Voltage power frequency wet withstand voltage Tests should have been carried out on the same current transformer.
- After the current transformers have been subjected to lightning Impulse Test, and High Voltage power frequency wet withstand voltage tests, these must have been subjected to all the routine tests as per IS:2705 (Part-I to IV).

6.2 ROUTINE TESTS :

The following routine tests shall be conducted on each Current Transformer in the presence of Owner's representative(s) for which no charges will be payable by Owner. No sampling will be allowed.

- (i) Appearance and Dimensional Check.
- (ii) Verification of Terminal Marking and polarity.
- (iii) Verification of all individual parts / components of the Current Transformer so as to ensure to have complied the above specification.
- (iv) Measurement of Insulation Resistance.
- (v) Power Frequency Dry withstanding Test on Primary and Secondary winding including primary intersections.
- (vi) Over – Voltage Interturn test.
- (vii) Partial discharge Test
- (viii) Knee point voltage and Excitation current measurement for 'PS' class cores.
- (ix) Secondary winding resistance measurement.
- (x) Determination of errors.
- (xi) ISF Test.
- (xii) Leakage Test.
- (xiii) Magnetization Characteristics of the Current Transformers.
- (xiv) Turn ratio error on 'PS' class cores.
- (xv) Measurement of capacitance
- (xvi) Measurement of tan delta at 0.3, 0.7, 1.0 and $1.1U_m/\sqrt{3}$ for 33KV CTs.

- The Method For Conducting Partial Discharge Test.

The test circuit for the measurement of partial discharge (PD) should have been in accordance with sub-clause 4.2 of IEC-270. The applied voltage should be raised to the rated voltage of the Current Transformers and should have been maintained for a period greater than or equal to 10 seconds. The voltage should have been reduced to measuring voltage as specified in the IS and maintained for a period greater than or equal to 1 minute. The PD should not exceed 10 Pico-coulombs.

7.0 INSPECTION :

7.1 The Owner shall have access at all times to the works and all other places of manufacture, where the Current Transformers are being manufactured and the supplier shall provide all facilities for unrestricted inspection of the supplier's works, raw materials, manufacture of all the accessories and for conducting the necessary tests.

7.2 The Bidder shall keep the Owner informed in advance of the time of starting and of the progress of manufacture of equipment in its various stages so that arrangement could be made for inspection.

7.3 No material shall be despatched from its point of manufacture unless the material has been satisfactorily inspected, tested and despatch clearance issued. However, the Owner reserves the right to alter the despatch schedule, attached to this specification without any extra financial liability to OPTCL.

7.3.1 The acceptance of any quantity of equipment shall in no way relieve the supplier of his responsibility for meeting all the requirements of this specification and shall not prevent subsequent rejection, if such equipments are found to be defective.

8.0 DOCUMENTATION :

8.1 All drawings shall conform to relevant Indian Standard as per relevant IS. All drawings shall be in ink and suitable for microfilming. All dimensions and data shall be in S.I. units.

8.2 The supplier shall furnish four sets of following drawings/documents along with his offer for 0.2 accuracy class metering core CTs.

- (a) General outline and assembly drawings of the Current Transformers.
- (b) Sectional views showing.
 - (i) General constructional features.
 - (ii) Materials / gaskets / sealing used.
 - (iii) The insulation of the winding arrangement, method of connection of the primary / secondary winding to the primary / secondary terminals etc.
- (c) Schematic drawing
- (d) Rating and Diagram plate.
- (e) Secondary Terminal Box.
- (f) Assembly Sectional view of Primary Terminal
- (g) Assembly drawing for secondary terminal.
- (h) The detailed dimensional drawing of Porcelain Housing such as ID, OD, thickness and Insulator details such as height, profile of petticoats, angle of inclination and gap between successive petticoats, total creepage distance etc.
- (i) Sectional view of Pressure Release device.
- (j) Drawing showing details of Oil level Indicator.
- (k) All type and special test reports relating to tests, as mentioned at Cl. No. 6.1 of this Technical Specification.
- (l) Ratio and phase angle error curves for CTs.
- (m) Magnetization characteristic curves such as B-H curves and sp.loss vs. flux density curves.
- (n) Drawings for Terminal Connector.

9.0 TEST REPORTS :

- (i) A set of type test and special test reports if any shall be furnished to the purchaser during detailed Engineering & drawing approval.
- (ii) Copies of acceptance test reports and routine test reports shall be furnished to the purchaser. One copy will be returned, duly certified by the purchaser and only thereafter shall the materials be despatched.
- (iii) All records of routine test reports shall be maintained by the supplier at his works for periodic inspection by the purchaser.
- (iv) All test reports of tests, conducted during manufacture shall be maintained by the supplier. These shall be produced for verification as and when required by the Owner.

**TECHNICAL SPECIFICATION
FOR
CURRENT TRANSFORMERS (OUT DOOR)**

11KV CT (OUT DOOR)

a) RATIO-400-200 /1-1-1A

TECHNICAL SPECIFICATION FOR 11KV CURRENT TRANSFORMERS (Ratio: 400-200 /1-1-1A) WITH METERING CORES OF ACCURACY CLASS 0.2

1.0 SCOPE :

1.1 The specification covers the design, manufacture, assembly, inspection and testing at the manufacture's work, packing and delivery F.O.R. (destination) of the outdoor mounted dead tank type, single phase, single unit type current Transformers **(Ratio: 400-200 /1-1-1A)** for protection and metering services in 11kV solidly grounded system.

1.2 The current transformers shall be of the outdoor type, single phase, 50 C/S, oil immersed, self cooled, hermetically sealed and suitable for operating in the tropical conditions with maximum ambient temperature up to 50⁰C. The C.TS should be suitable for use in the areas subject to heavy lightning storms and highly polluted conditions.

1.3 Followings are the list of documents constituting this specification.

[i]	Technical specification(TS)	
[ii]	Technical Requirements & General Requirement	E16
[iii]	Calibration Status of testing equipments and meters / Instruments	E16
Note :	E16 to be filled up by the Bidder	

1.4 The current transformer shall conform in all respects to high standards of engineering, design, workmanship and latest revisions of relevant standards at the time of offer and purchaser shall have the power to reject any work or material which in his judgment is not in full accordance therewith.

1.5 Bidders are required to quote for 0.2 accuracy class of metering cores with the following data / information etc.

- [a] Guaranteed Technical particulars.
- [b] Technical literatures, brochures and drawings as per this specification.
- [c] Type Test Reports.
- [d] List of orders, executed and User's certificates, failing submission of the above particulars with the offer, the tender may not be considered for evaluation.

2 STANDARDS

2.1 Except to the extent modified in the specification, the C.TS shall conform to the latest editions and amendments of the standards listed hereunder.

Sl. No.	Standard Ref. No.	Title
1	IEC-44	Instrument transformer-measurement of PDS
2.	IEC-60	High Voltage Testing Technique.
3.	IEC-171	Insulation co-ordination
4.	IEC-185	Current Transformers.
5.	IEC-270	Partial Discharge Measurement
6.	IEC-8263	Method for RIV Test on High Voltage Insulators.
7.	IS-335	Insulating oil for Transformers
8.	IS:2071	Method of High Voltage Testing
9.	IS:2099	High Voltage porcelain Bushings
10.	IS:2147	Degree of Protection Provided by Enclosures for Low Voltage Switchgear and Control.
11.	IS:2165	Insulation Co-ordination for equipment of 100KV and above
12.	IS:2705 [Part-I to IV)	Current Transformers
13.	IS:3347	Dimensions of Porcelain Transformer Bushing
14.	IS:5621	Specification for Large Hollow Porcelain for use in Electrical installation.
15.	IS:4201	Application guide for CTS
16.		Indian Electricity Rules, 1956
17.	<i>IS:13072 –of1991</i>	<i>SF6 Gas (for 220kv SF6 gas filled CTs only)</i>
18.	<i>IEC:60376</i>	<i>SF6 Gas(for 220kv SF6 gas filled CTs only)</i>

- 2.2 Current Transformers with the requirements of other authoritative standards, which ensure equal or better quality than the standards, mentioned above, shall also be acceptable, where the equipment, offered by the supplier conforms to other standards, salient points of difference between the standards adopted and specified standards shall be brought out in the offer. 4 (four) copies of the reference standards in English language shall be furnished along with the offer.
- 2.3 The supplier is to furnish the latest edition of the standards as mentioned above from Sl.1 to Sl.15 with their amendments, if any, at their own cost, if required by the Purchaser.
- 2.4 All the above along with amendments thereof shall be read and interpreted together. However, in case of a contradiction between the Technical Specification and any other volume, the provisions of this specification will prevail.

3 CLIMATIC & SERVICE CONDITIONS :

Please refer **chapter E3** of Technical Specification on climatic conditions.

3.1 EARTHQUAKE INCIDENCE

The current Transformers are to be designed to withstand earthquakes of an intensity equivalent to seismic acceleration of 0.3g in the horizontal direction and 0.15g in the vertical direction, where 'g' stands for acceleration due to gravity.

3.3 The current Transformers covered under this specification shall be suitable for outdoor installation.

4 GENERAL TECHNICAL REQUIREMENTS :

4.1 The C.T. shall be of dead tank design and shall be so constructed that it can be easily transported to site within the allowable limitation and in horizontal position if the transport limitations so demand. For compensation of variation in the oil volume due to ambient variation, nitrogen cushion / metal bellows shall be used. Rubber diaphragms shall not be permitted for this purpose.

4.1.1 The C.T. secondary terminals shall be brought out in a weather proof terminal box. The terminal box shall be provided with removable gland plate and gland (s) suitable for 1100 volts grade PVC insulated, PVC sheathed, multicore 4 Sq. mm stranded copper conductor cable. The terminal blocks shall be stud-type and provided with ferrules indelibly marked or numbered. The terminals shall be rated for not less than 10 Amps. The terminal box shall be dust and vermin proof. Suitable arrangements shall be made for drying of air inside the secondary terminal box. The dimensions of the terminal box and its openings shall be adequate to enable easy access and working space with the use of normal tools.

4.1.2 Polarity shall be indelibly marked on each primary and secondary terminal. Facility shall be provided for short-circuiting and grounding of the C.T. secondary terminals inside the terminal box.

4.1.3 The C.T. shall be provided with non-corrosive, legible name plate with the information, specified in the relevant standards, duly engraved/punched on it.

4.1.4 The current Transformer shall be vacuum filled with oil after processing and thereafter hermetically sealed to eliminate breathing and to prevent air and moisture from entering the tanks. Oil filling and / or sampling cocks, if provided to facilitate factory processing should be properly sealed before despatching the C.T., The method adopted for hermetic sealing shall be described in the offer.

- 4.1.5 The castings of base, collar etc. shall be die cast and tested before assembly to detect cracks and voids, if any.
- 4.1.6 The instrument security factor of metering core shall be low enough and not greater than '5'. This shall be demonstrated on all the ratios of the metering core in accordance with procedure, specified in IEC-185 OR IS: 2705. In case the instrument security factor of 5 or less is not possible to be achieved on higher ratios, auxiliary CTS of ratio 1/1 and 0.2 accuracy class shall be deemed to be included in the supplier's scope of supply. This shall also be specifically brought out by the supplier in his offer. However, all parameters, specified shall have to be met treating auxiliary CT/ reactor as an integral part of the current Transformer. The auxiliary C.TS/reactor shall be inbuilt construction of the C.TS.
- 4.1.7 Current transformers' guaranteed burdens and accuracy class are to be intended as simultaneous for all cores.
- 4.1.8 For 12 KV Current Transformers, characteristics shall be such as to provide satisfactory performance for burdens ranging from 25% to 100% of rated burden over a range of 5% to 120% of rated current in case of metering CTS and up to accuracy limit factor / knee point voltage in case of relaying C.TS.
- 4.1.9 Current Transformers shall be designed so as to achieve the minimum risk of explosion in service. The Bidder shall bring out in his offer, the measures taken to achieve this.

5 PRIMARY WINDING

5.1 Primary winding may be either ring type or hair pin type or the type, which has been type tested. For 11KV class C.Ts, the rated extended primary current shall be 120% on all cores of the C.Ts, specified in tables.

5.1.1 The primary windings of current transformers shall be constructed of high purity, annealed, high conductivity electrolytic copper/Aluminium meeting to the requirements of IEC 28/IS: 2705.

5.2 SECONDARY WINDINGS:

Suitably insulated copper wire of electrolytic grade shall be used for secondary windings. Type of insulation, used shall be described in the offer. The secondary taps shall be adequately reinforced to withstand handling without damage.

The rating of the Current Transformer's secondary winding shall be 1 (One) Amp. The secondary terminals shall be brought out in a compartment for easy access.

5.3 PRIMARY TERMINALS

The primary terminals shall be heavily tinned electrolytic copper or Aluminium alloy of 99.95% conductivity. The minimum thickness of tinning shall be 1.5 microns.

5.4 SECONDARY TERMINALS

5.4.1 Secondary terminal studs shall be provided with at least three nuts and adequate plain and spring washers for fixing the leads. The studs, nuts and washers shall be of brass, duly nickel plated. The minimum outside diameter of the stud shall be 6 mm. The length of at least 15 mm shall be available on the studs for inserting the leads. The horizontal spacing between the centers of the adjacent studs shall be at least 1.5 times the outside circum-dia of the nuts.

5.4.2 The current transformer shall be provided with suitable test tap for measurement of capacitance, tan delta as well as partial discharges. Provision shall be made on a screw cap for solid and secured earthing of the test tap connection, when not in use. A suitable caution plate shall be provided duly fixed on the cover of the secondary terminal box indicating the purpose of the test tap and the necessity of its solid earthing as per prescribed method before energising the Current Transformer.

5.4.3 The secondary terminals shall be provided with shorting arrangements.

5.5 CORE

Each core of the Current Transformer shall be of torroidal shape. Core laminations shall be of cold rolled grain oriented silicon steel or other equivalent alloys of low hysteresis and eddy current losses, high permeability to ensure high accuracy at both normal and over-current conditions. The cores used for protection shall produce undistorted secondary current under transient conditions at all ratios, with specified Current Transformer parameters. The core material, thickness of lamination, the relevant graphs showing the characteristics of the core material shall be submitted along with the offer.

5.6 TANK

5.6.1 Both expansion chambers and the tanks of the Current Transformers shall be made up of high quality steel, which should be able to withstand full vacuums and pressure occurring during transit and thermal and mechanical stresses resulting from maximum short circuit current during operation. The tanks along with all ferrous parts shall be galvanised as per relevant standard.

5.6.2 The metal tanks shall have bare minimum number of welded joints so as to minimise possible locations of oil leakage. Welding in horizontal plane is to be avoided as welding at this location may give way due to vibrations during transport resulting in oil leakage. Supplier has to obtain specific approval from purchaser for any horizontal welding used in the bottom tank.

5.7 SECONDARY TERMINAL BOX :

- 5.7.1 Secondary Terminal Boxes shall be weather proof with a rating not less than IP 55
- 5.7.2 All secondary terminals shall be brought out in a compartment on one side of each current transformer for easy access.
- 5.7.3 The exterior of this terminal box shall be of aluminium alloy sheet of minimum 3 mm thickness.
- 5.7.4 A terminal board which shall have arrangement for series / parallel connection and arrangement for shorting of secondary terminals shall be provided. For 11KV C.Ts, at least one of the ratios should be achieved through secondary tapping(s). I.e. primary re-connection is allowed for two ratios where as third ratio is to be achieved by provision of secondary tapping or alternatively all the stipulated ratios may be achieved through secondary tapplings. Series parallel connection or by secondary tapping.
- 5.7.5 The terminal box shall be provided with a removable cable gland plate at bottom for mounting cable glands for 1.1KV PVC sheathed 3 nos. of 4x 4 Sq. mm stranded copper conductor cables.
- 5.7.6 The terminal box shall be provided with a door in front so as to have easy access of secondary terminals. The door shall have a sealing / locking arrangement and shall be suitable to prevent penetration of moisture and rain water.
- 5.7.7 All terminals shall be clearly marked with identification number to facilitate connection to external wiring.
- 5.7.8 The secondary box of the CT's also of high quality steel materials with galvanizing as per standard (IS).

PORCELAIN HOUSING

- 5.7.8.1 The housing shall be made up of homogeneous, vitreous porcelain of high mechanical and dielectric strength, Glazing of porcelain shall be of uniform brown or dark brown colour with a smooth surface, arranged to shed away rain

water or condensed water particles (fog.) The details of location and type of joint, if provided on the porcelain, shall be furnished by the Bidder along with the offer.

- 5.7.8.2 The bushings of the Current Transformers shall conform to the latest edition of IS: 2099. The hollow porcelain insulator shall conform to the latest edition of IS: 5621.
- 5.7.8.3 The insulators shall be cemented with Portland cement to the flanges resulting in high mechanical, tensile and breaking strength.
- 5.7.8.4 The bushings shall have ample insulation, mechanical strength and rigidity for the condition under which they shall be used and shall be designed to prevent accumulation of explosive gases and provide adequate oil circulation to remove the internal heat.
- 5.7.8.5 Cast metal end caps for the bushings shall be of high strength, hot dip galvanized malleable iron. They shall have smooth surface to prevent discharge taking place between the metal parts and porcelain as a result of ionisation.
- 5.7.8.6 The insulation of bushings shall be coordinated with that of the current transformer such that the flashover, if any, will occur only external to the Current Transformer.
- 5.7.8.7 Oil level gauge and convenient means of filling, sampling and draining of oil should be provided.
- 5.7.9 End shields should be provided for distribution of stresses.
- 5.7.10 Corona shields for bushings, if required should be provided.

5.8 INSULATING MEDIUM (OIL TYPE)

The quantity of insulating oil for the filling and the complete specification of the insulating oil shall be stated. The oil shall comply in all respects with the provisions of latest edition of IS: 335. The current Transformers shall be supplied, filled with purified oil completely.

5.8.1 PREVENTION OF OIL LEAKAGE AND ENTRY OF MOISTURE:

The supplier shall ensure that the sealing of the Current Transformer is properly achieved. In this connection, the arrangement provided by the supplier at various locations including the following ones shall be described, supported by sectional drawings.

- (d) locations of emergence of primary and secondary terminals.
- (e) Interface between porcelain housing and metal tank/s
- (f) Cover of the secondary terminal box.

5.8.2 Nuts and bolts or screws, used for fixation of the interfacing porcelain bushings for taking out terminals shall be provided on flanges, cemented to the bushings and not on the porcelain.

5.8.3 For gasketed joints, wherever used, nitrile butyl rubber gaskets shall be used. The gasket shall be fitted in properly machined groove with adequate space for accommodating the gasket under compression.

5.9 FITTINGS AND ACCESSORIES :

Fittings and accessories, listed below shall be supplied with each Current Transformer. Any fitting, required essential other than those listed below shall also be supplied along with each Current Transformer without any extra cost to the purchaser:

- (h) Oil level gauge.
- (i) Oil filling hole and cap.
- (j) Pressure relieving device.
- (k) Phase terminal connectors.
- (l) Lifting lugs for core and windings, bushings and complete Current Transformers.
- (m) Tank earthing pads/terminals with necessary nuts, bolts and washers for connecting to purchaser's earth strip.
- (n) Name / Rating plate.

5.9.1 (A) OIL LEVEL GAUGE :

An oil level gauge shall be provided to indicate the oil level in the Current Transformer. This gauge shall be mounted in such a way that the oil level can be seen from ground level. If metal bellow is used, a ground glass window shall be provided to monitor the position of the metal bellow. The metal below shall be tested in accordance with relevant standards. The details shall be to the approval of the purchaser.

5.9.2 PRESSURE RELIEVING DEVICE :

Each Current Transformer shall be provided with a pressure relieving device so as to protect bushing of the Current Transformer even under unfavorable conditions. In case of non-provision of the PRD, the same should be brought out clearly in the offer with detailed explanation and proof.

5.9.3 (A) OIL DRAIN COCK :

An oil drain cock along with a stop cock shall be provided in the bottom flange so as to permit taking of oil samples for testing, if required.

5.9.4 EARTHING :

Metal tank of each Current Transformer shall be provided with two separate earthing terminals for bolted connection to 50mm X 6 mm flat, to be provided by the purchaser for connection to station earth-mat.

5.9.5 LIFTING ARRANGMENT :

The Current Transformer shall be provided with suitable lifting arrangement to lift the entire unit. The lifting arrangement shall be clearly shown in the general arrangement drawing. Lifting arrangement (lifting eye) shall be positioned in such a way so as to avoid any damage to the porcelain housing or the tanks during lifting for installation / transport. Necessary string guides shall be offered which shall be of removable type.

5.9.6 NAME PLATE & MARKING :

5.9.6.1 The Current Transformer shall be provided with non-corrosive, legible name plate with the information specified in relevant standards, duly engraved/punched on it.

5.9.6.2 A schematic drawing indicating the connections shall be provided in the interior of the Terminal box.

5.9.7 TERMINAL CONNECTORS :

All the Current Transformers shall be provided with bimetallic solder less clamp type, rigid type terminal connectors, suitable for

(i) **11KV C.T. – AAAC 150 Sq mm conductor.**

Each terminal connector shall be of universal type, suitable for both horizontal and vertical connections to the transmission line conductors / station bus bars.

5.9.7.1 Terminal connectors shall be manufactured and tested as per IS: 5561.

5.9.7.2 All castings shall be free from blow holes, surface blisters, cracks and cavities. All sharp edges and corners shall be blurred and rounded off.

5.9.7.3 No part of a clamp shall be less than 10mm thick.

5.9.7.4 All ferrous parts shall be hot-dip galvanised conforming to relevant standard.

- 5.9.7.5 For bimetallic connectors, copper alloy linear of minimum thickness of 2 mm shall be cast integral with aluminium body.
- 5.9.7.6 All current carrying parts shall be designed and manufactured to have minimum contact resistance.
- 5.9.7.7 Connectors shall be designed to be corona free in accordance with the requirements, stipulated in IS: 5561.

6.0 TEST:

6.1 TYPE TESTS & SPECIAL TESTS:-

The current transformers, offered should have been subjected to the following type tests and Special Tests in Government approved test laboratory. The bidder shall furnish four sets of type test and Special Tests reports along with the offer for 0.2 accuracy class CTs. These tests should not have been conducted earlier than five years from the date of opening of the bid. For any change in the design/type already type tested and the design/type offered against this specification, the purchaser reserves the right to demand repetition of some or all type & special tests without any extra cost to OPTCL in the presence of OPTCL's representative(s) at the cost of the supplier.

- (h) Lightning Impulse Voltage Test.
- (i) High Voltage power frequency wet withstands voltage Test.
- (j) Short time current test.
- (k) Temperature rise test.
- (l) Determination of errors or other characteristics according to the requirements of the appropriate designation and accuracy class as per individual parts of IS: 2705.
- (m) Instrument Security Factor Test.
- (n) IP-55 Test on Secondary Terminal Box.

N.B:

- Lightning Impulse Test, switching Impulse Voltage test and High Voltage power frequency wet withstand voltage Tests should have been carried out on the same current transformer.
- After the current transformers have been subjected to lightning Impulse Test, and High Voltage power frequency wet withstand voltage tests, these must have been subjected to all the routine tests as per IS:2705 (Part-I to IV).

6.2 ROUTINE TESTS :

The following routine tests shall be conducted on each Current Transformer in the presence of OPTCL's representative(s) for which no charges will be payable by OPTCL. No sampling will be allowed.

- (i) Appearance and Dimensional Check.
- (xvii) Verification of Terminal Marking and polarity.
- (xviii) Verification of all individual parts / components of the Current Transformer so as to ensure to have complied the above specification.
- (xix) Measurement of Insulation Resistance.
- (xx) Power Frequency Dry withstanding Test on Primary and Secondary winding including primary intersections.
- (xxi) Over – Voltage Interturn test.
- (xxii) Partial discharge Test
- (xxiii) Knee point voltage and Excitation current measurement for 'PS' class cores.
- (xxiv) Secondary winding resistance measurement.
- (xxv) Determination of errors.
- (xxvi) ISF Test.
- (xxvii) Leakage Test.
- (xxviii) Magnetization Characteristics of the Current Transformers.
- (xxix) Turn ratio error on 'PS' class cores.
- (xxx) Measurement of capacitance
- (xxxi) Measurement of tan delta at 0.3, 0.7, 1.0 and $1.1U_M/\sqrt{3}$ for 33KV C.Ts.
- The Method For Conducting Partial Discharge Test.

The test circuit for the measurement of partial discharge (PD) should have been in accordance with sub-clause 4.2 of IEC-270. The applied voltage should be raised to the rated voltage of the Current Transformers and should have been maintained for a period greater than or equal to 10 seconds. The voltage should have been reduced to measuring voltage as specified in the IS and maintained for a period greater than or equal to 1 minute. The PD should not exceed 10 Pico-coulombs.

7.0 INSPECTION :

7.1 The purchaser shall have access at all times to the works and all other places of manufacture, where the Current Transformers are being manufactured and the supplier

shall provide all facilities for unrestricted inspection of the supplier's works, raw materials, manufacture of all the accessories and for conducting the necessary tests.

7.2 The supplier shall keep the purchaser informed in advance of the time of starting and of the progress of manufacture of equipment in its various stages so that arrangement could be made for inspection.

7.3 No material shall be despatched from its point of manufacture unless the material has been satisfactorily inspected, tested and despatch clearance issued. However, the purchaser reserves the right to alter the despatch schedule, attached to this specification without any extra financial liability to OPTCL.

7.3.1 The acceptance of any quantity of equipment shall in no way relieve the supplier of his responsibility for meeting all the requirements of this specification and shall not prevent subsequent rejection, if such equipments are found to be defective.

8.0 DOCUMENTATION :

8.1 All drawings shall conform to relevant Indian Standard as per relevant IS. All drawings shall be in ink and suitable for microfilming. All dimensions and data shall be in S.I. units.

8.3 The supplier shall furnish four sets of following drawings/documents along with his offer for 0.2 accuracy class metering core CTs.

- (o) General outline and assembly drawings of the Current Transformers.
- (p) Sectional views showing.
 - (i) General constructional features.
 - (iv) Materials / gaskets / sealing used.
 - (v) The insulation of the winding arrangement, method of connection of the primary / secondary winding to the primary / secondary terminals etc.
- (q) Schematic drawing
- (r) Rating and Diagram plate.
- (s) Secondary Terminal Box.
- (t) Assembly Sectional view of Primary Terminal
- (u) Assembly drawing for secondary terminal.
- (v) The detailed dimensional drawing of Porcelain Housing such as ID, OD, thickness and Insulator details such as height, profile of petticoats, angle of inclination and gap between successive petticoats, total creepage distance etc.
- (w) Sectional view of Pressure Release device.
- (x) Drawing showing details of Oil level Indicator.

- (y) All type and special test reports relating to tests, as mentioned at Cl. No. 6.1 of this Technical Specification.
- (z) Ratio and phase angle error curves for CTS.
- (aa) Magnetization characteristic curves such as B-H curves and sp.loss vs. flux density curves.
- (bb) Drawings for Terminal Connector.

9.0 TEST REPORTS:

- (i) A set of type test and special test reports if any shall be furnished to the purchaser during detailed Engineering & drawing approval.
- (v) Copies of acceptance test reports and routine test reports shall be furnished to the purchaser. One copy will be returned, duly certified by the purchaser and only thereafter shall the materials be despatched.
- (vi) All records of routine test reports shall be maintained by the supplier at his works for periodic inspection by the purchaser.
- (vii) All test reports of tests, conducted during manufacture shall be maintained by the supplier. These shall be produced for verification as and when required by the purchaser.

**TECHNICAL SPECIFICATION
FOR
SURGE ARRESTERS(33kV & 11kV)**

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OF
SURGE ARRESTERS (33kV & 11kV)

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SURGE ARRESTERS(33kV & 11kV)

TECHNICAL SPECIFICATION FOR SURGE ARRESTERS

1.0 SCOPE

This Specification provides for the design, manufacture, inspection and testing before dispatch, packing and delivery F.O.R. (destination) of **Metal Oxide (gapless)** Surge Arresters with discharge counters, insulating base, terminal connectors and other accessories as specified here in.

Following is the list of documents constituting this Specification. :

(i)	Technical Specification (TS)	
(ii)	Check-List.	Annexure-A
(iii)	Calibration Status of testing equipments and meters/ Instruments.	Annexure-B
(iv)	Check-list towards Type Test Reports.	Annexure-C
Note : Annexure-A,B ,& Care to be filled up by the Bidder.		

All the above along with amendments thereof shall be read and interpreted together. However, in case of a contradiction between the Technical Specification and any other volume, the provisions of this volume will prevail.

The Surge Arrester shall conform in all respects to high standards of engineering, design, workmanship and latest revisions of relevant standards at the time of offer and purchaser shall have the power to reject any work or materials, which in his judgement is not in full accordance therewith.

2.0 STANDARDS:-

Except to the extent modified in the Specification, the Surge Arrester shall conform to the latest editions and amendments of the standards listed hereunder.

Sl. No.	Standard Ref. No.	Title.
1	IEC-99-4	Specification for Surge Arresters without gap for AC System.
2	IS:2147	Degree of protection, provided by enclosures for low voltage switchgear and control.
3	IS:2629	Recommended practice for hot dip galvanization of iron

		and steel.
4	IS:2633	Method for testing uniformity of coating on zinc coated articles.
5	IS:3070	Specification for surge arresters for alternating current system.
6	IS:5621 & IEC-621155	Specification for large hollow porcelain for use in electrical installation.
7	IEC-60-1	High-Voltage Test technique.
8	IEC-270	Partial discharge measurements.
9	IEC-99-1	Non-linear resistor type gapped arresters for a.c. systems.
10		Indian Electricity Rules, 1956.
11	IEC-60815	Shed profile of hollow porcelain Insulator.

- 2.1 Surge Arresters which ensure equal or better quality than the standards, mentioned above shall also be acceptable. Where the equipment offered by the supplier conforms to other standards, salient points of difference between the standards adopted and the specified standards shall be clearly brought out in the offer.

3.0 GENERAL TECHNICAL REQUIREMENTS :

The Surge Arrester shall confirm the technical requirements

The energy handling capability of each rating of Arrester offered, supported by calculations, shall be furnished with the offer.

The Surge Arresters shall be fitted with pressure relief devices and arc diverting paths and shall be tested as per the requirements of IEC for minimum prospective symmetrical fault current as specified in Appendix-I.

A grading ring shall be provided if required, (for attaining all the relevant technical parameters) on each complete Surge Arrester.

4.0 PROTECTIVE LEVELS :

Surge Arresters shall be capable of providing protection to sub-station equipments, designed for the withstand levels, given in the following table.

Sl. No.	Equipment to be protected	Insulation Level of 36KV System	Insulation Level of 12KV System
		BIL (kV _{peak})	BIL (kV _{peak})
1	Power Transformers.	170	78

2	Instrument Transformers.	170	78
3	Reactors	170	78
4	Circuit Breakers/Isolators.		
(i)	Phase to ground.	170	78

Surge arrester shall be suitable for the following duty cycles of circuit breaker at the following system voltages:

36 kV Circuit Breaker	O-0.3 sec-CO-3 min-CO
12 kV Circuit Breaker	O-0.3 sec-CO-3 min-CO

5.0 DUTY REQUIREMENT :

Surge Arresters shall be of heavy-duty station class and gapless type without any series or shunt gaps.

- i. Surge Arresters shall be capable of discharging over voltages occurring during switching of un-loaded transformers, lines, capacitors and reactors.
- ii. The Surge Arresters shall be capable of discharging lightning and switching surges and temporary power frequency over-voltages.
- iii. The Surge Arresters shall be capable of discharging the energy equivalent to class 3 of IEC-99-4.

The reference current of the arrester shall be high enough to eliminate the influence of grading and stray capacitance on the measured reference voltage. The supplier shall submit values and the supporting evidence along with calculations on above. Surge Arresters shall be fully stabilized thermally to give a life expectancy as per standard under site conditions. Surge Arresters shall be able to withstand maximum wind load of 260 Kg./sq.m. Surge Arresters shall be capable of withstanding effects of direct solar radiation. Surge arresters shall be capable of spark over on severe switching Surges and multiple strokes.

The Surge Arrester should be adequately designed to operate satisfactorily under temporary power frequency over-voltage as given in specific technical requirements, after discharging two shots of respective long duration surges.

Unless otherwise brought out separately by the Bidder in the schedule of deviations, the Surge Arresters, offered shall conform to the specification scrupulously. All deviations from the specification shall be brought out in the schedule of deviations. The discrepancies between the specification and the catalogues or literature, submitted as part of the offer shall not be considered as valid deviations unless specifically brought out in the schedule of deviations.

6.0 CONSTRUCTION :

Non linear blocks shall be sintered metal oxide material. These shall be provided in such a way as to obtain robust construction with excellent electrical and mechanical properties even after repeated operations. All the units of arresters of same rating shall be inter-changeable without adversely affecting the performance. The Surge Arresters shall be suitable for pedestal type mounting. All the necessary flanges, bolts, nuts, clamps etc. required for assembly of complete arrester with accessories and mounting on support structure to be supplied by the Contractor. The drilling details for mounting the Arrester on OPTCL/DISTCOM's support shall be supplied by the OPTCL/DISTCOM.

The minimum permissible separation between the Surge Arrester and any earthed object shall be indicated by the Bidder in his offer. Surge Arresters shall be designed to incorporate pressure relief devices and arc diverting paths to prevent shattering of the blocks or the porcelain housing, following prolonged current flow or internal flash over and providing path for flow of rated fault currents in the event of arrester failure. Surge Arresters shall incorporate anti-contamination feature to prevent arrester failure, caused by uneven voltage gradient across the stack, resulting from contamination of the arrester porcelain. Seals shall be provided in such a way that these are always effectively maintained even when discharging rated lightning current.

The heat treatment cycle details along with necessary quality checks used for individual blocks along with insulation layer, formed across each block are to be furnished. Metalised coating thickness for reduced resistance between adjacent discs is to be furnished along with the procedure for checking the same. Details of thermal stability test for current distribution of current on individual disc is to be furnished.

Each individual unit of Surge Arresters shall be hermetically sealed and fully protected against ingress of moisture. The hermetic seal shall be effective for the entire lifetime of the arrester and under the service conditions as specified. The supplier shall furnish sectional view of the arrester showing details of sealing employed. The Surge Arresters shall be suitable for hot line washing.

7.0 PORCELAIN HOUSING :

All porcelain Housings shall be free from lamination cavities or other flaws, affecting the maximum level of mechanical and electrical strengths. The porcelain shall be well vitrified and non-porous. The minimum creepage distance of the arrester housing shall be as per TS.

The porcelain petticoat shall be preferably of self-cleaning type (Aerofoil design). The details of the porcelain housing such as height, angle of inclination, shape of petticoats, gap between the petticoats, diameter (ID and OD) etc. shall be indicated by the Bidder in his offer in the form of detailed drawing. Porcelain housings shall be so co-coordinated that external flash over will not occur due to application of impulse or switching Surge voltages up to the maximum design value for arrester.

8.0 GALVANISATION, NICKEL PLATING ETC.

All ferrous parts exposed to atmosphere shall be hot dip galvanized as per IS: 2629, as amended from time to time. **Tinned copper/brass lugs shall be used for internal wiring of discharge counter.** Screws used for electrical connections shall be either made of brass or shall be nickel-plated. Ground terminal pads and nameplate brackets shall be hot dip galvanized. The material shall be galvanized only after completing all shop operations

9.0 ACCESSORIES AND FITTINGS

9.1 Surge Counters

A self- contained Surge counter, suitably enclosed for outdoor use and requiring no auxiliary of battery supply for operation shall be provided for each unit. The surge counter shall be operated by the discharge current, passed by the surge arrester and shall be suitable for mounting on the support structure of the Arrester.

Surge counters shall be of the Electro-mechanical type and designed for continuous service. The cyclometer counter shall be visible through an inspection window from ground level. The counter terminals shall be robust and adequate size and shall be so located that the incoming and outgoing connections are made with minimum possible bends. Internal parts shall be unaffected by atmospheric conditions at site. Alternatively, a weather proof housing to IP 55 shall be provided and this shall be designed to allow the recording device to be read from ground level without exposing the internal parts to the atmosphere.

The Surge Counter shall be connected in the main earth lead from the arrester in such a manner that the direction of the earth lead is not changed or its surge impedance materially altered. A bolted link shall be provided so that the surge counter may be short circuited and removed without taking the arrester out of service. All necessary accessories and earthing connection leads between the bottom of the Arrester and discharge counter shall be in the Contractor's scope of supply.

10.0 LEAKAGE CURRENT METERS : (In case of 33 kV Surge Arrester only)

Leakage current meters (suitable milli-ammeter) shall be connected in the earthing path of the surge arresters to measure the resistor grading leakage current. Meters shall be designed for continuous service.

The ammeter shall be suitable for mounting on the support structure of the arrester. The push buttons shall be mounted such that it can be operated from the ground level.

The internal parts shall be fully weather - proof to IP 55 or better with a transparent cover to provide an unobstructed view of the ammeter. Arresters shall be complete with insulating base having provision for bolting to flat surface of the structure. The grounding terminals shall be suitable for accommodating grounding connection to steel earth mat.

Clamp type terminal connector, suitable for AAAC conductor of 148 & 100 Sq mm shall be provided having both horizontal and vertical take-off. Two clamp type ground terminal connectors, suitable for G. I. Strip (50 x 6) should be provided. All interconnecting hardware such as nuts, bolts, spring washers etc. with 5% spares shall be supplied for different units. Pollution Shunt (Copper braid) shall be supplied along with each Surge Arrester for bypassing the surface current. Other standard accessories, which are specifically not mentioned, but are usually provided with Surge Arrester of such type and rating for efficient and trouble free operation should be supplied.

11.0 NAME PLATE :

Each single pole Arrester shall be provided with non-corrosive legible name plate, at the base bearing thereon, voltage rating of the complete pole and the number of demountable sections with the following data, indelibly marked

- (a) Name of the DISTCOM
- (b) Purchase order No. & Date.
- (c) Name of device.
- (d) Manufacturer's name and trademark and identification no. of the arrester being supplied.
- (e) Year of manufacture
- (f) Rated voltage
- (g) Rated Frequency
- (h) Maximum continuous operating voltage.
- (i) Type
- (j) Nominal discharge current.
- (k) Long duration discharge class.
- (l) Pressure relief current in KA(rms)
- (m) Energy discharge capability (KJ / KV rating).

12.0 TEST :

12.1 Type Tests:

The surge Arrester offered should have been subjected to the following **Type tests** in an independent Government approved test laboratory. The bidder shall furnish four sets of type test reports along with the drawings for approval. These tests must not have been conducted earlier than five years from the date of opening of technical bid. For any change in the design type, already type tested and the design type offered against this specification, the purchaser reserves the right to demand repetition of some or all type tests without any extra cost and in presence of Purchaser's representative at the cost of the Contractor.

1 Insulation withstands tests :

- (a) Lightning Impulse Voltage Test.
- 2 Residual voltage tests.
- 3 Long duration current impulse withstand tests.
- 4 Operating duty tests.
- 5 Pressure relief tests.
- (a) High current test.
- (b) Low current test.
- 6 Power frequency voltage vs. time curve.
(Temporary over voltage test)
- 7 Contamination test. (artificial pollution test).
- 8 Seismic withstand test.
- 9 IP-55 test on surge counter.
- 10 Minimum current operation tests of the surge counter.
- 11 Maximum current withstand test of the surge counter.
- 12 Mechanical terminal load test on bushing.
- 13 Partial discharge test.

N.B. :-Even if the condition i.e. the dry arcing distance or the sum of the partial dry arcing distances is larger than the test voltage divided by 500 KV/m, the lightning impulse voltage test must have been conducted or is to be conducted without any financial liability to OPTCL.

12.2 ROUTINE TESTS :

The following **Routine tests** shall be conducted at the supplier's cost on each Surge Arrester and shall be submitted along with or before offering for inspection for purchaser's approval.

- (a) Measurement of reference voltage.
- (b) Residual voltage tests.
- (c) Measurement for partial discharge and contact noise.
- (d) Sealing test for units with sealed housings.

12.3 ACCEPTANCE TESTS :

The following tests, considered as **Acceptance tests**, shall be conducted in the presence of purchaser's representative for which no charges will be payable by purchaser. The acceptance tests, whenever possible shall be conducted on the complete arrester unit. The number of samples to be subjected to acceptance test shall be decided by the purchaser at the time of actual testing.

- I Temperature Cycle Test on Housing.
- II Measurement of Power Frequency Voltage at the reference current.
- III Measurement of leakage current and capacitive current at M.C.O.V.
- IV Lightning Impulse Residual Voltage Test at N.D.C., 50% of N.D.C. & 200% of N.D.C.
- V Partial Discharge Tests on complete arresters/units at 1.05 times M.C.O.V.
- VI Special Thermal stability test.
- VII Porosity test on porcelain components.
- VIII Galvanization test on metal parts.
- IX The functional (operational) test on the Surge Counter by way of checking its operation at following nominal discharge currents :
 - a) 100 Amps with 8/20 micro second wave shape.
 - b) 10 KA with 8/20 micro second wave shape.
- X Check of calibration of leakage current meters.

13.0 INSPECTION :

- I The purchaser shall have access at all time to the works and all other places of manufacture, where the Surge Arresters are being manufactured and the supplier shall provide all facilities for unrestricted inspection of the supplier's works, raw materials, manufacture of all the accessories and for conducting the necessary tests.
- II The supplier shall keep the purchaser informed in advance of the time of starting and the progress of manufacture of equipment in its various stages so that arrangements could be made for inspection.

- III No material shall be despatched from its point of manufacture unless the material has been satisfactorily inspected, tested and despatch schedule attached to this specification.
- IV The acceptance of any quantity of equipment shall in no way relieve the supplier of his responsibility for meeting all the requirements of this specification and shall not prevent subsequent rejection, if such equipments are later found to be defective.

14.0 DOCUMENTATION :

All drawings shall conform to relevant Indian Standard as per relevant IS. All drawings shall be in ink and suitable for microfilming. All dimensions and data shall be in S.I. Units. The supplier shall furnish two sets of following drawings / documents along with his offer.

- (i) General outline drawings of the complete Arrester with technical parameters.
- (ii) Drawings showing clearance from grounded and other line objects and between adjacent poles of Surge Arresters, required at various heights of Surge Arresters.
- (iii) Drawings showing details of pressure relief devices.
- (iv) Detailed drawing of discharge counters along with the wiring and schematic drawing of discharge counter and meter.
- (v) Outline drawing of insulating base.
- (vi) Details of grading rings, if used.
- (vii) Mounting details of Surge Arresters.
- (viii) Details of line terminal and ground terminals.
- (ix) Volt-time characteristics of Surge Arresters.
- (x) Details of galvanization being provided on different ferrous parts.
- (xi) The detailed dimensional drawing of porcelain Housing such as ID, OD, thickness and insulator details such as height, profile of petticoats, angle of inclination and gap between successive petticoats, total creepage distance etc.
- (xii) Cross-sectional view of the Surge Arrester Units showing all components.

15.0 TEST REPORTS :

- (i) Three copies of type test reports shall be furnished to the purchaser with the tender specification. Copies of acceptance test reports and routine test reports shall be furnished to the purchaser. One copy will be returned duly certified by the purchaser and only thereafter shall the materials be despatched.
- (ii) All records of routine test reports shall be maintained by the supplier at his works for periodic inspection by the purchaser.
- (iii) All test reports of tests, conducted during manufacture shall be maintained by the supplier. These shall be produced for verification as and when requested for by the purchaser.

16.0 Table :-**TECHNICAL REQUIREMENTS FOR METAL OXIDE (GAPLESS) SURGE ARRESTERS**

Sl. No	Particulars.	Technical Parameters for Surge Arrestors	
		30 kV	9 kV
1	Nominal system voltage (phase to phase) (KV rms).	33	11
2	Highest system voltage (phase to phase) (KV rms).	36	12
3	System Frequency (HZ).	50 \pm 5%	
4	System Neutral earthing.	Effectively earthed	
5	Installation.	Outdoor	
6	Class.	Station class, 10 KA, heavy duty type.	
7	Type of construction for 10 KA rated arrester.	Single column, single phase	
8	No. of phases.	Three	
9	Maximum duration of earth fault (Sec.)	3	
10	Maximum prospective symmetrical fault current at arrester location (KA rms.)	40	
11	Rated arrester voltage (KV rms)	30	9
12	Nominal discharge current (KAP) Discharge current at which insulation co-ordination will be done	10 KA of 8/20 μ sec Wave.	
13	Minimum energy discharge capability (KJ/KV)	As per relevant ISS/IEC	

14	Maximum continuous operating voltage at 50° C (KV rms)	25	9.6
15	Maximum switching surge residual voltage (KVP)	72 at 500A	28
16	Maximum residual voltage at 8/20 micro second(KVP)		
	(i) 5 KA.	85	32
	(ii) 10 KA Nominal discharge current.	90	35
	(iii) 20 KA.	100	40
17	Long duration discharge class	2	2
18	High current short duration test value (KAP) (4/10 Micro-second wave).	100	100
19	Current for pressure relief test (KA-rms)	40	40
20	Minimum total creepage distance (mm).	900	380
21	One minute dry and wet power frequency withstand voltage of Arrester housing (KV-rms).	70	28
22 (a)	Impulse withstand voltage of arrester housing with 1.2/ 50 micro-second wave (KVP).	110.5	41.6
b)	Switching Impulse Voltage (Wet) (KVP)	-	-
23	Pressure relief class.	A	A
24	Corona extinction voltage (KV-rms).	-	-
25	RIV at 92 KV rms.	Less than 500 micro volts	Less than 500 micro volts
26	Partial discharge at 1.05 times continuous over-voltage.	Nor more than 50 PC	Nor more than 50 PC
27	Seismic acceleration.	0.3g horizontal 0.15g vertical	0.3g horizontal 0.15g vertical
28	Reference ambient temperature.	50°C	50°C

29	(a) IR at MCOV.	Less than 400 micro amperes	Less than 400 micro amperes
	(b) IC at MCOV.	Less than 1200 micro amperes	Less than 1200 micro amperes
30	a) Reference Current (mA)	1 to 5 mA	
	b) Reference voltage at reference current.	Greater than rated voltage.	
31	Maximum steep current Impulse RDV (KVP). at KAP	100	
32	Maximum cantilever strength of the arresters (KGM).	325	325
33	TOV(KVP).		
	(i) 0.1 sec.	53	20
	(ii) 1.0 sec.	51	18
	(iii) 10.0 sec.	49	16
	(iv) 100.0 sec.	47	14

ANNEXURE – A

CHECK – LIST

- 1 Whether calculation towards energy handling capability of the Surge Arrester furnished?
- 2 Whether the heat treatment cycle details along with necessary quality checks used for individual blocks furnished ?
- 3 Whether sectional view of arrester furnished showing details of sealing provided?
- 4 Whether porcelain petticoat is of Aero foil design? Whether drawing of porcelain Housing as per Clause No.7.9 of TS furnished?
- 5 Whether drawings and documents as per TS furnished?
- 6 Whether special measures in the manufacture of Surge Arrester for operating at ambient temperature of 50°C (against 40 °C as per IEC-99-4, Clause No.4.4.1) are to be taken? State the special measures in details

Signature of the Tenderer With Seal & Date

ANNEXURE –B

CALIBRATION STATUS OF TESTING EQUIPMENTS AND INSTRUMENTS/ METERS.

Nam e of the test.	Meters and equip ments require d for the corres pondin g test with range accura cy make and Sl. No.	Date of Calibr ation.	Du e dat e of Cali brat ion.	Nam e of the Calib ratin g Agen cy	Wheth er Calibra ting Agenc y is Govt. Approv ed.	Whether docume nts relating to Govt. Approval of the calibrati ng Agency furnishe d ?	Whether the meters/ equipme nt fulfill the accurac y class as per calibrati on report	Whether the calibrati ng agency has put any limitation towards the use of the particula r meter/eq uipment. If yes, state the limitation s.	Wheth er green sticker or blue sticker or yellow sticker has been affixed on the body of the particul ar equipm ent/ meter. State the colour of the affixed sticker.	Inspit e of impos ed limitati ons, wheth er the partic ular meter/ equip ment can still be used? Justify its use for corres pondi ng test(s) .	Rem arks
1	2	3	4	5	6	7	8	9	10	11	12

Signature of the tenderer with seal and date.

ANNEXURE-C

CHECK LIST TOWARDS TYPE TEST REPORTS.

Name of the Type Test .	Date of Test .	Name of the Laboratory where the Test has been conducted.	Whether the Laboratory is Government Approved.	Whether the Test reports are valid as per Clause No.15.0 of T.S.	Whether the copy of Test Report in complete shape along with drawings etc. furnished or not ?	Whether the Type Tested Surge Arrester fulfills the technical requirements as per TS.	If the type tested surge Arrester does not fulfill the technical requirements as per this specification, whether the bidder agrees to conduct the particular type test again at their own cost without any financial liability to OPTCL in the presence of OPTCL's representative within the specified delivery period.	Remarks.
1	2	3	4	5	6	7	8	9

Signature of the tenderer with seal and date.

**TECHNICAL SPECIFICATION
FOR
33 KV & 11 KV ISOLATOR**

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TECHNICAL SPECIFICATION FOR 33 KV & 11 KV ISOLATOR

1.0 SCOPE

This specification provides for design, manufacturer, testing at manufacturer's Works and delivery ,supervision of erection, commissioning of outdoor station type 33kV & 11kV, 3 phase triple pole double break gang operated centre rotating type (Single Isolator with / without earth switches, with electrical interlock (castle key), insulators and complete in all respect with bimetallic connectors arcing horns operating mechanism, auxiliary switches, indicating devices, fixing detail etc. as described hereinafter. **Double Tandem operating GI pipes** (40mm Dia. medium gauge) & down pipe of 50mm dia, medium gauge GI pipe has to be used.

The material offered shall be procured from short listed vendor at **E-14** and shall have been successfully Type Tested during last five years on the date of bid opening. The Type Test reports shall be submitted along with the bid.

1.1 Main features

Sl.No	Type	33kV	11kV
1	Main switch	Double end break Centre post rotating, gang operated	
2	Service	Outdoor	
3	Applicable standard	IS : 9921 / IEC-129/IEC-62271-102	
4	Pole	3 pole gang operator	
5	Rated voltage nominal/ Maximum	33/36 kV	11/12 kV
6	Rated Frequency	50 Hz \pm 5%	
7	System earthing	Effectively earthed	
8	Temperature rise	As per relevant IS/IEC publication	
9	Insulation level impulse with stand voltage		
	a) Across Isolating distance	195 kV _{peak}	85 kV _{peak}
	b) To earth & between poles	170 kV _{peak}	75 kV _{peak}
10	1 minute power frequency with stand voltage		
	a) Across Isolating distance	80 kV _{peak}	32 kV _{peak}
	b) To earth & between poles	70 kV _{peak}	28 kV _{peak}
11	Rated current in Amp	1250	1250
12	Short time current for 3 sec	25kA	25kA
13	Operating mechanism	Motorised	Manual
14	Auxiliary voltage	33kV	11kV
	a) Control & Inter lock	24 DC 80% to 110%	

15	Safe duration of overload		
	a)150% of rated current	5 minute	
	b)120% of rated current	30 minute	
16	Minimum creepage distance of support and Rotating insulator	900mm	500mm
	i) Mounting structure	Upright on G.I structure	
	ii) Terminal connector type	Bimetallic clamp size as per requirement	
	iii) Control	Local	

IMPORTANT NOTE:

The operating mechanism for 33kV main switch of isolator shall be motorized operation but 11 kV main switch and both 33 kV & 11 kV earth switch shall be manual operated.

2.0 STANDARDS

Disconnecting switches covered by this specification shall conform to latest edition IEC-129/IEC 62271-102 I.S.1813 and IS: 9921,IS-325,and unless specifically stated otherwise in this specification.

3.0 TYPE

The 33kV & 11kV Isolators shall be outdoor type with three phase double break centre rotating type [Single Isolator(SI) with/without E/S] Isolators suitable for manual/electrical(motorized) operation at Remote/ local end. They shall have crank and reduction gear mechanism.

All Isolators offered shall be suitable for horizontal upright mounting on steel structures. Each pole unit of the multiple Isolators shall be of identical construction and mechanically linked for gang operation.

Each pole of the Isolator shall be provided with two sets of contacts to be operated in series and the moving contact blades shall rotate in horizontal plane.

The design shall be such that the operating mechanism with the linkages shall be suitable for mounting on any of the outer pole ends without much difficulty and with minimum shifting of parts.

Moving contacts of all isolators shall rotate through 90 deg from their “fully closed position” to “fully open position so that the break is distinct and clearly visible from ground level.

The **33kV & 11kV** Isolators offered by the Bidder shall be designed for Normal rating current for **1250 amp**. It should be suitable for continuous service at the system voltages specified herein.

The Isolators shall be suitable to carry the rated current continuously and full short circuit current of 25kA for 33kV & 11kV respectively for 3 second at site

condition without any appreciable rise in temperature. These shall also be suitable for operation at 110% rated (normal) voltage. The Isolators shall be suitable for Isolating low capacitive / inductive currents of 0.7amp at 0.15 power factor. The isolators shall be so constructed that they don't open under the influence of short circuit conditions.

The Isolators and earthing switches are required to be used on electrically exposed installation and this should be taken into account while fixing the clearance between phases and between phase and earth.

4.0 MAIN CONTACTS & MOVING ARM

All Isolators shall have heavy duty, self aligning and high pressure line type contacts made of high conductivity, corrosion resistant, hard-drawn electrolytic copper strips with 5 mm minimum thickness and proper contact area. Also current density to be assured @ $1 \text{ mm}^2 = 1.5 \text{ Amp}$. Fixed contact should consist of loops of above copper strips suitable for 1250 Amps ratings for 33kV & 11kV Isolators. The hard dawn electrolytic copper strips should be silver plated 10 micron thickness or more as per the requirement and fixed contacts should be backed by powerful phosphor bronze/stainless steel springs of suitable numbers. However, the thickness and contact area of the contact should conform to the drawing approved during type test.

These fixed and moving contacts shall be able to carry the rated current continuously and the maximum fault current of 25kA for 33kV & 11kV for 3 seconds without any appreciable rise in temperature. The Isolator blades shall retain their form and straightness under all conditions of operation including all mechanical stress arising out of operation as well as under rated short circuit condition.

Fixed guides shall be provided so that even when the blades are out of alignment by one inch (maximum), closing of the switches, proper seating of the blades in between contacts and adequate pressure to give enough contact surface is ensured. Wherever possible, the blades shall be counter balanced by weights and springs. The contact shall be self cleaning by the wiping action created by the movements of the blades. The surface of the contacts shall be tendered smooth and silver plated.

The Isolator shall be self cleaning type so that when isolator remain closed for long periods in a heavily polluted atmosphere, binding does not occur. No undue wear or scuffing shall be evident during the mechanical endurance tests, contacts and springs shall be designed so that adjustment of contact pressure shall not be necessary throughout the life of the isolator. Each contact or part of contacts shall be independently sprung so that full pressure is maintained on all contact at all times.

5.0 ARCING HORN AND GRADING HORN

Suitable arcing horn made of tinned electrolytic copper which are required for guiding contacts shall be provided on the fixed and moving contacts of all Isolators. The contacts shall be of 'make before and break after' type.

6.0 ELECTRICAL INTERLOCK / MECHANICAL INTERLOCK

The disconnecting switches whenever required shall be with an approved type electrical interlock for interlocking with the associated circuit breakers and earth switch. Electrical interlock assembly should be more right in construction and properly mounted to ensure reliable operation. The design should be such that the electrical circuit for the interlocking mechanism will only remain energised during operation of the switches.

7.0 AUXILIARY SWITCHES

All isolators and earthing switches shall be provided with 48V DC auxiliary switches for their remote position indication on the control board and for electrical interlocking with other equipment. The auxiliary switch shall be provided with a minimum of auxiliary contacts normally 4 open and normally 4 closed contacts with 10 amp. Current carrying capacity.

8.0 EARTH SWITCH

Line earth switch shall consist of three earthing blades for Isolator which normally rest against the frame when the connected Isolator is in closed position. The earthing blades for three phase shall be mechanically linked to a coupling shaft which shall be capable of being fitted on either side of the Isolator. The earthing blades shall match and be similar to the main switch blades and shall be provided at the hinge; with suitable flexible conductors with terminal lugs for connecting to the station ground bus. The earthing blades shall be operated by a separate mechanism but shall be mechanically interlocked with the main switch so that the earthing blades can be closed only when the main switches are in open position and vice-versa. The earthing blades shall be gang operated and all the three blades will operate simultaneously.

9.0 OPERATING MACHANISM

The operating mechanism shall be simple and shall ensure quick and effective 1000 operation. The design shall be such as to enable one man to operate it with nominal effort. The operating mechanism box shall be made out of Aluminum extruded (Aluminum Alloy) sections of minimum 3mm thickness.

The Isolator blades shall be in positive continuous control throughout the entire cycles of operation. The operating rods and pipes shall be rigid enough to maintain positive control under most adverse conditions and to withstand all torsional and bending stresses arising from operation. Operation of the switches at any speed should not result in improper functioning, in displacement of parts / machines after final adjustment has been made. All

holes in cranks, linkages etc. having moving pins shall be drilled and fitted accurately so as to prevent slackness and lost motion.

Provision shall be made for padlocking the operating mechanism of disconnecting and earth switches in both open and closed positions.

Bearings shall be ball and roller type shall be protected from weather and dust by means of cover and grease retainers. Bearings pressures shall be kept low to ensure long life and ease of operation.

Each operated isolator shall be driven as well as manually operated and shall be complete with local selector switch and open / close push buttons. The function of all control facilitates operating isolators.

10.0 DESIGN, MATERIALS AND WORKMANSHIP

The live parts shall be designed to eliminate sharp points, edges and similar corona producing surfaces, where this is impracticable, adequate shields to be provided. All ferrous metal parts shall be hot dip galvanized, as per IS 2629. All metal parts shall be of such materials or treated in such a way so as to avoid rust, corrosion and deterioration due to continued exposure to atmosphere and rain. All current carrying parts shall be made from high conductivity electrolytic Copper.

Bolts, screws and pins shall be provided with standard locking device viz. Locknuts, spring washers, keys etc. and when used with current carrying parts, they shall be made of copper silicon or other high conductivity and wear resistant alloys.

The switches should not need lubrication of any parts except at very long interval of five year minimum.

11.0 PROTECTIVE COATINGS

All ferrous parts including bolts, nuts and washers of the switches assembly shall be galvanized to withstand at least six times one minute dips in Copper Sulphate solution of requisite strength (Pierce tests) except the threaded portions which should withstand four dips.

12.0 INSULATORS

Support insulators for all type of isolators shall be of solid core type. The insulator shall be made of homogeneous and vitreous porcelain of high mechanical and dielectric strength. It shall have sufficient mechanical strength to sustain electrical and mechanical loading on account of wind load, short circuit forces etc. Glazing of the porcelains shall be of uniform dark brown color with a smooth surface arranged to shed away rain water. The porcelain shall be free from laminations and other flaws or imperfections that might affect the mechanical or dielectric quality. It shall be thoroughly vitrified, tough and impervious to moisture. The porcelain and metal parts shall be assembled in such a manner and with such material that any thermal differential

expansion between the metal and porcelain parts throughout the range of temperature specified in this specification shall not loosen the parts or create under internal stresses which may affect the mechanical or electrical strength or rigidity. The assembly shall not have excessive concentration of electrical stresses in any section or across leakage surfaces. The cement used shall not give rise to chemical reaction with metal fittings. The insulator shall be suitable for water washing by rain or artificial means in service condition. Profile of the insulator shall also conform to IEC-815. Insulator shall have a minimum cantilever strength of 800 kgs. Caps to be provided on top of the insulator shall be of high grade cast iron or malleable steel casting. It shall be machine faced and hot dip galvanized. The cap shall have four numbers of tapped holes spaced on a pitch circle diameter of 76 mm. The holes shall be suitable for bolts with threads having anti corrosive protection. The effective depth of threads shall not be less than the nominal diameter of the bolt. The cap shall be so designed that it shall be free from visible corona and shall have radio interference level within 500 micro volts. Casing shall be free from blow holes cracks and such other defects.

13.0 CONTROL CABINET:

The control cabinet of the operating mechanism shall be made out of Aluminum sheet of minimum **3mm** thickness. Hinged door shall be provided with pad locking arrangement. Sloping rain hood shall be provided to cover all sides. 15 mm thick neoprene or better type of gaskets shall be provided to ensure degree of protections of at least IP 55 as per IS 2147/IS-3947. The cabinet shall be suitable for mounting on support structure/or on a separate plinth foundation with adjustment for vertical, horizontal and longitudinal alignment. Details of these arrangements shall be furnished along with the offer.

14.0 Gear :

The Disconnecter / Isolator may be required to operate occasionally, with considerably long idle intervals. Special care shall be taken for selection of material for gear and lubrication of gears to meet this requirement. The gear shall be made out of Aluminum bronze or any other better material lubricated for life with graphite or better quality non-drawing and non-hardening type grease. Wherever necessary automatic relieving mechanism shall be provided suitable relay, Device shall be provided to prevent over loading of the motor. Single phase preventer (for 3 phase motor) shall be provided to operate on open circuiting of any phase and shall trip off the motor. Complete details of the devices shall be furnished in the offer.

15.0 Terminal block and Wirings –

Each operating mechanism shall be provided with 1100V grade stud type terminal block of polyamide material of **Elmex/Connectwell** make. All auxiliary switches, interlocks and other terminals shall be wired up to terminal block. The terminal block shall have at least 20% extra terminals. All wiring shall be carried out with 1.1KV grade insulated 2.5 sq mm copper wires.

A. Position indicator :

A position indicator to show the isolator is in ON or OFF position to be provided.

B. Name plate :

Isolator, earthing switches and their operating devices shall be provided with name plate. The name plate shall be weather proof and corrosion proof. It shall be mounted in such a position that it shall be visible in the position of normal service and installation.

It shall carry the following information's duly engraved or punched on it.

C. Isolator Base

Name of manufacturer –
Order No. –
Type Designation –
Manufacturers serial No. –
Rated voltage –
Rated normal current –
Rated short time current (rms) and duration –
Rated short time peak current (kA_{peak})
Weight

D. Earthing Switch

Name of manufacturer –
Order No. –
Type Designation –
Manufacturers serial No. –
Rated voltage –
Rated normal current –
Rated short time current (rms) and duration
Rated short time peak current (kA_{peak})
Weight

E. Operating Device

Name of manufacturer –
Order No.
Type Designation –
Reduction gear ratio –

AC motor

- 1) Rated auxiliary voltage
- 2) Starting current
- 3) Designation of AC motor as per I.S 4722/325
- 4) Starting torque at 80% of supply voltage
- 5) Over travel in degrees after cutting off supply

Total operating time in seconds

- 6) Close operation – Electrical
- 7) Open operation – Electrical
- 8) Open operation – Manual

All components shall be given adequate treatment of climate proofing as per IS:3202 so as to withstand corrosive and severe service conditions.

All metal parts not suitable for painting such as structural steel, pipes, rods, levers, linkages, nuts and bolts used in other than current path etc. shall be hot dip galvanized as per IS -2629.

Complete details of painting, galvanizing and climate proofing of the equipment shall be furnished in the offer.

16.0 TESTS

16.1 Type Tests

Isolators offered, shall be fully type tested as per the relevant standards. The Bidder shall furnish three sets of the following valid type test reports for their different type of offered Isolators along with the offer. The Purchaser reserves the right to demand repetition of some or all the type tests in the presence of purchaser's representative. For this purpose the Bidder may quote unit rates for carrying out each type test and this will be taken during bid price evaluation, if required.

- a) Short time withstand & peak withstand current test for Isolator & Earth Switch.
- b) Power frequency (Dry & Wet),Lightening Impulse dry withstand Test
- c) Mechanical endurance Test
- d) IP-55 test

During type tests the isolator shall be mounted on its own support structure or equivalent support structure and installed with its own operating mechanism to make the type tests representative. Drawing of equivalent support structure and mounting arrangements shall be furnished for Purchaser's approval before conducting the type tests.

The type tests shall be conducted on the isolator along with approved insulators and terminal connectors.

Mechanical endurance test shall be conducted on the main switch as well as earth switch of one isolator of each type.

16.2 Acceptance and Routine Test :

All acceptance and routine test as stipulated in the relevant standards shall be carried out by the supplier in presence of Purchaser's representative.

Mechanical operation test (routine test) shall be conducted on isolator (main switch and earth switch) at the supplier's works as well as purchaser's substation site.

Immediately after finalisation of the programme of type / acceptance, routine testing the supplier shall give sufficient advance intimation (clear 20 days advance intimation), along with shop routine test certificates, valid calibration reports from Govt. approved test house for the equipments, instruments to be used during testing for scrutiny by the purchaser to enable him to depute his representative for witnessing the tests. If there will be any discrepancies in the shop routine test certificates and calibration reports furnished by the firm then after settlement of the discrepancies only, purchaser's representative will be deputed for witnessing the tests.

Special tests proposed to be conducted (if decided to conduct) as type test on isolators, are given at TABLE-1 IN this chapter. These special type test charges shall be quoted along with all other type tests as per relevant IEC standard and these charges shall be included in the total bid price.

Test certificates of various items including but not limited to the following shall be furnished at the time of routine tests.

- i. Chemical analysis of copper along with a copy of excise certificate indicating genuine source of procurement of electrolytic grade copper.
- ii Bearings
- iii Fasteners
- iv Universal / swivel joint coupling
- v Insulators
- vi Gears
- vii Auxiliary switch
- viii Overload / single phase preventer relay
- ix Interlocking devices
- x Terminal block
- xi Any other item

17.0 INSPECTION

- i) The Purchaser shall have access at all times to the works and all other places of manufacture, where the dis-connectors, earth switches and associated equipment are being manufactured and the supplier shall provide all facilities for unrestricted inspection of the works raw materials

manufacture of all the accessories and for conducting necessary tests as detailed herein.

- ii) The supplier shall keep the purchaser informed in advance of the time of starting of the progress of manufacture of equipment in its various stages so that arrangements could be made for inspection.
- iii) No material shall be dispatched from its point of manufacture unless the material has been satisfactorily inspected and tested.
- iv) The acceptance of any quantity of the equipment shall in no way relieve the supplier of his responsibility for meeting all the requirements of this specification and shall not prevent subsequent rejection if such equipment are later found to be defective.

18.0 DOCUMENTATION

All drawings shall conform to relevant international standards organization (ISO). All drawings shall be in ink and suitable for micro filming. All dimensions and data shall be in S.I. Units.

List of Drawings and Documents

The Bidder shall furnish four sets of following drawings / documents along with his offer.

- a) General outline and assembly drawings of the dis-connector operating mechanism, structure, insulator and terminal connector.
- b) Sectional views and descriptive details of items such as moving blades, contacts, arms contact pressure, contact support bearing housing of bearings, balancing of heights, phase coupling pipes, base plate, operating shaft, guides, swivel joint operating mechanism and its components etc.
- c) Loading diagram
- d) Drawings with structure for the purpose of type tests.
- e) Name plate.
- f) Schematic drawing.
- g) Type test reports.
- h) Test reports, literature, pamphlets of the bought out items and raw material.

The contractor should submit two sets of final versions of all the above said drawings for Purchaser's approval. The purchaser shall communicate his comments / approval on the drawings. The supplier shall, if necessary, modify the drawings and resubmit the modified drawings for Purchaser's approval within two weeks from the date of comments. After receipt of approval the supplier shall within three weeks submit 15 prints and two good qualities reproducible of the approved drawings for purchaser's use. Six sets of the type test reports, duly signed by the Purchaser shall be submitted by the supplier for distribution, before commencement of supply Adequate copies of acceptance and routine test certificates, duly approved by the Purchaser shall accompany the despatched consignment.

The manufacturing of the equipment shall be strictly in accordance with the approved drawings and no deviation shall be permitted without the written approval of the purchaser. All manufacturing and fabrication work in connection with the equipment prior to the approval of the drawing shall be at the supplier risk.

19.0 INSTRUCTION MANUALS :

Fifteen copies of the erection, operation and maintenance manuals in English be supplied for each type of disconnecter one month prior to dispatch of the equipment. The manual shall be bound volumes and shall contain all drawings and information required for erection, operation and maintenance of the disconnecter including but not limited to the following particulars.

- (a) Marked erection prints identifying the component parts of the disconnect or as shipped with assembly drawings.
- (b) Detailed dimensions and description of all auxiliaries.
- (c) Detailed views of the insulator stacks, metallic, operating mechanism, structure, interlocks, spare parts etc.

TABLE – I

LIST OF SPECIAL TESTS TO BE CARRIED OUT IF DECIDED BY THE PURCHASER

Sl. No.	Name of the Test	Standard to which it conforms.
1.	Test for visible Corona and Radio interference voltage (RIV) on disconnectors and terminal connector	NEMA Pub No. 107-1964 ISRI Pub No. 1-1972
2.	Tests on insulators	IS-2544 IEC. 168
3.	Tests on terminal connectors	IS:5561
4.	Tests on galvanised components	IS:2633
5.	Stalled torque test on motor operating mechanism	At 110% of supply voltage

TECHNICAL SPECIFICATION
FOR
33kV & 11kV AB SWITCH

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OF
AB SWITCH

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TECHNICAL SPECIFICATION FOR AB SWITCH

1.0 SCOPE:-

This specification covers manufacturing, testing and supply of 3 Pole, 200Amp, 50Hz, Single break 33kV Air Break switches (**for Station Transformers**) & 3 Pole, 200Amp, 50Hz, Single break 11kV Air Break switches (**for Distribution Transformers**) for outdoor installations.

The materials shall be procured from a vendor having three years of manufacturing experience in India and as per the Technical Particulars furnished in this Specification at **Chapter E16**.

1.1 DESCRIPTION OF THE MATERIALS:-

The A.B. Switch sets shall conform to the following parameters:-

Sl. No.	Description	Parameters of AB Switch	
		33kV	11kV
i)	Number of poles	3	
ii)	Number of Post Insulator per pole	4 nos. (22/24 kV class)	2 nos. (12 kV class)
iii)	Nominal system voltage	33kV	11kV
iv)	Highest System Voltage	36kV	12kV
v)	Rated frequency	50Hz	
vi)	System earthing	Effectively earthed.	
vii)	Rated nominal current Amp.	200Amp	200Amp

The post insulators used in the A.B. Switches shall have the following ratings

Sl. No.	Description	Parameters P.I. of AB Switches for	
		33kV	11kV
i)	Power frequency withstand voltage (dry) kV (rms)	95kV	28 kV
ii)	Power frequency withstand voltage (wet) kV (rms)	70kV	28kV
iii)	Impulse withstand voltage (dry) kV (peak)	170kV	75kV
iv)	Power frequency puncture withstand voltage	1.3 times the actual dry flashover voltage of the unit	

2.0 STANDARDS: - The AB Switch Set shall conform to the following standards:-

- IS-9920 (Part-I to V.)
- IS-2544/1973 (for porcelain post insulators)

iii) IS-2633 (for galvanization of ferrous parts.) or its latest amendments if any.

2.1 INSULATORS:-

12kV class (for 11kV AB Switches) and 22/24 KV class (for 33kV AB Switches) Post Insulators complete with pedestal cap duly cemented to be used in the AB Switch Set conforming to IS-2544/1973

The Bidder shall **upload** the first page of the **Type test certificate** duly signed by the bidder showing the evidence of successful test, along with the bid. The Type test must have been done during last 5years from bid submission date.

The Bidder shall mention make, type of insulation materials, metal fittings, Creepage distance, protected Creepage distance, tensile strength, compression strength, torsion strength and cantilever strength.

2.2 CLIMATIC CONDITIONS:-

Please refer **Chapter E3** of Technical Specification on climatic conditions.

3.0 TECHNICAL DETAILS:-

- 3.1** The 33kV A.B. Switch Set shall be gang operated (**with double tandem pipe**) single air break outdoor type horizontal mounting having 4 nos. 22/24 KV post insulator per phase and the 11kV A.B. Switch Set shall be gang operated single (**with double tandem pipe**) air break outdoor type horizontal mounting having 2 nos. 12kV post insulator per phase. The operating mechanism shall be suitable for manual operation from the ground level and shall be so designed that all the three phases shall open or close simultaneously. The Switches shall be robust in construction, easy in operation and shall be protected against over travel or straining that might adversely affect any of its parts. The required base M.S. Channel, phase coupling rod, operating rod with intermediate guide braided with flexible electrolytic copper, tail piece of required current carrying capacity and operating mechanism with 'ON' & 'OFF' positions shall be provided. The operating rod shall be medium gauge of 32mm diameter nominal bore G.I. pipe single piece 6 meters. The phase coupling rod for gang operation shall medium gauge 25mm dia nominal bore G.I. Pipe. Rotating post insulators shall be provided with suitable bearing mounted on a base channel with 6 mm thick thrust collar and 6mm split pin made out of stainless steel. The operating down rod shall be coupled to the spindle (minimum dia - 32mm) for gang operation through another suitable bearing by two numbers 10mm dia through stainless steel bolts with double nuts. The post insulators should be fixed with the base channel using Galvanized Nuts and Bolts.

All the bearings shall be provided with grease nipple. All ferrous parts shall be galvanized and polished. The pipes shall be galvanized in accordance with IS-4736/1968.

3.2 **Mounting:** - The A.B. Switches shall be suitable for horizontal mounting in all type of sub-station structures.

3.3 **Switching Blades:-** It shall be made out of **electrolytic copper with silver plated**. The approximate size shall be 250mm x 50 x 8mm for 11kV & 33kV. The switch shall have such a spring mechanism so as to ensure that the speed of the opening of contact is independent of speed of manual operation

3.4 **Fixed Contracts:-** The fixed jaw type female contracts (50x8x80)mm for 11kV shall be made of electrolytic copper (minimum 95 % copper composition) duly electroplated controlled by Phosphor bronze high pressure spring housed in robust G.I. Cover.

It is essential that provision shall be made in fixed female contracts to take the shock arising from the closing of moving contract blade without the same being transmitted to the post insulator. The arrangement made in this regard shall be specifically shown in the drawing.

3.5 **Arcing Horn-** As the switches are generally meant for isolating the line and distribution transformers, **arcing horns** shall be provided for breaking the charging current. It shall be made of 10 mm dia G.I. Rod with spring assisted operation.

3.6 **Terminal Connectors:-** Terminal connectors shall be robust in design. The size of fixed connector shall be (80 x 50 x 8 mm) and size of movable connector shall be of (80 x 50) x (80 x 50) x 8 mm of copper casting with uniform machine finishing duly silver plated made out of minimum 95 % copper composition with 2 nos. 14 mm dia holes provided with suitable brass bolts and double nuts, flat washers & 2 nos. bimetallic solderless sockets suitable up to ACSR Zebra conductor.

3.7 **Spacing:-**

a) **Minimum clearance between the adjacent phases for 33kV AB Switch shall be as follows:**

- i) When switch is closed, the space between center to center is 1200mm
- ii) When switch is opened, the space between post insulator to the edge of the blade is 640mm
- iii) Vertical clearance from the top of the insulator Cap to Mounting channel 508mm

b) **Minimum clearance between the adjacent phases for 11kV AB Switch shall be as follows:**

- i) When switch is closed, the space between center to center is 760mm
- ii) When switch is opened, the space between post insulator to the edge of the blade is 380mm

iii) Vertical clearance from the top of the insulator Cap to Mounting channel 254mm

- 3.8 **Drawing & Literatures:** - Drawings of each item i.e. 11kV, 200 Amp and 33 kV 200 Amp, 3 Pole, single break A.B. Switch shall be furnished along with the tender.

The details of construction and materials of different parts of the A.B. Switches shall clearly be indicated in the tender and illustrative pamphlet / literature for the same shall be submitted along with the tender.

4.0 TESTS & TEST CERTIFICATE

- 4.1 **Type Test:** - The following Type tests shall have been conducted in a Govt. Testing Laboratory preferably at CPRI, Bhopal/ Bangalore etc.

- i. Impulse voltage dry test
- ii. Power frequency voltage dry test
- iii. Power frequency voltage wet test
- iv. Temperature of resistance.
- v. Measurement of resistance.
- vi. Test to prove the capability of carrying the rated peak short circuit current and the rated short time current.
- vii. Mainly active load breaking capacity test.
- viii. Transformer off-load breaking test.
- ix. Line charging breaking capacity test.
- x. Operation tests.
- xi. Mechanical endurance test.
- xii. Mechanical strength test for the post insulator as per IS-2544/1973.
- xiii. Test for galvanization of metal (ferrous) parts as perm IS-2633/1973.

Besides, Mechanical endurance test shall have been conducted on one set in the presence of our authorized person who shall be deputed to carryout acceptance tests before delivery of the materials.

- 4.2 **Routine Tests:** - The following routine tests shall have to be conducted on each set.

1. Power frequency voltage dry test
2. Measurement of resistance of main circuit
3. Tests to prove satisfactory operation.
4. Dimension check
5. Galvanization test.

5.0 GUARANTEED TECHNICAL PARTICULARS:-

The tenderer shall furnish the guaranteed technical particulars duly filled in the format **at E-16** along with the tender.

6.0 COMPLETENESS OF EQUIPMENT:-

Any fittings, accessories for apparatus which may not have been specifically mentioned in this specification but which are usual or necessary in equipment of similar plant shall be deemed to be included in the specification and shall be supplied by the Tender without extra charge. All plant and equipment shall be completed in all details whether such details are mentioned in the specification or not.

7.0 INSPECTION:-

Routine and acceptance tests shall be conducted at the place of manufacturer.

**TECHNICAL SPECIFICATION
FOR
33KV & 11KV HG FUSES**

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OF
33kV & 11kV H.G. FUSE

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TECHNICAL SPECIFICATION FOR 33KV & 11KV HG FUSES

1.0 SCOPE

This specification covers the design manufacture, shop testing, loading, transportation and delivery at sub-station site of 33KV, 200Amp, 3Pole & 11KV, 200Amp, 3Pole H.G. Fuse Sets for out door installations to be used at 33/11KV Sub-stations suitable for operation under off load conditions and Distribution Transformer.

1.1 DESCRIPTION OF THE MATERIALS:-

1.1.1 The 33KV. 200Amps, 3 Pole H.G Fuse Sets shall confirm to the following parameters:-

- | | |
|---------------------------------|-------------------------------------|
| i) Number of Poles:- | 3 |
| ii) No. of insulator per pole:- | 4nos. 22/24KV Post Insulator/ Phase |
| iii) Nominal system voltage | 33 KV |
| iv) Highest system voltage:- | 36KV |
| v) Rated frequency:- | 50 Hz |
| vi) System earthing:- | Effectively earthed |
| vii) Rated normal current | 200 Amps |
| viii)Altitude of installation | Not exceeding 1000 M. |

The post insulator used in the H.G. Fuse set shall have the following ratings:-

- | | |
|--|--|
| i) Power frequency withstand voltage (dry) | 95 kV (RMS) |
| ii) Power frequency withstand voltage (wet) | 75 kV (RMS) |
| iii) Impulse withstand voltage (dry) | 170 kV (Peak) |
| iv) Power frequency puncture withstand voltage | 1.3 times the actual dry
flashover voltage of the unit. |

1.1.2 The 9KV, 200Amps, 3 Pole H.G Fuse Sets shall confirm to the following parameters:-

- | | |
|----------------------|---|
| i) Number of Poles:- | 3 |
|----------------------|---|

ii) No. of insulator per pole:-	2nos. 12KV Post Insulator/ Phase
iii) Nominal system voltage	11KV
iv) Highest system voltage:-	12KV
v) Rated frequency:-	50 Hz
vi) System earthing:-	Effectively earthed
vii) Rated normal current	200 Amps
viii)Altitude of installation	Not exceeding 1000 M.

The post insulator used in the H.G. Fuse set shall have the following ratings:-

- | | |
|--|---|
| i) Power frequency withstand voltage (dry) | 35kV (RMS) |
| ii) Power frequency withstand voltage (wet) | 35 kV (RMS) |
| iii) Impulse withstand voltage (dry) | 75 kV (Peak) |
| iv) Power frequency puncture withstand voltage | 1.3 times the actual dry flashover voltage of the unit. |

2.0 STANDARDS:- The H.G. Fuse Set shall confirm to the following standards:-

- i) IS- 5792- 1973 (For high voltage expulsion fuses & similar fuses)
- ii) IS-2544-1973 (for porcelain post insulators)
- iii) IS-9385-1979 or its latest amendments if any.
- iv) IS-2633-1979 (For Galvanization of ferrous parts)

3.0 INSULATORS:-

The **2nos. of 12KV & 22KV/ 24KV** post insulators complete and **4nos. of 22/24KV** Post Insulator/ Phase with pedestal cap duly cemented to be used in the H.G. Fuse sets confirming to IS-2544/1973.

The tenderer shall mention make, type of insulation materials, metal fittings, Creepage distance, protected Creepage distance, tensile strength compression strength, torsion strength and cantilever strength.

The tenderer shall furnish the type test certificate of the post insulators from their manufacturer for reference & scrutiny.

4.0 TECHNICAL DETAILS:-

The H.G. Fuses shall have adjustable arcing horns made of solid copper rod having 8.23 mm dia. The horns shall be fitted with screwing devices with flynuts for fixing and tightening the fuse wire. It shall have robust terminal connector 5s of size 80mm x50 mm x 8 mm made of copper casting (95% minimum copper composition) duly silver plated with two numbers of 12mm dia brass bolts and double nuts with flat brass washers. The connector should be capable of connecting crimp able conductor up to 232 Sq.mm. size (ACSR/ AAAC) with bimetallic solder less sockets .The H.G. Fuse Set shall suitable for horizontal mounting on sub-station structures. The minimum clearance between the adjacent phases of the fuse set shall be 1200 mm and the centre to centre (distance between two post insulators of the same phase) shall be 760 mm. All metal (ferrous) parts shall be galvanized and polished. Only post insulator (original cemented and not pin insulators shall be used for the H.G. Fuse Set.

5.0 DRAWING & LITERATURES:-

Drawings of 33KV & 11KV, 200Amp, 3 Pole H.G. Fuse to be up-loaded by the Bidder. The details of construction and materials of different parts of the H.G Fuse shall clearly be indicated in the drawing and illustrative pamphlet/ literature for the same shall be submitted by the bidder within one month of LOA.

6.0 TESTS & TEST CERTIFICATE:-

6.1 Type Test:- Certificates for the following type tests conducted within five years proceeding to the date of opening of tender on a prototype set of H.G. Fuse in a Govt. Approved Testing Laboratory preferably at CPRI Bangalore shall be submitted one month of LOA.

- i) Impulse voltage dry test
- ii) Power frequency voltage dry test

- iii) Power frequency voltage wet test
- iv) Temperature of resistance.
- v) Test to prove the capability of carrying the rated peak short circuit current and the rated short time current.
- vi) Mainly active load braking capacity test.
- vii) Transformer off-load breaking test.
- viii) Line charging breaking capacity test.
- ix) Operation tests.
- x) Mechanical endurance test.
- xi) Mechanical strength test for the post insulator as per IS:2544/1973, 5350 (Pt-II)/1970 & relevant IEC.
- xii) Test for galvanization of metal (ferrous) parts as per IS- 2633/1973.

Besides above, mechanical endurance test will have to be conducted on one set in the presence of our authorized person who shall be deputed to carryout acceptance test before delivery of the materials.

6.2 Routine Tests:-

The following routine tests shall have to be conducted on each sets and results are to be furnished for consideration for acceptance of deputing inspecting Officer for inspection & conducting testing of the materials.

- i) Power frequency voltage dry test.
- ii) Tests to prove satisfactory operation.
- iii) Dimension check.
- iv) Galvanisation test.

7.0 GUARANTEED TECHNICAL PARTICULARS :-

The Guaranteed Technical Particulars is furnished at **Chapter – E16** of this Technical Specification.

8.0 COMPLETENESS OF EQUIPMENT:-

Any fittings accessories or apparatus which may not have been specifically mentioned in this specification but which are usually necessary in equipment of similar plant shall be deemed to be included in the specification and shall be

supplied by the Contractor without extra charge. All plant and equipment shall be complete in all details whether such details are mentioned in the specification or not.

9.0 INSPECTION AND TESTING:-

The Purchaser shall have free entry at all times, while work on the contract is being performed, to all parts of the manufacturer's works which concern the processing of the equipment ordered. The manufacturer shall afford the Purchaser without charge, all reasonable facilities to assure that the equipment being furnished is in accordance with this specification.

The equipment shall successfully pass all the type tests and routine tests referred to and those listed in the most recent edition of the standards given in this specification.

The Purchaser reserves the right to reject an item of equipment if the test results do not comply with the values specified or with the data given in the technical data schedule.

Type tests shall have been / shall be carried out at CPRI / National Govt. approved Laboratory and be witnessed by a representative of such laboratory or some other representative acceptable to the Purchaser. Routine tests shall be carried out by the Supplier at no extra charge at their works.

Adequate facility with calibrated testing equipment must be provided by the manufacturer free of cost to carry out the tests. Type test certificates must be furnished along with the tender for reference of the Purchaser.

All costs in connection with the testing, including any necessary re-testing, shall be borne by the Supplier who shall provide the Purchaser with all the test facilities which the latter may require, free of charge. The Purchaser shall have the right to select the samples for test and shall also have the right to assure that the testing apparatus is duly calibrated and correct. Measuring apparatus for routine tests shall be calibrated at the expense of the Supplier at an approved laboratory and shall be approved by the Purchaser.

The Supplier shall be responsible for the proper testing of the plant or materials supplied by sub-suppliers to the same extent as if the work, plant or materials were completed or supplied by the Supplier.

Any cost, incurred by the Purchaser in connection with inspection and re-testing as a result of failure of the equipment under test or damage during transport or offloading shall be to the account of the Supplier.

The supplier shall submit to the Purchaser five signed copies of the test certificates, giving the results of the tests as required. No materials shall be despatched until the test certificates have been received by the Purchaser and the Supplier has been informed that they are acceptable.

The test certificates must show the actual values obtained from the tests, in the units used in this specification, and not merely confirm that the requirements have been met.

In the case of components for which specific type tests or routine tests are not given in this specification, The Supplier shall include a list of the tests normally required for these components. All materials used in the Contract shall withstand and shall be certified to have satisfactorily passed such tests.

The Purchaser at his discretion may re-confirm the Test Results in his own laboratory or laboratory of his choice.

No inspection or lack of inspection or passing by the Purchaser's Representative of equipment or materials whether supplied by the Supplier or sub-supplier, shall relieve the Supplier from his liability to complete the contract works in accordance with the contract or exonerate him from any of his guarantees.

TECHINICAL SPECIFICATIONS

OF

11KV CTPT COMBINED METERING UNITS

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OF
11KV CTPT COMBINED METERING UNITS
(400-200/1-1) & (200-100/1-1)

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**TECHNICAL SPECIFICATION FOR 11KV CTPT COMBINED METERING UNITS
(400-200/1-1) for Trunk Feeder & (200-100/1-1) for Spur Feeder OF 0.2 CLASS
ACCURACY**

1.0 SCOPE :

This specification covers design, engineering, manufacture, **assembly, stage testing, inspection**, testing before dispatch, supply and delivery of 11 kV CT PT Combined Metering unit (400-200/1-1) Sets of class of accuracy **0.2** as per the particulars given in the schedule attached.

2.0 STANDARD :

Except where modified by this specification the component parts of the equipment shall comply with the following ISS available (the latest versions).

Current Transformers	:	IS 2705/1 992
Potential Transformers	:	IS 3156/1 992
HV Porcelain Bushing	:	IS 2099/1 986
Oil	:	IS 335/1983
Galvanization	:	IS 2633
Primary Terminals	:	IS 10601
Oil	:	IS 335

3.0 TYPE FOR 11 KV:

The 3P4W, metering transformer equipment should be of pole mounting type for outdoor use. They are to be used in 11kV Three Phase with solidly earthed neutral and suitable for 3 Phase 3 Wire 50 cycles network. The equipment is required for operation of HT Trivector Meters and should be oil cooled.

The 3P4W, CTPT sets shall have the following ratings.

i. Rated Voltage	:	11 KV
ii. Highest system voltage	:	12 KV
iii. Insulation level	:	12 KV
iv. Standard Impulse withstand voltage	:	75 KV Peak
v. One minute power frequency withstand Voltage		
a. Primary	:	28 KV
b. Secondary	:	3 KV

vi. Short time thermal current and its duration

1. 6 KA for 1 sec for CT ratio up to 20/5 A or 20/1A
 2. 13 KA for 1 sec for CT ratio > 20/5 A or 20/1A
- vii. Class of Accuracy: 0.2
- viii. Rated burden per Phase
1. For CTs : 15 VA
 2. For PTs : 50 VA
- ix. Frequency: 50 HZ
- x. Maximum attainable winding temperature = 80°C
- xi. Minimum Phase to Phase distance = 255 mm
- xii. Shortest distance between metal part & earth = 190 mm
- xiii. Creepage distance of HV bushing = 300mm (Min)
- xiv. Gauge of MS Tank Min 5mm for top cover & 3.15 mm bottom & all other side.
- xv. Entire tank shall be hot dip galvanized.
- xvi. Bi-metallic terminal connector with a nut, plane washer, spring washer & check nut suitable for aluminium conductor required for different rating of Metering units. Six nos to be provided with each metering units.
- xvii. Minimum volume of oil shall not be less than 45 Ltr.

4.0 DESIGN:

- a) The equipment shall be designed to ensure satisfactory operation under all conditions of service to facilitate easy inspection, cleaning and repairs.
- b) The design shall incorporate every reasonable precaution and provisions for safety of all those concerned in the operation and maintenance of the equipment. A pressure relief valve shall be invariably provided to the CTPT set. It shall be provided at the top cover of the tank.
- c) All outdoor apparatus shall be so designed that water cannot collect at any point and enter the CT/PT set. The top cover of the tank, secondary terminal cover, inspection chamber cover plate may be designed accordingly.
- d) All connections and terminals shall be of sufficient size for carrying the specified currents continuously without undue heating.
- e) All bolts, nuts, washers in contact with non-ferrous parts shall be of brass.
- f) All ferrous parts including bolts & nuts liable to corrosion, forming integral part of the equipment shall be smoothly and continuously hot dip galvanized.
- g) The secondary terminal box with double door arrangement (Inner & Outer) detail at (10- J), inspection cover and oil gauge shall be provided with MU.
- h) **The core shall be high grade non-ageing electrical silicon laminated steel of low hysteresis loss and high permeability to ensure high accuracy, at both normal and over current/ voltage.**

- i) **All winding shall be of insulated high grade Electrolytic copper wire and**

the manufacturing of the units shall be done in completely closed and air-conditioned room otherwise Fibre glass insulation sleeves are to be provided for primary winding. Details of winding and core shall be furnished.

- j) The CTPT set should have Three CTs and One three phase PTs with star / star connection.

5.0 SEALING:

Sealing bolts for sealing at 4 points on the secondary terminal box (both inner & outer door), inspection cover, the top cover of the tank shall be **provided**. This may be made by providing a hole **on tail of corner bolts** of adequate size to pass the sealing wire of above 13 SWG.

6.0 FLUCATUATION IN VOLTAGE AND FREQUENCY:

For continuous operation entire equipment shall be subjected to variation of voltage up to **plus 20 minus 30 percent** and frequency of plus or minus 5 percent.

7.0 INSTRUMENT TRANSFORMERS

- a) The voltage and current transformers shall have normal continuous rating as per the schedule of requirement.
- b) The voltage transformer shall be so designed that the increased magnetizing currents due to any persisting over voltage, does not produce injurious overheating. Phase barriers shall be provided.
- c) The peak value of the rated dynamic current shall not be less than 2.5 times the rated short time thermal current unless stated otherwise. (6.62 of ISS: 2705/Part-I of 1992, latest version).
- d) Modified polyester enamel copper wire is to be used for winding and it shall conform to IS-4800/Part-V (latest version).
- e) The terminals of the instrument transformer shall be clearly marked by distinctive letters as stated in Annex "C" of ISS: 3156/ Part.I /1992 (latest version) for voltage transformer and Annex "C" of IS-2705/ Part.I/1992 (latest version) for current transformers.
- f) The winding shall be neatly laid and anchored.
- g) **The metering set tank and other metal parts shall be galvanised both inside & outside as per latest IS applicable.**

8.0 INCOMING SIDE:

- a) **TERMINALS: Brass rods 12 mm dia up to 20A & 16mm dia >20A for Primary and 6 mm dia for secondary.**
- b) Bushing for outgoing side of CT/PT set : The porcelain portion of HT bushings shall be of standard make and conform to IS-2099/1996.

The dimensions of the bushings shall conform to IS- 3347/Part.III/1972. The minimum phase-to-phase clearance shall be as per IS/GTP.

The tests as per IS-2099/1 962 shall be conducted on the MU bushings as detailed below:

- a) **Dry flash over voltage.**
- b) **Wet flash over voltage.**
- c) **Dry 1 Minute withstand voltage.**
- d) **Impulse withstand voltage (1 .2/50 Micro Seconds –ve wave)**
- e) **Manufacturer's test certification may be furnished for every lot of offer.**

The bushing stems shall be provided with suitable bimetallic connectors so as to connect the jumper without disturbing the bushing stem.

9.0 STEEL TANK:

- a) The oil filled container incorporating the voltage transformers and current transformers should be fitted with incoming and outgoing primary terminals and secondary terminal box. The secondary terminal box shall be arranged on sides. The general arrangement drawing with 3 bushing on the incoming side and 3 bushings on the outgoing side shall be submitted along with tender. Adequate level of oil shall be maintained in the tank for proper cooling & curb flashover.
- b) The tank shall be built with a plate of 5 mm thick top and 3.15 mm sides and bottom and with all fittings shall be capable of withstanding without leakage or distortion at the standard test pressure. All joints of the tank and fittings shall be hot oil tight and no leakage should occur during service. Both side of the joint should have continuous welding.
- c) It shall be provided with an oil gauge as shown. The oil gauge glass shall be fixed to the side of the raised wall of the inspection box.

The tank shall be provided with necessary lifting lugs. Tank including top cover shall be hot deep Galvanized.

- d) The secondary terminal box cover, tank cover and inspection cover and other vertical joints where gaskets are used may be suitably bent **at least 25 mm bent** with necessary sealing arrangement **with sealing bolts at all corners and bolts should be at least 10 mm diameter GI bolts spaced maximum 70 mm apart.**
- e) This is to safeguard against seepage of water into tank in case of damaged gasket.

- f) The **6 mm** gaskets shall be dovetailed without joints to prevent moisture entry. In case of dovetailed joint, they shall not be more than two. The gaskets shall be of good quality Neoprene or **superior quality** rubberized gasket.
- g) **EARTHING:** Two earthing terminals shall be adequate size protected against corrosion and metallically clean and identified by means of the sign marked in a legible and indelible manner on or adjacent to the terminals.
- h) All bolts should be provided with 2 flat washers and a spring washer with a nut.
- i) Conservator should not be provided for these CTPT sets.
- j) The Secondary terminal box incoming hole should be 32 mm diameter and at a suitable height from bottom to avoid replacement/ modification of secondary wires pipe when CTPT set is replaced.. The secondary terminals size should be 6 mm diameter, 25 mm stem length, 2 flat washers with 3 nuts of brass material should be provided. The terminals should be provided at least 70 mm height from incoming hole and clearances shall be as per IS to avoid shorting terminals due to secondary wires pipe.
- k) Secondary chamber shall have double door (inner & outer) with suitable arrangement for sealing of both the doors. The inner door shall be of transparent polycarbonate so that secondary terminal connections can be viewed without breaking the inner door seals.
- l) The following details of equipment shall be engraved on tank with at least 10 mm letters. 1. Make, 2. Ratio, 3. Class of accuracy, 4. Serial No., 5. Month & year of manufacturing.
- m) 24 months guarantee embossed plate shall be welded opposite side of name plate.

10.0 MOUNTING ARRANGEMENT:

The under base of all CTPT sets shall be provided with two 75x40mm GI channels and foundation dimensions shall be suitable placing with tank base uniform for all sets with only +/- 2mm tolerance, to avoid modification of structure/plinth, whenever CTPT set is replaced.

11.0 OIL:

The insulation oil used in the tank shall comply with the requirements specified in latest relevant IS: 335/93 and as per Annexure-c.

12.0 GUARANTEED TECHNICAL PARTICULARS:

The technical particulars as specified in IS shall be guaranteed. Every bidder should furnish the particulars required and guarantee the values so furnished for the supplies.

13.0 TESTS:

TYPE TESTS: The equipment offered shall be fully type tested from at CPRI/ NABL accredited laboratory by the bidder as per the relevant standards. The bidder shall furnish copies of type test certificates with the bid (for 0.2 class, 3P4W, 11KV MU).

These type test certificates shall be got approved by the purchaser before commencement of supply. The bidders also furnish type test certificates for bushings and oil along with the bid. **The type test certificates shall be not older than (3) years from the date of opening of bid.**

TYPE TESTS FOR CTs:

- a) Verification of terminal marking and polarity
- b) Short time current Test.
- c) Temperature rise test.
- d) Lightning Impulse Test
- e) High Voltage Power frequency wet withstand voltage test
- f) Determination of errors or other characteristics according to the requirements of the appropriate designation or accuracy class.

TYPE TESTS FOR PTs:

- a) Verification of terminal marking and polarity.
- b) High voltage Power frequency wet withstand voltage test
- c) Power frequency dry withstand tests on Primary winding. Power frequency dry withstand test on Secondary winding.
- d) Determination of errors according to the requirements of the appropriate accuracy class.
- e) Temperature rise test.
- f) Impulse Voltage test.
- g) Lightning Impulse test

TYPE TESTS FOR TRANSFORMER BUSHINGS:

- a) Dry flash over voltage
- b) Wet flash over voltage
- c) Dry 1 Minute withstand voltage
- d) Impulse withstand voltage (1.2/50 Micro Seconds –ve wave)

ACCEPTANCE AND ROUTINE TESTS:

The following shall be conducted as per IS: 3156 (Latest version).

- a) Verification of Terminal marking and polarity.
- b) Power frequency/ dry withstand tests on primary windings.
- c) Power frequency dry withstand tests on secondary windings.
- d) Determination of errors according to the requirements of the appropriate accuracy class.

e) Air pressure test on empty tank of transformer opened for physical verification test(Once for every lot offered for pre-

dispatch inspection)

f) All acceptance and routine tests as stipulated in the relevant standards for CTs & PTs shall be carried out by the supplier in presence of purchaser's representatives.

Immediately after finalization of the programme of acceptance/ routine testing, the manufacturer shall give advance intimation to the purchaser, to enable him to depute his representative for witnessing the tests.

14.0 DRAWINGS AND LEAFLETS :

Two sets of drawings showing clearly the general arrangements, sectional views, fitting details, electrical connections, **foundation details, overall dimensions** (length, breadth & height) and design features of each component part should accompany the tender. The bidder has to submit clear & detail drawing with description how he will arrange the double door system in secondary chamber with sealing. Technical leaflets giving the operating instructions should also be furnished along with tender. Tenders without details are liable to be rejected.

15.0 DEVIATIONS:

The deviations between tendered CTPT sets specifications and Standard Lab (CPRI, NABL, etc.,) type tested CTPT set along with detailed reasons for deviations shall be submitted along with tender.

16.0 TOLERANCES:

Unless otherwise specified herein the test value of the transformers supplied should be within the tolerance permitted in the IS on the guarantee values.

17.0 INSPECTION:

17.1 The supplier will keep the Purchaser informed in advance of the time of the starting and the progress of manufacture of equipment in its various stages so that arrangement could be made for inspection. The accredited representative of the DISCOM will have access to the supplier's or his subcontractor's work at any time during working hours for the purpose of inspecting the materials during manufacturing of the materials / equipment and testing and may select test samples from the materials going into plant and equipment. The supplier will provide the facilities for testing such samples at any time including access to drawings and production data at no charge to Purchaser. As soon as the materials are ready the supplier will duly send intimation to DISCOM by Regd. Post and carry out the tests in the presence of representative of the DISCOM. If DISCOM feels necessary may select one sample from the lot at factory to send for testing at CPRI/ NABL etc. accredited laboratory. In this case all inspection & testing charges in this connection will be borne by the supplier. In case of factory inspection a random sample of 20 nos or 20% of the offered quantity which is more will be tested and firm will submit routine test report of all metering units basing upon which dispatch instruction will be issued.

17.2 The acceptance of any quantity of materials will in no way relieve the supplier of its responsibility for meeting all the requirements of this specification and will not prevent

subsequent rejection if such materials are later found to be defective or deviation from specification/IS.

17.3 The supplier will give 15 days advance intimation to enable the Purchaser depute his

representative for witnessing the acceptance and routine tests.

17.4 Should any inspected or tested materials / equipment fail to conform to the specification, the Purchaser may reject the materials and supplier will either replace the rejected materials or make alterations necessary to meet specifications requirements free of costs to the Purchaser.

17.5 After delivery of materials at DISCOM's Store the materials may be verified/retested in full or taking random samples before acceptance. In case of any deviation to the specification, GTP is found during the tests the lot will be rejected or will be replaced by supplier.

18.0 SEALING OF CTPT SETS AFTER TESTING AND INDIVIDUAL TEST REPORTS:

After witnessing testing on sample quantity and physical inspection of all offered CTPT sets or 20% randomly collected samples of offered quantity, the purchaser's representative will provide numbered plastic seals to two opposite corners of tank, Secondary Chamber and inspection cover of all offered CTPT sets, for delivery of correct inspected materials only. The manufacturer has to provide test report duly mentioning all test results, seals numbers and name & address of purchaser's representative after inspection is over. The seals numbers shall also be mentioned in the test reports signed by purchaser's representative submitted for delivery instructions.

19.0 INSPECTION AND TESTING OF TRANSFORMER OIL:

To ascertain the quality of transformer oil the manufacturer's test report should be submitted at the time of inspection. Arrangements should also be made for testing the transformer oil, after taking out the samples from the manufactured CTPT sets and tested in the presence of DISCOM's representative (or) if desired, in an independent laboratory.

20.0 DEPARTURE FROM SPECIFICATION:

If the bidder wishes to depart from this specification in any respect, he shall draw the attention to such points of departure explaining fully the reasons thereof. Unless this is done the requirements of this specification will be deemed to have been accepted in every respect.

21.0 NAME PLATE: -

The name plate shall be non-detachable type & fixed with rivets, not with bolts & nuts. The nameplate should bear year & month of manufacture & other data as per IS.

22.0 WARRANTY:

The supplier will warrant for the satisfactory functioning of the material / equipment as per specification for a minimum period of **72** months from the date of last supply of the material / equipment in good condition.

The bidder shall indicate the source of all materials. He shall also indicate the name of the supplier and make of conductor, Transformer oil Electrical Steel Laminations, Construction Steel etc.

23.0 FITTINGS :

The following standard fittings shall be provided.

- a) Rating and terminal marking plates non detachable -1No.
- b) Earthing terminals with bolt, nuts & washers for connecting earth wire - 2Nos.
- c) Lifting lugs -4Nos.for main tank and 2Nos. for top cover.
- d) Pressure relief valve. – 1 No.
- e) Bimetallic terminal connectors on the HV bushings – 6 Nos.
- f) HV bushings Outdoor – 6 Nos.
- g) Secondary terminals bushings – as per requirement of CT ratio.
- h) Base channels 75 x 40 mm.
- i) 6 year guarantee embossed plate welded to tank opposite side of name plate.

TECHINICAL SPECIFICATIONS

FOR

HTTV METER (CATEGORY A) WITH BOX,

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OF
HTTV METER**

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PART – A

**TECHNICAL SPECIFICATION
FOR
3 PHASE 4 WIRE CT/PT OPERATED FULLY STATIC
AMR COMPATIBLE TRI-VECTOR ENERGY METERS
(Common Protocol Energy Meters conforming to companion standard for
IEC 62056 / IS 15959) (CATEGORY 'A')**

TECHNICAL SPECIFICATION FOR HTTV METERS

1.0 SCOPE:

This specification covers design, manufacturing, testing, supply of high precision three phase four wire static tri-vector energy meters with DLMS protocol of accuracy class 0.2s or better, capable of performing functions of energy audit, feeder metering. The HT Tri-vector meter should be 3-phase 4-wire type suitable for connection to a 3 phase 4 wires as well as 3-phase 3-wire system. The meter should be capable to record and display KWh, KVAh, KVAh and maximum demand in KVA for 3 phase 4 wire as well as 3 phase 3 wire AC balanced/unbalanced loads for a power factor range of zero (lagging) through unity up to zero (leading) as per requirement given in this specification.

2.0 APPLICATION:

In Substation on Outgoing HT feeders,

3.0 STANDARDS TO WHICH METERS SHALL COMPLY:

Guidelines on "Data Exchange for Electricity Meter Reading, Tariff and Load Control – Companion Specification" enclosed with this document as annexure.
IS: 14697 /1999 (reaffirmed 2004) Specification for AC Static Transformer operated Watt Hour & VAR-Hour meters (class 0.2S);
IS-15707 Specification for Testing, evaluation, installation & maintenance of AC Electricity Meters-Code of Practice.
CBIP technical report No. 304 for Specification for AC Static Electrical Energy Meters with latest amendments.
IEC 62053-33, IEC 62053-22-2003 & IEC 62052-11-2003 for AC Static Watt-hour Meters for Active Energy, class 0.2S & 0.5S.
CBIP Technical Report No.111 Revised July 1996 for Specification for Common Meter Reading Instrument.
IS: 9000 for Basic Environmental Testing Procedures for Electronic & Electrical items
IS: 15959 (DLMS/ COSEM) for Open protocol standard for communication of meter datas
IS: 15707 for Testing, Evaluation, Installation and maintenance of AC Electricity meters- Code of Practice.

The equipment meeting with the requirements of other authoritative standards, which ensure equal or better quality than the standard mentioned

above, also shall be considered; in case of conflict related with communication protocol, the Guidelines on “Data Exchange for Electricity Meter Reading, Tariff and Load Control – Companion Specification” enclosed with this document as annexure shall prevail upon. For conflict related with other parts of the specification, the order of priority shall be – i) This technical specification ii) IS: 14697 /1999 (reaffirmed 2004).

For open protocol IS 15959 is published now.

4.0 GENERAL TECHNICAL REQUIREMENTS

1	TYPE	<i>AMR Compatible Static, 3 Ph, 4 Wire Tri-Vector Energy Meter</i>
2	FREQUENCY	<i>50 Hz \pm 5%</i>
3	ACCURACY CLASS	<i>0.2s for HT</i>
4	SECONDARY VOLTAGE	<i>For CT/PT operated HT Meters-Suitable for operation from 110V Ph-Ph or 63.5V Ph-N</i>
5	BASIC CURRENT (Ib)	<i>-/1 Amps</i>
6	MAXIMUM CONTINUOUS CURRENT	<i>Starting and Short time current shall be as per IS-14697</i>
7	POWER CONSUMPTION	<i>The active and apparent power consumption, in each voltage circuit, at reference voltage, reference temperature and reference frequency shall not exceed 1.5 W and 8 VA. The apparent power taken by each current circuit, at basic current, reference frequency and reference temperature shall not exceed 1.0 VA</i>
8	POWER FACTOR	<i>0.0 Lag -Unity- 0.0 Lead</i>
9	DESIGN	<i>Meter shall be designed with application specific integrated circuit (ASIC) or micro controller; shall have no moving part; electronic components shall be assembled on printed circuit board using surface mounting technology; factory calibration using high accuracy (0.05 class) software based test bench.</i>

5.0 CONSTRUCTIONAL REQUIREMENT/ METER COVER & SEALING ARRANGEMENT:

The Meters should be designed and constructed in such a way as to avoid introducing any danger in use and under normal conditions so as to ensure specially

- Personnel safety against electric shock.
- Personnel safety against effects of excessive temperature as per relevant standards.
- Protection against penetration of solid objects, dusts and water as per relevant standards. - Protection against spread of fire as per relevant standards.
- Detection against fraud or pilferage.

All the materials used in the manufacture of the meters should be of highest quality. The entire design and construction should be capable of with standing stresses likely to occur in actual service and rough handling during transportation as per standards.

All insulating materials used in the construction of meters should be non hygroscopic, non- aging and of tested quality and should conform to tests as specified in relevant standards. The meter should be designed on application specific integrated circuit and should be manufactured using SMT (Surface Mount Technology) components except a few PTH components.

The terminal block, the terminal cover and the meter case should have reasonable safety against the spread of fire. They should not be ignited by thermo overload of live parts in contact with them.

The meter must conform to the degree of protection IP51 against ingress of dust moisture and vermin"s.

All the parts which are subjected to corrosion under normal working conditions should be protected effectively. A protective coating should not be liable to damage by ordinary handling or damage due to exposure of air under normal working conditions.

The meters should be so designed that their working should remain unaffected by electromagnetic interference, electrostatic discharges and high voltage transients as specified in CBIP report No. 88 (latest amendments thereof)

For connecting the meters to modem for automatic reading the power supply port shall be provided with breakable plastic cover on the meter cover which shall be broken & used for connecting the modem (this feature is only optional). Sealable RJ11 connector will be given either under ETBC or side of meter with sealing arrangement.

5.1 METER COVER & CASE:

The Meter Case & Cover shall conform to IS 11731 (FH-1category) besides meeting the test requirement of heat deflection test as per ISO 75, glow wire test as per the IS: 11000 (part 2/SEC1) 1984 OR IEC PUB, 60695-2-12, Ball pressure test as per IEC--60695-10-2 and Flammability Test as per UL 94 or as per IS 11731(Part-2) 1986.

Meter should be wall mounted projected type, fitted with help of screws and should have handle at its top to facilitate carrying around.

Meter Cover and extended terminal block cover (ETBC) shall be totally transparent & made of unbreakable high grade flame retardant & injection molded in UV stabilized poly carbonate with minimum thickness of 2.0 mm on all sides except 4.0 mm on load bearing sides and of good dielectric & mechanical strength. All sides have 2.0 mm thickness only.

Meter cover should be fixed permanently seamless with ultrasonic welding with Meter Case and should not be removable without breakage of top cover. The meter cover should have two covered unidirectional sealing screws, each screw having two sealing holes. These screws should be made of brass and capable of being tightened from the front. The firm shall provide his seals on meter as:

Paper seals with Sl. No., Hologram seals with Sl. No., bar code, hologram and continuity bar. The quality of the paper seal should be such that it should not be detachable & if removed will be torn into pieces.

After seamless welding non conductive hologram seals can be given only.

The meter case should have at least three mounting holes. Two holes for mounting screws on terminal block sealed beneath the terminal cover and one for hanging screw on the top.

5.1.1 METER CASE OPEN:

The Meter shall have meter case opening detection mechanism. The event shall be indicated on meter display continuously in auto scroll mode & shall be logged in memory. The detection & logging mechanism shall work even when meter is not energized. In case of indication in display, it shall get reset in 150 days, logic shall be defined.

On opening of the meter case relevant display like cover open count, last cover open date and time shall be updated and event shall be logged permanently as per DLMS.

5.2 TERMINALS AND TERMINAL BLOCK:

The meter should have tin plated brass terminals suitable for termination of service cable. The terminal block of the meters should be of high-grade engineering plastic, which should form an extension of the meter case and should have terminal holes of sufficient size to accommodate the insulation of conductors. It should have terminal holes of adequate length and of minimum internal diameter 5.5 mm to accommodate the insulation of conductor. The manner of fixing the conductors to the terminals should ensure adequate and durable contact such that there is no risk of loosening or undue heating.

Screw connections transmitting contact force and screw fixings that may be loosened and tightened several times during the life of the meter. All parts of each terminal should be such that the risk of corrosion resulting from contact with any other metal part is minimized. Two screws should be provided in each current terminal for effectively clamping the external leads or thimbles. Each clamping screw should engage at-least 3 threads in the terminal. The ends of screws should be such as not to pierce the conductor.

The clearances and creepage distances should conform to relevant standard. All parts of each terminal should be such that the risk of corrosion resulting from contact with any other metal part is minimized.

The electrical connections should be so designed that contact pressure is not transmitted through insulating material.

5.3 TERMINAL COVER:

The terminal cover should be transparent extended type, which can be sealed independently of the meter cover. The terminal cover should enclose the actual terminals. The conductor fixing screws, the external conductors and their insulation i.e. no part of the meter or cables accessories should be accessible from the front of the meter.

When the meter is mounted, no access to the terminals should be possible without breaking the seals of the meter terminal cover. The meter terminal cover should be fitted with the help of seal able screws.

The terminal cover should have two sealing screws independent of each Other. The fixing screws used on the terminal cover for fixing and sealing should be kept captive in the terminal cover.

5.4 TERMINAL ARRANGEMENTS:

The terminals should be marked properly on terminal block for giving external connections. A sticker showing connections should be provided inside the extended cover of terminal block. The terminal cover should be of extended type such that when it is placed in position it is not possible to approach the connections or connecting wires.

5.5 CONNECTION DIAGRAM:

Every meter should be indelibly marked with connection diagram showing the phase sequence for which it is intended and should be attached to the inner side of the extended terminal block cover. In case of any special precautions need to be taken at the time of testing the meter, the same should be indicated along with the circuit diagram.

5.6 SEALING OF METER:

Proper sealing arrangement should be provided on the meter to make it tamper proof/evident and avoid mishandling by unauthorized persons. The meter cover should have provision for minimum 2 Nos. seals. The terminal block cover should also be provided with two sealing arrangements. Separate sealing arrangement for the communication ports to CMRI/Modem should also be provided.

6.0 WORKING ENVIRONMENT

As per IS 14697-1999 (reaffirmed 2004). Meter to perform satisfactorily under Non-Air Conditioned environment (within stipulations of IS)

Meter body will conform to IP51 degree of protection. For outdoor use meter shall be installed in sealed enclosure conforming to IP 55.

The meter shall be suitable designed for satisfactory operation under the hot and hazardous tropical climate conditions and shall be dust and vermin proof. All the parts and surface, which are subject to corrosion, shall either be made of such material or shall be provided with such protective finish, which provided suitable protection to them from any injurious effect of excessive humidity.

7.0 MANUFACTURING PROCESS, ASSEMBLY AND TESTING:

Meters shall be manufactured using latest and "state of the art" technology and methods prevalent in electronics industry. The meter shall be made from high accuracy and reliable surface mount technology (SMT) components. All inward flow of major components and sub assembly parts (CT, PT, RTCs/Crystal, LCDs, LEDs, power circuit electronic components etc.) shall have batch and source identification. Multilayer "PCB" assembly with "PTH" (Plated through Hole) using surface mounted component shall have adequate track clearance for power circuits. SMT component shall be assembled using automatic "pick-and-place" machines, Reflow Soldering oven, for stabilized setting of the components on "PCB". For soldered PCBs, cleaning and washing of cards, after wave soldering process is to be carried out as a standard practice. Assembly line of the manufacturing system shall have provision for testing of sub-assembled cards. Manual placing of components and soldering, to be minimized to items, which cannot be handled by automatic machine. Handling of "PCB" with ICs/C-MOS components, to be restricted to bare minimum and precautions to prevent "ESD" failure to be provided. Complete assembled and soldered PCB should undergo functional testing using computerized Automatic Test Equipment.

Fully assembled and finished meter shall undergo "burn-in" test process for 12 hrs at 55 degree Celsius (Max. temperature not to exceed 60 degree Celsius) under base current (Ib) load condition.

Test points should be provided to check the performance of each block/stage of the meter circuitry. RTC shall be synchronized with NPL time at the time of manufacture. Meters testing at intermediate and final stage shall be carried out with testing instruments, duly calibrated with reference standard, with traceability of source and date.

8.0 DISPLAYS:

The meter shall have 7 digits (with \pm indication), parameter identifier, backlit Liquid Crystal Display (LCD) of minimum 10 mm height, and wide viewing angle. LCD shall be suitable for temperature withstand of 70 deg C; Sequence of display of various instantaneous electrical parameters shall be as desired by Purchaser at the time of order.

The data stored in the meters shall not be lost in the event of power failure. The meter shall have Non Volatile Memory (NVM), which does not need any battery backup. The NVM shall have a minimum retention period of 10 years. In case of failure of power supply the meter could be powered up through an internal battery backup with a push button arrangement.

9.0 PERFORMANCE UNDER INFLUENCE QUANTITIES:

The meters performance under influence quantities shall be governed by IS 14697-1999 (reaffirmed 2004). The accuracy of meter shall not exceed the permissible limits of accuracy as per standard IS: 14697 (latest version).

10.0 OUTPUT DEVICE:

Energy Meter shall have test output, accessible from the front, and be capable of being monitored with suitable testing equipment while in operation at site. The operation indicator must be visible from the front and test output device shall be provided in the form of LED. Resolution of the test output device shall be sufficient to enable the starting current test in less than 10 minutes.

11.0 REAL TIME INTERNAL CLOCK (RTC):

RTC shall be pre-programmed for 30 Years Day/date without any necessity for correction. The maximum drift shall not exceed \pm 300 Seconds per year.

The clock day/date setting and synchronization shall only be possible through password/Key code command from one of the following:

Hand Held Unit (HHU) or Meter testing work bench and this shall need password enabling for meter;

From remote server through suitable communication network or Sub-station data logger "PC"

Time set can be done through transaction only. Time synchronization feature is not supported.

12.0 QUANTITIES TO BE MEASURED & DISPLAYED:

The meter shall be capable of measuring and displaying the following electrical quantities within specified accuracy limits for polyphase balanced or unbalanced loads:

INSTANTANEOUS PARAMETERS

1. Real Time Clock - Date and Time
2. Current - IR
3. Current - IY
4. Current - IB
5. Voltage - VRN
6. Voltage - VYN
7. Voltage - VBN
8. Voltage - VRN
9. Voltage - VBY
10. Signed Power Factor - R phase
11. Signed Power Factor - Y phase
12. Signed Power Factor - B phase
13. Three Phase Power Factor - PF
14. Frequency
15. Apparent Power - KVA
16. Signed Active Power - kW (+ Forward; -Reverse)
17. Signed Reactive Power - kvar (+ Lag; - Lead)
18. Cumulative Energy - kWh
19. Cumulative Energy - kvarh - Lag
20. Cumulative Energy - kvarh - Lead
21. Cumulative Energy - kVAh
22. Number of Power - failures.
23. Cumulative Power-failure duration
24. Cumulative Tamper count
25. Cumulative Billing count
26. Cumulative programming count
27. Billing Date
28. Cumulative MD resets count

29. Date and time of last MD reset
30. Maximum Demand - kW
31. Maximum Demand - kVA

NOTES -

- a) The items at Sl. No. 5, 6 & 7 are for 3 Ph./4 W system of measurement with Neutral as reference point
- b) The items at Sl. No. 8 & 9 are for 3 Ph./3 W system of measurement with Y – Phase as reference point
- c) Signed power factor – (+ indicates lag) and (- indicates lead)
- d) The items at Sl. No. 22 – 26 hold cumulative values at that instant from the date of manufacturing or installation of the meter as the case may be.
- e) The item at Sl. No. 25 refers to the Billing Period counter

BLOCK LOAD SURVEY PARAMETERS

1. Real Time Clock – Date and Time
2. Current - IR
3. Current - IY
4. Current – IB
5. Voltage - VRN
6. Voltage – VYN
7. Voltage – VBN
8. Voltage - VRV
9. Voltage – VBY
10. Block Energy – kWh
11. Block Energy – kVArh – lag
12. Block Energy – kVArh – lead
13. Block Energy – kVAh

NOTES -

- a) The parameters listed in this table are for load survey purpose and are logged as per the block period time.
- b) The parameters at Sl. No. 2 to 9 are the average values during the block period time and stored at the end of that time block.

- c) The parameters at Sl. No. 10 to 13 are the actual energy consumption during that time block.

BILLING PROFILE PARAMETERS

The list of parameters shown above in Instantaneous Parameters & Block Load Survey parameters shall be used for computing the daily accounting data at the HOST.

13.0 DEMAND INTEGRATION PERIOD:

The maximum demand integration period should be Programmable with 15 min default.

14.0 MD RESET:

Auto reset at 24:00 hrs at the end of each billing cycle

15.0 MARKING OF METERS:

The marking of meters shall be in accordance with IS: 14697/1999 (reaffirmed 2004). The meters shall bear marking "ODSSP, OPTCL"

The meter shall also store name plate details as given in the table A5.1 of annexure containing the category of meters viz. DLMS – A, DLMS – B & DLMS – C etc. in capital letters. These shall be readable as a profile as and when required.

16.0 COMMUNICATION CAPABILITY:

The meter shall be provided with two ports for communication of the measured/collected data as per guideline document enclosed in the annexure, i.e. a hardware port compatible with RS 232 or RS 485 specifications which shall be used for remote access through suitable Modem (GPRS/GSM/EDGE/CDMA/PSTN/LPR) and an Optical port complying with hardware specifications detailed in IEC-62056-21 / IS 15959 . This shall be used for local data downloading through a DLMS compliant HHU.

The RS 485 port shall be used at Substations suitable for multi-drop connections of the meter for exporting data to sub-station data logger/DCU/Computer and the remote end server. The RS 232 port shall be used at boundary points meters and Distribution Transformer meters & consumer meters capable to transfer and export data to the remote end server through suitable communication mediums (GPRS/GSM/EDGE/CDMA/ PSTN/LPR). Both ports shall support the default and minimum baud rate of 9600 bps.

17.0 HAND HELD UNIT (HHU):

To enable local reading of meters data a DLMS compliant HHU shall be used. The HHU shall be as per specification given in the enclosed guidelines document. It shall be compatible to the DLMS compliant energy meters that are to be procured / supplied on the basis of this specification. The HHU shall be supplied by the meter manufacturer along with the meter. 1 (One) number of HHU compatible to all categories of COSEM meters shall be provided by the supplier to DISCOM free of cost for each 50 (Fifty Meters).

18.0 TAMPER & FRAUD MONITORING FEATURES:

The meter shall work satisfactorily under presence of various influencing conditions like External Magnetic Field, Electromagnetic Field, Radio Frequency Interference, harmonic Distortion, Voltage/Frequency Fluctuations, and electromagnetic High Frequency Fields etc. The meter shall be immune to abnormal voltage/frequency generating devices and shall record the occurrence and restoration of such tamper events along with parameters such as current, voltages, kWh, power factor, event code, date & time etc. (listed in Table A6.1 to A6.7 in Annexure of the enclosed document).

The bidder may offer any other recordable abnormality event, which will be useful in consumer metering, along with the detailed descriptions, literatures, usefulness and every other implications.

Tamper details shall be stored in internal memory for retrieval by authorized personnel through either of the following:

1 - HHU. 2 - Remote access through suitable communication network.

Minimum 200 numbers of events (occurrences & restoration with date & time) should be available in the meter memory.

LOAD SURVEY

60 DAYS, 15 MIN IP with following

parameters:

PARAMETERS

- 1.Real Time Clock – Date and Time
- 2.Current - IR
- 3 Current - IY
- 4.Current – IB
- 5.Voltage - VRN
- 6.Voltage – VYN
- 7.Voltage – VBN
- 8.Block Energy –
kWh

- 9.Block Energy – kvarh – lag
- 10.Block Energy – kvarh – lead
- 11.Block Energy – kVAh

Forwarded energy channels can be given for load profile monitoring on total basis only.

TOD TIMING (Both MD & ENERGY)

00: 00 Hrs to 06:00 Hrs

06:00 Hrs to 24:00 Hrs

MD RESET REQUIRED

AUTO MODE ONLY, MANUAL RESET NOT REQUIRED

HISTORY

TOD MD - 12 months

All Energy - 12 months

History & TOD is not supported in Category A & B

19.0 TYPE TESTS:

The meter offered should have successfully passed all type tests described in the IS 14697 and the meter Data Transfer and Communication capability as per enclosed guidelines document. The front page of the Type test certificate, duly signed by the bidder, shall be uploaded along with the offer and the same shall not be more than 24 months old at the time of bid submission. Make & type of major components used in the type- tested meter shall be indicated in the QAP.

20.0 INSPECTION:

- 20.1** The supplier will keep the Owner informed in advance of the time of the starting and the progress of manufacture of equipment in its various stages so that arrangement could be made for inspection. The supplier will provide the facilities for testing such samples at any time including access to drawings and production data at no charge to Owner. As soon as the materials are ready the supplier will duly send intimation to Owner to carry out the tests in the presence of representative of the Owner.
- 20.2** The Owner may at its option get the materials inspected by the third party if it feels necessary and all inspection charges in this connection will be borne by the supplier.
- 20.3** The dispatches will be affected only if the test results comply with the specification. The dispatches will be made only after inspection by representative of the Owner is completed to the satisfaction or such inspection is waived by the competent authority.

- 20.4** The acceptance of any quantity of materials will in no way relieve the supplier of its responsibility for meeting all the requirements of this specification and will not prevent subsequent rejection if such materials are later found to be defective or deviation from specification/IS.
- 20.5** The supplier will give 15 days advance intimation to enable the Owner to depute his representative for witnessing the acceptance and routine tests.
- 20.6** Should any inspected or tested materials / equipment fail to conform to the specification, the Owner may reject the materials and supplier will either replace the rejected materials or make alterations necessary to meet specifications requirements free of costs to the Owner.
- 20.7** After deliver of materials at site, the materials may be verified / retested in full or taking random samples before acceptance. In case of any deviation to the specification, GTP & IS found during the tests the lot will be rejected or will be replaced by supplier.

21.0 ACCEPTANCE & ROUTINE TESTS:

Criteria for selection for such tests and performance requirements shall be as per IS 14697-1999 (reaffirmed 2004)

Additional acceptance shall include Surge withstand (SWC) for 6 kVp as per IEC 62052-11, Lightning impulse test and HF disturbance test as per IS 14697, Magnetic Influence Test as per CBIP report-88, Ageing Test, Burn test for 12 hrs in F.L.. One sample meter per order from one of the offered lot shall be subjected to these specific tests. Meters subjected to these tests shall not be used after tests.

Accuracy tests shall be performed at the beginning and at the end of the acceptance tests specified.

22.0 AGEING TEST:

Prior to final testing and calibration, all meters shall be subjected to accelerated ageing test to eliminate infant mortality, i.e., meters are to be kept in ovens for 72 hours at 55 deg. Centigrade temperature & atmospheric humid condition. After 72 hours meters should work correctly. Facilities / arrangement for conducting ageing test should be available with the manufacturer.

23.0 FULL LOAD TEST FOR 12 HOURS:

The meter should also be subjected to a full load operation continuously for a minimum period of 12 hours to test its durability at high loads.

24.0 QUALITY ASSURANCE:

The manufacturer shall have a comprehensive quality assurance program at all stages of manufacture for ensuring products giving reliable, trouble free performance. Details of the bidder's quality assurance and test set up shall be

furnished with the bid. A detailed quality assurance program shall be finalized with the successful bidder during the award stage. Bidder shall furnish following information along with his bid:

- Organization structure of the manufacturer and his main sub-suppliers (PCBs, SMT cards, CT/PT) with details of "QA" setup, overall workflow;
- Copy of system manual showing "QAP" (Quality Assurance Plan) as actually practiced during manufacturing and final testing.
- List of raw materials and critical components (ASIC chip, crystal clock, memory register Chip, transformers, optical ports etc.) with their suppliers;
- Stage inspection of product before final testing;
- Procedure adopted for "In-situ" testing of PCBs, after placement of surface mounted component, for quantitative parametric variation of tolerance by self or sub-contractor.
- Testing and calibration facility date of calibration of test bench, manpower data of bench operators;
- Sample copies of test certificate of bought out component.

25.0 GUARANTEE:

Energy Meters supplied shall be guaranteed for a period of 72 months from the date of commissioning . Bidders shall guarantee to repair or replace the meters and meter boxes (if supplied), which are found to be defective/ inoperative at the time of installation, or become in-operative/ defective during guarantee period. Replacements shall be effected within 1 month from the date of intimation.

26.0 TIME OF DAY (TOD) TARIFF:

The meter should be capable to record and store energy consumption as per following time zones of register. This is as per current tariff order. These should be configurable up to 8 time zones.

TOD TIMING (Both MD & ENERGY)

00: 00 Hrs to 06:00 Hrs

06:00 Hrs to 24:00 Hrs

27.0 SOFTWARE LOCKING:

The meter shall have password protected software locking for change of TOD timing, IP etc.

28.0 SOFTWARES:

The firm has to provide required base computer & MRI software for data down loading & analysis with free of cost.

29.0 METER READING PROTOCOL:

The Supplier has to provide Meter Reading Protocols, for billing parameters, tamper data etc. at free of cost. Interoperable DLMS protocol is implemented for meter reading, and tamper data. Suitable software will be provided to read the mentioned parameters.

PART - B

**TECHNICAL SPECIFICATION
FOR
TAMPER PROOF BOX**

TECHNICAL SPECIFICATION OF POLYCARBONATE OR SMC OR COMBINATION OF POLYCARBONATE & SMC MAKE PILFER PROOF METER BOX TO HOUSE THE THREE PHASE FOUR WIRE HTTV ENERGY METERS

1.0 SCOPE:

- 1.a This specification covers the design, manufacture and testing of Polycarbonate or SMC or combination of Polycarbonate & SMC Meter Box of excellent weather ability.
- 1 .b The meter box shall be anti-corrosive, dust proof, rust proof, shock proof, dust and vermin proof, U.V. stabilized and flame retardant property. Base door or other joint should not bend or soften on heating so as to ensure tamper proof construction.
- 1 .c The body of box & door should be single piece moulded without any construction joint. The meter box shall have double door (i.e. inner & outer) arrangement.
- 1 .d Meter Box should be suitable for indoor & outdoor use.
- 1 .e Meter Box should not melt at high temperature.
- 1 .f The meter box will be suitable to house one number three-phase four-wire HTTV energy meter & a modem of any make. The meter box shall comply with
IS: 14772: 2000 (For Box)
IS: 13410- 1992 [For SMC Material]

2.0 MATERIAL

The meter box will be made of high grade Engineering Plastic (Polycarbonate) or SMC or combination of Polycarbonate & SMC. It will be weather proof, capable to withstanding temperatures of boiling water for 5 minutes continuously without distortion or softening. Box will be made of Flame Retardant material which will pass Glow wire test, Environment friendly and easily recyclable.

3.0 CONSTRUCTION

- 3.1 Meter Box will have a roof tapering arrangement for easy flow of rainwater.
- 3.2 The thickness of the box will not be less than 2.5 mm from load bearing side (i.e. back side of the box) and other sides, doors & roof will not be less than 2.0 mm.
- 3.3 The overall dimensions of the box will be approximately Length-47 cm, Breadth-38 cm, Depth-20 cm. The box shall be suitable to accommodate 3phase 4wire HTTV Meter & a modem of any make such as Secure, L&T, Genus etc. (a)Outer door - Opaque with viewing window or Transparent and provision of "D"port in inner door with proper sealing arrangement for D port & meter box.

- 3.4 Box cover will be fixed with minimum three nos. hinges, well protected against corrosion. Box cover will be able to open by more than 120 degrees.
- 3.5 Soft rubber gasket for protection from ingress of dust and water will be provided on all around the box.
- 3.6 Handle/Knob will be provided on the Box door for easy door opening.
- 3.7 Concealed hinges should be fixed for easy door opening using proper size of hardware from inside in such a manner that neither it will be visible nor interfered from outside.
- 3.8 The External door in closed position should be overlapped on base such way that direct entry of screwdriver, tool or rod is not possible.
- 3.9 Adjustable Meter Mounting Arrangement may be provided to accommodate any make of Meter (like Secure, L&T etc.).
- 3.10 Box shall be provided with 4 nos. fixing holes of 6 mm diameter at all four corners of meter box. The base support of meter mounting shall be raised by about 10mm in the meter box for easy wiring.
- 3.11 For holding rigidly the inner & outer door, latches/clamps with two sealing holes shall be provided. Latches/clamps shall be provided on the body of the box with proper sealing arrangements at two locations. All metallic parts will be protected against corrosion.
- 3.12 The viewing window for meter reading will be made of break resistant, UV stabilized, transparent Polycarbonate of minimum 2.0 mm thickness. The transparent Window will be ultrasonically welded/ fixed in rigid way with meter opaque door from inside. The viewing window will have a Shade arrangement to protect meter display from direct sunlight. Size of the viewing window shall be 10.0 CM x12.0 CM approximately.
- 3.13 Adjustable meter mounting arrangement may be provided in such a way that the display portion of any make meter can be easily aligned with the viewing window of outer door , So that meter reading can be done easily without opening any door of meter box.
- 3.14 The box colour will be dark admiralty gray/off white/Transparent.
- 3.15 Meter Box should comply IP-54. Type test report will be submitted along with offer.
- 3.16 For cable entry, one suitable circular holes fitted with adjustable glands will be provided at the bottom of the box for cable inlet and outlet. Internal diameter of the gland will be such as to accommodate the control cable having outer diameter 25-30mm.The cable entry hole position can be changed by Engg.-in-charge as per the field requirement.

3.17 Tender No. & Date will be mentioned on metallic name plate in such a manner that it will not be erased & removed easily. Name of Manufacturer will be embossed on meter box cover.

4.0 TESTS:

4.1 Type Tests:

The front page of the type tests report of the box, including identification of the materials carried out at CPRI/ any NABL Accredited laboratory, duly signed by the bidder, shall be uploaded with the tender.

4.2 Acceptance Tests:

The following will constitute acceptance test for box:

- i. Physical verification of dimensions of the box.
- ii. Compatibility of the box for housing the meter for ensuring ease of connections and reading the meter.

5.0 Sample Test for acceptance:-

- A- The bidders will submit one sample boxes along with the tender, the box will be tested at DISCOM MRT Lab. to know the** Compatibility of the box for housing the meter for ensuring ease of connections and reading the meter basing on the type test report submitted with sample.
- B- Two random samples will be collected from first lot supply meter box. One will be** tested at Govt. approved independent test house for compliance of performance parameters as given in IS including Material identification to be carried out by CIPET or some other standard Lab. **& other will be tested at DISCOM MRT Lab. to know the** Compatibility of the box for housing the meter for ensuring ease of connections and reading the meter before acceptance. Subsequent lot will be accepted after successful verification by DISCOM MRT Laboratory.

ANNEXURE – IV (A)

GUARANTEED TECHNICAL PARTICULARS FOR 3 PHASE 4 WIRE CT/ PT OPERATED FULLY STATIC AMR COMPATIBLE TRI-VECTOR ENERGY METERS (Common Protocol Energy Meter Conforming to companion standard for IEC 62056/IS15959) Category -A

S I	Item	Purchaser's Requirement	Bidder's Data
1.	Make		
2	Type	3PH 4 Wire, Trivector Energy Meter (AMR Compatible)	
3	Country of origin	India	
4	Application	3 phase 4 wire, CT PT operated	
5	Rated Voltage	For CT/PT operated HT Meters-Suitable for operation from 110V Ph-Ph or 63.5V Ph-N (ii) For Distribution Transformer & other LT-CT	
6	Rated Current (Basic current)	1A for -/1A,5A for -/5A	
7	Frequency	50 Hz \pm 5 %	
8	Overload capacity	200% of Ib	
9	Minimum starting current in % of base current	As per IS 14697: 1999	
10	Short Time Current	As per IS 14697: 1999	
11	Loss in potential circuit	Less than 1.5 Watt & 8VA per	
12	Loss in current circuit	Less than 1 VA	
13	Power Factor	0.0 Lag -Unity- 0.0 Lead	
14	Change in error due to		
	Variation in frequency	50 Hz +/- 5%	
	Variation in temperature	As per IS 14697: 1999	
	Variation in voltage	As per IS 14697: 1999	
15	Accuracy Class	LT- 0.5s, HT-0.2s	
16	Constructional Requirement/Meter Cover	As per Clause:-5.0 of Tech. Specification.	
17	Meter Cover & Case	As per Clause:-5.1 of Tech. Specification.	
18	Meter Case Opening Temper Recording	As per Clause:-5.1.1 of Tech. Specification.	
19	Terminal & Terminal Block	As per Clause:-5.2 of Tech. Specification.	
20	Terminal Cover	As per Clause:-5.3 of Tech. Specification.	
21	Terminal Arrangement	As per Clause:-5.4 of Tech. Specification.	

2 2	Connection Diagram	As per Clause:-5.5 of Tech. Specification.	
2 3	Sealing of Meter	As per Clause:-5.6 of Tech. Specification.	
2 4	Working environment & degree of protection.	As per Clause:-6 of Tech. Specification.	
2 5	Manufacturing Process assembly & Testing	As per Clause:-7 of Tech. Specification.	
2 6	Displays	As per Clause:-8.0 of Tech. Specification.	
2 7	Non Volatile Memory	The data stored in the meters shall not be lost in the event of power failure. The meter shall have Non Volatile Memory (NVM), which does not need any battery backup. The NVM shall have a minimum retention period of 10 years.	
2 8	Battery Back up	In case of failure of power supply the meter could be powered up through an internal battery backup with a push button arrangement.	
2 9	Performance under Influence Quantities	As per IS-14697/1999 (reaffirmed 2004) & CBIP Technical Report	
3 0	Out Put Device	As per Clause:-10 of Tech. Specification.	
3 1	RTC	As per Clause:-11 of Tech. Specification.	
3 2	Quantities to be measured & displayed.	As per Clause:-12 of Tech. Specification.	
3 3	Demand Integration Period	Should be programmable & 15 min by default.	
3 4	MD Reset	Auto reset at 24:00 hrs at the end of each billing cycle.	
3 5	Marking	As per Clause:-15 of Tech. Specification.	
3 6	Communication Capability	As per Clause:-16 of Tech. Specification.	

37	HHU	As per Clause:-17 of Tech. Specification.	
38	Free supply of HHU	One DLMS Compliant HHU shall be provided by the supplier to DISCOM free of cost for each 50(fifty) meters for data down loading. It shall be compatible to the DLMS compliant energy meters that are to be procured/supplied on the basis of this technical specification	
39	Tamper & Fraud monitoring features	As per Clause:-18 of Tech. Specification.	
40	Abnormality Events Detection	As per Table A6.1 to A6.7 "Data Exchange for Electricity Meter Reading, Tariff and Load Control –	
41	Load Survey capability		
41-i	Parameter Logged	1.Real Time Clock – Date and Time. 2.Current – IR 3. Current – IY 4.Current – IB 5.Voltage – VRN 6.Voltage – VYN 7.Voltage – VBN 8.Block Energy	
41-ii	Logging interval	(PROGRAMMABLE,15 Minutes by default)	
41-iii	No. of days of Load Survey	60 power on days	
41-iv	Apparent Calculation	Lag + Lead	
42	TOD TIMING (Both MD & ENERGY)	00: 00 Hrs to 06:00 Hrs 06:00 Hrs to 24:00 Hrs	

43	MD RESET REQUIRED	AUTO MODE ONLY, MANUAL RESET NOT	
44	Software Locking	The meter shall have password protected software locking provision for changing the TOD timings & MD integration period.	
45	Software	The firm has to provide required base computer & MRI software for data down loading & analysis with free of cost.	
46	Meter Reading Protocol	The Supplier has to provide Meter Reading Protocols for billing parameters, tamper data etc. at free of cost.	

NNEXURE – IV (E)

GUARANTEED TECHNICAL PARTICULARS FOR POLYCARBONATE OR SMC OR COMBINATION OF POLYCARBONATE & SMC PILFER PROOF METER BOX TO HOUSE THE THREE PHASE FOUR WIRE HTTV ENERGY METERS

Sl. No.	Characteristics	Requirements	Bidders
1.	Manufacturer's / Supplier's name and address with works address.		
2.	Material used for box body	Poly Carbonate/SMC (Sheet Moulding Compound)ref-IS: 13410/1992 /IS:14772 :2000Combined	
3.	Color of Box	Dark Admiral Gray/off White/Transparent	
4.	Dimensions of box (L x W x H)	45x38x20 CM (approx)	
5.	Meter Fixing Arrangement	Adjustable Meter Mounting Arrangement may be provided to accommodate any make of Meters (like Secure, L&T etc.).	
6.	Earthing Provisions	To be provided	

7.	Thickness of meter box a. From Back Side b. From all other sides	2.5 mm Back Side 2.0 mm all other side.	
8.	Clearance of meter from box surface approx. : (Varies from meter to meter) a. Right , Left b. Top side c. Bottom side (from meter terminals) d. Bottom side (from terminals cover)	a. 10 cm b. 1 cm c. 12 cm d. 8 cm e. 11 cm	
9	Additional “D” Port	Additional “D” Port provision provided in the inner door of the box with sealing arrangement for downloading data through MRI.	
10	Doors	Provision of two (Inner door & outer door) arrangement to be provided.	
11	Push button hole	Push button hole shall be done by DISCOMs at the time of installation.	
12	The material of inner door shall be	SMC	
13	Cable Entry Hole.	For cable entry, one suitable circular holes fitted with adjustable glands will be provided at the bottom of the box for cable inlet and outlet. Internal diameter of the gland will be such as to accommodate the control cable having outer diameter 25-30mm. The cable entry hole position can be changed by DISCOMs as per the field requirement & will be narrated during the	
14	Type of Use Meter Box should be suitable for	Meter Box should be suitable for indoor & outdoor use.	
15	Suitable to house	The meter box will be suitable to house one number three-phase four-wire HTTV energy meter & a modem of any make.	
16	The meter box shall comply with	IS:13410- 1992	
17	Roof tapering	Meter Box will have a roof tapering arrangement for easy flow of rainwater, as per sample.	

18	Hinges	Box cover will be fixed with minimum three nos hinges in each door well protected against corrosion. Box cover will be able to open by more than 120 degrees. Concealed hinges should fix the Box and cover, with hardware from inside in such a manner that it can't be	
19	Gasket	Soft rubber gasket for protection from ingress of dust and water will be provided on all around the box.	
20	Handle	Handle/Knob will be provided on the Box door for easy door opening.	
21	Inner door, viewing window & D-Port.	The box shall be provided with two (inner & outer) doors. A viewing window must be provided in inner door if not transparent. One D-Port provision for communication must be provided in the inner door of each box with sealing arrangements.	
22	Fixing Holes	Box shall be provided with 4 nos. fixing holes of 6 mm diameter at all four corners of meter	
23	Sealing & Latches.	For holding and sealing the outer door, U-shaped latches/clamps with two sealing holes will be provided. Two nos Latches will be provided on the base of the box. These latches will also hold the box cover with base. All metallic parts will be protected against corrosion. Provision shall be made for sealing	
24	Viewing window	The viewing window for meter reading will be made of break resistant, UV stabilized, transparent Polycarbonate of minimum 2.0 mm. Thickness the transparent window will be properly welded/fixed in rigid way with meter opaque door from inside. The viewing window will have a shade arrangement to protect meter display from direct sunlight. The viewing window shall be 10.0CM X 12.0CM approximately.	

25	Adjustable meter mounting Arrangement.	Adjustable meter mounting arrangement to be provided in such a way that the display portion of any make meter can be easily aligned with the viewing window of outer door, So that meter reading can be done easily without opening any door of meter box.	
26	Name Plate.	Purchase order No. & Date, Property of DISCOMS, Purchase under CAPEX Programme etc. will be mentioned on metallic name plate in such a manner that it will not be erased & removed easily. Name of Manufacturer will be embossed on meter box cover.	

TECHNICAL SPECIFICATION
FOR
CONTROL & PROTECTION PANEL
(AT SOURCE SUB STATION)

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OF
CONTROL, RELAY & PROTECTION PANELS

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CONTROL, RELAY & PROTECTION PANELS

The Control and Relay panel offered shall be procured fitted with Relays from short listed vendor at Chapter E-14. IP-54 / IP-64 Ingress Protection should have been conducted.

1.0 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 & front for relay/**protection** 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.

2.0 CONSTRUCTIONAL FEATURES

- 2.1. 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 be properly accommodated in the panels without congestion.
- 2.2. 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-31 in accordance with IS: 2147.
- 2.3. 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 **3.0 mm** for weight bearing members of the panels such as base frame, front sheet and door frames, and **2.0 mm** for sides, door, top and bottom portions. There shall be sufficient reinforcement to provide level transportation and installation.
- 2.4. All doors, removable covers **of** panels shall be gasketed all around with synthetic gaskets Neoprene/EPDM generally conforming with provision of IS 11149. However, XLPE gaskets can also be used for fixing protective glass doors. Ventilating louvers, if provided shall have screens and filters. The screens shall be made of either brass or GI wire mesh.
- 2.5. 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 true and smooth.
- 2.6. 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, which shall be placed between panel & base frame.

- 2.7. 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.
- 2.8. Relay/protection panels of modern modular construction would also be acceptable.

3.0 MOUNTING

- 3.1. 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.
- 3.2. 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.
- 3.3. The 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**.
- 3.4. The centre lines of switches, push buttons and indicating lamps shall be not less than 750mm from the bottom of the panel. The centre lines of relays, meters and recorders shall be not less than 450mm from the bottom of the panel.
- 3.5. The centre lines of switches, push buttons and indicating lamps shall be matched to give a neat and uniform appearance. Like wise the top lines of all meters, relays and recorders etc. shall be matched.
- 3.6. No equipment shall be mounted on the doors.
- 3.7. At existing station, **panels shall be matched with other panels in the control room in respect of dimensions, colour, appearance and arrangement** of equipment (centre lines of switches, push buttons and other equipment) on the front of the panel.

4.0 PANEL INTERNAL WIRING

- 4.1. 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 carried out internally.
- 4.2. All wiring shall be carried out with 1100V 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 2.5 mm sq. per lead.
 - All current transformer circuits - one 2.5 sq.mm per lead.
 - Voltage transformer circuit (for energy meters): Two 2.5 mm sq. per lead.
- 4.3. 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.
- 4.4. 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.
- 4.5. Wire termination shall be made with solderless 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.
- 4.6. 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.
- 4.7. Contractor shall be solely responsible for the completeness and correctness of the internal wiring and for the proper functioning of the connected equipments.

The sizes of wiring in different circuits shall not be less than those specified below :

Table – I

Circuit	Minimum permissible Size of wire.
(i) Metering and relaying circuits connected to Current Transformers.	2.5 mm sq.
(ii) Potential circuits for metering and Relaying	2.5 mm sq.
(iii) Other control, visual and audible alarm signaling circuits etc.	2.5 mm sq

The following colour scheme shall be used for the wiring.

Table – II

Circuit where use	Colour of wire and ferrule
(i) Red phase of instrument transformer circuit	Red
(ii) Yellow phase of instrument transformer	Yellow
(iii) Blue phase of instrument transformer circuits	Blue
(iv) Neutral connections earthed or not earthed in the instrument transformer circuit	Green
(v) All other wires shall be	Grey

5.0 TERMINAL BLOCKS:

All the terminal blocks to be used in the operating mechanism should be of stud type of Poly-amide material (for non-disconnecting type and for disconnecting type).

- 5.1. All internal wiring to be connected to external equipment shall terminate on 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.
- 5.2. 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.
- 5.3. **At least 20% spare terminals** shall be provided on each panel and these spare terminals shall be uniformly distributed on all terminal blocks.
- 5.4. 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 2.5 mm² Copper
 - AC/DC Power Supply Circuits: One of 2.5 mm² Copper
 - All other circuits: minimum of one of 2.5 mm² Copper
- 5.5. 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.
- 5.6. 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 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.

- 5.7. 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 in the scope of supply.

6.0 PAINTING

Powder coating type

All sheet steel work shall be **Phosphated** in accordance with the IS:6005 Code of practice for phosphating iron and steel.

(1) All unfinished surface of the steel panels and frame work shall be sand blasted to remove rust, scale, foreign, adhering matter of grease.

(2) A suitable rust resisting primer shall be applied on the interior and exterior surfaces of the steel, which shall be followed by application of an under coat suitable to serve as base and binder for the finishing coat. The finishing coat on the exterior of the panels shall be deep grey powder coated. Polished cellulose appearance while on the interior faces the finishing coat shall be of light grey shaded paint sprayed to give a contrasting effect with the cubicle wiring. A small quantity of finishing paint shall be supplied with each consignment of the panels to enable the Employer's store at site any finish which may get damaged during the transshipment. The panel boards may alternatively be given a plastic durable covering coat for protection of the finish during the transshipment, which shall be capable of being peeled off after installation.

7.0 MIMIC DIAGRAM

- 7.1. Coloured mimic diagram and symbols showing the exact representation of the system shall be provided in the front of control panels.
- 7.2. Mimic diagram shall be made preferably of anodised aluminium or plastic of approved fast colour material, which shall be screwed on to the panel and can be easily cleaned. The mimic bus shall be 2mm thick. The width of the mimic bus shall be 10mm for bus bars and 7mm for other connections. Painted overlaid mimic is also acceptable.

7.3 COLOUR SCHEME FOR MIMIC DIAGRAMS

Equipment	Colour	I.S. Code No.(IS.5)
33 KV	Signal Red	537
11 KV	Brilliant Green	414
415/250V	Black	221
Earth	White	309

7.4. When Semaphore indicators are used for equipment position, they shall be so mounted in the mimic that the equipment in close position shall complete the continuity of mimic.

7.5. Indicating lamp, one for each phase, for each bus shall be provided on the mimic to indicate bus charged condition

8.0 NAME PLATES AND MARKINGS

8.1. 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 nameplates shall be provided for circuit/feeder designation.

8.2. 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.

8.3. 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.

8.4. Name Plates shall be made of non-rusting metal or 3 ply lamicoid. Name plates shall be black with white engraving lettering.

8.5. Each switch shall bear clear inscription identifying its function e.g. 'BREAKER' '52A', "SYNCHRONISING" etc. Similar inscription shall also be provided on each device whose function is not other-wise identified. If any switch device does not bear this inscription separate name plate giving its function shall be provided for it. Switch shall also have clear inscription for each position indication e.g. "Trip- Neutral-Close", "ON-OFF", "R-Y-B- OFF" etc

8.6. 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.

9.0 MISCELLANEOUS ACCESSORIES

- 9.1. **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.
- 9.2. **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.
- 9.3. **Switches and Fuses:** Each panel shall be provided with necessary arrangements for receiving, distributing and isolating of DC and AC supplies for various control, signaling, lighting and space heater circuits. The incoming and sub-circuits shall be separately provided with Fuses. Selection of the main and sub-circuit Fuses rating shall be such as to ensure selective clearance of sub-circuit faults. 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. The short time fuse rating of Fuses shall be not less than 9 KA. Fuse carrier base shall have imprints of the fuse 'rating' and 'voltage'.
- 9.3. **Space Heater:** Each panel shall be provided with a thermostatically connected 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.

10.0 EARTHING

- 10.1. All panels shall be equipped with an earth bus securely fixed. Location of earth bus shall ensure no radiation interference from earth systems under various switching conditions of isolators and breakers. The material and the sizes of the bus bar shall be at least **25x6** sq.mm copper with threaded holes at a gap of 50 mm with 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.
- 10.2. Provision shall be made on each bus bar of the end panels for connecting Substation earthing grid. Necessary terminal clamps and connectors for this purpose shall be included in the scope of supply of Contractor.
- 10.3. 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 colour code of earthing wires shall be green.

- 10.4. 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.
- 10.5. 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.
- 10.6. An electrostatic discharge **arrangement** shall be provided in each panel **so as to discharge human body before he handles the equipments inside the panels.**

11.0 INDICATING INSTRUMENTS & TRANSDUCERS FOR CONTROL PANEL (Multi function meter to be inserted)

All instruments, meters and transducers shall be enclosed in dust proof, moisture resistant, black finished cases and shall be suitable for tropical use. All MEGAWATT , MEGAVAR, BUS VOLTAGE AND FREQUENCY indicating instruments shall be provided with individual transducers and these shall be calibrated along with transducers 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.

11.1. Indicating Instruments

- 11.1.1. Unless otherwise specified, all electrical indicating instruments shall be of digital type suitable for flush mounting.
- 11.1.2. Instruments shall have 4-digit display; display height being not less than 25mm.
- 11.1.3. Instrument shall conform to relevant IS and shall have an accuracy class of 1.0 or better. Watt and Var meters shall have an indication of (+) and (-) to indicate EXPORT and IMPORT respectively.
- 11.1.4. Digital voltage and frequency meters shall be of class: 0.5 and shall have digital display of 5 and 4 digits respectively, with display size, not less than 25mm (height).

11.2. Transducers

- 11.2.1. Transducers (for use with Indicating Instruments and Telemetry / Data Communication application) shall in general conform to IEC:688-1
- 11.2.2. The transducers shall be suitable for measurement of active power, reactive power, voltage, current and frequency in three phase four wire unbalanced system.
- 11.2.3. The input to the transducers will be from sub-station current & potential transformers. The output shall be in milli ampere D.C. proportional to the input & it shall be possible to feed the output current directly to the telemetry terminal or indicating instruments.
- 11.2.4. The transducer characteristic shall be linear throughout the measuring range.
- 11.2.5. The transducer output shall be load independent.
- 11.2.6. The input & output of the transducer shall be galvanically isolated.
- 11.2.7. Each transducer shall be housed in a separate compact case and have suitable terminals for inputs & outputs.
- 11.2.8. The transducers shall be suitably protected against transient high peaks of voltage & current.
- 11.2.9. The transducer shall withstand indefinitely without damage and work satisfactorily at 120% of the rated voltage and 120% of the rated input current as applicable.
- 11.2.10. All the transducers shall have an output of 4-20 mA.
- 11.2.11. The response time of the transducers shall be less than 1 second.
- 11.2.12. The **Accuracy Class** of transducers shall be 0.5.
- 11.2.13. The transducers shall have a low AC ripple on output less than 1%.
- 11.2.14. The transducer shall have dual output.

12.0 ANNUNCIATION SYSTEM for Control Panel

- 12.1. 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.
- 12.2. The visual annunciation shall be provided by annunciation facia, mounted flush on the top of the control panels.
- 12.3. The annunciation 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.

12.4. 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.

12.5. All Trip facia shall have **Red** colour and all Non-trip facia shall have **White** colour.

12.6. 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

12.7 Sequence of operation of the annunciator shall be as follows :

Sl. NO.	Alarm	Condition Contact	Visual Annunciation	Audible Annunciation
	Normal	Open	Off	Off
	Abnormal	Close	Flashing	On
	Accept Push Button Pressed	Close Open	Steady On Steady On	Off Off
	Reset Push Button Pressed	Close Open	On Off	Off Off
	Lamp Test Push Button Pressed	Open	Steady On	Off

12.8. 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.

12.9. 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.

12.10. The annunciation system described above shall meet the following additional requirements :

- a) The annunciation system shall be capable of catering to at least 20 simultaneous signals at a time.
- b) One set of the following push buttons shall be provided on each control panel:
 - Reset push button for annunciation system
 - Accept push button for annunciation system
 - Lamp test push button for testing the facia windows
- c) One set of the following items shall be provided common for all the control panel (not applicable for extension of substation) :
 - Flasher relay for annunciation system
 - Push button for Flasher test
 - Three Push buttons for test of all audible alarm systems
- d) These testing circuits shall be so connected that while testing is being done, it shall not prevent the registering of any new annunciation that may land during the test.
- e) The annunciation shall be repetitive type and shall be capable of registering the fleeting signal. Minimum duration of the fleeting signal registered by the system shall be 15 milli seconds.
- f) In case of static annunciator scheme, special precaution shall be taken to ensure that spurious alarm condition does not appear due to influence of external electromagnetic/ electrostatic interference on the annunciator wiring and switching disturbances from the neighbouring circuits within the panels and the static annunciator shall meet the high voltage susceptibility test , impulse voltage with stand test , high frequency disturbance test– class III and fast transient disturbance test –level III as per IEC 60255.

12.11. The annunciation system to be supplied for existing sub-stations shall be engineered as **an extension to the existing scheme**.

13.0 SWITCHES

13.1. 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.

13.2 The selection of operating handles for the different types of switches shall be as follows :

Breaker, Isolator control switches	Pistol grip, black
Synchronising switches	Oval, Black, Keyed handle (one common removable handle for a group of switches or locking facility having common key).
synchronising Selector switches	Oval or knob, black Instrument
switches	Round, knurled, black
Protection Transfer switch	Pistol grip, lockable and black.

- 13.3. 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.
- 13.4. Lockable type of switches which can be locked in particular positions shall be provided when specified. The key locks shall be fitted on the operating handles.
- 13.5. The contacts of all switches shall preferably open and close with snap action to minimise 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.
- 13.6. The contact combination and their operation shall be such as to give completeness to the interlock and function of the scheme.
- The contact rating of the switches shall be 10A Continuous rating.

14.0 INDICATING LAMPS

- 14.1. Indicating lamps shall be of cluster LED type suitable for panel mounting with rear terminal connections. Lamps shall be provided with series connected resistors preferably built in the lamp assembly. 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.
- 14.2. The lamps shall be provided with suitable resistors.
- 14.3. Lamps and lenses 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 the supply.

- 14.4. The indicating lamps with resistors shall withstand 120% of rated voltage on a continuous basis.

Lamps shall have translucent lamp covers to diffuse lights coloured red, green, amber, clear white or blue as specified as per the following:

	Function	Quantity	Colour of lens
1.	Circuit Breaker spring charged/normal pressure indication.	1 No.	Blue
2.	Circuit Breaker trip circuit healthy indication.	2 Nos.	White
3.	Circuit Breaker Low Air Pressure indication	1 No.(where necessary	White
4.	Incoming D.C. fail indication.	2 Nos.	White
(i)	A. C. fail indication.	1 No.	White
6.	P. T. supply indication.	3 Nos	Red/Yellow/ Blue
7.	Indication lamps for CB closing ,opening Isolator closing and opening		Red and Green
i)	Auto trip	1 No.	Amber
ii)	Protection on Transfer Mode	1 No.	White
iii)	CB on Local/Remote	2 Nos	White

15.0 POSITION INDICATORS (if Applicable)

- 15.1. 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.
- 15.2. 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.
- 15.3. The rating of the indicator shall not exceed 2.5 W.
- 15.4. The position indicators shall withstand 120% of rated voltage on

a continuous basis.

16.0 RELAYS

- 16.1. All relays shall conform to the requirements of IS: 3231/IEC-60255/IEC 61000 .Relays shall be suitable for flush or semi-flush mounting on the front with connections from the rear.
- 16.2. All protective relays shall be of numerical type and communication protocol shall be as per IEC 61850. Further, the test levels of EMI as indicated in IEC 61850 shall be applicable to these relays.
- 16.3. All protective relays shall be 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.
- 16.4. 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 **1A 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.
- 16.5. The protective relays shall be suitable for efficient and reliable operation of the protection scheme described in the specification. 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.
- 16.6. Timers shall be of solid state type. Time delay in terms of milliseconds obtained by the external capacitor resistor combination is not preferred and shall be avoided.
- 16.7. No control relay, which shall trip the power circuit breaker when the relay is de-energised, shall be employed in the circuits.
- 16.8. Provision shall be made for easy isolation of trip circuits of each relay for the purpose of testing and maintenance.
- 16.9. 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.
 - (d) Trip-circuit seal-in is required for all trip outputs, irrespective of the magnitude of the interrupted current. The trip-circuit seal-in logic shall not only seal-in the trip output(s), but also the relevant initiation signals to other scheme functions, (e.g. initiate signals to the circuit-breaker failure function, reclosing function etc.), and the alarm output signals.
 - (e) Two methods of seal-in are required, one based on the measurement of AC current, catering for those circumstances for which the interrupted current is above a set threshold, and one based on a fixed time duration, catering for those circumstances for which the interrupted current is small (below the set threshold).
 - (f) For the current seal-in method, the seal-in shall be maintained until the circuit-breaker opens, at which time the seal-in shall reset and the seal-in method shall not now revert to the fixed time duration method. For this seal-in method, the seal-in shall be maintained for the set time duration. For the line protection schemes, this time duration shall be independently settable for single- and three-pole tripping.
 - (g) Seal-in by way of current or by way of the fixed duration timer shall occur irrespective of whether the trip command originates from within the main protection device itself (from any of the internal protection functions), or from an external device with its trip output routed through the main protection device for tripping. Trip-circuit seal-in shall not take place under sub-harmonic conditions (e.g. reactor ring down).
- 16.10. The setting ranges of the relays offered, if different from the ones specified shall also be acceptable if they meet the functional requirements.
- 16.11. Any 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 OPTCL.
- 16.12. All relays and their drawings shall have phase indications as R-Red, Y- yellow, B-blue.

16.13. For **numerical relays**, the scope shall include the following:

- a) Necessary software and hardware to up/down load the data to/from the relay from/to the personal computer installed in the substation. However, the supply of PC is not covered under this clause.
- b) The relay shall have suitable communication facility for SCADA connectivity. The relay shall be capable of supporting IEC 61850 protocol.
- c) The features like fault recorder and event logging function in the relays shall be supplied.

16.14 For 33 KV (Line)

	Back up: Numerical Directional & Non-directional(site selectable) Over Current and Earth fault Protection. The detailed description of line protections is given here under.
(a)	shall have continuous self monitoring and diagnostic feature. include a directional back up Inverse Definite Minimum Time (IDMT) earth fault relay with normal inverse characteristics as per IEC 60255-3 as a built in feature

17.0. Numerical Back-up Directional Over Current and Earth fault protection scheme.

- (a) shall have three over current and one earth fault element(s) which shall be either independent or composite unit(s)
- (b) shall include necessary VT fuse failure relays for alarm purposes
- (c) **Over Current elements** shall
 - have IDMT characteristic with a definite minimum time of 3.0 seconds at 10 times setting
 - have a variable setting range of 50-200% of rated current
 - have a characteristic angle of 30/45 degree lead
 - Include LEDs
- (d) **Earth fault element** shall
 - have IDMT characteristic with a definite minimum time of 3.0 seconds at 10 times setting
 - have a variable setting range of 20-80% 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
- (e) Shall have over & under voltage protection facility.
- (f) Shall have facility for under frequency protection facility (minimum 03 stages)
- (g) Shall have facility of LBB protection.

18.0 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.

19.0 DC/AC SUPPLY SUPERVISION RELAY

- (a) The relay shall be capable of monitoring the failure of **D.C./A.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.

20.0. Type Test:-

As detailed below test have been done.

- a) Insulation tests as per IEC 60255-5
- b) DC Voltage dips and interruptions/Variation as per IEC 6100-4-29.
- c) High frequency disturbance test as per IEC 61000-4 16, Class IV (Not applicable for electromechanical relays)
- d) Electrostatic discharges as per IEC 61000-4-2, level; 4 (not applicable for Electromechanical relays)
- e) Fast transient test as per IEC 61000, Level IV (Not applicable for electromechanical relays)
- f) 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
- Conformance test as per IEC 61850-10.

For Fault recorder, Disturbance recorder; only performance tests are intended under this item.

g) Tests for thermal and mechanical requirements as per IEC 60255-6 h) Tests for rated burden as per IEC 60255-6

i) Contact performance test as per IEC 60255-0-20 (not applicable for Distance to fault locator and Disturbance recorder)

In case there is a change either in version or in model (Except firmware) of the relay, the contractor has to submit the type test reports for the offered revision/model.

21.0 CONFIGURATION OF RELAY AND PROTECTION PANELS

The following is the general criteria for the selection of the equipments to be provided in each type of panel. However, contractor can optimise the requirement of panels by suitably clubbing the feeder protection and CB relay panels.

Control Panel: Various types of control panels shall consist of the following

Sl No.	Description	Qty	Description
a.	Multifunction Metr	1	To monitor & display V,I,KW,KVA,KVAR,F,Cos ϕ etc
b.	CB Control switch	1 No	for each Circuit breaker
c.	Isolator Control switch	1 No	for each isolator
d.	Semaphore Red indicating lamp	1 no. 1 no.	for each earth switch for each Circuit breaker
e.	Red indicating lamp	1 no.	for each isolator
f.	Green indicating lamp	1 no.	for each Circuit breaker
g.	Green indicating lamp	1 no.	for each isolator
h.	White indicating lamp (DC healthy lamp)	2 nos	for each feeder
i.	Annunciation windows with associated annunciation relays	18 nos	for each feeder

j.	Push button for alarm Accept/reset/lamp test	3 nos	for each control panel
k.	Protection Transfer Switch with indication lamp(for transfer position)	1 no.	for each breaker in case of DMT /DM*/SMT schemes (Except TBC and BC breaker) - * with by pass isolator
n.	Mimic to represent SLD	Lot	in all control panels
o.	Trip Circuit Healthy with push button	2 Nos	In all the control panel

3. 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.

(I) **LINE PROTECTION PANEL**

The Line Protection panel for transmission lines shall consist of following protection features/schemes

Sl No.	Description	33 KV
1	Numerical Directional & Non-directional (Site selectable) Back up Over current and E/F protection scheme with LBB protection	1 Set
	Under frequency protection	
	Over Voltage & under voltage Protection Scheme	
	LBB protection	
2	3 Phase Trip Relays	1 Nos
3	Flag relays, carrier receive relays, aux. Relays, timers etc as per scheme requirements	As required

22.0 ERECTION AND MAINTENANCE TOOL EQUIPMENTS

All special testing equipment required for the installation and maintenance of the apparatus, instruments devices shall be furnished in relevant schedule

23.0 TROPICALISATION

Control room will be normally air- conditioned. All equipments shall however be suitable for installation in a tropical monsoon area having hot, humid climate and dry and dusty seasons with ambient conditions specified in the specification. All control wiring, equipment and accessories shall be protected against fungus growth,

condensation, vermin and other harmful effects due to tropical environment.

**** ALL THE RELAYS SHALL BE OF NUMERICAL VERSION HAVING IEC 61850 PROTOCOL COMPLIANCE. ALL CARE SHALL BE TAKEN IN DESIGNING THE PROTECTION SYSTEM FOR SCADA PROVISION. THERE SHALL BE ADEQUATE NO OF INPUT AND OUT PUT CONTACTS FOR USE. SHALL HAVE SELF SUPERVISING AND INTERNAL FAULT DETECTING/DIAGNOSING FACILITY. SUFFICIENT FAULT /DISTURBANCE RECORDING FACILITIES.**

**TECHNICAL SPECIFICATION
FOR
CONTROL , XLPE & LT POWER CABLES**

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OF
CONTROL, XLPE & LT POWER CABLES

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PART – A

**TECHNICAL SPECIFICATION
FOR
CONTROL CABLES**

TECHNICAL SPECIFICATION FOR CONTROL CABLES

1.0 SCOPE

This specification covers the manufacturing, testing and supply of Control Cables for use in 33/11kV Substations.

The material offered shall be procured from short listed vendors at **E-14** and shall have been successfully Type Tested during last five years from the date of bid submission. The Bidder shall **upload** the first page of the **Type test certificate** duly signed by the bidder showing the evidence of successful test, along with the bid.

2.0 STANDARDS

Except where modified by this specification, the control cables shall be designed, manufactured and tested in accordance with the latest editions of the following standards.

IEC / Indian Standard	Title
IEC 811 IS-18-10810:1982	Testing cables
IEC 502 IS-7098:1985 (part 2)	LT and 3.3 - 33kV XLPE PVC Sheathed cables
IEC 502 IS - 1554:1988 (part 1)	PVC Cables 0.65 - 1.1kV
IEC 227 IS - 5819:1970	Short circuit ratings for PVC cables
IEC 228 IS-8130:1984	Conductors for insulated cables
IEC 502 IS - 6474: 1984	XLPE Cables
IEC 502	Extruded solid dielectric insulated power cables for rated voltages from 1.1kV to 30kV
IEC 540 IS - 5831: 1984	Test Methods for PVC insulation and sheaths of electric cables and cords
IEC 287	Calculation of the continuous current rating of cables.
IS - 3975: 1979	Mild steel wires, strips and tapes for armouring of cables
IS – 4905	Sampling Size
IS – 731	

3.0 TECHNICAL DETAILS

All Control cables to be used in the in the Substations shall be of the Polyvinyl chloride (PVC) insulated with PVC sheathing types.

3.1 1.1kV POLYVINYL CHLORIDE (PVC) INSULATED CABLES

3.2

Control and Panel Wiring Cables (PVC insulated)

The conductor shall be of round stranded plain copper wires complying with IS - 8130:1984/ IEC 228.

The conductors shall be of Flexibility Class 2 as per IS - 8130: 1984.

Conductor screening not required

3.2 Insulation

The insulation shall be of Polyvinyl Chloride (PVC) compound. 'Heat Resisting' Type C for the Control and Panel Wiring cables. Both shall conform to the requirements of IS - 5831: 1984.

Type of Insulation	Normal Continuous Operation	Short Circuit Operation
General Purpose	70°C	160°C
Heat Resisting	85°C	160°C

The PVC insulation shall be applied by extrusion and the average thickness of insulation shall not be less than the specified nominal value and the maximum value as specified in IS – 1554 (part 1): 1988.

The insulation shall be applied so that it fits closely on to the conductor and it shall be possible to remove it without damage to the conductor.

Insulation Screening is not required.

Core Identification and Laying up of Cores.

In multi-core cables, the cores shall be laid up together with a suitable lay as recommended in IS - 1554 (Part 1): 1988. The layers shall have successive right and left hand lays with the outermost layer having a right hand lay.

3.3 Inner Sheath

The laid up cables shall be covered with an inner sheath made of thermoplastic material (PVC) applied by extrusion.

The thickness of the sheath shall conform to IEC 502/IS - 1554: 1988. Single core cables shall have no inner sheath.

The outer serving shall incorporate an effective anti-termite barrier and shall be capable of withstanding a 10kV DC test voltage for five minutes after installation and annually thereafter.

Current ratings shall be calculated in accordance with IEC 287 "Calculation of the continuous current rating of cables with 100% load factor".

3.4 Conductor Sizes

The following shall be used for Control and Panel Wiring:

The No. of Cores & Sizes of the Control Cable shall be 4 Core, 7 Core & 10 Core. The size of each shall be done by 2.5 sq.mm flexible Copper Wires.

3.5 Cable Drum Length

The cable shall be supplied in 500meter lengths or more.

4.0 CABLE IDENTIFICATION

The manufacturer's and Employer's name or trade mark, the voltage grade, cable designation and year of manufacture shall be indented or embossed along the whole length of the cable. The indentation or embossing shall only be done on the outer sheath. The alphanumerical character size shall be not less than 20% of the circumference of the cable and be legible.

5.0 SAMPLING OF CABLES

5.1 Lot

In any consignment the cables of the same size manufactured under essentially similar conditions of production shall be grouped together to constitute a lot.

5.2 Scale of Sampling

Samples shall be taken and tested from each lot to ascertain the conformity of the lot to specification.

5.3 Sampling Rates

The number of samples to be selected shall be as follows:

Number of drums in the Lot	Number of Drums to be taken as samples	Permissible number of defective drums
Up to 25	3	0
26 to 50	5	0
51 to 100	8	0
101 to 300	13	1
301 and above	20	1

The samples shall be taken at random. In order to achieve random selection the procedure for selection detailed in IS - 4905: 1968 shall be followed.

6.0 NUMBER OF TESTS AND CRITERION FOR CONFORMITY

Suitable lengths of test samples shall be taken from each of the selected drums. These samples shall be subjected to each of the acceptance tests. A test sample shall be classed as defective if it fails any of the acceptance tests. If the number of defective samples is less than or equal to the corresponding number given in the above table, shall be declared as conforming to the requirements of acceptance test.

7.0 TESTS ON 1.1 KV PVC INSULATED Control Cable.

7.1 Type Tests

The following tests shall be carried out in accordance with the requirements of IS -8130: 1984/IEC 502, IS - 5831:1984/IEC 540 and IEC 811 unless otherwise specified.

Test	Requirement Reference (Test Method as a Part of IS-10810/IEC 811)
(a) Tests on conductor	
Annealing test (copper)	IS-8130: 1984/IEC 502
Tensile test (aluminium)	IS-8130: 1984/IEC 502
Wrapping test (aluminium)	IS-8130: 1984/IEC 502
Resistance test	
(b) Tests for Armour wires/strips	IS - 3975: 1979/IEC 502
(c) Tests for thickness of insulation and sheath	IS-5831:1984/IEC 540
(d) Physical tests for InsulationTensile strength and elongation at break	IS-5831:1984/IEC 540
Ageing in air oven	IS-5831:1984/IEC 540
Hot test	IS-5831:1984/IEC 540
Shrinkage test	IS-5831:1984/IEC 540
Water absorption (gravimatic)	IS-5831:1984/IEC 540
(e) Physical tests for outer sheath	
Tensile strength and elongation at break	IS-5831: 1984/IEC 540
Ageing in air oven	IS-5 831: 1984/IEC 540
Shrinkage test	IS-5831: 1984/IEC 540
Hot deformation	IS-5831: 1984/IEC 540
Loss of mass in air oven	IS-5831: 1984/IEC540
Heat shock	IS-5831: 1984/IEC540
Thermal stability	IS-5831: 1984/IEC540 IS-5831: 1984
(f) Partial discharge test	IS10810 (Part 46)-1984
(g) Bending test	IS10810 (Part 50)-1984
(h) Dielectric power factor test	IS10810 (Part 48)-1984
(As a function of voltage & As a function of temperature)	
(j) Insulation resistance test	IS-8130: 1984/IEC502

	(Volume resistivity)	
(j)	Heating cycle test	IS10810 (Part 49)-1984
(k)	Impulse withstand test	
(l)	High voltage test	IS10810 (Part 45)-1984
(m)	Flammability test	IS10810 (Part 53)-1984

Tests (g), (h), (j), (l) and (m) are only applicable to screened cables.

7.2 Acceptance Tests

The following shall constitute acceptance tests:

- Tensile test (aluminium)
- Annealing test (copper)
- Wrapping test
- Conductor resistance test
- Test for thickness of insulation and sheath
- Hot set test for insulation*
- Tensile strength and elongation at break test for insulation and outer sheath
- Partial discharge test (for screened cables only)**
- High voltage test
- Insulation resistance (volume resistivity) test.

** test to be completed on full drum of cable

7.3 Routine Tests

Routine tests shall be carried out on all the cable. These tests shall be carried out in accordance with the requirements of IS - 8130: 1984/IEC 502 and IS - 5831:1984/IEC 540 unless otherwise specified.

The following shall constitute routine tests.

- Conductor resistance test
- Partial discharge test (for 11 kV and 33kV screened cables only)*
- High voltage test
- Cold impact test

8.0 DETAILS OF TESTS

8.1 General

Unless otherwise stated, the tests shall be carried out in accordance with the appropriate part of IS -10810/IEC 502: 1994 and the additional requirements as detailed in this specification.

8.2 Partial Discharge Test

Partial discharge tests shall only be made on cables insulated with XLPE of rated voltages above 1.9/3.3kV.

For multicore cables, the test shall be carried out on all insulated cores, the voltage being applied between each conductor and the metallic screen.

8.3 Bending Test

The diameter of the test cylinder shall be $20 (d + D) \pm 5\%$ for single core cables and $15 (d + D) \pm 5\%$ for multicores, where D is the overall diameter of the completed cable in millimeters and d is the diameter of the conductor. After completing the bending operations, the test samples shall be subjected to partial discharge measurements in accordance with the requirements of this specification.

8.4 Dielectric Power Factor Test

Tan δ as a Function of Voltage

For cables of rated voltage 1.1 kV and above

The measured value of tan δ at up shall not exceed 0.004, where U_0 is the rated power frequency voltage between conductor and earth.

8.5 Heating Cycle Test

The sample which has been subjected to previous tests shall be laid out on the floor of the test room and subjected to heating cycles by passing alternating current through the conductor until the conductor reaches a steady temperature 10°C above the maximum rated temperature of the insulation in normal operation. After the third cycle the sample shall be subjected to a dielectric power factor as a function of voltage and partial discharge test.

8.6 High Voltage Test

I. Type/ Acceptance Test

The cable shall withstand, without breakdown, at ambient temperature, an ac voltage equal to $3U_0$, when applied to the sample between the conductor and screen/ armour (and between conductors in the case of unscreened cable). The voltage shall be gradually increased to the specified value and maintained for a period of 4 hours.

If while testing, interruption occurs during the 4 hour period the test shall be prolonged by the same extent. If the interruption period exceeds 30 minutes the test shall be repeated.

II. Routine Test

Single core unscreened cables shall be immersed in water at room temperature for one hour and the test voltage then applied for 5 minutes between the conductor and water.

Multicore cables with individually screened cores, the test voltage shall be applied for 5 minutes between each conductor and the metallic screen or covering.

Multicore cables without individually screened cores, the test voltage shall be applied for 5 minutes in succession between each insulated conductor and all the other conductors and metallic coverings, if any.

When a DC voltage is used, the applied voltage shall be 2.4 times the power frequency test voltage. In all instances no breakdown of the insulation shall occur.

8.7 Flammability Test

The period for which the cable shall burn after the removal of the flame shall not exceed 60 seconds and the unaffected portion (uncharged) from the lower edge of the top clamp shall be at least 50mm.

9.0 CONTROL / LV WIRING ACCESSORIES

9.1 Terminations

Control wire terminations 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 termination. 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. Numbers 6 and 9 shall not be included for ferrules purposes except where underlined and identified as 6 and 9. Low Voltage AC cable terminals shall be provided with adequate size crimp type lugs. The lugs shall be applied with the correct tool, which shall be regularly checked for correct calibration. Bi-metallic joints between the terminals and lugs shall be provided where necessary.

Terminals shall be marked with the phase colour in a clear and permanent manner.

A removable gland plate shall be provided by the contractor at every cable entry to mechanism boxes, cabinets and kiosks. The Contractor shall be responsible for drilling the cable gland plate to the required size.

10.0 PACKING

10.1 Packing

The cable shall be wound on strong drums or reels capable of withstanding all normal transportation and handling.

Each length of cable shall be durably sealed before shipment to prevent ingress of moisture. The drums, reels or coils shall be lagged or covered with suitable material to provide physical protection for the cable during transit and during storage and handling operations.

Each drum or reel shall carry or be marked with the following information:

- Individual serial number
- Employer's name
- Destination
- Contract Number
- Manufacturer's Name
- Year of Manufacture
- Cable Size and Type
- Length of Conductor (meters)
- Net and Gross Mass of Conductor (kg)
- All necessary slinging and stacking instructions.
- Destination;
- Contractor's name;
- Name and address of Contractor's agent in Orissa;
- Country of origin;

The direction of rolling as indicated by an arrow shall be marked on a flange.

10.2 Storage

The site selected for the storage of cable drums shall be well drained and preferably have a concrete/firm surface which will prevent the drums sinking into the ground or being subjected to excess water thus causing flange rot.

All drums shall be stood on battens, in the upright position, and in such a manner to allow sufficient space between them for adequate air circulation. During storage the drums shall be rotated 90° every three months. In no instances shall the drums be stored "flat" on their flanges or one on top of each other.

PART-B

**TECHNICAL SPECIFICATION
OF
33KV & 11 KV XLPE CABLES**

TECHNICAL SPECIFICATION OF 11 KV XLPE CABLES

1.0. SCOPE

- 1.1. It covers manufacture, testing, supply and commissioning of 12kV voltage grade of 3-core Aluminium Conductor, Cross-linked Polyethylene (XLPE) insulated, PVC sheathed, armoured, screened Power Cables.

1.2 STANDARDS

Sl. No.	ISS No.	Description
1	7098 (Part II) latest	Specification for cross-linked polyethylene Insulated PVC Sheathed cables for working Voltage of 11kV and 33 kV.
2	8130 – 1984 latest	Specification for Conductors for insulated electric cables and flexible cords.
3	5831– 1984 latest	PVC insulation & sheath of electric cables.
4	3975 – 1979 latest	Armour for cables
5	10810 – 1984 latest	Methods for test for cables.
6	10418 – 1982 latest	Cable Drum for Electric Cables.
7	3961	Recommended current rating for Cables.

- 1.3 The cable joints, outdoor and indoor termination and their accessories and fittings shall conform to the relevant latest Indian standards in their offers.

2.0 ELECTRICAL CHARACTERISTICS & PERFORMANCE:-

2.1. Description of Cable

11 KV Grade 3-cores: Standard compacted circular Aluminum (H4 Grade) Conductor, FRLS type, 3-core / 1-core, but insulation shielding with black semi-conducting tape not necessary. Inner sheath to be wrapped not extruded and strip armoured. The design shall fully conform to IS:7098 (Part – II)

3.0. CABLE CONSTRUCTION:

- 3.1. XLPE underground cable is to be manufactured in continuous catenary process at controlled elevated temperature and pressure in inert atmosphere with use of suitable materials for XLPE semi-conducting, insulation and XLPE screen. The inner and outer semi-conducting sheaths and main polyethylene insulation between the sheaths are to be simultaneously extruded during the Triple Extrusion Process of manufacturing and main insulation of the Cable is to be extruded unified. The XLPE Cables in this specification does not have any metal sheath and the short circuit rating of the cable will depend on the conductivity and continuity of the strands of the armour wires, which shall be ensured by guarding against corrosion.

3.2. CONDUCTOR SCREENING.

A semi-conducting cross-linked polyethylene (XLPE) screening shall be extruded over the conductor to act as an electrical shield which together with elimination of the so called "Strand Effect" prevents to great extent air ionization on the surface of the conductor.

3.3. INSULATION

The main insulation of the Cable shall be extruded unfilled, chemically cross-linked polyethylene (XLPE) inert gas cured satisfying the requirement of ISS: 7098 (Part- II).

3.4. INSULATING SCREEN:

3.5. The screen shall be made up as indicated. The metal screen eliminates tangential stress electrostatic field surrounding the conductor and uniform electrical stress in the insulation. The semi conducting polyethylene (XLPE) screen shall be extruded over the main poly ethylene- insulating wall to prevent partial discharge at the surface of the insulation. The copper tape shall be wrapped over the semi conducting tape or extrusion as mentioned earlier for 3-core cables. The metal screen so formed around the cores shall be in contact with one another as the cores are laid up at triangular configuration.

3.6. The mechanical and chemical properties of the materials for semi conducting screens are much more important than their electrical properties, but for obtaining the high overall degree of electrical properties of an E.H.V. cable, the inner and outer semi conducting, sheaths and the main polyethylene insulation between the sheaths shall be simultaneously extruded during the manufacturing, process known as "**triple extrusion**". The advantages are

- i) The partial discharge level at the surface of the insulation is brought to a minimum.
- ii) There will be no displacement of the semi conducting screen and insulation during expansion and contraction due to load cycles and bending.
- iii) The semi conducting screens are easily removable during joining and termination operations.

Note: Cable manufactured without having "triple extrusion" process will not be considered / accepted. The Contractor shall have to produce necessary documents in respect of process line.

4.0. ARMOUR

The 3-core cable shall be armoured with steel strip to insure an adequate return path for the flow of fault current and also to provide suitable mechanical protection. Steel wires/aluminum wire / steel strips of required size in requisite number as per clause shall be laid closely in the spiral formation to protect the circumference of the cable fully and to provide adequate cross section area for flow of maximum fault current within limits of specified temperature rise and duration of fault. Direction of the

lay of the armour shall be opposite to that of the cable cores in case of single core cable armour should be of magnetic material.

5.0. OUTER SHEATH

A reliable surving shall be necessary for maintaining conductivity of the armour particularly under corrosive condition in the form of jacket. Cable shall be therefore finished with extruded PVC over sheath of thickness as indicated.

The quality of PVC over sheath (jacket) shall be ensured for service reliability against moisture intrusion and shall confirm to type ST-2 of IS : 5831.

The colour of the outer sheath shall be follows:

For 11 KV cable : Blue

The sheaths shall be protected against white ants, vermin and termites by suitable, durable and reliable measures.

The suppliers shall suggest suitable materials for use, in the event of damage to the over sheath to prevent the passage of moisture along the cable

6.0. CABLE IDENTIFICATION:

The following shall be embossed on the outer sheath for the identification.

- a.Manufacturer's Name or Trade Mark.
- b.Owner's Name
- c.Voltage Grade.
- d.Nominal section and material of conductors and number of cores.
- e.Year of manufacture.
- f. Inscription of length of cables at 1.0 mtr interval.
- g.Marking "Power" shall be embossed throughout the length of the cable at 10 mtr spacing.
- h.Type of insulation i.e. XLPE

7.0. CEILING OF CABLE ENDS

The cable ends of the cable in the cable drum for delivery shall be sealed with heat shrinkable caps.

8.0. Tests to be performed as per IS: 7098 (part II)

- 8.1. Type test all the test mentioned below are to be made as per details given in IS: 10810

Sl. No.	Details of Tests
a)	Test on conductor i) Tensile test (For aluminum) ii) Wrapping test for aluminum iii) Resistance test.
b)	Test for armoring wire strips
c)	Test for thickness of insulation and sheath
d)	Physical test for insulation i) Tensile strength and elongation at break ii) Ageing in air oven iii) Hot test iv) Shrinkage test v) Water absorption (Gravimetric)
e)	Physical tests for outer sheath i) Tensile strength and elongation at break ii) Ageing in air oven iii) Shrinkage test iv) Hot deformation v) Heat shock vi) Loss of mass in air oven vii) Thermal stability
f)	Partial discharge test
g)	Bending test
h)	Dielectric power factor test
	i) As a function voltage ii) As a function of temperature
i)	Insulation resistance (volume resistivity) test
j)	Heating cycle test
k)	Impulse with stand test
l)	High voltage test
m)	Flammability test

8.2. The following test on screen cable shall be performed successfully on the same test sample of completed cable, not less than 10 m. in length between the test accessories.

- a) PD test
- b) Bending test followed by PD test
- c) Di-electric power factor as function of voltage
- d) Di-electric power factor as a function of temperature
- e) Heating cycle test followed by Di-electric power factor as a function of voltage and PD test.
- f) Impulse with stand test and
- g) High voltage test as indicated

If a sample fails in test (g) one more sample shall be taken for this test, preceded by test (b) and (e).

8.3. Acceptance test: the following shall constitute acceptance test:

- a) Tensile test (For aluminum)
- b) Wrapping test for aluminum
- c) Conductor resistance test
- d) Test for thickness of insulation and sheath
- e) Hot set test for insulation
- f) Tensile strength and elongation at break test for insulation and outer sheath
- g) PD test (Screen enables) only on full drum length
- h) High voltage test, and
- i) Insulation resistance (volume resistivity) test
- j) Spark test on extruded un-insulated outer PVC sheath as per provision clause no 3.2 IEC standard (Publication no.229 of 1982).

8.4. Routine test:

The routine test shall be carried out on all cables manufacturer in accordance with this specification. The following routine test shall be made on cable length as specified in ISS.

- a) Conductor resistance test
- b) Partial discharge test on full drum length
- c) High voltage test as indicated

8.5. Test witness

All tests shall be performed in presence of Owner's representatives if so desired by the Owner.

8.6. Test Certificate

All test reports like routine & acceptance test reports are to be furnished for record & approval.

9.0. Descriptive literatures test results etc.

The following details for the cable shall be submitted with bid

- a) Manufacturers catalogue giving cable construction details and characteristics
- b) Manufacturing process for cable highlighting with the steps of control
 - i. Contamination
 - ii. Formation of water trees
 - iii. Effects of byproducts of cross linking ii. Stress control etc.
- c) Cross section drawing of the cable
- d) Cable current ratings for different types of installation inclusive of derating factors due to ambient temperature, grouping etc.
- e) Over-load characteristics of the cable without endangering the normal life and electrical quality of the insulation.
- f) Complete technical data of the cables.
- g) Type test certificate
- h) The bidder to fillup the GTP in the table in **Chapter E-16**

PART - C

TECHNICAL SPECIFICATION

FOR

LT XLPE POWER CABLES

TECHNICAL SPECIFICATION FOR LT XLPE POWER CABLES

1.0 SCOPE :

The specification covers design, manufacture, shop testing, packing and delivery of 1100 Volts grade , Aluminium conductor , XLPE insulated multi core power cables by road/rail to the designated Store Centers in the State of Maharashtra..

2.0 SERVICE CONDITIONS :

Please refer **Chapter E3** of Technical Specification on climatic conditions.

3.0 STANDARDS :

- 31 Unless otherwise specified elsewhere in this specification, the rating as well as testing of the LT XLPE power cables shall conform to the latest revisions available at the time of placement of order of all the relevant standards as listed in, but not limited to the following:

LIST OF STANDARDS (All amended upto date)

SL.NO.	STANDARD NO.	TITLE
1.	IS: 7098(Part 1)- 1988	Specification for XLPE insulated , PVC sheathed for working voltages upto and including 1100 Volts.
2.	IS : 583 1-1984	Specification for PVC insulation and sheath of electric cables.
3.	IS: 8130-1984	Specification for conductors for insulated electric cables and flexible cords.
4.	IS: 3975-1988	Specification for Mild Steel wires, formed wires and tapes for armouring of cables.
5.	IS: 10462 (Part I) – 1983	Fictitious calculation method for determination of dimensionS of protective covering of cables.

4.0 GENERAL TECHNICAL REQUIREMENTS

4.1 ARMoured CABLES

1100 Volts Grade L.T. cable with stranded H2/H4 grade aluminium conductor , XLPE insulated , colour coded , laid up , with fillers and/or binder tape where necessary provided with extruded PVC inner sheath , single galvanized round steel wire / strip armoured and provided with PVC outer sheath . Both inner and outer sheath shall be of Type ST-2 as per IS: 5831-1984 and cable shall be conforming to IS: 7098 (Part 1) - 1988 (amended upto date) and bearing ISI mark . In case of single core cable armouring shall be of almunium.

4.2 INSULATION, INNER SHEATH AND OUTER SHEATH :

Insulation, inner sheath and outer sheath shall be applied by separate extrusion. Inner sheath shall be applied by extrusion only. Bedding of PVC tape for inner sheath is not acceptable. Colour of outer sheath shall be black .

The quality of insulation should be good and insulation should not be deteriorated when exposed to the climatic conditions.

4.3 SEQUENTIAL MARKING OF LENGTH ON CABLE

Non erasable Sequential Marking of length shall be provided by embossing on outer sheath of the cable for each meter length.

4.4 CONTINUOUS A.C. CURRENT CAPACITY:

Continuous a.c. current capacity shall be as per Table given below.

Conductor sizes in <u>sq.mm.</u>	Continuous A.C. current capacity in Amps.	
	When laid direct in the ground 30 deg.C.l1	When laid in air 140 deg.C.l1
70 <u>sq.mm</u>	165	175
95 sq mm	200	224
120 sq mm	225	240
150 sq mm	255	305
185 sq mm	285	315
240 sq mm	325	385
300 sq mm	370	410
300 sq mm	370	410
400 sq mm	425	470

4.5 SHORT CIRCUIT CURRENT

Short circuit current of LT XLPE cable shall be as per Table given below.

Duration of Short Circuit in sec	Area of Al. conductor	Short circuit current in kA
T	A	$I=0.094 \times A/\text{sq.rt (t)}$
1	70 <u>sq.mm</u>	6.58
1	95 <u>sq.mm</u>	8.93
1	120 <u>sq.mm</u>	11.28

1	150	14.10
1	185	17.39
1	240	22.56
1	300	28.20
1	400	37.60

5.0 TESTS :

5.1 TYPE TESTS:

All the type tests in accordance with IS: 7098 (Part 1) - 1988 (amended upto date) shall have been performed on cable samples drawn by Owner.

Type tests are required to be carried out from the first lot of supply on a sample of any one size of cable ordered . In case facilities of any of the type tests are not available at the works of the supplier , then such type test shall be carried out by the supplier at the independent recognized laboratory at the cost of supplier. Sample for the type test will be drawn by the purchaser's representative and the type test will be witnessed by him.

5.2 ROUTINE TESTS:

All the Routine tests as per IS: 7098 (Part 1) - 1988 amended upto date shall be carried out on each and every delivery length of cable. The result should be given in test report.

The details of facility available in the manufacturer's works in this connection should be given in the bid.

5.3 ACCEPTANCE TESTS:

All Acceptance tests as per IS-7098 (Part-I) 1988 as amended upto date including the optional test as per clause no 15.4 and Flammability Test as per clause No. 16.3 shall be carried out on sample taken from the delivery lot.

5.4 The following additional acceptance test should be carried out on PVC compounds used for outer sheath , as per IS: 5831 - 1984 (amended upto date)

1 .Hot Deformation Test.

6.0 PACKING AND MARKING :

6.1 a) Upto 120 sq. mm. Size :

Cables shall be supplied in continuous standard length of 500 meters with plus minus 5% (five percent) tolerance wound on non returnable wooden

drums of good quality or on non-returnable steel drums without any extra cost to the purchaser.

b) Above 120 sq.mm. size :

Cables shall be supplied in continuous standard length of 250 meters with plus minus 5% (five percent) tolerance wound on non returnable wooden drums of good quality or on non-returnable steel drums without any extra cost to the purchaser.

6.2 Non standard length :

5% (five percent) of the ordered quantity of respective size shall be acceptable in non-standard length which shall not be less than 100 meters in length.

6.3 The following particulars shall be properly legible embossed on the cable sheath at the intervals of not exceeding one meter through out the length of the cable. The cables with poor and illegible embossing shall be liable for rejection.

- a) Manufactures name .
- b) Voltage grade.
- c) Year of manufacture.
- d) OPTCL
- e) Successive Length.
- f) Size of cable
- g) ISI mark

6.4 Packing and marking shall be as per clause No. 18 of IS 7098 (part I)/1988 amended up to date.

6.5 Supplier should provide statistical data regarding cables of all sizes viz. -

- 1) Weight of one meter of finished product of cable of various sizes and ratings.
- 2) Weight of one meter of bare conductor used for cables of various sizes and ratings.

**TECHNICAL SPECIFICATION
FOR
PSC POLE**

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OF
PSC POLE**

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PSC Pole (10mtr x 400Kg) & PSC Pole (10mtr x 300Kg)

TECHNICAL SPECIFICATIONS

1.0 Qualification Criteria of Sub Vendor / Manufacturer:-

The prospective bidder may source PSC Poles from manufacturers who should have supplied at least the following quantity of PSC Poles to Electricity Supply Utilities / PSUs. The bidder should enclose Performance Certificates from the above users, issued in favour of the Sub Vendor / manufacturer, as proof of successful operation in field.

Sl. No.	Size	Minimum Past Supply Qty
1	10 Mtr. X 300 Kg	200
2	10 Mtr. X 400 Kg	200

2.0 Applicable Standard :

The Poles shall comply with latest standards as under:

REC Specification No. 15/1979, REC Specification No. 24/1983, IS 1678, IS 2905, IS 7321.

3.0 Materials :

a. Cement

Cement to be used in the manufacture of pre-stressed concrete poles shall be ordinary for rapid hardening Portland cement confirming to IS: 269-1976 (Specification for ordinary and low heat Portland cement) or IS: 8041 E-1978 (Specification for rapid hardening Portland cement).

b. Aggregates

Aggregates to be used for the manufacture of pre-stressed concrete poles shall confirm to IS: 383 (Specification for coarse and fine aggregates from natural sources for concrete) .The nominal maximum sizes of aggregates shall in no case exceed 12 mm.

c. Water

Water should be free from chlorides, sulphates, other salts and organic matter. Potable water will be generally suitable.

d. 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.

e. Pre-Stressing Steel

Pre-stressing steel wires including those used as un tensioned wires 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 design given in the annexure are for plain wires of 4 mm diameter with a guaranteed ultimate strength of 160 kg/mm². All pre-stressing steel shall be free from splits, harmful scratches, surface flaw, rough, aged and imperfect edges and other defects likely to impair its use in pre-stressed concrete.

f. Concrete Mix

Concrete mix shall be designed to the requirements laid down for controlled concrete (also called design mix concrete) in IS: 1343-1980 (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: Minimum works cube strength at 28 days should be at least 420 Kg/cm^2 .

The concrete strength at transfer should be at least 210 Kg/cm^2 .

The mix should contain at least 380 Kg of cement per cubic meter of concrete.

The mix should contain as low water content as is consistent with adequate workability. It becomes necessary to add water to increase the workability the cement content also should be raised in such a way that the original value of water cement ratio is maintained.

4.0 Design Requirements

The poles shall be designed for the following requirements:

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 bidder at no extra cost to owner. The bidder shall furnish necessary design calculations/details of alternative arrangements in this regard. The working load on the poles should correspond to those that are likely to come on the pole during their service life.

The factor of safety for all poles 9.0Mts. Shall not be less than 2.0

.The average permanent load shall be 40% of the working load. The F.O.S. against first load shall be 1.0.

At average permanent load, permissible tensile stress in concrete shall be 30 kg/cm^2 .

At the design value of first crack load, the modulus of rupture shall not exceed 53.0 kg/cm^2 for M-40. The ultimate moment capacity in the longitudinal direction should be at least one fourth of that in the transverse direction.

The maximum compressive stress in concrete at the time of transfer of pre-stress should not exceed 0.8 times the cube strength.

The concrete strength at transfer shall not be less than half, the 28 days strength ensured in the design, i.e. $420 \times 0.5 = 210 \text{ kg/cm}^2$. 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".

5.0 Dimensions and Reinforcements

5.1 The cross-sectional dimensions and the details of pre-stressing wires should conform to the particulars given in the enclosed drawing. The provisions of holes for fixing cross-arms and other fixtures should conform to the REC specification No.15/1979.

All pre-stressing wires and reinforcements shall be accurately fixed as shown in drawings and maintained in position during manufacture. The un-tensioned reinforcement as indicated in the drawings should be held in position by the use of stirrups which should go round all the wires.

All wires shall be accurately stretched with uniform pre-stress in each wire. Each wire or 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.

5.2 The poles shall then be lifted to the pit with the help of wooden supports. The pole shall then be kept in the vertical position with the help of 25 mm (min.) manila ropes, which will act as the temporary anchor. The verticality of the pole shall be checked by spirit level in both longitudinal & transverse directions. The temporary anchor shall be removed only when **poles set properly in the pit for foundation concreting & backfilling with proper compacting the soil. The backfilling should be done in layers (maxm. 0.5 mts at a time with sprinkling of water and by using wooden hammer. No stone more than 75 mm should be used during back filling.**

5.3 Suspension type 11/W fittings in all tangent locations and Four pair bolted type tension 11/W fittings should be used in all new 33&11 Kv lines.

70 KN normal B&S insulators will be used in suspension & tension locations respectively.

5.4 Concreting of foundation up to a minimum height of 1.8 mtrs from the bottom of the pit with a circular cross-section of radius 0.25 mtrs. (volume of 0.3 cu.mtr. per pole) in the ratio of 1:2:4 shall be done at the following locations: The **depth** has to be increased to 2mtr or as required at site condition if poles more than 11 Mts. are to be used.

- i) At all the tapping points and dead end poles.
- ii) At all the points as per REC construction dwg. No. A-10 (for the diversion angle of 10-60 degree) or **better there of as per the instruction of Engineer in charge. The decision of Engineer in charge will be final.**
- iii) Both side poles at all the crossing for road, Nallaha railway crossings etc.
- iv) Where Rail poles, Joist poles, double pole and four pole structures are to be erected.

5.5 Each tower/structures should be earthed by providing 2.5 mts.50x6 GI flat and 40 x 3000 mm heavy gauge ISI mark earthing pipe. The top of the earthing pipe should remain 600 mm below ground level. All railway X-ing locations two nos. earthing should be provided.

In case the required footing resistance is not achieved on measurement, counterpoise earthing has to be provided as per the standard.

6.0 **C o v e r** - The cover of concrete measured from the outside of pre-stressing tendon shall be normally 20 mm.

7.0 **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, joining or coupling may be permitted provided the strength of the joint or coupling is not less than the strength of each individual wire.

8.0 **Compacting**

Concrete shall be compacted by spinning, vibrating, shocking or other suitable mechanical means. Hand compacting shall not be permitted.

9.0 **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 pre-stress. 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 pre-stressing wires shall be de-tensioned 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 condition 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 pre-stressed concrete). The manufacture 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 manufacture so desired, the manufacture shall supply cubes for test purpose and such cubes shall be tested in accordance with IS: 456 (Code of practice for plain and reinforced concrete).

10.0 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 purpose, should be perpendicular to the broad face of the pole.

11.0 Holes for Cross Arms etc

Sufficient number of holes shall be provided in the poles for attachment of cross arms and other equipments.

12.0 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 at 0.15 times the overall length, measured from the end. The timber supported in the stack should be aligned in vertical line.

13.0 Earthing

(a) Earthing shall be provided by having length of 6 SWG 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 1000 mm below ground level.

(b) Earth wire shall not be allowed to come in contact with the pre-stressing wires.

13.1 Earthing of Support

13.2 Each pole shall be earthed with coil type earthing as per REC Construction Standard J-1.

13.3 All DP & Four pole structures & the poles on both sides of railway crossing shall be earthed by providing two nos. **pipe earthing as per Drawing provided by OPTCL.**

**TECHNICAL SPECIFICATION
FOR
“V” CROSS ARM, BACK CLAMP & F CLAMP**

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“V” CROSS ARM, BACK CLAMP & F CLAMP

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TECHNICAL SPECIFICATIONS
For
33 KV,11 KV “V” CROSS ARM, BACK CLAMP FOR “V”
CROSS ARM & POLE TOP BRACKET (F CLAMP)

1.0 Qualification Criteria of Manufacturer:-

The prospective bidder may source the above item from manufacturers who must qualify the following requirements:

The manufacturer should have supplied at least 1000 no.s (of each item) to electricity supply utilities / PSUs.

The bidder should enclose Performance Certificates from the above users issued in the name of the manufacturer as proof of successful operation in field.

a) Hot Dip Galvanised Cross arm and Pole Top Brackets for both 33 KV & 11kV construction at intermediate and light angle pole shall be fabricated from grade 43A mild steel of channel section and for heavy angle poles, end poles and section poles fabricated from grade 43A mild steel of angle section. The grades of structural steel shall conform to IS – 226: 1975.

b) The 33 KV & 11 KV ‘ V ’ Cross arm shall be made out of **ISMCP 100** i.e 100x 50x5 mm GI Channel of (9.56 kg/mtr weight) .

The Back Clamp for 11 KV shall be made out of 75 x 10 GI Flat and shall be suitably designed to fit PSC Pole 10 Mtr x 300 Kg , 10 Mtr x 400 Kg.

c) The Pole Top Bracket (F Clamp) shall be made out of 75 x 10 GI Flat, 100x 50x5 mm GI Channel suitably designed to fit , Joist pole, PSC Pole 10 Mtr x 300 Kg , 10 Mtr x 400 Kg for both 33 KV & 11 KV As per drawing supplied.

Except where otherwise indicated all dimensions are subject to the following tolerances:

dimensions up to and including 50mm: +1mm: and dimensions greater than 50mm: +2%

All steel members and other parts of fabricated material as delivered shall be free of warps, local deformation, unauthorized splices, or unauthorized bends. Bending of flat strap shall be carried out cold. Straightening shall be carried out by pressure and not by hammering.

Straightness is of particular importance if the alignment of bolt holes along a member is referred to its edges.

Holes and other provisions for field assembly shall be properly marked and cross referenced. Where required, either by notations on the drawing or by the necessity of proper identification and fittings for field assembly, the connection shall be match marked. A tolerance of not more than 1mm shall be permitted in the distance between the center lines of bolt holes.

The holes may be either drilled or punched and, unless otherwise stated, shall be not more than 2mm greater in diameter than the bolts. When assembling the components force may be used to bring the bolt holes together (provided neither members nor holes are thereby distorted) but all force must be removed before the bolt is inserted. Otherwise strain shall be deemed to be present and the structure may be rejected even though it may be, in all other respects, in conformity with the specification.

The back of the inner angle irons of lap joints shall be chamfered and the ends of the members cut where necessary and such other measures taken as will ensure that all members can be bolted together without strain or distortion. In particular, steps shall be taken to relieve stress in cold worked steel so as to prevent the onset of embitterment during galvanizing. Similar parts shall be interchangeable.

Shapes and plates shall be fabricated and assembled in the shop to the greatest extent practicable. Shearing flame cutting and chipping shall be done carefully, neatly and accurately. Holes shall be cut, drilled or punched at right angles to the surface and shall not be made or enlarged by burning. Holes shall be clean-cut without torn or ragged edges, and burrs resulting from drilling or reaming operations shall be removed with the proper tool.

Shapes and plates shall be fabricated to the tolerance that will permit field erection within tolerance, except as otherwise specified. All fabrication shall be carried out in a neat and workmanlike manner so as to facilitate cleaning, painting, galvanizing and inspection and to avoid areas in which water and other matter can lodge.

Contact surfaces at all connections shall be free of loose scale, dirt, burrs, oil and other foreign materials that might prevent solid seating of the parts.

2.0 Fabrication has to be made as per Drg. No. ODAFFP/LINE/4, ODAFFP/LINE/5 Of ' V ' X-arm, Back clamp & ' F ' clamp.

GALVANISING

All type of cross arGI back clamps, F clamps & stay clamps shall be hot dip galvanized, are as following:

All galvanizing shall be carried out by the hot dip process, in accordance with Specification IS 2629. However, high tensile steel nuts, bolts and spring washer shall be electro galvanized to Service Condition 4. The zinc coating (610 gm GI per sq.mt) shall be smooth, continuous and uniform. It shall be free from acid spot and shall not scale, blister or be removable by handling or packing.

There shall be no impurities in the zinc or additives to the galvanic bath which could have a detrimental effect on the durability of the zinc coating.

Before picking, all welding, drilling, cutting, grinding and other finishing operations must be completed and all grease, paints, varnish, oil, welding slag and other foreign matter completely removed.

All protuberances which would affect the life of galvanizing shall also be removed.

The weight of zinc deposited shall be in accordance with that stated in Standard IS 2629 and shall not less than 0.61kg/m² with a minimum thickness of 86 microns for iteGI of thickness more than 5mm, 0.46kg/m² (64 microns) for iteGI of thickness between 2mm and 5mm and 0.33kg/m² (47 microns) for iteGI less than 2mm thick.

Parts shall not be galvanized if their shapes are such that the pickling solutions cannot be removed with certainty or if galvanizing would be unsatisfactory or if their mechanical strength would be reduced. Surfaces in contact with oil shall not be galvanized unless they are subsequently coated with an oil resistant varnish or paint.

In the event of damage to the galvanizing the method used for repair shall be subject to the approval of the Engineer in Charge or that of his representative.

In no case the repair of galvanisation on site will be permitted.

The threads of all galvanized bolts and screwed rods shall be cleared of spelter by spinning or brushing. A die shall not be used for cleaning the threads unless specifically approved by the Engineer in Charge. All nuts shall be galvanized. The threads of nuts shall be cleaned with a tap and the threads oiled.

Partial immersion of the work shall not be permitted and the galvanizing tank must therefore be sufficiently large to permit galvanizing to be carried out by one immersion.

After galvanizing no drilling or welding shall be performed on the galvanized parts of the equipment excepting that nuts may be threaded after galvanizing.

To avoid the formation of white rust galvanized materials shall be stacked during transport and stored in such a manner as to permit adequate ventilation. Sodium dichromate treatment shall be provided to avoid formation of white rust after hot dip galvanization.

The galvanized steel shall be subjected to test as per IS-2633.

3.0 Fixing of Cross Arms

After the erection of supports and providing guys, the cross-arGI are to be mounted on the support with necessary clamps, bolts and nuts. The practice of fixing the cross arGI before the pole erection should be followed.

TECHNICAL SPECIFICATION
FOR
HT STAY SETS & STAY WIRE

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OF
HT STAY SETS & STAY WIRE

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PART - A

**TECHNICAL SPECIFICATION
FOR
HT STAY SETS FOR 33kV & 11kV**

TECHNICAL SPECIFICATION FOR HT STAY SETS

1.0 SCOPE

This specification covers design, manufacture, testing, supply & commissioning of HT stay sets 20 mm dia.

2.0 Qualification Criteria of Manufacturer:-

The prospective bidder may source Stay Sets from manufacturers only, having the following qualifying requirements:

The manufacturer should have supplied at least 1000 sets (both HT & LT taken together) to electricity supply utilities / PSUs.

3.0 GENERAL REQUIREMENTS

3.1 HT Stay Set of 20 mm Dia (Galvanized) for 33 kV & 11 kV Lines

The Stay Set (Line Guy Set) will consist of the following components:

3.2 Anchor Rod with one Washer and Nut

Overall length of Rod should be 1800mm to be made out of 20 mm dia GI rod one end threaded up to 40 mm length with a pitch of threads per cm. And provided with one square G.I Washer of Size 50x50x1.6mm and one GI Hexagonal nut conforming to IS: 1363:1967 & IS:1367:1967. Both washer and nut to suit the threaded rod of 20mm. The other end of the rod to be made into a round eye having an inner dia of 40mm with best quality of welding. Dimensional and other details are to be indicated and submitted by bidders for owner's approval before start of manufacturing.

3.3 Anchor Plate Size 300 x 300 x 8 mm

To be made out of G.S. Plate of 8 mm thickness. The anchor plate to have at its centre 22mm dia hole.

3.4 Turn Buckle, Eye Bolt with 2 Nuts.

To be made of 20 mm dia G.I Rod having an overall length of 450 mm. One end of the rod to be threaded up to 300 mm length with a pitch of 4 threads per cm. The 20 mm dia bolt so made shall be provided with two G.I Hexagonal nuts of suitable size conforming to IS: 1363:1967 & IS: 1367:1967. The other end of the rod shall be rounded into a circular eye of 40mm inner dia with proper and good quality of welding. Welding details are to be indicated by the bidder separately for approval.

3.5 Bow with Welded Channel:

To be made out of 16mm dia G.I Rod. The finished bow shall have an overall length of 995 mm and height of 450 mm. The apex or top of the bow shall be bent at an angle of 10°. The other end shall be welded with proper and good quality welding to a G.I Channel 200 mm long having a dimension of

100x50x4.7 mm. The Channel shall have 2 holes of 18 mm dia and 22 dia hole at its centre as per drawing No.3 enclosed herewith.

3.6 Thimble 2 Nos.

To be made of 1.5 mm thick G.I sheet into a size of 75x22x40mm and shape as per standard.

3.7 Galvanizing

The complete assembly shall be hot dip galvanized.

3.8 Welding

The minimum strength of welding provided on various components of 20 mm dia stay sets shall be 4900kg. 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.

3.9 Threading

The threads on the Anchor Rods, Eye Bolts and Nuts shall be as per specification IS: 4218:1967 (IS Metric Screw Threads). The Nuts shall be conforming to the requirements of IS: 1367:1967 and have dimension as per IS 1363:1967. The mechanical property requirement of fasteners shall confirm to the properly clause 4.6 each for anchor rods and Eye bolt and property clause 4 for nuts as per IS: 1367:1967.

Average weight of finished 20 mm Stays Set: 14.523 Kg. (Min) (Excluding Nuts Thimble & Washer):15.569 Kg. (Max.)

4.0 TESTS

The contractor shall be required to conduct testing of materials at Govt./Recognized testing laboratory during pre-dispatch inspection for Tensile Load of 4900Kg. applied for one minute on the welding and maintained for one minute for 16 mm and 20mm dia stay sets respectively.

5.0. IDENTIFICATION MARK

All stay sets should carry the identification mark of the OWNER.

This should be engraved on the body of stay rods to ensure proper identification of the materials. The nuts should be of a size compatible with threaded portion of rods and there should be not play or slippage of nuts.

Welding wherever required should be perfect and should not give way after erection.

6.0 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 20mm dia excluding nuts, thimbles and washers shall not be less than the weight specified above.

PART – B

TECHNICAL SPECIFICATIONS
FOR
STAY WIRE (7/10 SWG)

TECHNICAL SPECIFICATIONS FOR STAY WIRE (7/10 SWG)

1.0 Scope:-

This specification covers design, manufacture, testing, supply & commissioning of **STAY WIRE (7/10 SWG) (7/3.15 mm)**.

2.0 Qualification Criteria of Manufacturer:-

The prospective bidder may source Stay Wire from manufacturers only, having the following qualifying requirements:

The manufacturer should have supplied at least 1000 Kg (all sizes taken together) to electricity supply utilities / PSUs.

3.0 Application 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.

4.0 Application and Sizes

The G.I. stranded wires covered in this Specification are intended for use on the overhead power line poles, distribution transformer structures etc.

The G.I stranded wires shall be of 7/10 SWG (7/3.15 mm).

5.0 Materials

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.

6.0 Tensile Grade

The wires shall be of tensile grade 4, having minimum tensile strength of 700 N/mm² conforming to IS:2141.

7.0 General Requirements

The outer wire of strands shall have a right-hand lay.

The lay length of wire strands shall be 12 to 18 times the strand diameter.

8.0 Minimum Breaking Load

The minimum breaking load of the wires before and after stranding shall be as follows:

No. of	Wire Dia	Min. breaking	Min. breaking
--------	----------	---------------	---------------

Wires & Const.	(mm)	load of the Single wire before stranding (KN)	load of the standard wire (KN)
7 (6/1)	3.15	5.46	34.00

9.0 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 metres apart in the finished strands.

The wire shall be circular and free from scale, irregularities, imperfection, flaws, splits and other defects.

10.0 Tolerances

A tolerance of (+) 2.5% on the diameter of wires before stranding shall be permitted.

11.0 Sampling Criteria

The sampling criteria shall be in accordance with IS: 2141.

12.0 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

13.0 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 of Galvanizing Test

The Zinc Coating shall conform to "Heavy Coating" as laid down in IS:4826.

14.0 Marking

Each coil shall carry a metallic tag, securely attached to the inner part of the coil bearing the following information:

- a) Manufacturers name or trade mark
- b) Lot number and coil number
- c) Size
- d) Construction
- e) Tensile Designation
- f) Lay
- g) Coating
- h) Length
- i) Mass
- j) ISI certification mark, if any

15.0 Packing

The wires shall be supplied in 75-100 kg coils. The packing should be done in accordance with the provisions of IS: 6594

16.0 Other Items:

For remaining items of stay sets mentioned in the enclosed drawing, relevant applicable Indian standards shall be applicable.

GURANTEED TECHNICAL PARTICULARS of STAY WIRE (7/10 SWG)
(7/3.15 mm) is furnished at **Chapter E-16**.

**TECHNICAL SPECIFICATION
FOR
RS JOIST**

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OF
RS JOIST**

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TECHNICAL SPECIFICATION OF 11 mtr, R.S Joist Pole

1.0 Scope of Work:

This specification covers design, manufacture, testing and supply of 150x150mm RS Joist 11 Meter long designed for a working load of 34.6kg. The bidder should enclose Performance Certificates from the above users, issued in favour of the Sub Vendor / manufacturer, as proof of successful operation in field.

Sl. No.	Size	Purpose	Supply Qty(Nos)
1	11 Mtr	DP	As per BOQ
2	11 Mtr	4-Pole	

150x150mmRS Joist	150 x 150 mm R.S. Joist length:-11 mtr,34.6kg / mtr total weight 336.6kg	M1
-------------------	--	----

2.0 Applicable Standards:

This specification covers the manufacturing, testing before dispatch and delivery of above R.S Joists

2.1 Standards:

The RS JOISTS shall comply with the requirements of latest issue of IS – 2062 Gr – A except where specified otherwise.

3.0 Climatic Conditions:

Please refer **Chapter E3** of Technical Specification on climatic conditions.

4.0 Rolled Steel Joists

RSJ DESIGNATION	150 x 150 mm ISHB
Length of Joist in Mtr with +100mm/- 0% Tolerance	11mtr
Weight kg/m with $\pm 2.5\%$ Tolerance	34.6
Thickness of Flange (Tf) (mm) with ± 1 .5mm Tolerance	9.00
Thickness of Web (Tw) (mm) with ± 1 .0mm Tolerance	11.8

Corner Radius of fillet or root (R1) (mm)	8.00
Corner Radius of Tow (R2) (mm)	4.00
Moment of Inertia Ixx (cm ⁴) Iyy (cm ⁴)	1640.00 495.00
Radius of Gyration (cm) Rxx Ryy	6.09 3.35
Flange Slope(a) in Degree	94.0
Tolerance in Dimension	As per IS:1 852

41 Dimensions and Properties

4.2 MECHANICAL PROPERTIES:

Tensile Test :	Requirement as per IS:2062/1999 Grade-A
Yield Stress(MPa)	Min250
Tensile Strength(MPa)	Min410
Lo=(5.65I _{So})Elongation%	Min23
Bend Test	Shall not Crack

4.3. CHEMICAL PROPERTIES:

Chemical Composition	Requirement as per IS:2062/1999 Grade-A	Permissible variation over the Specified Limit, Percent, Max
Grade	A	-
Chemical Name	Fe-410W A	-
Carbon(%Max.)	0.23	0.02
Manganese(%Max.)	1.5	0.05
Sulphur(%Max.)	0.050	0.005
Phosphorous(%Max.)	0.050	0.005
Silicon(%Max.)	0.40	0.03
Carbon Equivalent(%Max.)	0.42	-

Deoxidation Mode	Semi-killed or killed	-
Supply condition	As rolled	-

4.4. However, In case of any discrepancy between the above data & the relevant ISS, the values indicated in the IS shall prevail.

4.5. The Acceptance Tests shall be Carried out as per Relevant ISS.

5.0.150x150mm RS Joists:

RS Joists of Specific Weight 30.6kg/mtr with length of each type of pole being 11 mtr pole weighing 336.6Kg for specified number of poles with specified weight in MT as given in the NIT table given above shall have to be supplied as per IS:2062;2006 Grade"A" , IS:808;1989/2001, IS1608:1995 & IS:12779-1989 and their latest amendment if any complying the required Dimension, Weight, Chemical & Mechanical properties confirming to the relevant IS, as per the Tolerrance given Below.

6.0 APPLICABLE TOLLERANCES:

1. Length of each pole = + 100mm / - 0 % As per relevant IS: 12779-1989

(with proportionate change in no of Poles)

2. Specific Weight of RS Joists = $\pm 2.5\%$ As per relevant IS: 1852/1 985
3. Weight for whole lot of supply for all categories = $\pm 3.0\%$ As per relevant IS: 12779-1989 for both type of RS Joists.

7.0. EMBOSSING ON EACH R.S JOIST:

Following distinct non-erasable embossing is to be made on each R.S Joists. a) Name & Logo of the Manufacturer. b) B.I.S Logo (ISI Mark) if applicable. c) Size of the

8.0. Chemical Properties:

Tensile Test :	Requirement as per IS:2062/ 1999 Grade-A	Manufacturer's Data
Yeild Stress(MPa)	Min250	
Tensile Strength(MPa)	Min410	
Lo=(5.65ISo)Elongation%	Min23	
Bend Test	Shall not Crack	

9.0. Mechanical Properties:

Chemical Composition	Requirement p e r IS:2062/ 1999 Grade- A	Permissible variation over the Specified Limit,Percent,Max	Manufacturer's Data
Grade	A	-	
Chemical Name	Fe-410W A	-	
Carbon(%Max.)	0.23	0.02	
Manganese(%Max.)	1.5	0.05	
Sulphur(%Max.)	0.050	0.005	
Phosphorous(%Max.)	0.050	0.005	
Silicon(%Max.)	0.40	0.03	
Carbon Equivalent(%Max.)	0.42	-	
Deoxidation Mode	Semi-killed or killed	-	
Supply condition	As rolled	-	

However, In case of any discrepancy between the above data & the relevant ISS, the values indicated in the IS shall prevail. The Acceptance Tests shall be Carried out as per Relevant ISS.The RS Joists shall be manufactured confirming to the relevant IS with Manufacturer's name/logo & B.I.S Logo if applicable embossed on it.

**TECHNICAL SPECIFICATION
FOR
ALL ALUMINIUM ALLOY CONDUCTOR
(55mm², 100mm² & 148mm² AAAC)**

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OF
ALL ALUMINIUM ALLOY CONDUCTOR
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PART – A

TECHNICAL SPECIFICATION FOR ALL ALUMINIUM ALLOY CONDUCTOR (55mm²)

TECHNICAL SPECIFICATION FOR ALL ALUMINIUM ALLOY CONDUCTOR (55mm²)

1.0 Applicable Standards

Sl.No	International Standard	IS	Description
1	IEC :1089		Round wire concentric lay overhead electrical standard Conductor
2		IS 398	Aluminum Alloy Stranded Conductors
3		IS 9997	Aluminum Alloy redraw rods for electrical purposes
4	IEC 502 : 1994		Extruded solid dielectric insulated power cables for rated voltages 1.0 kV up to 30 kV
5	IEC 104		Aluminum Magnesium Silicon alloy wire for overhead line conductors
6		IS 1778	Reels and drums of bare conductor.
7	BS : 6485-1971		PVC covered conductors for overhead power lines.

2.0 Technical details

The details of the AAAC Conductors of various sizes are given below: **55mm² AAA Conductor**

- i) Code name : AAAC
- ii) Stranding and wire : 7/3.15 mm dia
- iii) Number of Strands : 7
- iv) Total sectional area : 55 mm².
- v) Overall diameter : 9.45 mm
- vi) Approximate mass : 149.2 kg/km
- vii) Calculated D.C. resistance at 20°C maximum: 0.6210 ohm/km
- viii) Approx. Calculated breaking load : 16.03 kN
(Minimum UTS)
- ix) Direction of lay of outer layer : Right hand.
- x) Modulus of Elasticity : $0.6324 \times 10^6 \text{ kg/cm}^2$

- xi) Co-efficient of linear Expansion (Per°C) : 23.0×10^{-6}
- xii) Details of aluminum strand :
 - a) Minimum breaking load of Strand before stranding : 1.52 N
 - b) Minimum breaking load of Strand after stranding : 1.44 kN
 - a) Maximum D., C, resistance of strand at 20 dg. Centigrade : 6.845 Ohms/km
 - d) Weight : 13.25 kg/km

- (xiii)
- | | | |
|---------------------------------|---|----------|
| a) Standard length of conductor | : | 2000 mtr |
| b) Conductor length in drum | : | 4000 mtr |
- (xiv) Withstand Temperature : 85 °C

3.0 Workmanship

3.1 All the Al-alloy strands shall be smooth, uniform and free from all imperfections, such as spills and splits, die marks, scratches, abrasions, etc., after drawing and also after stranding.

3.2 The finished conductor shall be smooth, compact, uniform and free from all imperfections including kinks (protrusion of wires), scuff marks, dents, pressmarks, cut marks, wire crossover, over riding, looseness (wire being dislocated by finger/hand pressure and/or unusual bangle noise on tapping), material inclusions, white rust, powder formation or black spot (on account of reaction with trapped rain water etc.) dirt, grit etc.

4.0 Joints in Wires.

There will be no joint in any wire of the conductor, except those made in the base rod or wire before final drawing.

5.0 Stranding.

In all constructions, the successive layers shall be stranded in opposite directions. The wires in each layer shall be evenly and closely stranded round the underlying wire or wires. The outer most layer of wires shall have a right hand lay. The lay ratio of any layer shall not be greater than the lay ratio of the layer immediately beneath it.

6.0 Tolerances.

The manufacturing tolerances to the extent of the following limits only shall be permitted in the diameter of individual strands and lay-ratio of the conductor.

Lay ratio of Conductor

		Maximum	Minimum
Aluminum Alloy	3/6 wire layer	14	10

7.0 Materials

Aluminum Alloy

The wire shall be of heat treated aluminum, magnesium silicon alloy having a composition appropriate to the mechanical & electrical properties as specified in IS 398 (Part-4)

The Aluminum Alloy strands drawn from heat treated aluminum alloy redraw rods conforming to Type B as per IEC: 104-1987, the chemical composition of redrawn rods shall conform to IS 1997-91, as given below:

Elements	Present
Si	0.50-0.90
Mg	0.60-0.90
Fe	0.50 max
Cu	0.10 max
Mn	0.03 max
Cr	0.03 max
Zn	0.10 max
B	0.06 max
Other Element (Each)	0.03 max
Other Element (Total)	0.10 max
Al	Remainder

8.0 Standard Length

8.1 The standard length of the conductor shall be 2000 meters. Contractor shall indicate the standard length of the conductor to be offered by them. A tolerance of **+/- 0.5%** on the standard length offered by the Bidder shall be permitted.

8.2 Bidder shall also indicate the maximum single length, above the standard length, he can manufacture in the guaranteed technical particulars of offer. The Owner reserves the right to place orders for the above lengths on the same terms and conditions applicable for the standard lengths during the execution of the Contract.

9.0 Tests

The following tests shall be conducted on samples of each type of conductor.

9.1 Acceptance Tests.

- | | | |
|-----|--|------------------|
| (a) | Visual check for joints)
scratches etc. And length)
measurement of) | As per clause 14 |
| (b) | Conductor by rewinding.)

Dimensional check on Al-
alloy Strands | |
| (c) | Check for lay-ratio) | |
| (d) | Elongation test) | |
| (e) | Breaking load/tensile test on)
Aluminum alloy strands.) | |

- | | | | |
|-----|---|---|-------------------|
| (f) | DC resistance test on
Aluminum Alloy strands |) | IEC 104, IEC 1089 |
| (g) | Wrap test on Aluminum Alloy strands |) | |
| (h) | Visual and dimensional
Check on drum |) | IS: 1778-1980 |

9.2 Routine Test.

- (a) Check to ensure that there are no joints.
- (b) Check that there are no cuts, fins etc. on the strands.
- (c) Check that drums are as per Specification.
- (d) All acceptance test as mentioned above to be carried out on each

9.3 Tests During Manufacture

Chemical analysis of Aluminum alloy)
Used for making strands.) As per clause 14

The following test facilities shall be available at the Contractor's works:

- a) Calibration of various testing and measuring equipment including tensile testing machine, resistance measurement facilities, burette, thermometer, barometer etc.
- b) Standard resistance for calibration of resistance bridges.
- c) Finished conductor shall be checked for length verification and surface finish on separate rewinding machine at reduced speed (variable from 8 to 16 meters per minute). The rewinding facilities shall have appropriate clutch system and free of vibrations, jerks etc. with traverse laying facilities.

9.4 Testing Expenses.

- a) The type test charges for the conductor should be to the account of the quoted in the relevant schedule of Bid proposal Sheets.
- b) Contractor shall indicate the laboratories in which they propose to conduct the type tests. They shall ensure that adequate facilities are available in the laboratories and the tests can be completed in these laboratories within the time schedule guaranteed by them.
- c) In case of failure in any type test, the Contractor is either required to manufacture fresh sample lot and repeat all the tests successfully once

or repeat that particular type test three times successfully on the sample selected from the already manufactured lot at his own expenses. In case a fresh lot is manufactured for testing, then the lot already manufactured shall be rejected.

- d) The entire cost of testing for the acceptance and routine tests and Tests during manufacture specified herein shall be treated as included in the quoted unit price of conductor, except for the expenses of the inspector/Owner's representative.
- e) In case of failure in any type test, if repeat type tests are required to be conducted, then all the expenses for deputation of Inspector/Owners' representative shall be deducted from the contract price. Also if on receipt of the Contractor's notice of testing, the Owner's representative does not find "PLANT" to be ready for testing the expenses incurred by the Owner for re-deputation shall be deducted from contract price.

9.5 Additional Tests.

- a) The Owner reserves the right of having at his own expenses any other test(s) of reasonable nature carried out at Contractor's premises, at site or in any other place in addition to the aforesaid type, acceptance and routine tests to satisfy himself that the materials comply with the Specifications.
- b) The Owner also reserves the right to conduct all the tests mentioned in this specification at his own expense on the samples drawn from the site at Contractor's premises or at any other test centre. In case of evidence of non-compliance, it shall be binding on the part of Contractor to prove the compliance of the items to the technical specifications by repeat tests, or correction of deficiencies, or replacement of defective items all without any extra cost to the Owner.

9.6 Sample Batch for Type Testing

- a) The contractor shall offer material for selection of samples for type testing only after getting Quality Assurance Plan approved from Owner's Quality Assurance Deptt. The sample shall be manufactured strictly in accordance with the Quality Assurance Plan approved by Owner.
- b) The Contractor shall offer at least three drums for selection of sample required for conducting all the type tests.
- c) The Contractor is required to carry out all the acceptance testssuccessfully in pre

9.7 Test Reports.

- a) Copies of type test reports shall be furnished in at least six copies

along with one original. One copy will be returned duly certified by the Owner only after which the commercial production of the material shall start.

- b) Record of routine test reports shall be maintained by the Supplier at his works for periodic inspection by the Owner's representative.
- c) Test certificate of tests during manufacture shall be maintained by the Contractor. These shall be produced for verification as and when desired by the Owner.

10.0 Packing.

- a) The conductor shall be supplied in 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.
- b) 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.
- c) The Contractor should submit their proposed drum drawings along with the bid.
- d) The Contractor may offer more than one length of the conductor in a single drum.
- e) 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.
- f) The flanges shall be of two ply construction with a total thickness of 64 mm 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.
- g) 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 batten 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.
- h) 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 treaded over a length on either end, sufficient to accommodate washers, spindle plates and nuts for fixing flanges at the required spacing.
- i) 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.
- j) The inner cheek of the flanges and drum barrel surface shall be painted with bitumen based paint.
 - k) Before reeling, card board or double corrugated or thick bituminous 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. After reeling the conductor, the exposed surface of the outer layer of conductor shall be wrapped with water proof thick bituminous bamboo paper to preserve the conductor from dirt, grit and damage during transport and handling.
 - l) A minimum space of 75 mm for conductor shall be provided between the inner surface of the external protective lagging 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.
 - m) 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.
 - n) 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.
 - o) 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.
 - p) 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.
 - q) 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.
 - r) As an alternative to wooden drum Contractor may also supply the conductors in nonreturnable 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.

11.0 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 layer.
- (j) Gross weight of the drum after putting lagging.
- (k) Average weight of the drum without lagging.
- (l) Net weight of the conductor in the drum
- (m) Month and year of manufacture of conductor. The above should be indicated in the packing list also.

12.0 Verification Conductor Length

The Owner reserves the right to verify the length of conductor after unreeling at least five (5) percent of the drums in a lot offered for inspection. For the balance drums, length verification shall be done by the owner based on report/certification from Manufacturer/ Contractor.

13.0 Standards.

- b) The conductor shall conform to the following Indian/International Standards, which shall mean latest revisions, with amendments/changes adopted and published, unless specifically stated otherwise in the Specification.
- c) In the event of the supply of conductor conforming to standards other than specified, the Bidder 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 Contractors to establish their equivalence.

Sl. No.	Indian Standard	International Standard Title
1.	IS: 398(Part-IV) Aluminum Alloy Standard conductor	IEC: 208-1966
2.	IS: 9997 - 1988 Aluminum Alloy Redraw Rods.	IEC 104-1987
3.	IS: 1778 - 1980 Reel and Drums for Bare Conductors.	

14.0 TESTS ON AAAC CONDUCTORS

14.1 UTS Test on Stranded Conductor

Circles perpendicular to the axis of the conductor shall be marked at two places on a sample of conductor of minimum 5 m length between fixing arrangement suitably fixed on a tensile testing machine. The load shall be increased at a steady rate up to 50% of minimum specified UTS and held for one minute. The circles drawn shall not be distorted due to relative movement of strands. Thereafter the load shall be increased at steady rate to minimum UTS and held for one minute. The Conductor sample shall not fail during this period. The applied load shall then be increased until the failing load is reached and the value recorded.

14.2 D.C. Resistance Test on Stranded Conductor

On a conductor sample of minimum 5 m length two contact-clamps shall be fixed with a predetermined bolt torque. The resistance shall be measured by a Kelvin double bridge by placing the clamps initially zero meter and subsequently one meter apart. The test shall be repeated at least five times and the average value recorded. The value obtained shall be corrected to the value at 20° C as per IS: 398-(Part-V)-1982. The resistance corrected at 200C shall conform to the requirements of this Specification.

14.3 Chemical Analysis of Aluminum alloy

Samples taken from the Aluminum alloy ingots/coils/strands shall be chemically/spectrographically analyzed. The same shall be in conformity to the requirements stated in this Specification.

14.4 Visual and Dimensional Check on Drums

The drums shall be visually and dimensionally checked to ensure that they conform to the requirements of this Specification.

14.5 Visual Check for Joints, Scratches etc.

Conductor drums shall be rewound in the presence of the Owner. The Owner shall visually check for scratches, joints etc. and that the conductor generally conforms to the requirements of this Specification. Five percent (5%) drums from each lot shall be rewound in the presence of the Owner's representative.

14.6 Dimensional Check on Aluminum alloy Strands.

The individual strands shall be dimensionally checked to ensure that they conform to the requirement of this Specification.

14.7 Check for Lay-ratios of Various Layers.

The lay-ratios of various layers shall be checked to ensure that they conform to the requirements of this Specification.

14.8 Torsion and Elongation Tests on Aluminum ally Strands.

The test procedures shall be as per clause No. 10.3 of IE: 888. In torsion test, the number of complete twists before fracture shall not be less than 18 on a length equal to 100 times the standard diameter of the strand. In case test sample length is less or more than 100 times the stranded diameter of the strand, the minimum number of twists will be proportioned to the length and if number comes in the fraction then it will be rounded off to next higher whole number. In elongation test, the elongation of the strand shall not be less than 4% for a gauge length of 250 mm.

14.9 Check on Barrel Batten strength of Drums.

The details regarding barrel batten strength test will be discussed and mutually agreed to by the Contractor & Owner in the Quality Assurance Programme.

14.10 Breaking Load Test on Individual Aluminum Alloy Wires.

The test shall be conducted on Aluminum alloy wires. The breaking load of one specimen cut from each of the samples taken shall be determined by means of suitable tensile testing machine. The load shall be applied gradually Si the jaws of the testing machine shall be not less than 25mm/min. and not greater than 100 mm/min. The ultimate breaking load of the specimens shall be not less than the values specified in the Specification.

14.11 D.C Resistance Test

The electrical resistance test of one specimen cut from each of the samples taken shall be measured at ambient temperature. The measured resistance shall be corrected to the value at 20⁰ C by means of the formula

$$R_{20} = R_T [1/(1+\alpha(T-20))]$$

Where R_{20} = Resistance corrected at 20°C

R_T = Resistance measured at T°C

A = Constant – Mass temperature coefficient of resistance, 0.0036, and

T = ambient temperature during measurement

The resistance corrected at 20⁰ C shall not be more than the maximum values specified .

PART – B

**TECHNICAL SPECIFICATION
FOR
ALL ALUMINIUM ALLOY CONDUCTOR (100&148mm²)**

TECHNICAL SPECIFICATION FOR ALL ALUMINIUM ALLOY CONDUCTOR (100&148mm²)

1.0 STANDARDS

Except where modified by the specification, the Aluminum Alloy Conductor shall be designed, manufactured and tested in accordance with latest editions of the following standards:

Sl.No	International Standard	IS	Description
1	IEC :1089		Round wire concentric lay overhead electrical standard Conductor
2		IS 398	Aluminum Alloy Stranded Conductors
3		IS 9997	Aluminum Alloy redraw rods for electrical purposes
4	IEC 502 : 1994		Extruded solid dielectric insulated power cables for rated voltages 1.0 kV up to 30 kV
5	IEC 104		Aluminum Magnesium Silicon alloy wire for overhead line conductors
6		IS 1778	Reels and drums of bare conductor.
7	BS : 6485-1971		PVC covered conductors for overhead power lines.

2.0 Technical details

The details of the AAAC Conductors of various sizes are given below: **100mm² AAA Conductor**

- i) Code name : AAAC
- ii) Stranding and wire : 7/4.26 mm dia
- iii) Number of Strands : 7
- iv) Total sectional area : 100 mm².
- v) Overall diameter : 12.78 mm
- vi) Approximate mass : 273 kg/km
- vii) Calculated D.C. resistance at 20°C maximum: 0.3299 ohm/km
- viii) Approx. Calculated breaking load : 29.26 kN
(Minimum UTS)
- ix) Direction of lay of outer layer : Right hand.
- x) Modulus of Elasticity : $0.6324 \times 10^6 \text{ kg/cm}^2$

- xii) Co-efficient of linear Expansion (Per°C) : 23.0×10^{-6}
- xii) Details of aluminum strand :
 - a) Minimum breaking load of Strand before stranding : 1.53 kN
 - b) Minimum breaking load of Strand after stranding : 1.44 kN
 - d) Maximum D., C, resistance of strand at 20 dg. Centigrade : 6.845 Ohms/km
 - d) Weight : 13.25 kg/km

- (xiii)
- | | | |
|---------------------------------|---|----------|
| a) Standard length of conductor | : | 2000 mtr |
| b) Conductor length in drum | : | 4000 mtr |
- (xiv) Withstand Temperature : 85 °C

3.0 LENGTHS AND VARIATIONS IN LENGTHS:

Unless otherwise agreed between the Owner and the Contractor, stranded aluminium alloy conductors shall be supplied in the manufacturer's usual production lengths to be indicated in the bid Schedule. The Owner reserves the right to specify particular lengths of conductor such that certain drum lengths will be shorter than others. There will in both cases be a permitted variation of -0 + 5% in the length of any one conductor length.

4.0 TESTS

4.1 D.C Resistance Test

The electrical resistance test of one specimen cut from each of the samples taken shall be measured at ambient temperature. The measured resistance shall be corrected to the value at 20⁰ C by means of the formula

$$R_{20} = R_T [1/(1+\alpha(T-20))]$$

Where R_{20} = Resistance corrected at 20°C

R_T = Resistance measured at T°C

A = Constant – Mass temperature coefficient of resistance, 0.0036, and

T = ambient temperature during measurement

The resistance corrected at 20⁰ C shall not be more than the maximum values specified .

4.2 Chemical Analysis of Aluminium Alloy

Samples taken from the alloy coils / strands shall be chemically / spectrographically analysed. The results shall conform to the requirements stated in this specification. The Contractor shall make available material analyses, control documents and certificates from each batch as and when required by the <OPTCL>.

Test should be conducted at the independent test house by the purchaser in the case of absence of facility at manufacturer. However the cost of such testing shall be borne by the manufacturer/Contractor.

**TECHNICAL SPECIFICATION
FOR
INSULATOR (DISC)**

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OF
DISC. INSULATOR

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TECHNICAL SPECIFICATION FOR DISC INSULATORS

1.0 SCOPE.

This specification covers the manufacturing, testing and supply of 33kV & 11kV Disc Insulators.

These insulators are to be used in suspension and tension insulator strings .

The insulators offered shall be procured from short listed vendor at **E-14** and shall have been successfully Type Tested during last five years on the date of bid submission. The Bidder shall **upload** the first page of the **Type test certificate** duly signed by the bidder showing the evidence of successful test, along with the bid.

2.0 STANDARDS:

- 2.1 Except as modified in this specification, the disc insulators shall conform to the following Indian Standards, which shall mean latest revisions and amendments.

Sl. No.	Indian Standard	Title.	International Standard
1.	IS: 206	Method for Chemical Analysis of Slab Zinc.	
2.	IS: 209	Specification for Zinc.	BS: 3436
3.	IS: 731	Porcelain insulators for overhead power lines with a normal voltage greater than 1000V	BS: 137(I&II); IEC 274 IEC 383
4.	IS: 2071 Part-(I), Part-(II) Part-(III)	Method of High Voltage Testing.	
5.	IS: 2121 (Part-I)	Specification of Conductors and Earth wire Accessories for Overhead Power lines. Armour Rods, Binding wires and tapes for conductor.	
6.	IS: 2486	Specification for Insulator fittings for overhead power lines with a nominal voltage greater than 1000V.	
	Part – I	General Requirement and Tests.	BS: 3288
	Part – II	Dimensional Requirements.	IEC: 120

	Part – III	Locking devices.	IEC: 372
7.	IS: 2629	Recommended practice for Hot Dip Galvanisation for iron and steel.	
8.	IS: 2633	Testing for Uniformity of Coating of Zinc coated articles.	
9.	IS: 3138	Hexagonal Bolts & Nuts.	ISO/R 947 & ISO/R 272
10.	IS: 3188	Dimensions for Disc Insulators.	IEC: 305
11.	IS: 4218	Metric Screw Threads	ISO/R 68-1969 R 26-1963, R 262-1969 & R965-1969
12.	IS: 6745	Determination of weight of zinc coating on zinc coated iron and steel articles.	
13.	IS: 8263	Methods of RIV Test of HV insulators.	IEC 437 NEMA Publication No.107/1964 CISPR
14.	IS: 8269	Methods for switching impulse test on HV insulators.	IEC: 506
15.		Thermal mechanical performance test and mechanical performance test on string insulator units.	IEC: 575

3.0 PRINCIPAL PARAMETERS.

3.1 DETAILS OF DISC INSULATOR / STRING:

The Insulator strings shall consist of standard discs for use in three phase, 50 Hz 33/11KV S/s & Lines in a moderately polluted atmosphere. The discs shall be Ball and Socket type (Cap & Pin type) and have arrangement as shown in Table-I.

The size of disc insulator, minimum creepage distance the number to be used in different type of strings, their electromechanical strength and mechanical strength of insulator string along with hardware shall be as follows:

Table I

Sl. No	Type of String.	Size of disc. Insulator (mm)	Minimum creepage distance of each disc(mm)	No. of standard discs 11KV	No. of standard discs 33KV	Electro-mechanical strength of insulator string fittings (KN)
1.	Single suspension	255x145	430	Refers Notes.	1x3	45
2.	Double suspension	-do-	-do-		2x3	2x45
3.	Single Tension	255x145	-do-	1x2	1x4	70
4.	Double Tension	-do-	-do-	2x2	2x4	2x70

3.2 SPECIFICATION / DRAWINGS:

The specification in respect of the disc insulators are described. These specification for information and guidance of the Bidder. The drawings to be furnished by the supplier shall be submitted to Engineer-in-charge.

3.3 Insulator units after assembly shall be concentric and coaxial within limits as permitted by Indian Standards.

3.4 The strings design shall be such that when units are coupled together there shall be contact between the shell of one unit and metal of the adjacent unit.

4.0 GENERAL TECHNICAL REQUIREMENTS:

4.1 Porcelain:

The porcelain used in the manufacture of the shells shall be ivory white nonporous of high dielectric, mechanical and thermal strength, free from internal stresses blisters, laminations, voids, forgone matter imperfections or other defects which might render it in any way unusable for insulator shells. Porcelain shall remain unaffected by climatic conditions ozone, acid, alkalis, zinc or dust. The manufacturing shall be by the wet process and impervious character obtained by through verification.

The insulator shall be made of highest grade, dense, homogeneous, wet-process porcelain, completely and uniformly vitrified throughout to produce uniform mechanical and electrical strength and long life service. The porcelain shall be free from warping, roughness, cracks, blisters, laminations, projecting points foreign particles and other defects, except those within the limits of

standard accepted practice. Surfaces and grooves shall be shaped for easy cleaning. Shells shall be substantially symmetrical.

4.2 Porcelain glaze:

Surface to come in contact with cement shall be made rough by sand glazing. All other exposed surfaces shall be glazed with ceramic materials having the same temperature coefficient of expansion as that of the insulator shell. The thickness of the glaze shall be uniform throughout and the colour of the glaze shall be Brown. The Glaze shall have a visible luster and smooth on surface and be capable of satisfactory performance under extreme tropical climatic weather conditions and prevent ageing of the porcelain. The glaze shall remain under compression on the porcelain body through out the working temperature range.

5.0 METAL PARTS:

(i) Cap and Ball Pins:

Ball pins shall be made with drop forged steel caps with malleable cast iron. They shall be in one single piece and duly hot dip galvanized. They shall not contain parts or pieces joined together welded, shrink fitted or by any other process from more than one piece of materials. The pins shall be of high tensile steel, drop forged and heat-treated. The caps shall be cast with good quality black heart malleable cast iron and annealed. Galvanizing shall be by the hot dip process with a heavy coating of zinc of very high purity. The bidder shall specify the grade composition and mechanical properties of steel used for caps and pins. The cap and pin shall be of such design that it will not yield or distort under the specified mechanical load in such a manner as to change the relative spacing of the insulators or add other stresses to the shells. The insulator caps shall be of the socket type provided with nonferrous metal or stainless steel cotter pins and shall provide positive locking of the coupling.

(ii) Security Clips:

The security clips shall be made of phosphor bronze or of stainless steel.

6.0 FILLER MATERIAL:

Cement to be used, as a filler material be quick setting, fast curing Portland cement. It shall not cause fracture by expansion or loosening by contraction. Cement shall not react chemically with metal parts in contact with it and its thickness shall be as small and as uniform as possible.

7.0 MATERIALS DESIGN AND WORKMANSHIP:

7.1 GENERAL:

All raw materials to be used in the manufacture of these insulators shall be subject to raw material quality control and to stage testing/ quality control during manufacturing stage to ensure the quality of the final end product. Manufacturing shall conform to the best engineering practices adopted in the

field of high voltage transmission. Bidders shall therefore offer insulators as are guaranteed by them for satisfactory performance. The design, manufacturing process and material control at various stages be such as to give maximum working load, highest mobility, best resistance to corrosion, good finish elimination of sharp edges and corners to limit corona and radio interference voltages.

7.2 INSULATOR SHELL:

The design of the insulator shells shall be such that stresses due to expansion and contraction in any part of the insulator shall not lead to deterioration. Shells with cracks shall be eliminated by temperature cycle test followed by mallet test. Shells shall be dried under controlled conditions of humidity and temperature.

7.3 METAL PARTS:

- 1) The pin and cap shall be designed to transmit the mechanical stress to the shell by compression and develop uniform mechanical strength in the insulator. The cap shall be circular with the inner and outer surfaces concentric and of such design that it will not yield or distort under loaded conditions. The head portion of the pinball shall be suitably designed so that when the insulator is under tension the stresses are uniformly distributed over the pinhole portion of the shell. The pinball shall move freely in the cap socket either during assembly of a string or during erection of a string or when a string is placed in position.
- 2) Metal caps shall be free from cracks, seams, shrinks, air holes, blowholes and rough edges. All metal surfaces shall be perfectly smooth with no projecting part or irregularities, which may cause corona. All load bearing surfaces shall be smooth and uniform so as to distribute the loading stress uniformly. Pins shall not show any microscopically visible cracks, inclusions and voids.

7.4 GALVANIZING:

All ferrous parts, shall be hot dip galvanized in accordance with IS: 2629. The zinc to be used for galvanizing shall conform to grade Zn 99.5 as per IS: 209. The zinc coating shall be uniform, smoothly adherent, reasonably light, continuous and free from impurities such as flux, ash, rust stains, bulky white deposits and blisters. Before ball fittings are galvanized, all die flashing on the shank and on the bearing surface of the ball shall be carefully removed without reducing the designed dimensional requirements.

7.5 CEMENTING:

The insulator design shall be such that the insulating medium shall not directly be engaged with hard metal. The surface of porcelain and coated with resilient

paint to offset the effect of difference in thermal expansions of these materials. High quality Portland cement shall be used for cementing the porcelain to the cap & pin.

7.6 SECURITY CLIPS (LOCKING DEVICES)

The security clips to be used as locking device for ball and socket coupling shall be 'R' shaped hump type to provide for positive locking of the coupling as per IS: 2486 (Part-IV). The legs of the security clips shall allow for spreading after installation to prevent complete withdrawal from the socket. The locking device shall be resilient, corrosion resistant and of sufficient mechanical strength. There shall be no possibility of the locking device to be displaced or be capable of rotation, which, when placed in position, and under no circumstances shall it allow separation of insulator units and fittings. 'W' type security clips are also acceptable. The hole for the security clip shall be counter sunk and the clip shall be of such design that the eye of the clip may be engaged by a hot line clip puller to provide for disengagement under energized conditions. The force required for pulling the clip into its unlocked position shall not be less than 50 N (5 kg.) or more than 500 N (50 kgs.).

7.7 BALL AND SOCKET DESIGNATION:

The dimensions of the ball and sockets for 70 KN discs shall be of 16 mm designation in accordance with the standard dimensions stated in IS: 2486 (Part-II).

8.0 DIMENSIONAL TOLERANCE OF INSULATOR DISCS:

It shall be ensured that the dimensions of the disc insulators are within the limits specified below:

a) Diameter of Disc (mm):-

	Standard	Maximum	Minimum
70 KN Disc	255	266	244

b) Ball to Ball spacing :-
Between Discs (mm)

	Standard	Maximum	Minimum
70 KN Disc	145	149	141

9.0 INTERCHANGEABILITY:

The insulators inclusive of the ball and socket fittings shall be of standard design suitable for use with hardware fittings of any make conforming to relevant Indian Standards.

10.0 FREEDOM FROM DEFECTS:

Insulators shall have none of the following defects:

- 1) Ball pin shake.

- 2) Cementing defects near the pin like small blow holes, small hair cracks lumps etc.
- 3) Sand fall defects on the surface of the insulator.

11.0 TESTS (FOR DISC INSULATORS) :

The following tests shall be carried out on the insulator string and disc insulators.

11.1 TYPE TEST:

This shall mean those tests, which are to be carried out to prove the design, process of manufacture and general conformity of the material and product with the intents of this specification. These tests shall have been conducted on a representative number of samples.

11.2 ACCEPTANCE TESTS:

This shall mean these tests, which are to be carried out on samples taken from each lot offered for pre-despatch inspection for the purpose of acceptance of the lot.

11.3 ROUTINE TESTS:

This shall mean those tests, which are to be carried out on each insulator to check the requirements, which are likely to vary during production.

11.4 TESTS DURING MANUFACTURE:

Stage tests during manufacture shall mean those tests, which are to be carried out during the process of manufacture to ensure quality control such that the end product is of the designed quality conforming to the intent of this specification.

11.5 TEST VALUE:

For all type and acceptance tests the acceptance values shall be the value guaranteed by the bidder in the guaranteed technical particulars of the acceptance value specified in this specification of the relevant standard whichever is more stringent for that particular test.

11.6 TEST PROCEDURE AND SAMPLING NORMS:

The norms and procedure of sampling for the above tests shall be as per the relevant Indian Standard or the Internationally accepted standards. This will be discussed and mutually agreed to between the supplier and purchaser before placement of order. The standards and normal according to which these tests are to be carried out are listed against each test. Where a particular test is a specific requirement of this specification, the norms and procedure for the same shall be as mutually agreed to between the supplier and the purchaser in the quality assurance programme.

11.7 TYPE, ROUTINE & ACCEPTANCE TESTS:

The following type test shall be conducted on a suitable number of individual unit components, materials or complete strings.

1. On complete insulator string with hardware fittings	Standards
a) Power frequency voltage withstand test rings under wet condition.	BS:137(Part-I)
b) Impulse voltage withstand test under dry condition.	IEC: 383
c) Mechanical strength test.	As per this specification.
2. On Insulators:	
a) Verification of dimensions.	IS: 731
b) Thermal mechanical performance test:	IEC:575
c) Power frequency voltage withstand and flashover (I) dry (ii) wet.	BS: 173
d) Impulse voltage withstand flashover test (dry)	: IEC: 383
e) Visible discharge test (dry)	: IS:731
All the type tests given under clause No.5.14 above shall be conducted on single suspension and Double Tension insulator string along with hardware fittings.	
3. ACCEPTANCE TESTS:	
For insulator:	
a) Visual examination	: IS:731
b) Verification of dimensions.	: IS:731
c) Temperature cycle test.	: IS:731
d) Galvanizing test.	: IS:731
e) Mechanical performance test.	: IEC:575
f) Test on locking device for ball and socket coupling.	: IEC:372
g) Eccentricity test.	As per this specification.
h) Electro-mechanical strength test.	:
i) Puncture test.	: IS:731
j) Porosity test.	: IS:731

4. ROUTINE TESTS:

For insulators:

- a) Visual inspection. : IS:731
- b) Mechanical routine test. :
- c) Electrical routine test. : IEC:383

5. TEST DURING MANUFACTURE:

Chemical analysis, hardness test and : As per this specification.
magnetic particle inspection for forgings.

11.8 ADDITIONAL TESTS:

The purchaser reserves the right for carrying out any other tests of a reasonable nature at the works of the supplier/ laboratory or at any other recognized laboratory/ research institute in addition to the above mentioned type, acceptance and routine tests at the cost of the purchaser to satisfy that the material complies with the intent of this specification.

11.9 CO-ORDINATION FOR TESTING:

For insulator strings, the supplier shall arrange to conduct testing of their disc insulators with the hardware fittings to be supplied to the purchaser by other suppliers. The supplier is also required to guarantee overall satisfactory performance of the disc insulator with the hardware fittings.

12.0 ACCEPTANCE AND ROUTINE TEST:

12.1 All acceptance and routine tests as stipulated herein shall be carried out by the supplier in the presence of owner's representative.

12.2 Immediately after finalisation of the programme of acceptance/ routine testing, the supplier shall give sufficient advance intimation to the purchaser to enable him to depute his representative for witnessing the tests.

12.3 In case of failure of the complete string in any tests, the supplier whose product has failed in the tests, shall get the tests repeated at his cost. In case of any dispute, assessment of the owner as to the items that has caused the failure in any of the type tests shall be final and binding.

12.4 MECHANICAL TEST:

- a) The complete insulator string along with its hardware fitting excluding arcing horn corona controlling/grading ring and suspension assembly/dead end assembly shall be subject to a load equal to 50% of the specified minimum ultimate tensile strength (UTS) which shall be increased already rate to 68% of the minimum UTS specified. The load shall be held for five minutes and then removed. After removal of the load, the string components shall not show any visual deformation and it shall be possible to disassemble them by hand,. Hand tools may be used to remove cotter pins and loosen the nuts initially. The string shall then be reassembled and loaded to 50% of UTS and the load

shall be further increased at a steady rate till the specified minimum UTS and held for one minute. No fracture should occur during this period. The applied load shall then be increased until the failing loads reached and the value recorded.

12.5 VIBRATION TEST:

The suspension string shall be tested in suspension mode, and tension string in tension mode itself in laboratory span of minimum 30 meters. In the case of suspensions string a load equal to 600 Kg. shall be applied along with the axis of the suspensions string by means of turn buckle. The insulators string along with hardware fittings and two sub conductors throughout the duration of the test vibration dampers shall not be used on the test span. Both the sub-conductors shall be vertically vibrated simultaneously at one of the resonance frequencies of the insulator string (more than 10Hz) by means of vibration inducing equipment. The amplitude of vibration at the antipode point nearest to the string shall be measured and the same shall not be less than 120.4 being the frequency of vibration. The insulator strings shall be vibrated for five million cycles then rotated by 90 deg and again vibrated for 5 million cycles without any failure, after the test, the disc insulators shall be examined for looseness of pins and cap or any crack in the cement. The hardware fittings shall be examined to fatigue fatter and mechanical strength test. There shall be no deterioration of properties of hardware components and disc insulators after the vibration test. The disc insulators shall be subjected to the following tests as per relevant standards.

Test.	Percentage of disc to be tested
a) Temperature cycle test followed by Mechanical performance test.	60
b) Puncture test (for porcelain insulator only)	40

13.0 IDENTIFICATION MARKING:

- (a) Each unit of insulator shall be legibly and indelibly marked with the trade mark of the supplier, the year of manufacture, the guaranteed combined mechanical and electrical strength in kilo-newtons abbreviated by 'KN' to facilitate easy identification and proper use.
- (b) The marking shall be on porcelain for porcelain insulators. The marking shall be printed and not impressed and the same shall be applied before firing.

14.0 CHEMICAL ANALYSIS OF ZINC USED FOR GALVANIZING.

Samples taken from the zinc ingot shall be chemically analysed as per IS: 209. The purity of zinc shall not be less than 99.95%.

15.0 TEST FOR FORGINGS:

The chemical analysis hardness tests and magnetic particle inspection for forgings will be as per the internationally recognized procedures for these

tests. The sampling will be based on heat number and heat treatment batch. The details regarding test will be as discussed and mutually agreed to by the supplier and owner in quality assurance programme.

16.0 TEST ON CASTING:

The chemical analysis mechanical and metallographic tests and magnetic particle inspection for castings will be as per the internationally recognized procedures for these tests. The samplings will be based on heat number and heat treatment batch. The details regarding test will be as discussed and mutually agreed to by the supplier and purchaser in quality assurance programme.

17.0 HYDRAULIC INTERNAL PRESSURE TEST ON SHELLS:

The test shall be carried out on 100% shells before assembly.

18.0 THERMAL MECHANICAL PERFORMANCE TEST:

The thermal mechanical performance test shall be carried out on minimum 15 number of disc insulators units as per the procedure given in IEC 575. The performance of the insulator unit shall be determined by the same standard.

19.0 ECCENTRICITY TEST:

The insulator shall be vertically mounted on a fixture using dummy pin and socket. A vertical scale with horizontal slider shall be used for the axial run out. The pointer shall be positioned in contact with the bottom of the outermost petticoat of the disc. The disc insulators shall be rotated with reference to the fixture and the slider shall be allowed to move up and down on the scale but always maintaining contact with the bottom of the outer most petticoats. After one full rotation of the disc the maximum and minimum position the slider has reached on the scale can be found out. Difference between the above two readings shall satisfy the guaranteed value for axial run out.

Similarly using a horizontal scale with vertical slider the radial run out shall be measured. The slider shall be positioned on the scale to establish contact with the circumference of the disc insulator and disc insulator rotated on its fixture always maintaining the contact. After one full rotation of the disc the maximum and minimum position the slider has reached on the scale can be found out. Difference between the above two readings shall satisfy the guaranteed value for axial run out.

20.0 CRACK DETECTION TEST:

Crack detection test shall be carried out on each ball and pin before assembly of disc unit. The supplier shall maintain complete record of having conducted such tests on each and every piece of ball pin. The bidder shall furnish full details of the equipment available with him for crack test and also indicate the test procedure in detail.

**TECHNICAL SPECIFICATION
FOR
POST INSULATOR (PIN TYPE)**

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TECHNICAL SPECIFICATION FOR POST INSULATOR (PIN TYPE & STATION TYPE)

1.0 STANDARDS

Post insulator (Pin Type) shall conform in general to IS 2544, IEC 168 and IEC 815.

Technical Parameters

SI No.	Parameters	33kV	11kV
1	Total minimum cantilever strength (kg)	Not < 300	Not < 300
2	Minimum torsion moment	As per IEC 273	As per IEC 273
3	Total height of insulator (mm)	508	254
4	Minimum PCD (mm) top/bottom	76	57
5	No. of bolts top/bottom	4/ 8	4/ 8
6	Diameter of bolt holes (mm) top/bottom	M12	M12
7	Pollution level as per IEC 815	Heavy	Heavy
8	Minimum total creepage distance (mm)	1050	450
9	Puncture Voltage(kV)	250	140

SI No 4 & 5 is not applicable for Pin type Post Insulator. The size of the pin shall given as per IS & should be of galvanized with necessary nuts & washers.

2.0 Constructional features

The Pin insulators shall consist of a porcelain part permanently secured in a metal base to be mounted on the supporting structures. They shall be capable of being mounted upright and be designed to with stand any shocks to which they may be subjected to by the operation of the associated equipment. Only solid core insulators will be acceptable.

Porcelain used shall be homogeneous, free from lamination, cavities and other flaws or imperfections that might affect the mechanical or dielectric quality and shall be thoroughly vitrified, tough and impervious to moisture.

Glazing of the porcelain shall be of uniform brown in colour, free from blisters, burrs and other similar defects.

The insulator shall have alternate long and short sheds with aerodynamic profile. The shed profile shall also meet the requirements of IEC 815 for the specified pollution level.

When operated at normal rated voltage there shall be no electric discharge between conductor and insulators which would cause corrosion or injury to conductors or insulators by the formation of substance produced by chemical action.

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.

All ferrous parts shall be hot dip galvanized in accordance with the latest edition of IS: 2633, and IS: 4579. The zinc used for galvanizing shall be grade Zn 99.95 as per IS: 209. The zinc coating shall be uniform, adherent, smooth, reasonably bright, continuous and free from imperfections such as flux ash, rust stains, bulky white deposits and blisters. The metal parts shall not produce any noise generating corona under the operating conditions. Flat washer shall be circular of a diameter 2.5 times that of bolt and of suitable thickness. Where bolt heads/nuts bear upon the beveled surfaces they shall be provided with square tapered washers of suitable thickness to afford a seating square with the axis of the bolt.

Bidder shall make available data on all the essential features of design including the method of assembly of shells and metals parts, number of shells per insulator, the manner in which mechanical stresses are transmitted through shells to adjacent parts, provision for meeting expansion stresses, results of corona and thermal shock tests, recommended working strength and any special design or arrangement employed to increase life under service conditions.

3.0 TEST DETAILS

3.1 TYPE TESTS:

The post insulators shall be subjected to the following type test :

- Visible discharge test
- Impulse voltage withstand test
- Dry power frequency voltage withstand test
- Wet power frequency voltage withstand test
- Mechanical strength test for post insulators as per IEC 168 / IS: 2544.

3.2 Acceptance Tests

The test samples having withstood the routine tests shall be subjected to the following tests according to the sampling procedure of IEC 383 clause 23:

- Verification of dimensions
- Temperature cycle test
- Mechanical strength test for post insulators as per IEC 168/ IS 2544
- Porosity test on post insulators
- Puncture test
- Test for galvanization of ferrous parts

3.3 Routine Tests

- Visual examination
- Power frequency voltage dry test
- Tests to prove mechanical strength.

**TECHNICAL SPECIFICATION
FOR
POLYMER INSULATOR**

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OF
POLYMER INSULATOR

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TECHNICAL SPECIFICATION FOR 33/11 KV POLYMER INSULATORS

1.0 SCOPE :-

- I. This specification covers design, manufacture, testing, inspection, packing and supply of composite insulators for use in the 33/11 KV overhead transmission lines and substations situated in any part of Odisha State.
- II. Long rod insulators for AAAC/ACSR conductors in tension application at dead end/angle/cut point. The insulators shall be of ball and socket type or tongue & Clevis type as desired by the purchaser.
- III. Line post insulators or pin insulators for straight line locations

2.0 CLIMATIC CONDITIONS

Please refer **Chapter E3** of Technical Specification on climatic conditions.

3.0 STANDARDS

3.1 Following Indian/ International Standards, which shall mean latest revision, with amendments /changes adopted and published, unless specifically stated otherwise in the Specification, shall be referred while accessing conformity of insulators with these specifications.

3.2 In the event of supply of insulators conforming to standards other than specified, the Bidder shall confirm in his bid that these standards are equivalent or better to those specified. In case of award, salient features of comparison between the standards proposed by the Bidder and those specified in this document will be provided by the Supplier to establish equivalence.

Indian Standard	Title	International Standard
--	Definition, test methods and acceptance criteria for composite insulators for A.C. overhead lines above 1000 V	IEC : 61109
IS : 731	Porcelain insulators for overhead power lines with a nominal voltage greater than 1000 V	IEC : 60883
IS : 2071	Methods of High Voltage Testing	IEC : 60060-1
IS : 2486	Specification for insulator fittings for overhead power lines with a nominal voltage greater than 1000 V General requirements and tests dimensional requirements locking devices.	IEC : 60120 IEC : 60732
	Thermal mechanical performance test and mechanical performance test on string insulators units	IEC : 60575

IS: 13134	Guide for the selection of insulators in respect of polluted conditions.	IEC : 60815
	Characteristics of string insulator units of the long rod type.	IEC : 60433
	Hydrophobicity Classification Guide	STRI guide 1.92/1
	Radio interference characteristics of overhead power lines and high voltage equipments	CISPR:18-2 Part-2
IS : 8263	Methods of RI Test of HV Insulators	IEC-60437
	Standards for insulators - Composite-Distribution Dead-end	ANSI C29.13-2000
IS : 4759	Hot dip zinc coatings on structural steel Et other allied products	ISO : 1459 ISO : 1461
IS : 2629	Recommended practice for Hot Dip Galvanization for iron and steel.	ISO : 1461 (E)
IS : 6745	Determination of Weight of Zinc Coating on Zinc coated iron and steel articles.	ISO : 1460
IS : 3203	Methods of testing of local thickness of electroplated coatings.	ISO :2178
IS : 2633	Testing of uniformity of coating of zinc coated articles.	
	Standard specification for glass fiber strands.	ASTM D 578-05
	Standard test method for compositional analysis by Thermogravimetry.	ASTM E 1131-03
IS : 4699	Specification for refined secondary Zinc.	

4.0 GENERAL REQUIREMENTS

- 4.1 The Composite insulators will be used on lines on which the conductor will be AAAC/ACSR of size up to 100 Sq.mm. The insulators should withstand the conductor tension, the reversible wind load as well as the high frequency vibrations due to wind.
- 4.2 Insulator shall be suitable for 3Q 50 Hz effectively earthed 11KV Overhead distribution system in a moderately/heavily polluted atmosphere. Long rod insulators shall be of ball Et socket type as specified.
- 4.3 Bidder must be an indigenous manufacturer and supplier of composite insulators of rating 11 KV or above OR must have developed proven in house technology and manufacturing process for composite insulators of above rating OR possess technical collaboration/association with a manufacturer of composite insulators of rating 11 KV or above. The Bidder shall furnish necessary evidence in support of the above along with the bid, which can be in the form of certification from the utilities concerned, or any other documents to the satisfaction of the owner.
- 4.4 Insulator shall be suitable for both the pin and strain type of load Et shall be of Ball Et Socket type for long Rod Type. The diameter of Composite Insulator shall be less than 200mm. The center-to-center distance between Ball & socket shall be max. 300mm. for 11KV composite insulator.

4.5 Insulators shall have sheds with good self-cleaning properties. Insulator shed profile, spacing, projection etc. and selection in respect of polluted conditions shall be generally in accordance with the recommendation of IEC60815/IS: 13134.

4.6. Dimensional Tolerance of Composite Insulators.

The tolerances on all dimensions e.g. diameter, length and creepage distance shall be allowed as follows in line with IEC 61109.

$\pm (0.04d+1.5)$ mm when $d \leq 300$ mm

$\pm (0.025d+6)$ mm when $d > 300$ mm

Where, d being the dimension in millimeters for diameter, length or creep distance as the case may be.

However, no negative tolerance shall be applicable to creepage distance. 4 4.7 Interchangeability

The composite insulators including the end fitting connection shall be of standard design suitable for use with the hardware fittings of any make conforming to relevant IEC/IS standards 11 kV/33 kV Composite Insulator (B & S Type) only.

4.8 Corona and RI Performance

All surfaces shall be clean, smooth without cuts, abrasions or projections. No part shall be subjected to excessive localized pressure. The insulator and metal part shall be so designed and manufactured that it shall avoid local corona formation and not generate any radio interference beyond specified limit under the operations conditions.

4.9 Maintenance :

The composite insulators offered shall be suitable for use of hotline maintenance technique so that usual hot line operation can be carried out with ease, speed and safety.

5.0 TECHNICAL DESCRIPTION OF COMPOSITE INSULATORS:

5.1 Composite Insulators shall be designed to meet the light quality, safety and reliability and are capable of withstanding a wide range of environmental conditions.

- (a). Core- the internal insulating part
- (b). Housing - the external insulating part.
- (c). Metal and fittings - for attaching to hardware to support conductor.

5.2 CORE

It shall be a glass-fiber reinforced epoxy resin rod of high strength (FRP rod). Glass fibers and resin shall be optimized in the FRP rod. Glass fibers shall be Boron free electrically corrosion resistant (ECR) glass fiber or Boron free E-Glass and shall exhibit both high electrical integrity and high resistance to acid corrosion. The matrix of the FRP rod shall be Hydrolysis resistant. The FRP shall be manufactured through Pultrusion process. The FRP rod shall be void free.

5.3 HOUSING (Sheath)

The FRP rod shall be covered by a seamless sheath of a silicone elastomeric compound or silicone alloy compound of a thickness of 3 mm minimum. It shall be one-piece housing using injection Molding Principle to cover the core. The elastomer housing shall be designed to provide the necessary creepage distance and protection against environmental influences, external pollution and humidity. Housing shall conform to the requirement of IEC 61109/92-93 with latest amendments.

It shall be extruded or directly molded on core and shall have chemical bonding with the FRP rod. The strength of the bond shall be greater than the tearing strength of the polymer. Sheath material in the bulk as well as in the sealing/bonding area shall be free from voids.

Manufacturer should furnish a description of its quality assurance programme including fabrication; testing and inspection for any material (i.e rubber). Components (i.e rod) or hardware (i.e. end filings). The manufacturer has had fabricated by others should also be included.

Manufacturing methods and material composition documentation will be a part of Technical Bid to be submitted along with offer.

5.4 WEATHERSHEDS

The composite polymer Weathersheds made of silicone elastomeric compound or silicon alloy shall be firmly bonded to the sheath, vulcanized to the sheath or molded as part of the sheath and shall be free from imperfections. The weathersheds should have silicon content of minimum 43% by weight. The strength of the weathershed to sheath interface shall be greater than the tearing strength of the polymer. The interface, if any, between sheds and sheath (housing) shall be free from voids.

5.5 METAL AND FITTINGS :

End fittings transmit the mechanical load to the core. They shall be made of malleable cast iron or forged steel, Metal end fittings shall be suitable for Ball and socket type hardware of respective specified mechanical load and shall be hot dip galvanized in accordance with IS 2629. The material used in fittings shall be corrosion resistant.

Metal end fittings shall be uniform and without sharp edges or corners and shall be free of cracks, flakes, silvers, slag, blow-holes shrinkages defects and localized porosity.

They shall be connected to the rod by means of a controlled compression technique. As the main duty of the end fittings is the transfer of mechanical loads to the core the fittings should be properly attached to the core by a coaxial or hexagonal compression process and should not damage the individual fibers or crack the core.

The gap between fittings and sheath shall be sealed by flexible silicone elastomeric compound or silicone alloy compound sealant, system of attached of end fitting to the rod shall provide superior sealing performance between housing, i.e. seamless sheath and metal connection. The sealing must be moisture proof.

The dimensions of end fittings of insulators shall be in accordance with the standard dimensions stated in IEC: 60120/IS:2486 - Part-II/1989.

Nominal dimensions of the pin, ball and socket interior shall be in accordance with the standard shown at Sr. No.4.0. No joints in ball and socket or pin will be allowed. Outer portion of ball or socket should be Zinc Sleeved with minimum 99.95% purity of electrolytic high grade Zinc.

The finished surface shall be smooth and shall have a good performance. The surface shall not crack or get chipped due to ageing effect under normal and abnormal service conditions or while handling during transit or erection.

The design of the fittings and the insulators shall be such that there is no local corona formation or discharges likely to cause the interference to either should or vision transmission.

Bottom end metal fitting (Shank) of Pin Insulator should be forged steel as per IS 2002/92. Length of thread on shank should be 100 mm and Shank diameter is 20 mm. Minimum Collar diameter should be 40 mm and its minimum thickness should be of 5 mm. Nuts as per IS 1363 (P-III) and 4 mm thick Spring Washer shall be as per IS 3063 with latest amendments if any, Nuts and spring washer shall be hot dip galvanized (For Pin insulators.)

6.0 WORKMANSHIP

- 6.1 All the materials shall be of latest design and conform to the best engineering practices adopted in the high voltage field. Bidders shall offer only such insulators as are guaranteed by them to be satisfactory and suitable for continued good service in power transmission lines.
- 6.2 The design, manufacturing process and material control at various stages shall be such as to give maximum working load, highest mobility, best resistance to corrosion, good finish and elimination of sharp edges and corners.
- 6.3 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.
- 6.4 The core shall be sound and free of cracks and voids that may adversely affect the insulators.
- 6.5 Weather sheds shall be uniform in quality. They shall be clean, sound, smooth and shall be free from defects and excessive flashing at parting lines.
- 6.6 End fittings shall be free from cracks, seams, shrinks, air holes and rough edges. End fittings should be effectively sealed to prevent moisture ingress, effectiveness of sealing system must be supported by test documents. All surfaces of the metal parts shall be perfectly smooth without projecting points of irregularities, which may cause corona. All load bearing surfaces shall be smooth and uniform so as to distribute the loading stresses uniformly.

6.7 All ferrous part shall be hot dip galvanized to give a minimum average coating of zinc equivalent to 610 gm/Sq.mm or 87 um thickness and shall be in accordance with the requirement of IS 4759. The zinc used for galvanizing shall be of purity 99.5% as per IS: 4699. The zinc coating shall be uniform adherent, smooth, reasonable bright continuous and free from imperfections such as flux, ash rust stains. Bulky white deposits and blisters. The galvanized metal part shall be guaranteed to withstand at least four successive dips each lasting for one (1) minute duration under the standard preece test. The galvanizing shall be carried out only after any machining.

7.0 TESTS AND STANDARDS :

Insulators offered shall be manufactured with the same configuration Et raw materials as used in the insulators for which design Et type test reports are submitted. The manufacturer shall submit a certificate for the same. The design Et type test reports submitted shall not be more than 5 years old.

(A) DESIGN TEST:

For composite insulators, it is essential to carry out design test as per clause 4.1 of IEC 61109/92-93 with latest amendments. The design test are intended to verify the suitability of the design, materials and method manufacture (technology). When a composite insulator is submitted to the design tests, the result shall be considered valid for the whole class of insulators, which the represented by the one tested and having the following characteristics.

Same materials for the core and sheds and same manufacturing method.

- > Same material of the fittings, the same design, the same method of attachment.
- > Same or greater layer thickness of the shed material over the core (including a sheath where used):
- > Same or smaller ratio of the highest system voltage to insulation length;
- > Same or smaller ratio of all mechanical loads to the smallest core diameter between fittings.
- > Same or greater diameter of the core.

The tested composite insulators shall be identified by a drawing giving all the dimensions with the manufacturing tolerances.

Manufacturer should submit test reports for design tests as per IEC - 61109 (Clause- 5) along with the bid. Additionally following tests shall be carried out or reports for the tests shall be submitted after award of contract.

UV test : The test shall be carried out in line with Clause of ANSI

C29.13

(B) TYPE TEST:

The type tests are intended to verify the main characteristics of a composite insulator. The type tests shall be applied to composite insulators, the class of which has passed the design tests.

Following type test shall be conducted on a suitable number of individual insulator units, components, materials or complete strings.

Sr. No.	Description of type test	Test procedure/standard
1	Dry lightning impulse withstand voltage test.	As per IEC 61109 (Clause 6.1)
2	Wet power frequency test	As per IEC 61109 (Clause 6.2)
3	Mechanical load-time test	As per IEC 61109 (Clause 6.4)
4	Radio interference test	As per IEC 61109 (Clause 6.5) revised
5	Recovery of Hydrophobicity test	Annexure-B This test may be repeated every 3 years by the manufacturer.
6	Chemical composition test for silicon content	Annexure-B Or any other test method acceptable to the owner.
7	Brittle fracture resistance test	Annexure : B

The bidder shall submit type test reports as per IEC 61109 from NABL approved laboratory along with the bid. Additional type tests required if any shall be carried out by the manufacturer, after award of contract for which no additional charges shall be payable. In case, the tests have already been carried out, the manufacturer shall submit reports for the same.

(C)ACCEPTANCE TEST

The test samples after having withstood the type test shall be subject to the following acceptance test-

Sr.No.	Description	Standard
1	Verification of dimensions	Clause 7.2 IEC : 61109
2	Verification of the locking system (if applicable)	Clause 7.3 IEC : 61109
3	Galvanizing Test	IS : 2633 /IS : 6745
4	Verification of the specified mechanical load	Clause 7.4 IEC : 61109

(D)ROUTINE TEST :

Sr.N	Description	Stand
1	Identification of marking	As per IEC : 61109 Clause
2	Visual inspection.	As per IEC : 61109 Clause 8.2
3	Mechanical routine test	As per IEC : 61109 Clause

Every polymeric insulator shall withstand mechanical routine test at ambient temperature tensile load at RTL corresponding to at least 50% of the SML for at least 10 sec.

(E) TEST DURING MANUFACTURE:

Following tests shall also be carried out on all components as applicable :

- (a) Chemical analysis of zinc used for galvanizing.
- (b) Chemical analysis, mechanical, metallographic test and magnetic particle inspection for malleable castings.
- (c) Chemical analysis, hardness tests and magnetic particle inspection for forgings.

(F) ADDITIONAL TESTS:

The Purchaser reserves the right of getting done any other test(s) of reasonable nature carried out at Purchaser's premises, at site, or in any other place in addition to the aforesaid type, acceptance and routine tests to satisfy himself that the material comply with the specifications. In such case all the expenses will be to Suppliers account.

8.0 TEST CERTIFICATE :

The tenderer shall furnish detailed type test reports of the offered composite Insulators as per clause 8.2 of the Technical Specifications from the NABL laboratory to prove that the composite Insulators offered meet the requirements of the specification. These type Tests should have been carried out within five years prior to the date of opening of this tender.

- (i) The offered composite Insulators are already fully type tested at approved Laboratory within five years prior to the date of opening of this tender.
- (ii) There is no change in the design of type-tested composite Insulators and those offers against this tender.

9.0 TESTING FACILITIES :

The following additional facilities shall be available at Supplier's works:-

- (a) The bidders must clearly indicate what testing facilities are available in the works of the manufacturer and whether facilities are adequate to carry out all Routine and acceptance Tests. These facilities should be available to MGVCCL's Engineers if deputed or carry out or witness the tests in the manufacturer works. If any test cannot be carried out at the manufacturer's work, the reasons should be clearly stated in the tender.
- (b) The insulators shall be tested in accordance with the procedure detailed in IEC 61109/92-93 with latest amendments.
- (c) Calibration Reports from Government approved testing laboratory of various testing and measuring equipment including tensile testing machine, resistance measurement facilities, burelle, thermometer, barometer etc.
- (d) Finished insulator shall be checked for dimension verification and surface finish separately.

Manufacturers of foreign origin shall, in addition to the above, also have arrangements in India, either at works of their authorized representative/licenses or in the NABL laboratory for conducting sampling test in accordance with IEC 81109/92-93 with latest amendments.

10.0 DRAWINGS :

10.1 The Bidder shall furnish full description and illustration of the material offered.

10.2 The Bidder shall furnish along with the bid the outline drawing (3 copies) of each insulator unit including a cross sectional view of the long rod insulator unit. The drawing shall include but not be limited to the following information.

- (a) Long rod diameter with manufacturing tolerances.
- (b) Minimum Creepage distance with positive tolerance.
- (c) Protected creepage distance.
- (d) Eccentricity of the long rod
 - (i) Axial run out.
 - (ii) Radial run out
- (e) Unit mechanical and electrical characteristics.
- (f) Size and weight of ball and socket/ tongue Et Clevis.
- (g) Weight of composite long rod units.
- (h) Materials
 - (i) Identification mark.
 - (ii) Manufacturer's catalogue number

10.3 After placement of awards, the Supplier shall submit full dimensioned manufacturing insulator drawings containing all the details in four (4) copies to owner for approval. After getting approval from owner and successful completion of all the type tests, the supplier shall submit 10 more copies of the drawing to the owner for further distribution and field use.

10.4 After placement of order, the Supplier shall also submit fully dimensioned insulator crate drawing for different type of insulators for approval of the owner.

11.0 RETEST AND REJECTION :

11.1 Sample Procedure for testing of insulators shall be as per clause 7.1 to 7.6 of IEC 61109 for Acceptance Et Routine Tests.

For the sampling tests, two samples are used, E1 and E2. The sizes of these samples are indicated in the table below.

Lot Size (N)	Sample Size	
	E1	E2
$N < 300$	Subject to agreement	
$300 < N < 2000$	4	3
$2000 < N < 5000$	8	4
$5000 < N < 10000$	12	6

If more than 10000 insulators are concerned, they shall be divided into an optimum number of lots comprising between 2000 and 10000 insulators. The results of the tests shall be evaluated separately for each lot. The insulators shall be selected by the purchaser's representative from the lot at random.

The samples shall be subjected to the applicable sampling tests.

The sampling tests are:

Verification of dimensions - (E1+E2)

Verification of the locking system - (E2)

Verification of tightness of the interface between end fittings Et - (E2)

Insulators housing

Verification of the specified mechanical load SML - (E1)

Galvanizing test - (E2)

In the event of a failure of the sample to satisfy a test, the retesting procedure shall be as follows:

If only one insulator or metal part fails to comply with the sampling tests, a new sample equal to twice the quantity originally submitted to the tests shall be subjected to retesting. The retesting shall comprise the test in which failure occurs. If two or insulator or metal parts fail to comply with any of the sampling tests or if any failure occurs during the retesting, the complete lot is considered as not complying with this standard and shall be withdrawn by the manufacturer.

Provided the cause of the failure can be clearly identified, the manufacturer may sort the lot to eliminate all the insulators with these defects. The sorted lot then be resubmitted for testing. The number then selected shall be three times the first chosen quantity for tests.

If any insulators fail during this retesting, the complete lot is considered as not complying with this standard and shall be withdrawn by the manufacturer.

11.2 Verification of dimensions (E1 + E2)

The dimensions given in the drawings shall be verified. The tolerances given in the drawing are valid. If no tolerances are given in the drawings the values mentioned in this specification shall hold good.

11.3 Verification of the locking system (E2)

This test applied only to the insulators equipped with socket coupling as specified by IEC-120 and is performed according to IEC 383.

11.4 Verification of tightness of the interface between end fittings and insulator housing (E2).

One insulator selected randomly from the sample E2, shall be subjected to crack indication by dye penetration, in accordance with ISO 3452, on the housing in the zone embracing the complete length of the interface between the housing and metal fitting and metal and including an additional area, sufficiently extended beyond the end of the metal part.

The indication shall be performed in the following way.

- > The surface shall be properly pre-cleaned with the cleaner;
- > The penetrant, which shall act during 20 minutes, shall be applied on the cleaned surface.
- > With in 5 minutes after the application of the penetrant, the insulator shall be subjected, at the ambient temperature, to a tensile load of 70% of the SML, applied between the metal fittings; the tensile load shall be increased rapidly but smoothly from zero upto 70% of the SML, and then maintained at this value for 1 minute;
- > The surface shall be cleaned with the excess penetrant removed, and dried;
- > The developer shall be applied if necessary;
- > The surface shall be inspected.

Some housing materials may be penetrated by the penetrant, In such cases evidence shall be provided to validate the interpretation of the results. After the 1 min, test at 70% of the SML, if any crack occur, the housing and, if necessary, the metal fittings and the core shall be cut, perpendicularly to the crack in the middle of the widest of the indicated cracks, into two halves. The surface of the two halves shall then be investigated for the depth of the cracks.

11.5 Verification of the specified mechanical load SML.

The insulators of the sample E1 shall be subjected at ambient temperature to a tensile load, applied between the couplings. The tensile load shall be increased rapidly but smoothly from zero to approximately 75% of the SML, and then be gradually increased to the SML in a time between 30 sec to 90 sec.

If 100% of the SML is reached in less than 90 s, the load (100% of the SML) shall be maintained for the remainder of the 90 s. (This test is considered to be equivalent to a 1 min withstand test at the SML).

This insulators have passed the test at 13.4 Et 13.5 above if ;

- > No failure (breakage or complete pull out of the core, or fracture of the metal fitting) occurs either during the 1 min. 70% withstand test (a) or during the 1 min. 100% withstand test (b).
- > No cracks are indicated after the dye penetration method described in 13.4 above.
- > The investigation of the halves described in 13.4 above shows clearly that the cracks do not reach the core.

11.6 Galvanizing Test :

This test shall be performed according to IS : 2633/IS : 6745 on galvanized parts.

12.0 MARKINGS :

Each insulator unit shall be legibly and indelibly marked with the following details as per IEC-61109.

- (a) Name or trademark of the manufacture.
- (b) Voltage Et Type
- (c) Month and Year of manufacturing.
- (d) Min.failing load/guaranteed mechanical strength in kilo Newton followed by the word ' kN' to facilitate easy identification.
- (e) Country of Manufacturer.
- (f) Name of DISCOM

13.0 PACKING :

13.1 All insulators shall be packed in strong corrugated box of min.7 ply duly palletted or wooden crates. The gross weight of the crates along with the material shall not normally exceed 100 Kg. to avoid handling problem. The crates shall be suitable for outdoor storage under wet climate during rainy season.

13.2 The packing shall be of sufficient strength to withstand rough handling during transit, storage at site and subsequent handling in the field.

13.3 Suitable cushioning, protective padding of dunnage or spacers shall be provided to prevent damage or deformation during transit and handling.

13.4 All packing cases shall be marked legibly and correctly so as to ensure safe arrival at their destination and to avoid the possibility of goods being lost or wrongly dispatched on account of faulty packing and faulty or illegible markings. Each wooden case/crate/corrugated box shall have all the markings stenciled on it in indelible ink.

13.5 The bidder shall provide instructions regarding handling and storage precautions to be taken at site.

14.0 INSPECTION :

14.1 The Owner's representative shall at all times be entitled to have access to the works and all places of manufacture, where insulator, and its component parts shall be manufactured and the representatives shall have full facilities for unrestricted inspection of

the Supplier's and sub-Supplier's works, raw materials, manufacture of the material and for conducting necessary test as detailed herein.

14.2 The material for final inspection shall be offered by the Supplier only under packed condition. The Owner shall select samples at random from the packed lot for carrying out acceptance tests. The lot offered for inspection shall be homogeneous and shall contain insulators manufactured in 3-4 consecutive weeks.

14.3 The Supplier shall keep the Owner informed in advance of the time of starting and the progress of manufacture of material in their various stages so that arrangements could be made for inspection.

14.4 No material shall be dispatched from its point of manufacture before it has been satisfactorily inspected and tested unless the inspection is waived off by the owner in writing. In the later case also the material shall be dispatched only after satisfactory testing specified herein has been completed.

14.5 The acceptance of any quantity of material shall in no way relieve the Supplier of his responsibility for meeting all the requirements of the specification and shall not prevent subsequent rejection, if such material are later found to be defective.

15.0 GUARANTEE :

(i) The stores covered by this specification should be guaranteed for satisfactory operation and against defects in design, materials and workmanship for a period of at least 36 [thirty six] months from the last date of delivery/demonstration . The above guarantee certificate shall be furnished in triplicate to the purchaser for his approval. Any defect noticed during this period should be rectified/replaced by the supplier free of cost to the purchaser provided such defects are due to faulty design, bad workmanship or bad materials used, within one month upon written notice from the purchaser. The guarantee period for the rectified/replaced equipment shall be further guaranteed for 36 months(thirty six) from the date of rectification/replaced.

(ii) Equipment/material failed or found defective during the guarantee period shall have to be guaranteed after repair/replacement for a further period of **36(thirty six)** months from the date of commissioning from the date of receipt at the store/site after such repair/replacement. Date of delivery as used in this clause shall mean the date on which the materials are received in OPTCL'S stores/site in full & good condition which are released for Despatch by the purchaser after due inspection

Annexure - A

The standards mentioned in this specification are available from

Reference Abbreviation	Name and Address
IEC/CISPR	International Electro technical Commission, Bureau Central de la Commission, electro Technique international, 1 Rue de verembe, Geneva, SWITZERLAND
BIS/IS	Bureau Of Indian Standards. Manak Bhavan, 9, Bahadur Shah Zafar Marg, New Delhi - 110001. INDIA
ISO	International Organisation for Standardization. Danish Board of Standardization Danish Standardizing Sraat, Aurehoegvej-12 DK-2900, Heeleprup, DENMARK
NEMA/ANSI	National Electric Manufacture Association, 155, East 44th Street. New York, NY-10017 U.S.A
ASTM	American Society for Testing and Materials, 1916 Race St. Phelledelphia,PA19103 U.S.A
STRI guide	STRI, Sweden. Website : www.stri.se

Annexure-B

Tests on Insulator units

1. RIV Test (Dry)

The insulator string along with complete hardware fittings shall have a radio interference voltage level below 100 micro volts at one MHz when subjected to 50 Hz AC voltage of 10 kV & 30 kV for 11 kV & 33 kV class insulators respectively under dry condition. The test procedure shall be in accordance with IS:8263 /IEC: 437/CISPR 18-2 .

2. Brittle Fracture Resistance Test

Brittle fracture test shall be carried out on naked rod along with end fittings by applying “1n HNO₃ acid” (63 g conc. HNO₃ added to 937 g water) to the rod. The rod should be held at 80% of SML for the duration of the test. The rod should not fail within the 96-hour test duration. Test arrangement should ensure continuous wetting of the rod with Nitric acid.

3 Recovery of Hydrophobicity & Corona test

The test shall be carried out on 4mm thick samples of 5cm x 7cm.

- i) The surface of selected samples shall be cleaned with isopropyl alcohol. Allow the surface to dry and spray with water. Record the Hydrophobicity classification in line with STRI guide for Hydrophobicity classification. Dry the sample surface.
- ii) The sample shall subjected to mechanical stress by bending the sample over aground electrode. Corona is continuously generated by applying 12 kV to a needle like electrode placed 1mm above the sample surface. Tentative arrangement shall be as shown in Annexure - E. The test shall be done for 100 hrs.
- iii) Immediately after the corona treatment, spray the surface with water and record the HC classification. Dry the surface and repeat the corona treatment as at clause 2 above. Note HC classification. Repeat the cycle for 1000 hrs. or until an HC of 6 or 7 is obtained. Dry the sample surface.
- iv) Allow the sample to recover and repeat hydrophobicity measurement at several time intervals. Silicone rubber should recover to HC 1 – HC 2 within 24 to 48hours, depending on the material and the intensity of the corona treatment.

4 Chemical composition test for Silicon content

The content of silicon in the composite polymer shall be evaluated by EDX (Energy Dispersion X-ray) Analysis or Thermo-gravimetric analysis. The test may be carried out at CPRI or any other NABL accredited laboratory.

ANNEXURE : C

Guaranteed Technical Particulars of 11 kv Insulator (B Et S Type)

Name of the Manufacturer :

BIDDER HAS TO CONFIRM FOLLOWING IMPORTANT REQUIREMENT:

Sr.	Description	Min. requirement for 11 kV 45 KN	Min. requirement for 33 kV 70 KN	As per firm offer
1.	Type of Insulator	Polymeric	Polymeric Composite	
2.	Standard according to which the insulators manufactured and tested.	IEC 61109	IEC 61109	
3.	Name of material used in manufacture of the insulator with class/grade)	SILICON Wacker-Germany Dow Corning-USA	SILICON Wacker-Germany Dow Corning-USA	
(a)	Material of core(FRP rod) (I)E-glass of ECR-glass.	ECR or BORRORON FREE	ECR or BORRORON FREE	
(b)	Material of housing Et weathersheds (silicon content by	SILICON RUBBER 43 %	SILICON RUBBER 43 %	
(c)	Material of end fittings	SGI	SGI	
(d)	Sealing compound for end fittings	RTV SILICON	RTV SILICON	
4.	Colour	GREY	GREY	
5.	Electrical characteristics			
(a)	Nominal system voltage	11 KV	33 KV	
(b)	Highest system voltage	12 KV	36 KV	
(c)	Dry Power frequency withstand voltage	70 KV	105 KV	
(d)	Wet Power frequency withstand voltage	50 KV	75 KV	
(e)	Dry flashover voltage	77 KV	125 KV	
(f)	Wet flash over voltage	55 KV	85 KV	
(g)	Dry lighting impulse withstand voltage (a) Positive (b) Negative	129 KV 135 KV	170 KV 170 KV	
(h)	Dry lighting impulse flashover voltage a) Positive b) Negative	135 KV 141 KV	180 KV 180 KV	
(i)	RIV at 1 MHz when energized at 10 kV/30kV (rms) under dry condition.	20	40	

Sr.No.	Description	Min. requirement	Min. requirement	As per firm offer
(j)	Creepage distance (Min.)	320 MM	900 MM	
6.	Mechanical characteristics	45 KN	70KN / 90KN	
(a)	Minimum failing load.			
7.	Dimensions of insulator			
(i)	Weight	1.25	1.6	
(ii)	Dia of FRP rod	16 MM	16 MM	
(iii)	Length of FRP rod	240 MM	440 MM	
(iv)	Dia of weathersheds	90±1 MM	100 MM	
(v)	Thickness of housing	3 MM	3 MM	
(vi)	Dry arc distance Dimensioned drawings of insulator (including weight with tolerances in weight)	160±5 MM	382 MM	
8.	Method of fixing of sheds to housing (specify). Single mould or Modular construction (injection moulding/compression	Injection moulding	Injection moulding	
9.	No of weathersheds	3	8	
10.	Type of sheds			
(i)	Aerodynamic	Aerodynamic	Aerodynamic	
(ii)	With underribds			
11.	Type of packing	Wooden Box	Wooden Box	
12.	Any other particulars which the bidder may like to give.			
13	The insulators shall have "W" type phosphors Bronze security clips for ball sockets portion of insulators confirming	YES	YES	

Signature :

Name :

Designation :

Place :

ANNEXURE : D

Guaranteed Technical Particulars of 11 KV Pin Insulator.

Name of the Manufacturer :

BIDDER HAS TO CONFIRM FOLLOWING IMPORTANT REQUIREMENT:

Sr.No.	Description	Min. requirement for 11 kV Pin Insulator	As per firm offer
1.	Type of Insulator	Polymeric	Polymeric Composite
2.	Standard according to which the insulators manufactured and tested.	IEC 61109	IEC 61109
3.	Name of material used in manufacture of the insulator with class/grade)	SILICON Wacker- Germany Dow	SILICON Wacker- Germany Dow
(a)	Material of core (FRP rod) (j) E-glass of ECR-glass.	ECR or BORRON	ECR or BORRON
(b)	Material of housing Et weather sheds (silicon content by weight)	SILICON RUBBER 43 %	SILICON RUBBER 43 %
(c)	Material of end fittings	SGI	SGI
(d)	Sealing compound for end	RTV SILICON	RTV SILICON
4.	Colour	GREY	GREY
5.	Electrical characteristics		
(a)	Nominal system voltage	11 KV	33 KV
(b)	Highest system voltage	12 KV	36 KV
(c)	Dry Power frequency withstand voltage	70 KV	105 KV
(d)	Wet Power frequency withstand voltage	50 KV	75 KV
(e)	Dry flashover voltage	77 KV	125 KV
(f)	Wet flash over voltage	55 KV	85 KV
(g)	Dry lighting impulse withstand voltage c) Positive d) Negative	129 KV 135 KV	170 KV 170 KV
(h)	Dry lighting impulse flashover voltage c) Positive d) Negative.	135 KV 141 KV	180 KV 180 KV
(i)	RIV at 1 MHz when energized at 10 kV/30kV (rms) under dry condition.	20 (T.C.Encl.)	40

Sr.No.	Description	Unit	Min. requirement for 11 kV Pin Insulator	As per firm offer
(j)	Creepage distance (Min.)		340 MM	900 MM
6. (a)	Mechanical characteristics : Minimum bending load		5 KN Bending	70 KN / 90 KN failing
7.	Dimensions of insulator			
(i)	Weight	Kg.	1.35 KG (Approx	1.6 KG (Ap
	Dia of FRP rod	mm	21.7 MM	16 MM
	Length. of	Mm	200 \pm 5 MM	440 \pm 5 MM
	Dia of weather sheds	mm	100 MM	100 MM
	Thickness of housing	mm	3 MM	3 MM
(vi)	Dry arc distance Dimensioned drawings of insulator (including weight with tolerances in weight) enclosed	mm	120 \pm 5 MM	382 \pm 5 MM
8.	Method of fixing of sheds to housing (specify). Single mould or Modular construction (injection moulding/		Injection moulding	Injection moulding
9.	No of weather sheds		3	3
10.	Type of sheds			
	Aerodynamic		Aerodynamic	Aerodynami
	With underribds			
11.	Type of packing		Wooden Box	Wooden
12.	Any other particulars which the bidder may like to give.			

Signature :

Name:

Designation :

ANNEXURE- E

TECHNICAL DEVIATION :

Bidder has to mention below deviation if any, quoting relevant clause of specification.

TECHNICAL SPECIFICATION FOR HARDWARE FITTINGS

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OF
HARDWARE FITTINGS

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TECHNICAL SPECIFICATION FOR HARDWARE FITTINGS

1.0 SCOPE

This Specification covers design manufacture, testing at manufacturer's Works, supply and delivery of power conductor accessories, insulator and hardware fittings for string insulators suitable for use in 33 kV and 11 kV Overhead transmission lines and sub-stations of DISCOMS. The hardware to be supplied shall be as per approved drawings of ODSSP under OPTCL. Any change there of shall be with due permission of ODSSP under OPTCL. The firm shall submit his drawings for approval of OPTCL and only after which the manufacturing shall be started.

The materials/equipment offered, shall be complete with all components, which are necessary or usual for the efficient performance and satisfactory maintenance. Such part shall be deemed to be within the scope of contract.

2.0 STANDARDS

The materials covered under this Specification shall comply with the requirement of the latest version of the following standards as amended up to date, except where specified otherwise.

- | | | |
|------|-----------------------|---|
| i) | IS:2486 Part-II & III | Insulator fitting for overhead power lines with a nominal voltage greater than 1,000 volts. |
| ii) | IS:2121 Part I & II | Conductor & earth wire accessories for overhead power lines. |
| iii) | IS:9708 | Stock Bridge Vibration Dampers on overhead power lines. |
| iv) | IS:2633 | Method of testing of uniformity of coating on zinc coated articles |
| v) | IS:209 | Specification for Zinc. |
| vi) | BS:916 | Specification for Hexagonal bolts and nuts. |

3.0 MATERIALS AND DESIGN

Aluminium and aluminium alloys, malleable iron and forged steel, having required mechanical strength, corrosion resistance and machinability depending on the types of application for which accessories / fittings are needed, shall be employed.

In manufacture of the accessories / fittings, the composition of the aluminium alloys used shall be made available to Employer if required for verification.

The materials offered shall be of first class quality, workmanship, well finished and approved design. All castings shall be free from blow-holes, flaws, cracks of other defects and shall be smooth, close grained and true forms and dimensions. All machined surfaces should be free, smooth and well finished.

Metal fittings of specified material for conductor and earth wire accessories and string insulator fittings are required to have excellent mechanical properties such as strength, toughness and high resistance against corrosion. All current carrying parts shall be so designed and manufactured that contact resistance is reduced to the minimum.

All bolts, nuts, bolt-heads shall be the white worth's standard thread. Bolt heads and nuts shall be hexagonal. Nuts shall be locked in an approved manner. The treads in nuts and tapped holes shall be cut after galvanizing and shall be well fabricated and greased. All other treads shall be cut before galvanizing. The bolt treads shall be undercut to take care of increase in diameter due to galvanizing.

All nuts shall be made of materials to Clause 4.8 of IS:1367 (latest edition) with regard to its mechanical properties.

The general design conductor and earth wire accessories and insulator fittings shall be such as to ensure uniformity, high strength, free from corona formation and high resistance against corrosion even in case of high level of atmosphere pollution.

All hooks, eyes, pins, bolts, suspension clamps and other fittings for attaching to the tower or to the line conductor or to the earth wire shall be so designed that the effects of vibration, both on the conductor and the fittings itself, are minimized.

Special attention must be given to ensure smooth finished surface throughout. Adequate bearing area between fittings shall be provided and point or line contacts shall be avoided.

All accessories and hard wares shall be free from cracks, shrinks, slender air holes, burrs or rough edges.

The design of the accessories and hard wares shall be such as to avoid local corona formation or discharge likely to cause interference to tele-transmission signals of any kind.

4.0 GENERAL:

1. All ferrous parts including fasteners shall be hot dip galvanized, after all machining has been completed. Nuts may however be tapped (threaded) after galvanizing and the threads oiled. Spring washers shall be electro-galvanized. The bolt threads shall be undercut to take care of the increase in diameter due to galvanizing. Galvanizing shall be done in accordance with IS-2629-1985 and shall satisfy the tests mentioned in IS: 2633-1986. Fasteners shall

withstand four dips while spring washers shall withstand three dips of one-minute duration in the standard Preece test. Other galvanized materials shall be guaranteed to withstand at least six successive dips each lasting one minute under the Standard Preece test for galvanizing.

2. The zinc coating shall be perfectly adherent of uniform thickness, smooth, reasonably bright, continuous and free from imperfections such as flux, ash, rust stains, bulky white deposits and blisters. The zinc used for galvanizing shall be of grade Zn 99.95 as per IS 209-1979.
3. Pin balls shall be checked with the applicable "G" gauges in at least two directions, one of which shall be across the line of die flashing and the other 90 deg. to this line. 'NO GO' gauges shall not pass in any direction.
4. Socket ends, before galvanizing shall be of uniform contour. The bearing surface of socket ends shall be uniform about the entire circumference without depressions or high spots. The internal contours of socket ends shall be concentric with the axis of the fittings as per IS 2486/IEC-120. The axis of the bearing surfaces of socket ends shall be coaxial with the axis of the fittings. There shall be no noticeable tilting of the bearing surfaces with the axis of the fittings.
5. All current carrying parts shall be so designed and manufactured that contact resistance is reduced to minimum.
6. Welding of aluminum shall be by inert gas shielded tungsten arc or inert gas, shielded metal arc process. Welds shall be clean, sound, smooth, and uniform without overlaps, properly fused and completely sealed. There shall be no cracks, voids incomplete penetration, incomplete fusion, under-cutting or inclusions Porosity shall be minimized so that mechanical properties of the aluminum alloys are not affected. All welds shall be properly finished as per good engineering practices.

5.0 Electrical Design:

The normal duty and heavy duty suspension, light duty, normal duty and heavy duty tension insulator sets shall all comply with the technical requirements and satisfy the test requirements

6.0 Mechanical design:

The mechanical strength of the insulators and corresponding insulator fittings must match .The design shall be such that stresses due to expansion and contraction in any part of the insulator shall not lead to the development of defects.

Insulating material shall not engage directly with hard metal. All fixing materials shall be of approved quality, shall be applied in an approved manner and shall not enter into chemical action with the metal parts or cause fracture

by expansion in service. Where cement is used as a fixing medium, cement thickness shall be as small and even as possible and proper care shall be taken to correctly centre and locate the individual parts during cementing.

7.0 GALVANISING:

All ferrous parts of conductor and ground wire accessories and insulator hardware shall be galvanized in accordance with IS: 2629-Recommended Practice for hot dip galvanizing of iron and steel or any other equivalent authoritative standards. The weight of zinc coating shall be determined as per method stipulated in IS: 2633 for testing weights, thickness and uniformity of coating of hot dip galvanized articles or as per any other equivalent authoritative standards. The zinc used or galvanization shall conform to grade Zn 98 of IS: 209. The galvanized parts shall withstand four (4) dips of 1 minute each time while testing uniformity of zinc coating as per IS: 2633. Spring washers shall be electro galvanized.

8.0 INSULATOR HARDWARES

The insulator disc hardware and string assemblies to be offered by the tenderer shall be suitable to meet the requirement given in the specific technical particulars as detailed hereinafter.

Hardware for suspension and tension insulator shall be suitable for insulator with normal pin shank diameter of 20 mm. in case of tension string unit and 16mm. for suspension string unit.

Each insulator string shall generally include the following hardware components.

Single Suspension Set.

- a) Ball Hook.
- b) Tower / Pole side arcing horn
- c) Socket Eye with R-Type security clip.
- d) Line side arcing horn.
- e) Suspension clamps Armoured Grip Suspension AGS Type

Single Tension Set :

- a) Anchor Shackle.
- b) Ball Eye.
- c) Tower / Pole side arcing horn.
- d) Socket Clevis with R-Type security clip.

- e) Line side arcing horn
- f) Bolted type dead end clamp.

9.0 SUSPENSION CLAMPS

This clamp will be AGS type made out of aluminum alloy suitable for accommodating preformed armored rod.

10.0 TENSION CLAMPS

The Tension Clamps shall be made out of aluminium alloy and of 4 **pair** bolted **(M-16)** type suitable for 100 mm² & 148 mm² AAAC conductor .The tension clamps shall not permit slipping or damage to failure of the complete conductor or any part thereof at a load less than 90% of the ultimate strength of conductor. The mechanical efficiency of tension / clamps shall not be affected by method of erection involving come / along or similar clamps or tension stringing operation during or after assembly and erection of tension clamp itself. The tension clamp shall be of a design that will ensure unrestricted flow of current without use of parallel groove clamps.

The clamps shall be as light as possible.

11.0 ARCING HORNS

Each hardware assembly shall have provision for attaching arcing horns of both adjustable and non/adjustable type across the suspension and tension strings or tower side. However each hardware assembly shall be provided with arching horn of fixed type on line side only.

12.0 TESTS, TEST CERTIFICATE AND PERFORMANCE REPORTS

12.1 The fittings and accessories for the power conductor, insulator and hardwares shall be tested in accordance with IS:2121, IS:2486, BS:916 for hexagonal bolts and nuts Routine test certificates and performance reports are to be submitted by the Contractor.

The Employer however, reserves the right to get all the tests performed in accordance with the relevant I.S. Specification as Acceptance Test in presence of Employer-s representatives.

The tenderer shall clearly state the testing facilities available in the laboratory at his Works and his ability to carry out the tests in accordance with this Specification. All the specified tests shall be carried out without any extra cost.

Acceptance Test for power conductor accessories.

- a) Visual examination
- b) Dimensional verification
- c) Failing load test

- d) Slip strength test (for clamps)
- e) Electrical resistance test
- f) Fatigue test (for vibration dampers)
- g) Mass pull off test (for vibration dampers)
- h) Galvanizing test.

12.2 ACCEPTANCE TEST FOR HARDWARES

- i) Dimensional verification.
- ii) Ultimate tensile test.
- i) Slip strength test.
- ii) Electrical resistance test.
- iii) Heating cycle test
- iv) Breaking strength of full string assembly.
- v) Galvanizing test.

13.0 BONDING PIECES:

- a) material : flexible copper bond (37/7/0.417 mm.
tinned copper flexible stranded cable).
- b) Length : Not less than 750 mm.
- c) Bolt size : 16mm x 40 mm.
- d) Copper area. : 34 sq.mm.
- e) Thickness of log : 6 mm.
- f) Material for connecting socket : Tinned Brass

14.0 FASTENERS: Bolts, Nuts & Washers

1. All bolts and nuts shall conform to IS-6639 – 1972. All bolts and nuts shall be galvanized. All bolts and nuts shall have hexagonal heads, the heads being truly concentric, and square with the shank, which must be perfectly straight.
2. Bolts upto M16 and having length upto ten times the diameter of the bolt should be manufactured by cold forging and thread rolling process to obtain good and reliable mechanical properties and effective dimensional control. The shear strength of bolt for 5.6 grade should be 310 Mpa minimum as per IS-12427. Bolts should be provided with washer face in accordance with IS-1363 Part-I to ensure proper bearing.
3. Fully threaded bolts shall not be used. The length of the bolt shall be such that the threaded portion shall not extend into the place of contact of the component parts.
4. All bolts shall be threaded to take the full depth of the nuts and threaded enough to permit the firm gripping of the component parts but not further. It shall be ensured that the threaded portion of the bolt protrudes not less than 3

mm and not more than 8 mm when fully tightened. All nuts shall fit and be tight to the point where shank of the bolt connects to the head.

5. Flat washers and spring washers shall be provided wherever necessary and shall be of positive lock type. Spring washers shall be electro-galvanized. The thickness of washers shall conform to IS-2016-1967.
6. The bidder shall furnish bolt schedules giving thickness of components connected, the nut and the washer and the length of shank and the threaded portion of the bolts and size of holes and any other special details of this nature.
7. To obviate bending stress in bolt, it shall not connect aggregate thickness more than three times its diameter.
8. Bolts at the joints shall be so staggered that nuts may be tightened with spanners without fouling.
9. Fasteners of grade higher than 8.8 are not to be used and minimum grade for bolts shall be 5.6.

15.0 Technical Specification for Design, Supply and Testing of Hardware fittings.

15.1 Type tests:

The following type tests shall have been conducted on hardware fittings within 5 Years prior to date of Bid submission.

A. On suspension hardware fittings only.

- (i) Magnetic power loss test.
- (ii) Clamp slip strength Vs torque
- (iii) Mechanical strength test.
- (iv) On one test on elastomer.

B. On Tension hardware fittings only.

- (i) Electrical resistance test for IS 2486 (Part-I) 1971
Dead end assembly.
- (ii) Heating cycle test for -do-
Dead end assembly.
- (iii) Slip strength test for IS 2486 (Part-I)
Dead end assembly.
- (iv) Mechanical strength test.

C. On both suspension and tension hardware fittings.

- (i) Visual examination. IS-2486 (Part-I) 1971
- (ii) Verification of dimension. -do-
- (iii) Galvanizing / electroplating test. -do-
- (iv) Mechanical strength test of each component
(including corona control ring/grading ring and arcing horn)
- (v) Mechanical strength test of welded joint.
- (vi) Mechanical strength test for corona control ring/
grading ring and arcing horn. BS-3288 (Part-I)
- (vii) Test on locking device for ball and socket coupling. IEC –
3721984
- (viii) Chemical analysis, hardness tests, grain size,
inclusion rating and magnetic particle inspection for
forging/casting.

D. On suspension hardware fittings only.

- (i) Clamp slip strength ver as torque test for suspension clamp.
- (ii) Shore hardness test of elastomer cushion for AG suspension
clamp.
- (iii) Bend test for armour rod set. IS-2121 (Part-I)
- (iv) Resilience test for armour rod set. -do-
- (v) Conductivity test for armour rod set. -do-

All the acceptance tests stated at clause shall also be carried out on composite insulator unit, except the eccentricity test at clause. In addition to these, all the acceptance tests indicated in IEC 1109 shall also be carried out without any extra cost to the employer.

E. For hardware fittings.

- (a) Visual examination. IS-2121 (Part-I)
- (b) Proof & test.

F. Mid span compression joint for conductor and earth wire.

- (a) Chemical analysis of materials.
- (b) Electrical resistance tests. IS-2121 (Part-II) 1981 clause 6.5 & 6.6
- (c) Heating cycle test. -do-
- (d) Slip strength test. -do-

TECHNICAL SPECIFICATION FOR EQUIPMET CLAMPS & CONNECTORS

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OF
EQUIPMET CLAMPS & CONNECTORS**

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TECHNICAL SPECIFICATION FOR EQUIPMET CLAMPS & CONNECTORS

1.0 SCOPE

This specification covers design, manufacture, assembly, testing at manufacturer's works, supply and delivery at site of all terminal connectors of 33KV equipment (mainly breaker, isolator, CT,PT,CVT,BPI and SA) and all other clamps and dropper connectors required for the switch yard as per approved lay out and system design.

2.0 STANDARDS

The terminal connectors under this specification shall conform strictly to the requirements of the latest version of the following standards as amended up-to-date, except where specified otherwise.

- i) IS: 556 Power Connectors.
- ii) IS: 617 Aluminium & Aluminium Alloy
- iii) IS: 2629 Recommended Practice for hot dip galvanizing of iron and steel.
- iv) IS: 2633 Method of testing uniformity of coating of zinc coated articles.

The materials conforming to the standards are only acceptable. The salient point of these specifications and points of difference between these and the above specifications shall be clearly brought out in the bid.

3.0 MATERIAL & WORKMANSHIP

The terminal connectors shall be manufactured from Aluminium Silicon Alloy and conform to designation A6 of IS: 617 (latest edition)

The connectors shall be of best quality and workmanship, well finished and of approved design. Specific materials for clamps and connectors should have high current carrying capacity, high corrosion resistance and be free from corona formation.

All connectors or its components to be connected with conductor shall be of bolted type having aluminium purity not less than 99.5%.

All bus bar clamps shall be made preferably from forged aluminium of purity not less than 99.5%. The thickness and contact surface should be maintained in such a way that the clamp should conform to IS:5561/1970 or any latest revision thereof.

4.0 RATING

The connector rating shall match with the rating of the respective equipment for the terminal connectors and the connectors for bus bar and dropper should be of the following rating. Minimum thickness at any part of connector shall be 10(ten) mm. Indicative ratings are given below:

SI No.	Rating	33 KV
1	Main bus bar connectors high level and low level (Amps)	1250
2	High level bus sectionalisation Isolator (Amps)	1250
3	-do- for CT	As per CT rating
4	-do- for PI	As per PI rating
5	-do- for LA	As per LA rating
6	-do- for PT	As per PT rating

5.0 EQUIPMENT CONNECTORS

Bimetallic connectors shall be used to connect conductors of dissimilar metal. The following bimetallic arrangement shall be preferred.

- a) Copper cladding of minimum 4 mm. thickness on the aluminium portion of connector coming in contact with the copper palm or stud of the equipment.
- ii) Alternatively, to provide cold rolled aluminium copper strip between the aluminium portion of the connection, the sheet thickness shall not be less than 2 mm.

Sufficient contact pressure should be maintained at the joint by the provision of the required number of bolts or other fixing arrangements, but the contact pressure should not be so great as to cause relaxation of the joint by cold flow, the joint should be such that the pressure is maintained within this range under all conditions of service, to avoid excessive local pressure, the contact pressure should be evenly distributed by use of pressure plates, washers or suitable saddles of adequate area of thickness should be less than that of an equal length of conductor where measured individually test results showing the milli drop test and resistance should be enclosed with the bid.

All connectors shall be so designed and manufactured as to offer ease of installation as these are to be used in overhead installations, design shall be such that full tightening of nuts and bolts should be possible with the use of double wrench.

The connectors shall be such as to avoid local corona, sound or visible discharge.

6.0 TEMPERATURE RISE

The temperature rise of connectors when carrying rated current shall not exceed 45° C above reference design temperature of 50° C.

- i) Acceptance Tests
 - (a) Tensile Test
 - (b) Temperature rise test
 - (c) Temperature rise test
- ii) Routine Test
 - (a) Visual Inspection
 - (b) Dimensional Check

Type test reports from a recognized laboratory shall have to be submitted.

7.0 WEIGHTS

Weights of different materials uses in manufacture, such as aluminium, silicon, copper etc. should be clearly indicated in GTP & Drawing.

8.0 INTERCHANGE ABILITY

Corresponding parts of similar clamps and connectors shall be made to gauge or jig and shall be interchangeable in every respect.

9.0 SCHEDULE FOR TECHNICAL REQUIREMENTS:

9.1 TENSION CLAMPS

Sl. No.	Details (TENSION CLAMPS)	Suitable for AAAC (148/100mm ²)
1	Type	Compression type tension clamp
2	Material	Ext. Al.Alloy/Ext. Al.
3	Breaking Strenght	95% of UTS of Conductor
4	Slipping Strenght	95% of UTS of Conductor
5	Galvanising	

6	Ferrous Parts	Hot Dip Galvanised
7	Spring Washers	Electro Galvanised
8	Quality of Zinc used	99.95 %
9	Number of dips which the clamp can withstand	4/ 1 minute dips
10	Standard to which Conforming	IS 2633
11	Electrical conductivity	
12	a.Results of heating cycle test carried out	T.C. Attached
13	b.Electrical resistance	Not more than 75% of equivalent length of conductor
14	Reference to type tests and other test reports attached	T.C. Attached
15	Make of bolts and Nuts used	Local Make

9.2 SUSPENSION CLAMPS

Sl. No.	Details (SUSPENSION CLAMPS)	Requirement: Suitable for AAAC (150/100mm ²)
1	Type of material used for retaining rod for AGS assembly giving reference of ISS	Alluminium Alloy 6061/Equivalent
2	Minimum tensile strength of retaning rod material	35 Kg/mm ²
3	Chemical composition of retaning rod materials	As per IS:733
4	Electrical conductivity of Armour Rod material(In percentage of the conductivity of IACS i.e. International Annealed Copper Standard	Not less than 40 %of IACS
5	Slipping strength of cushioned suspension assembly	8% to 15% of UTS of Conductor
6	Breaking strength of suspension Clamp	6000 Kgf
7	Minimum Tensile Strenght	2000 Psi

8	Minimum ultimate Elongation	300 %
9	Ageing (guaranteed life of the assembly)	40 Years
10	Hardness	65 to 80 A

9.3 FLEXIBLE CUPPER BOND

Sl. No.	Details (Flexible Cupper Bond)	Requirement:
1	Drawings enclosed	Yes
2	Stranding	37/ 7/ 0.417
3	Cross sectional area(Sq.mm)	75.6
4	Minimum copper equivalent area(sq.mm)	34(each individual wire)
5	Length of copper cable(mm)	500
6	Material Lugs	Tinned copper
7	Bolt Size	
	(i) Diameter(mm)	16
	(ii) Length(mm)	40
8	Resistance(ohm)	0.0004(as per IS.2121)
9	Total weight of Fexible copper bond(kg)	0.45(approx)

**TECHNICAL SPECIFICATIONS
FOR
CABLE TERMINATIONS AND JOINTING KITS**

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OF
CABLE TERMINATIONS AND JOINTING KITS**

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PART-A

TECHNICAL SPECIFICATIONS FOR HEAT SHRINKABLE CABLE JOINT KITS FOR 33KV & 11KV XLPE CABLE TERMINATIONS AND JOINTS

1.0 GENERAL:

1.1 The term heat shrink refers to extruded or molded polymeric materials which are cross linked to develop elastic memory and supplied in expanded or deformed size or shape. The manufacturer of kits besides stating the properties of each component of the kit as indicated below and as per the detailed specifications should also state the source of origin of each component viz; whether locally manufactured or imported in raw material form and processed. The manufacturing activity carried out on each component should be stated. Also, in case the kit is assembled with components imported from two or more foreign suppliers, the manufacturers should give documentary proof supported by the foreign manufacturers confirming that the kit assembled utilizing components of different suppliers are guaranteed by them.

2.0 QUALIFYING EXPERIENCE:

2.1. The kits should have satisfactory performance record in India in excess of 5 years supported with proof of customers having had satisfactory use of these kits in excess of 5 years on the date of Bid Submission.

3.0 HEAT SHRINKABLE MATERIAL:

3.1. The heat shrinkable material component used in the joint shall have been produced in a systematic procedure as follows:

- a) The required materials shall be mixed and extruded into the required shape and then cross-linked by irradiation or any other appropriate chemical process. The components are then warmed and stretched by a predetermined amount and allowed to cool in the extruded shape. The cross-linking shall create a memory and when heated again, the same shall come back to its original shape at which it was cross-linked. Heat shrinkable tubes can be reduced to 30% of its expanded dimension by heating.
- b) The volume resistivity of the sleeves shall be 10^8 ohm-cm and the dielectric constant of around 15 to 30. The limiting temperature shall not be less than 100°C for longer duration and 250°C for one minute.

4.0 TYPE TEST REPORTS:

The Joints and terminations should have been subjected to all the type tests and front page of type test reports not later than 5 years on the day of Bid opening shall be furnished for verification.

5.0 ELECTRICAL CLEARANCES:

The electrical clearances required for a Indoor/Outdoor termination and a straight through joint is shall be as per standards.

6.0 COMPRESSION TYPE TUBULAR TERMINAL ENDS:

The materials used in the terminals shall be Aluminum of grade 19501 conforming to IS 5082 - Specifications for wrought aluminum and aluminum alloys bars, rods, tubes and sections for electrical purposes. The finish inside the barrel shall either be suitably roughened throughout the crimping length of terminal end or provided with suitable greasebased compound with abrasive action. Edges and corners shall be free from burrs and sharp edges. The terminals shall meet the requirements of IS 8309 - Specification for Compression type tubular terminal ends for aluminum conductors of insulated cables.

7.0 JOINT KITS:

The requirements contained in a typical joint Kit are as follows:

- a) Heat shrinkable or push-on or Tapex or cold shrinkable type clear insulating tubes
- b) Stress control tubing where necessary
- c) Ferrule insulating tubing for joints.
- d) Conductive cable break outs for terminations, non tracking, erosion and
- e) Weather resistant tubing both outer / inner
- f) Non tracking erosions and weather resistant outdoor sheds in case of terminations
- g) High permittivity mastic wedge Insulating mastic.
- h) Aluminum crimping lugs of ISI specification.
- i) Tinned copper braids
- j) Wrap around mechanical protection for joints.
- k) Cleaning solvents, abrasive strips.
- l) Plumbing metal.
- m) Binding wire etc. adequate in quantity and dimensions to meet the service and test conditions.
- n) The kit shall contain a leaflet consisting of detailed installation instructions and shall be properly packed with shelf life of over 3 years.

PART-B

ANNEXURE - I

SPECIFICATIONS FOR MATERIAL PROPERTIES AND OTHER TECHNICAL REQUIREMENTS FOR HEAT SHRINKABLE CABLE TERMINATIONS AND JOINTS SUITABLE FOR 33 kV & 11 KV SCREENED CABLES/XLPE CABLES

1.0 GENERAL:

The term heat shrink refers to extruded or molded polymeric materials which are cross linked to develop elastic memory and supplied in expanded or deformed size or shape. The subsequent heating results in shrinking down to original size and shape. The manufacturer of kits besides stating the properties of each component of the kit as indicated below and as per the detailed specifications given in **Enclosures-I(A), I(B) & I(C)** should also state the source of origin of each component viz; whether locally manufactured or imported in raw material form and processed. The manufacturing activity carried out on each component should be stated. Also, in case the kit is assembled with components imported from two or more foreign suppliers, the manufacturers should give documentary proof supported by the foreign manufacturers confirming that the kit assembled utilizing components of different suppliers are guaranteed by them.

2.0 QUALIFYING EXPERIENCE:

The kits should have satisfactory performance record in India in excess of 5 years supported with proof of customers having had satisfactory use of these kits in excess of 5 years.

3.0 PERFORMANCE TESTING:

The successful contractor/bidder should undertake the testing of termination and jointing kits at CPRI or any Govt. laboratory.

Typical atmospheric conditions during the tests		
Sl No	Particulars	Details
1	Amb. Temperature	Maximum 45 ⁰ C
		Minimum 10 ⁰ C
2	Atmospheric pressure	963 to 987 m. bar
3	Relative Humidity	50 – 90 %

Test sequence				
SI No	Test Sequence		Test Voltage	Test results shall be as
1	Impact a wedge shaped weight of 4 kg having a 90° angle with a 2 mm radius shall be dropped freely 6 times from a height of 2.0M. On to the sample. The drops shall be distributed over the length of the joint and at right angles to the axis of the joint.(Electricity Council Engg.C.81)			No visual damage
2	AC voltage withstand (IEC Pub 60)	1 min	35 kV	Shall withstand satisfactorily
3	Impulse voltage withstand test (IEC Pub 60 & 230)	10 positive and 10 negative 1.2/50 micro seconds between each conductor & the grounded sheath or screen	Indoor -75 kV	-do-
			Outdoor 95 kV	
4	Load Cycling	63 cycles, 5 hrs heating, 3hrs cooling conductor temperature screened : 75° C	15 kV	-do-
5	Thermal short circuit	1 Sec. symmetrical fault with sheath temp. as per cable Spec.		-do-
6	Load Cycling	Repeat	15 kV	-do-
7	A/C voltage withstand	4 hrs	24 kV	-do-
8	Impulse voltage withstand	Repeat	Indoor -75 kV	-do-
			Outdoor 95 kV	
9	D/C voltage withstand	30 Min.	48 kV	-do-
10	Humidity indoor termination	Conductivity 800 M/h	7.5 kV	-do-

11	Dynamic short circuit (VDE 0278)	63 kA		-do-
12	Salt frog outdoor terminations	224 Kg/m ³	7.5 kV	-do-

ENCLOSURE – I (A)

MATERIAL SPECIFICATION FOR HEAT SHRINKABLE TUBING

Test	Test Method	Requirement				
		Non-Tracking Tubing	Stress Control Tubing	Ferrule insulating tubing	Clear insulating tubing	Inner Outer tubing for Joint
Tensile Strength	ISO 37	8 N/mm ² Min.	14 N/mm ² Min.	10 N/mm ² Min.	12 N/mm ² Min.	14 MPa Min.
Ultimate Elongation	ISO 37	300 % Min.	250 % Min.	300 % Min.	200 % Min.	500 % Min.
Accelerate dAgeing 168 Hrs. at 120° C	ISO 188					
Tensile Strength	ISO 37 Min.	7.5 N/mm ² Min.	13 N/mm ² Min.	10 N/mm ² Min.	12 N/mm ² Min.	14 MPa Min.
Ultimate Elongation	ISO 37	200 % Min.	130 % Min.	300 % Min.	200 % Min.	300 % Min.
Thermal Endurance	IEC 216	110° C Min.	90° C Min.	105° C Min.	110° C Min.	120° C Min.
Electric Strength	IEC 243	Wall Elec. Thkn. Strn. (Normal) KV/CM		Wall Elec. Thkn. Strn. (Normal)KV/C M	Wall Elec. Thkn. Strn. (Normal)KV/C M	100 kV/CM Min.
		3.0 mm. 100 Min.		3.0 mm. 100 Min.	*1.3 mm. 100 Min.	
Volume Resitivity	IEC 93	1 × 10 ⁸ OHM-CM Min.	5 × 10 ¹⁰ OHM-CM Min.	1 × 10 ¹³ OHM-CM Min.	1 × 10 ¹⁶ OHM-CM Min.	1 × 10 ¹² OHM-CM Min.

Dielectric	IEC 250	5.0 Max.	15.0 Min.	5.0 Max.	3.5 Max.	5.0 Max.
Tracking and erosion resistance	ASTM D2303	No tracking erosion to top surface or flame failure after: 1 HR at 2.5 kV 1 HR at 2.75 kV 1 HR at 3.0 kV 20 Mins at 3.25kV	-	KA 3C		KA 1
Water absorption	ISO/R 62 Procedu re A	1 % Max. AFT. 14 days at (23 ± 2) °C	1 % Max. AFT. 14 days at (23 ± 2) °C	1 % Max. AFT. 14 days at (23 ± 2) °C	0.5 % Max. AFT. 14 days at (23 ± 2) °C	0.2 % Max. AFT. 14 days at °C
Resistance to liquids	ISO 1817					
- Transformer oil to VDE 0370 immersion & days at (23 ± 2) °C						
-Tensile Strength	ISO 37	5 N/mm ² Min.	13 N/mm ² Min.	7.5 N/mm ² Min.	-	14 MPa Min.
-Ultimate Elongation	ISO 37	250 % Min.	250 % Min.	250 % Min.	-	300 % Min.

MATERIAL SPECIFICATION FOR HEAT SHRINKABLE MOULDED PARTS				
SI No	Test	Test Method	Requirement	
			Sheds	Conductive Break-outs
1	Tensile Strength	ISO 37	8 N/mm ²	9 N/mm ²
2	Ultimate Elongation	ISO 37	300 % Minimum.	230%
3	Accelerated Ageing 168	ISO 188		
4	Tensile Strength	ISO 37	7.5 N/mm ² Minimum.	9 N/mm ² Minimum.
5	Ultimate Elongation	ISO 37	200 % Minimum.	150 % Minimum.
6	Thermal Endurance	IEC 216	110°C Minimum.	105°C Minimum.
7	Electric Strength	IEC 243	Wall Elec. Thkn. Strn. (Normal) KV/CM	-
			<3.0 100 mm. Minimum.	
8	Volume Resistivity	IEC 93	1 × 10 ¹³ OHM-CM Minimum.	200 OHM-CM Max.
9	Dielectric constant	IEC 250	5.0 Maximum.	-
10	Tracking and erosion resistance	ASTM D2303	No tracking erosion to top surface or flame failure after: 1 HR at 2.5 kV	-
11	Water absorption	ISO/R 62 Procedure A	1 % Max. AFTER. 14 days at	1 % Max. AFTER. 14
12	Resistance to liquids	ISO 1817		
13	Transformer oil to VDE 0370 immersion & days at (23 ± 2) ^o C			
14	Tensile Strength	ISO 37	5 N/mm ² Minimum.	7.5 N/mm ² Minimum.
	Ultimate Elongation	ISO 37	250 % Minimum.	150 % Minimum.

ENCLOSURE- I(C)

MATERIAL SPECIFICATION FOR HEAT SHRINKABLE ADHESIVE/SEALANTS			
Test	Test Method	Requirement	
		Black Insulator Mastic	Sealant break-out and sheds
Softening Point	ASTM E28	$(115 \pm 10)^{\circ} \text{C}$	
Electric Strength	IEC 243	130 kV/CM Min.	80 kV/CM Min.
Volume resistivity	IEC 93	$1 \times 10^{14} \text{ OHM-CM}$ Min.	
Water absorption	ISO/R 62 Procedure A	1 % Max. AFT. 1 day at $(23 \pm 2)^{\circ} \text{C}$	1 % Max. AFT. 1 day at $(23 \pm 2)^{\circ} \text{C}$
Corrosive effect 16 Hrs. at 121°C	ASTM D2671 Method-B	No corrosion	
Adhesive peel strength substrate 2/1	as detailed in master Spec.	-	

			Below- 30 ⁰ C
NTR/ NTR			25N/25 mm Min.
NTR/ CON			20N/25 mm Min.
NTR/ AL			20N/25 mm Min.
NTR/ Pb			20N/25 mm Min.
T.E.R.T	ASTM D2303	-	No tracking erosion to top surface or flame failure after : 1 HR at 2.0 kV

CLASSIFICATION OF SOIL STRATA**1.00 Ordinary Soil:**

This shall comprise of vegetable or organic soil, turf, sand, sandy soil, silt, loam, clay, mud, red earth, suede, peat, black cotton soil, soft shale, loose murrum, mud debris, concrete below ground level, a mixture of all these and similar material which yields to the ordinary application of pick, shovel, rake or other ordinary digging implement. Removal of gravel or any other modular material having diameter in any one direction not exceeding 75 mm, such occurring strata shall be deemed to be covered under this category.

2.00 Hard Soil:

This shall include :

- 1) Stiff heavy clay, hard shale or compact murrum requiring grifting tool or pick or both and shovel closely applied.
- 2) Gravel, soft laterite, kankar and cobble stone having maximum diameter in any one direction between 75 mm and 300 mm.
- 3) Soliding of road paths, etc., and hard core.
- 4) Macadam surfaces such as water bound and bitumen/tar bound.
- 5) Lime concrete, stone masonry in lime/cement mortar below ground level.
- 6) Soft conglomerate, where the stones may be detached from the matrix with picks.
- 7) Generally any material which requires the close application of picks or sacrifiers to loosen and not affording resistance to digging greater than hardest of any soil mentioned in item (1) to (6) above.

3.00 Ordinary Rock:

- 1) Ordinary rock comprising of lime stone, sand stone, hard laterite, fissured rock, conglomerate or other soft or disintegrated rock which may be quarried or split with crow bars.
- 2) Unreinforced cement concrete which may be broken up with crow bars or picks and stone masonry in cement mortar below ground level.
- 3) Boulders which do not require blasting having maximum diameter in any direction of more than 300 mm found lying loose on the surface or embedded in river bed, soil, talus slope wash and terrace material of dissimilar origin.

NOTE : Hard laterite does not require blasting. It is to be classified under ordinary rock which does not require blasting.

4.00 Hard Rock:

This shall comprise:

- 1) Any rock or cement concrete or RCC for the excavation of which the use of mechanical plant or blasting is required.

**TECHNICAL SPECIFICATION
FOR
LT DISTRIBUTION BOX**

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OF
L.T. DISTRIBUTION BOX

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Technical Specification for L.T. DISTRIBUTION BOX FOR 100KVA 33/0.4 KV Transformer (3 phase, 200A)

1.0 DESCRIPTION OF MATERIALS

The L.T. Distribution Cabinets shall be installed on D.P. Structure for Plinth Mounted 33/4 KV Substation of the ratings indicated above. These Distribution Cabinets are to be outdoor type and to be fabricated out of 2 mm GI sheet steel. The body of the boxes shall have sufficient re- enforcement with suitable size of channels keeping a provision for fixing these boxes either on DP structure or plinths.

- 1.1 The Box shall have double door with self locking (When the main MCCB is in close position the inner door can not be opened and after closing of the inner door only the main MCCB can be closed) arrangement and a door handle conforming **to general quality conditions. Any compromise on quality of the door handle used shall be liable for rejection.** The roof of the box shall be slightly slanting both sides as per drawing with an over hang of 50 mm to the front and back side. **Locking arrangement shall be Godrej Type, 3 Position Locking System for better Security. However, a separate provision for manual locking arrangement shall also be provided as stand by.**

- 1.2 The nuts, bolts, washers used in the box shall be galvanized to avoid rusting.

The door hinges shall not be visible from outside. The box shall have two nos. of solid Earthing points on either side with an arrangement for sufficient ventilation.

- 1.3 The boxes should confirm to IP-55 degree of protection. The bidders shall have to enclose type test certificate for degree of protection (IP-55) after their product duly tested at CPRI or any Govt. approved laboratory failing which their bid is liable for rejection. Preference shall be given to those who have successfully conducted type test as mentioned above.

- 1.4 The box shall have provision of bus bars of Copper mounted on epoxy resin cast bus insulators fixed on suitable fixing arrangement. The bus bars shall be conveniently placed so as to provide adequate clearance from the body of the box conforming to I.E. Rules applicable for L.T. supply with provision for one Bus Bar arrangement with 4 pole MCCB for all capacities of LTDBs & 1 number of outgoing feeder arrangement with 2sets of three pole MCCBs in each feeder for 100KVA LTDB. The Bus-Bar arrangement may be suitably made to house one out-going feeders with sufficient clearance between phases inside the LT Distribution Boxes.

There should be Heat Shrinkable bus bar insulation tubing of Red Yellow-Blue &Black. Alternatively phase coloured insulated paint (not less than 3.0kv) should be applied on the Bus-Bars.

- 1.5 The arrangement and dimensions shall be as per the drawing enclosed.

- 1.6 The provision of Earthing is to be made up with **Copper Flat of Size 25x4mm.** Suitable cable glands of heavy duty, double compression type **made up of Brass** shall be provided at the bottom of the Box. One for incoming cable and one outgoing cable. Detachable plates shall be provided for fixing of cable glands.

- 1.7 The Drawings shown below are indicative. Prior to manufacturing the bidder shall submit detail drawing with arrangement of Bus bar, MCCB phase indicator lamps etc for approval by the purchaser.

2.0 MCCB

MCCB shall be of reputed make preferably of L&T, Siemens, Havells, MDS and ABB. (Make must be specified in the tender)

The purchaser reserves the right to choose any one out of 4/3 Pole M.C.C.B.

- i) Standard :- IS-13947 (Part-2) / 1993 & IEC Pub-947-2 (1989)
- ii) Rated Voltage : 415V.AC.
- iii) No. of Poles : 4pole for incomer & 3pole for Outgoing feeders'
- iv) Rated current : 200A,

The percentage of rated service short circuit breaking capacity to rated ultimate short circuit breaking capacity shall be mentioned as per the Table - I, Page -13 of IS - 13947 (Part - 2).

All other features of the MCCB shall conform to the

ISS : 13947 (Pt. - 2) / 1993 & IEC Pub - 947 (Pt. 2) /1989.

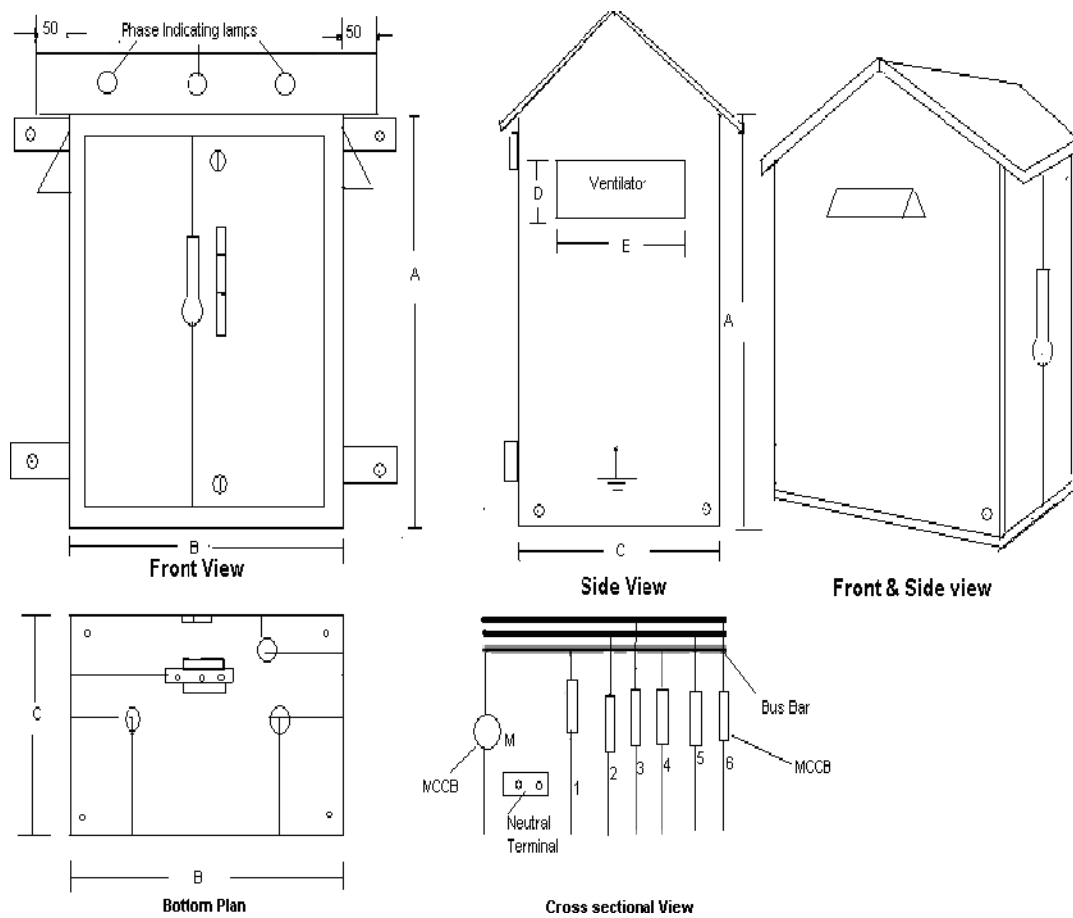
Preferably the rated ultimate Short Circuit Breaking Capacity is as follows,

The Percentage(%age of Rated Service short Circuit breaking capacity(Ics) to Rated Ultimate Short circuit Breaking Capacity(Icu) shall be mentioned as per Table-1 ,Page-13 of IS:13947(part-2)/1 989.

- vi) Type of protection: - Overload & short circuit protection is a must with static/electro magnetic/thermo magnetic trip release with manual resetting. For Neutral un-balance

current protection the bidders are to furnish alternative rates as indicated above.

3.0 DRAWING for L.T Distribution Box for 63 KVA, 100KVA to 200 KVA Transformers.



N.B :

Separate terminal bar to be provided for Neutral connection.

The Details:-

Sl No	Dimension Description	63 KVA	100 KVA	200 KVA
1	A	700	1000	1000
2	B	600	800	800
3	C	400	500	500
4	D	80	170	170
5	E	90	250	250
6	Incomer MCCB 4Pole	100 A, with Over Current	200 A, with Over Current Setting 80% to 100%	400 A, with Over Current Setting 80% to 100%
7	Cable Size for Incomer	50 mm ² , 3 1/2 core cable	95 mm ² , 3 1/2 core cable	185 mm ² , 3 1/2 core cable
8	Three Pole MCCB for out- going feeder	50 Amp, with Over Current Setting 80% to 100%	100 Amp, with Over Current Setting 80% to 100% (2sets each)	200 Amp, with Over Current Setting 80% to 100% (2sets each)
9	Bus Bar for Incoming & Out going feeders	25 x 6 mm	40 x 6 mm	50 x 8 mm
10	Bus Bar material	Electrolytic	Electrolytic Aluminium	Electrolytic Aluminium
11	A neutral Bus bar similar to phase Bus bar is to be provided.			

N.B. : - 1) 4Pole MCCB for Incomer & 3pole MCCB for outgoing feeder for individual tripping of each phase due to faults in the respective phases in the outgoing feeder, of reputed make to be specified in the tender along with test report from CPRI / Govt. testing lab. It shall confirm to IS – 13947 (pt – 2) / 1993 with latest amendment. The bidder should also furnish the purchase order of MCCBs with serial number for verification of genuineness of the MCCBs.

The in-coming cable should be connected to the terminals of the M.C.C.B. with Bi-metallic lugs preferably of Usha Martin make duly crimped with Die-less crimping tools. There should be a metallic/heat resistant insulating barrier between the individual M.C.C.Bs so that the heat generated during any fault inside the Box should not pass to the other M.C.C.Bs.

4.0 General Technical Particulars for LT Distribution Boxes : -

- 1) The L.T. Distribution Boxes should be of the dimensions as per the drawing & details in the table furnished.
- 2) The bidders can quote with their own design suitably accommodating the components as indicated in this bid in conforming to the approved clearances and technical requirements. The dimensions are only illustrative. Tolerances of dimensions are 10% over & above the dimensions specified. The bidder may specify their own dimensions and quote accordingly. The drawing and dimension should be submitted with the bidding document.
- 3) The distribution boxes shall be duly wired with suitable size of PVC insulated single core copper cable or equivalent section copper / aluminum

flat.

- 4) Terminal connectors for the earth connections to be provided in the box.
- 5) The distribution cabinet should be preferably of IP-55 protective category, with provision for lighting inside the cabinet. Purchaser's Name & Sl. No. Punching Marks should be given on any one of the sidewalls of each box as an identification of Purchaser's property, besides furnishing a non-detachable Nameplate, which should exhibit the details of L.T. Distribution Cabinet.
- 6) **TESTS** : - The 4 pole & Three pole M.C.C.Bs. to be mounted with Distribution Boxes shall have been fully type tested as per the relevant standard at CPRI/ Govt. approved laboratory/NABL accredited laboratory. The bid shall be accompanying with type-test reports conducted at Central Power Research Institute / Govt. approved laboratory for the offered materials conducted within five years before the date of opening of the tender. Copies of type test reports in respect of Impulse and Short Circuit tests must be enclosed with the tender failing, which the Bid is liable for rejection. Purchaser reserves the right to demand repetition of the tests without any extra cost.

Bids not accompanied with type test reports conducted within five years shall not be considered for evaluation.

5.0 INSPECTION :-

- (a) The inspection may be carried out by the Purchaser at any stage of manufacture. The successful tenderer shall grant free access to the Purchaser's representative at a reasonable time when the work is in progress. Inspection and acceptance of any equipment under this specification by the Purchaser shall not relieve the supplier of his obligation of furnishing equipment in accordance with the specification and shall not prevent subsequent rejection if the equipment is found to be defective.
- (b) The supplier shall keep the Purchaser informed in advance about the manufacturing programme so that arrangement can be made for inspection.
- (c) The purchaser reserves the right to insist for witnessing the acceptance / routine testing of the bought out items.

6.0 ACCEPTANCE AND ROUTINE TESTS :-

All acceptance and routine tests as stipulated in the relevant standards shall be carried out by the supplier in presence of owner's representative.

7.0 DOCUMENTATION :-

The Bidder shall furnish the following drawings along with the offer.

General outline and assembly drawing of the L.T. Distribution Box

- | | |
|-----|---|
| 1 . | C r o s s S e c t i o n a l v i e w |
| 2. | Arrangement of terminals & details of connection studs provided |
| 3 . | N a m e p l a t e |

- 4 . S c h e m a t i c d r a w i n g
5. Type test reports, in case MCCB has already been type tested
6. Test reports, literature of the bought out items and raw materials
7. Testing facilities available at the works
8. List of customers with detailed address / purchase reference, quantity and year of supply with user certificate for such items.

8.0 COMPLETENESS OF EQUIPMENT :

Any fittings accessories or apparatus which may not have been specifically mentioned in this specification but which are usually necessary in equipment of similar plant shall be deemed to be included in the specification and shall be supplied by the Tenderer without extra charge. All plant and equipment shall be complete in all details whether such details are mentioned in the specification or not.

9.0 INSPECTION AND TESTING

The Purchaser shall have free entry at all times, while work on the contract is being performed, to all parts of the manufacturer's works which concern the processing of the equipment ordered. The manufacturer shall afford the Purchaser without charge, all reasonable facilities to assure that the equipment being furnished is in accordance with this specification.

The equipment shall successfully pass all the acceptance tests and routine tests referred to and those listed in the most recent edition of the standards given in this specification.

The Purchaser reserves the right to reject an item of equipment if the test results do not comply with the values specified or with the data given in the technical data schedule.

Type tests shall have been / shall be carried out at CPRI / National Govt. approved Laboratory and be witnessed by a representative of such laboratoryr. Routine tests shall be carried out by the Supplier at no extra charge at their works.

Adequate facility with calibrated testing equipment must be provided by the manufacturer free of cost to carry out the tests. Type test certificates must be furnished along with the tender for reference of the Purchaser.

All costs in connection with the testing, including any necessary re-testing, shall be borne by the Supplier who shall provide the Purchaser with all the test facilities which the latter may require, free of charge. The Purchaser shall have the right to select the samples for test and shall also have the right to assure that the testing apparatus is duly calibrated and correct. Measuring apparatus for

routine tests shall be calibrated at the expense of the Supplier at an approved laboratory and shall be approved by the Purchaser.

The Supplier shall be responsible for the proper testing of the plant or materials supplied by sub-suppliers to the same extent as if the work, plant or materials were completed or supplied by the Supplier.

Any cost, incurred by the Purchaser in connection with inspection and re-testing as a result of failure of the equipment under test or damage during transport or offloading shall be to the account of the Supplier.

The supplier shall submit to the Purchaser five signed copies of the test certificates, giving the results of the tests as required. No materials shall be despatched until the test certificates have been received by the Purchaser and the Supplier has been informed that they are acceptable.

The test certificates must show the actual values obtained from the tests, in the units used in this specification, and not merely confirm that the requirements have been met.

In the case of components for which specific type tests or routine tests are not given in this specification, The Supplier shall include a list of the tests normally required for these components. All materials used in the Contract shall withstand and shall be certified to have satisfactorily passed such tests.

The Purchaser at his discretion may re-confirm the Test Results in his own laboratory or laboratory of his choice.

No inspection or lack of inspection or passing by the Purchaser's Representative of equipment or materials whether supplied by the Supplier or sub-supplier, shall relieve the Supplier from his liability to complete the contract works in accordance with the contract or exonerate him from any of his guarantees.

TECHNICAL SPECIFICAION
FOR
EARTHING , EARTHING COIL AND GI EARTH WIRE

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OF
EARTHING AND EARTHING COIL

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PART – A

TECHNICAL SPECIFICATION

FOR

SUB-STATION EARTHING

TECHNICAL SPECIFICATION FOR SUB-STATION EARTHING

1.0 EARTHING:

Earth mat design IS to be carried out referring to the **IEEE-Std 81**. Design shall be based on the soil resistivity. The measurement of the soil resistivity is to be taken before the representative of Owner by using a latest 4-port Digital Earth Tester duly calibrated having validity period. The design of Earth mat to be furnished by the Contractor for approval of the Owner.

The material offered shall be procured from short listed vendor at **E-14** and shall have been successfully Type Tested during last five years on the date of bid opening. Only the front page of the Type test report duly signed by the bidder shall be scanned & uploaded with the bid.

1.1 GUIDE LINE:

The Earth mat conductor shall be of 75x10 mm GI flat and it shall be laid in both the directions in the Switchyard and the gap between each conductor shall not be more than 2mtr. However, this gap may be further reduced depending on the design.

Earth risers should be of 50x6 mm GI flats. All equipment & metal parts of the Sub-station should be connected with main earth grid by using 50x6mm GI flats at two different places. The main earth grid should be laid not less than 600 mm below the finished ground level. The lap welding should not less than 150 mm. The welding of joints should be done after removal of Zinc by using Blow lamps. Welding should be done in all four sides and should be double layer continuous. Before taking up the second layer welding the deposited flux should be removed. During welding the two flats should be tightened properly by using 'C' clamps. Immediately after welding two layers of anti-corrosive paints should be painted over the welded portion along with two coats of Black bituminous paints. Before back filling of earth trenches the welded portion should be covered by wrapping with bituminous tape properly and also jointing portion should be covered with PCC (1:2:4) mix. The backfilling of earth pits and trenches should be done with powered loam soil mixed with Bentonite powder (10:1) mix.

All equipment, steel structures etc. should be connected with main earth mat at two points and with separate risers from the main earth mat. All equipment, structures, spikes (if any) should be connected individually with individual Pipe electrodes and again should be connected with main earth grid at two separate places. The Neutral of Power Transformer should be connected with two

separate Pipe electrodes and again connected with main earth electrodes at two separate places. The separation distance between each Pipe electrodes should not be less than 3 mts. The back filling of Pipe electrodes should be done in layer of Charcoal, loam soil mixed with Bentonite powder. The value of earth resistance should be less than 0.5 ohm with above arrangement. Where there is possibility of not achieving the earth resistance value, special type of earthing device (chemically treated) can also be used to achieve the desired value.

There should be a closely spaced earth grid of size 1.5 mts x 1.5mts by using 75 mm x 10mm GI flat, with 0.3 mts spacing both ways below the mechanism boxes of each Isolators & AB switches. In Sub-station the diameter of Pipe electrode should not be less than 50 mm dia, heavy gauge GI Pipe (perforated). **The Flange (50x6) mm GI flat should be welded in all sides with Pipe electrode.** In each face of Flange there should be two nos. of 17.5 mm hole to accommodate 16 mm GI Bolt & nut with spring washer.

The fencing of the Switchyard should not directly be connected with main earth mat grid. There should be a separate earth mat by running 75x10 mm GI flat at 2 mts away from outside the fence and should be connected rigidly with the fence at an interval of 5 mts. In addition, another GI Flat of 50x6mm should run continuously over the fencing and proper welding is also to be made. There should be one 50x6 mm GI Earth flat run over the cable rack and should be connected with main Earth mat grid at an interval of 5 mts . The jointing portion of Earth flats over the ground should be painted with two coats of Anti-corrosive paints and two coats of good quality of Aluminium paints (Berger/Asian paints).

Provision of watering to Earth pits shall have to be provided by using conduit pipe arrangement. The pipes are be connected to the water source provided in the S/s. Each handles of Isolators / AB switches etc should be connected with earth mat grid by using flexible Tinned Copper earth bonds (25mm x 5mm through net). In each earth switches 2(two) nos. flexible earth bonds should be provided. Each earth pits having pipe electrodes should be provided 250 mm Brick wall chambers duly plastered on all the side with RCC cover Slab. The size of the chamber shall be 450x400x400mm.

2.0 G.I. Flat (75x 10 mm) & G.I.Flat (50 x 6 mm)

The specification covers supply and testing of Galvanized Steel flat for Earthing arrangements.

3.0 APPLICABLE STANDARDS:

Materials shall conform to the latest applicable Indian standards / International standards.

Sl. No.	Standard No.	Title
1	IS:2062 Grade 'A' Quality	Specification for M.S. Channel and M.S. Flat
2	IS:2062	Chemical and Physical Composition of material
3	IS:1852	Rolling and Cutting Tolerances for Hot Rolled Steel products

4.0 . INSPECTION AND TEST CERTIFICATE

All conductors buried in earth or in concrete or above the ground level shall be galvanized steel. Galvanized steel shall be subject to one minute dips in copper sulphate solution as per IS:2633/1922.

The materials to be supplied will be subject to inspection and approval by the purchaser's representatives before dispatch unless otherwise waived. Inspection before dispatch shall not, however, relieve the Contractor of his responsibility to supply the steel section strictly in accordance with the ISS.

The representative of Purchaser shall pick up samples at random from the GI Flats offered for carrying out Routine tests as per specified IS. The representative shall make visual inspection on each & every GI flats. **The purchaser reserves the right to reject the material if the same is found defective at destination.**

5.0. METHOD OF GALVANISING:

<u>Sl. No.</u>	<u>Tests</u>	<u>For GI Flat</u>
1	Dip test	6 dips of 1 min each
2	Mass of Zinc coating	610 gram/sq.m minimum

Pre dispatch inspection shall be performed to witness following tests:

- i) Freedom from defects
- ii) Verification of dimensions
- iii) Galvanization tests
- iv) Mechanical tests
- v) Chemical composition tests

These tests are to be performed and certified at Govt. recognized laboratory. MS flat shall conform to IS 2062 & its latest amendments for Steel & Galvanization as per IS 4759 & its latest amendments.

The flat shall be coated with Zn 98 Zinc grade.

The minimum Zinc coating shall be 610 gm/sqm for thickness more than 5 mm and 460 gm/sqm for item thickness less than 5 mm.

6.0 Earth Electrode (50mm Dia. GI having gauge perforated pipe as per ISS)

6.1. Scope:- This specification provides for Supply of Earthing Device (**Heavy Duty**) (50x3000 mm), as per enclosed Drawing.

6.2. APPLICABLE STANDARDS:-

The Earthing Device must be made out of 50 mm (Heavy Gauge- No minus Tolerance is allowed on Wall thickness) Hot Dip G.I. Pipe (as per IS: - 1239, Part-1, 1990 of reputed Make – i.e. **TATA / Jindal**) & 3.0 mtrs length tapered finished smooth at one end for a length of 75 mm & Clamp at the other end.

Staggered drills hole of 12mm Dia. at an interval of 150mm shall be made before galvanization.

The GI Earthing Clamp/ Strip (C- Clamp Type) is to be of 50mm width, 6mm thickness & flange length of 65 mm in each side. This should be suitable for termination of 4 nos. of GI Flat earth electrodes. The Clamp/ Strip & Earthing pipe after fabrication will be hot dip galvanized confirming to IS: 2629/85 with latest amendments. The clamp shall have two holes in both sides suitable for 16 mm GI Bolts & Nuts. There shall be provision of funnel for pouring water through pipes. The height of the funnel shall be such that the watering will be better. Provision of reduced of GI pipe to be converted to the main GI earth pipe & on the top of the funnel is to be provided.

PART – B

**TECHNICAL SPECIFICATION
FOR
EARTHING COIL**

TECHNICAL SPECIFICATION FOR EARTHING COIL

1.0. SCOPE

The specification covers design, manufacture, testing for use in earthing of the HT poles.

1.1 TYPE TEST OF THE MATERIAL

The material offered shall be procured from a Vendor who must have at least three years experience in manufacturing of the same. The materials shall have been successfully Type tested during last five years on the date of bid opening. Only the front page of the Type Test report duly signed by the bidder and upload the same with the bid.

2.0. GENERAL REQUIREMENTS

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 material. The coil shall be made as per REC constructions standard.

The Hot Dip galvanizing shall conform to IS: 2629/1966, 2633/1972 and 4826/1969 with latest amendments.

3.0. TESTS

(a) Galvanizing Tests

Minimum Mass of Zinc on GI Wire used 280 gm/m² after Coiling-266 gm/m². The certificate from recognized laboratory shall be submitted towards mass of zinc.

(b) Dip Test

Dip test shall stand 3 dips of 1 minute and one dip of ½ minute before coiling and 4 dips of 1 minute after coiling as per IS: 4826/1979

(c) Adhesion Test

As per ISS 4826 – 1979.

4.0. DIMENSIONAL REQUIREMENT OF EARTHING COIL

Nominal dia of GI Wire - 4 mm (Tolerance \pm 2.5%)

Minimum no. of turns – 115 Nos.

External dia of Coil (Min) – 50 mm

Length of Coil (Min) – 460 mm

Free length of GI Wire at one end coil (Min.) – 2500 mm

Minimum length of wire to be grounded during installation -1000 mm.

The turns should be closely bound. Weight of one finished Earthing Coils (min.) – 1.850 kg.

PART – C

**TECHNICAL SPECIFICATION
FOR
G.I. EARTH WIRE**

TECHNICAL SPECIFICATION FOR G.I. EARTH WIRE

1.0 SUSPENSION CLAMPS: FOR GROUND WIRE

Clamps of suitable size are required for holding the galvanized steel stranded ground wire at suspension points. The suspension clamps shall be suspended from the lower hanger or 'D' belt of 16mm diameter and should therefore be supplied with a suitable attached that would allow the clamps to swing freely both in the transverse and longitudinal direction. The clamps shall be so designed that the effect of vibration both on the ground wire and the fittings itself is minimum.

The clamps shall be manufactured and finished so as to avoid sharp radii of curvature, ridges which might lead to localized pressure and damage the ground wire in service.

The clamps shall be made of heat treat malleable iron one Eye hook made of forced steel. The entire assembly shall be hot dip galvanized.

The clamping surface shall be smooth and formed to support the ground wire on long easy curves to take care of required steel vertical and horizontal angles.

The clamps shall permit the groundwire to slip before the failure of the latter occurs. The leg of U-bolt holding the keeper piece of the clamps shall be kept sufficient long and shall be provided with threads, nuts and locking nuts for fixing the flexible earthing bond between the suspension clamps and tower structures.

2.0 TENSION CLAMPS (DEAD END ASSEMBLY) FOR GROUND WIRE.

Compression type dead end assembly of G.S.S. ground wire shall be required for use on the tension towers. The dead end assembly shall be supplied with complete jumper terminals, nuts and bolts suitable link pieces between the steel clevis and tower strain plates so as to provide sufficient flexibility not less than that of G.S.S. ground wire and the tensile strength not less than 90% that of the G.S.S. ground wire.

The assemblies shall comprise of compression type dead end clamps and one anchor shackle made of forged steel. The entire assembly shall be hot dip galvanized.

One of bolt holding joint per terminal of dead end assemblies shall be kept sufficiently long and threaded and shall be provided with nuts, washers and

locking nuts for fixing the flexible earthing bond between the dead-end clamp and tower structures.

3.0 Basic Technical Requirement

The following Technical requirement is furnished below:

H	<i>7/3.15mm Galvanised Stranded Steel Wire For Suspension Clamps</i>	
i	Materials	Malleable Cast Iron / Galvansied Steel
ii	Size	As per Drawing (No.-----)
iii	Suitable for groundwire	Yes (7/3.15)
iv	Weight in kg	
v	Slip strength	12-17 KN
vi	Minimum failing load	70 KN
vii	Galvanising	
	a.Ferrous parts	Hot Dip Galvanised
	b.Spring washers	Electro Galvanised
	c.Quality of Zinc used	99.5%
	d.Number of dips which the clamp can withstand	4/1 minute dips
viii	Standard to which conforming	IS 2486 and IS 2633
I	<i>Compression type dead end assemblies For 7/3.15mm Galvanised Stranded Steel Wire</i>	
i	Materials	Forged steel
ii	Size	As per drawing (No. -----)
iii	Suitable for ground wire	Yes (7/3.15)
iv	Weight in kg	3.694
v	Slipping strength	95% of UTS of Conductor
vi	Minimum failing load	70 KN
vii	Galvanising	
	a.Ferrous parts	Hot Dip Galvanised
	b.Spring washers	Electro Galvanized
	c. Quality of zinc used	99.5%
	d. Number of dips which the clamp can withstand	4/ 1 minute dips
vii	Standard to which conforming	IS 2486 and IS 2633

	<i>Flexible copper bond</i>	
i	Drawings enclosed	Yes (Drg. No. -----)
ii	Stranding	37/7/0.417mm
iii	Cross sectional area (Sq.mm)	75.6
iv	Minimum copper equivalent area (Sq.mm)	34Sq.mm
vi	Length of copper cable (mm)	500mm
vii	Material lugs	Tinned Copper
viii	Bolt Size	
	(a) Diameter (mm)	16
	(b) Length (mm)	40
ix	Resistance (Ohm)	0.0004 (as per IS:2121)
x	Total weight of flexible copper bond (kg)	0.45 (approx)

SPECIFICATION FOR LINE & ERECTION

TECHNICAL SPECIFICATION FOR CONSTRUCTION OF 11KV LINES

1.0 GENERAL: The work covered by this Specification is for 11 kV distribution lines as specified herein. The contractor shall conduct the Preliminary survey within one month of the signing of the agreement and detailed survey within three months of the agreement. The Right of way shall be solved by the contractor and all expenses thereof shall be borne by him. However, OWNER shall render all helps in co-ordination with law and order department for solving the same. Involvement of Forest land should be restricted as far as possible.

2.0 SURVEY (detail survey, spotting of Poles & estimating of quantities):

- 2.1 Preliminary survey to find out the alternative routes and detailed survey shall have to be carried out to confirm the Route alignment by the contractor. If the line is passing in any Municipal/ NAC areas permission from local bodies has to be obtained prior to execution of work. Suitable distance from the side of the road has to be made towards placement of line poles.
- 2.2 Provisional quantities/numbers of different types of tower structures/Joist poles/PSC poles have been estimated and indicated in the BOQ Schedule given. However final quantities for work shall be determined by the Contractor, 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 and scope of work.
- 2.3 While surveying the alternative route, the following points shall be taken care by the contractor.
 - (a) The line is as near as possible to the available roads in the area.
 - (b) The route is straight and short as far as possible.
 - (c) 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.
 - (d) The line should be far away from telecommunication lines as reasonably possible. Parallelism with these lines shall be avoided as far as practicable.
 - (e) Crossing with permanent objects are minimum but where unavoidable preferably at right angles.
 - (f) Difficult and unsafe approaches are avoided.
 - (g) The survey shall be conducted along the approved alignment only.

- (h) For river crossing/ Crossing of Nallas : Taking levels at 5 meter interval on bank of river and at 20 meter interval at bed of river so far as to show the true profile of the ground and river bed 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.

The Contractor shall submit three alternate route alignments on toposheets for approval of the Engineer- in-charge. After approval of route alignments drawing, the Contractor shall do the detail survey.

2.4 Optimization of Pole Location

2.4.1 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.

2.4.2 Road Crossings:- At all road crossings guarding should be provided. There should absolutely no joints in the conductors in all road, power line and all other major crossing. The ground clearance from the road surfaces under maximum sag condition shall be not less than 8.5mtr over roads. In National Highway the minimum height of guarding at the maximum sagging point should not less than 8.5 mts.

2.4.3 Railway Crossings- The railway crossing shall be carried out in the underground 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. The crossing shall be done as per Rly Guide lines. 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.

2.4.4 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.

2.5 Details En-route

All poles on both sides of all the crossings shall be tension poles i.e. disc type insulators shall be used on these poles. At all the crossing described above the contractor shall use protective guarding as per REC Construction Standard A-1 to fulfill statutory requirements for 11 kV & 33 KV trunks & main spur line. 11kV & 33 KV branch spur line, being in the village, protective guarding shall be used wherever it will be required.

Clearance from Ground, Building, Trees etc. – Clearance from ground, buildings, trees and telephone lines shall be provided in conformity with the Indian Electricity Rules, 1956 as amended up to date. The vendor shall select the height of the poles in order to achieve the prescribed electrical clearances.

2.6 Final Schedule

After detail survey, the Contractor shall submit the profile, final schedule including Bill of quantity indicating location of poles specifically marking locations of failure containment pole/structure, 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 soft copy in CD to OWNER for record purpose.

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 suitable wooden/iron pegs shall be driven firmly at the intermediate points.

3.0 CHECK SURVEY

The contractor shall undertake the check survey during execution on the basis of the alignment profile drawing and tower schedule approved by the Owner. 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 Owner.

4.0 POLE FIXTURE AND ACCESSORIES

4.1 Danger Boards

The vendor shall provide & install danger plates on all 11 kV line , DP structures, 4 pole structures, H pole structures and towers. The danger plates shall conform to REC specification No. 57/1993.

4.2 Anti-climbing Devices

The vendor shall provide and install anti-climbing device on all DP structures, 4 pole structures ,towers and at all poles as per CEA guide line. This shall be done with G.I. Barbed wire or modified spikes. The barbed wire shall conform to IS-278 (Grade A1). The barbed wires shall be given chromatin dip as per procedure laid down in IS: 1340.

4.3 Fittings Common to all Line

Pin Insulator Binding: The contractor shall use AL. Binding wire for binding shall be as per REC Construction Standards No. C-5 or better thereof.

Mid Span Compression Joint & Repair Sleeves: The contractor shall supply & install the Mid Span Compression Joint and Repair Sleeves as per IS: 2121 (Part II).

Guy/Stay wire Clamp: The contractor shall supply & install Guy/Stay wire Clamp as per REC Construction Standard G-1 or better..

4.4 Stay/Guy Sets

a) The Stay/Guys shall be used at the following pole locations;

At all the tapping points & dead end poles

At all the points as per REC construction dwg. No. A-10 (for the diversion angle of 10-60 degree)

Both side poles at all the crossing for road, nallaha, railway crossings etc.

b) The arrangement and number of stay sets to be installed on different pole structures shall be as per REC Construction Standards no. A-23 to A-27, G-5 & G-8. However, this shall be decided finally during erection, as per the advice of Engineer.

c) The stay set to be installed complete in all respect and would broadly consist of following items:

7/10 SWG G.I. Stay wire for 11 kV lines as per REC Specification No.46/1986. Stay Insulator type C for 11 kV line as per REC Specification No. 21/1981, Turn Buckle. Anchor rod and plate (Hot Dipped galvanized). Thimbles and Guy Grip Complete stay set shall be as per REC Construction Standards no. G-1. The stay clamp is envisaged as GS structure along with other clamps brackets etc.

4.5. Erection of stay sets

The contractor shall install the stay set complete in all respect. This includes excavation of pit in all kinds of soil with PCC in the ratio 1:2:4 as specified which shall be placed in the bottom of the pit.

The rest (upper half) of the pit shall be filled with excavated soil duly compacted layer by layer. An angle between 30 to 45 degrees shall be maintained between stay wire and the pole. The stay wire shall be used with a stay insulator at a height of 5 mts. above ground level with F.I. turn buckle.

5.0. Stringing and Installation of Line with Conductors.

5.1 General

The scope of erection work shall include the cost of all labour, tools and plants such as tension stringing equipment and all other incidental expenses in connection with erection and stringing work. The Bidders shall indicate in the offer the equipment he would deploy exclusively for work under each package. The stringing equipments shall be of sufficient capacity to string AAA conductor.

The Contractor shall be responsible for transportation to site of all the materials to be provided by the Contractor as well as proper storage, insurance etc. at his own cost, till such time the erected line is taken over by the owner.

Contractor shall set up required number of stores along the line and the exact location of such stores shall be discussed and agreed upon with the owner.

5.2 Insulator Fixing

Pin insulators shall be used on all poles while strain insulators shall be used on all angle & dead end poles. Special type Pin Insulators should be used for conductors more than 100 mm². In coastal districts of Balasore, Bhadrak, Jajpur, Kendrapara, Jagatsinghpur, Cuttack, Khurdha, Puri and Ganjam polymer insulators shall be used. Damaged insulators and fittings, if any, shall

not be used. Prior to fixing, all insulators shall be cleaned in a manner that shall not spoil, injure or scratch the surface of the insulator, but in no case shall any oil be used for this purpose. Torque wrench shall be used for fixing various line materials and components, such as suspension clamp for conductor, whenever recommended by the manufacturer of the same.

5.3 Running Out of the Conductors

The contractor shall be entirely responsible for any damage to the pole or conductors during stringing. The conductors shall be run out of the drums from the top in order to avoid damage to conductor

A suitable braking device shall be provided to avoid damaging, loose running out and kinking of the conductors. Care shall be taken to ensure that the conductor does not touch and rub against the ground or objects, which could scratch or damage the strands.

The sequence of running out shall be from the top to down i.e. the top conductor shall be run out first, followed in succession by the side conductors. Unbalanced loads on poles shall be avoided as far as possible.

Wherever applicable, inner phase off-line conductors shall be strung before the stringing of the outer phases is taken up.

When lines being erected run parallel to existing energized power lines, the Contractor shall take adequate safety precautions to protect personnel from the potentially dangerous voltage build up due to electromagnetic and electrostatic coupling in the pulling wire, conductors and earth wire during stringing operations.

The Contractor shall also take adequate safety precautions to protect personnel from potentially dangerous voltage build up due to distant electrical storms or any other reason.

5.4 Repairs to Conductors

The conductor shall be continuously observed for loose or broken strands or any other damage during the running out operations. Repair to conductors, if necessary, shall be carried out with repair sleeves and not more than one repair sleeve will be used in one span.

Repairing of the conductor surface shall be carried out free of cost only in case of minor damage, scuff marks, etc. The final conductor surface shall be clean,

smooth and free from projections, sharp points, cuts, abrasions etc. After compression the sharp edges must be smoothened by filing.

The Contractor shall be entirely responsible for any damage to the poles, insulators etc during stringing.

5.5 Stringing of Conductor

The stringing of the conductor shall be done by the standard stringing method. The Bidder shall submit complete details of the **stringing method** for owner's approval. Conductors shall not be allowed to hang in the stringing blocks for more than 96 hours before being pulled to the specified sag.

Derricks/ scaffoldings or other equivalent methods shall be used to ensure that normal services are not interrupted and any property is not damaged during stringing operations for roads, telecommunication lines, power lines and railway lines. However, shut-down shall be obtained when working at crossings of overhead power lines. The contractor shall make specific request for the same to the owner.

5.6 Jointing

When approaching the end of a drum length at least three coils shall be left in place when the stringing operations are stopped. These coils are to be removed carefully, and if another length is required to be run out, a joint shall be made as per the recommendations of the conductor manufacturer.

Conductor splices shall not crack or otherwise be susceptible to damage during stringing operation. The Contractor shall use only such equipment/methods during conductor stringing which ensures complete compliance in this regard.

All the joints on the conductor shall be of compression type, in accordance with the recommendations of the manufacturer, for which all necessary tools and equipment like compressors, dies etc., shall be arranged by the contractor. Each part of the joint shall be cleaned by wire brush till it is free of rust or dirt, etc. This shall be properly greased with anti-corrosive compound if recommended by the manufacturer, before the final compression is carried out with the compressors.

All the joints or splices shall be made at least 30 meters away from the pole. No joints or splices shall be made in spans crossing over main roads, railway line and SmallRiver spans. Not more than one joint per conductor per span shall be allowed. The compression type fittings shall be of the self centering type or care shall be taken to mark the conductors to indicate when the fitting is centered properly.

During compression or splicing operation, the conductor shall be handled in such a manner as to prevent lateral or vertical bearing against the dies. After compressing the joint, the Aluminium sleeve shall have all corners rounded; burrs and sharp edges removed and smoothened.

To avoid any damage to the joint, the contractor shall use a suitable protector for mid span compression joints in case they are to be passed over pulley blocks/aerial rollers. The pulley groove size shall be such that the joint along with protection can be passed over it smoothly.

In AAAC each press should overlap 25% of the previous press.

5.7 Tensioning and Sagging Operations:

The tensioning and sagging shall be done in accordance with the approved stringing charts or sag tables.

The sag shall be checked in the first and the last section span for sections up to eight spans and in one additional intermediate span for sections with more than eight and sagging operations shall be carried out in calm weather when rapid changes in temperature are not likely to occur.

5.8 Clipping In

Clipping of the conductors into position shall be done in accordance with the manufacturer's recommendations. Jumpers at section and angle towers shall be formed to parabolic shape to ensure maximum clearance requirements. Pilot pin insulator shall be used, if found necessary, to restrict jumper swing & to ensure proper clearance to design values.

Fasteners in all fittings and accessories shall be secured in position. The security clip shall be properly opened and sprung into position.

5.9 Fixing of Conductors Accessories

Conductor accessories supplied by the Contractor shall be installed by the Contractor as per the design requirements and manufacturer's instructions.

While installing the conductor accessories, proper care shall be taken to ensure that the surfaces are clean and smooth and that no damage occurs to any part of the accessories or of the conductors.

5.10 Replacement:

If any replacements are to be effected after stringing and tensioning or during maintenance e.g. replacement of cross arms, the conductor shall be suitably tied to the pole at tension points or transferred to suitable roller pulleys at suspension points.

5.11 Normal Span length

1. Normally the span length is to be kept 50 mtr, But where there is way leaf problem, the span length can be modified by maintaining minimum ground clearance.
2. Three cut points have been considered in every km.

6.0 WAY-LEAVE AND TREE CUTTING

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. Owner may extend help to get the permission within a reasonable time as mutually agreed upon 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.

The Owner 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.

The contractor shall take necessary precaution to avoid damage to any ripe and partially grown crops and in the case of unavoidable damage, the Owner shall be informed and necessary compensation shall be paid by the contractor.

All the documents required for application to the statutory authorities must be prepared by the contractor & submitted to the Owner for submission of the application towards approval of Railway Crossing etc. However, the responsibilities lie with the contractor to get the clearance.

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 Owner 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.

7.0 SUB-SOIL INVESTIGATION (In case of river crossing locations/other locations where PILLING may be required)

To ascertain soil parameters in locations where higher tower either 220KV (UR+6) or 132 KV type tower (PC+6) of OPTCL design, will be required in order to get adequate ground clearance, the contractor shall carry out sub-soil investigation through reputed soil consultant as approved by the Owner.

7.1 SCOPE OF WORK

The scope of sub-soil investigation covers execution of complete soil exploration for the transmission line under this contract including boring, drilling, collection of undisturbed soil sample where possible, otherwise disturbed samples, conducting laboratory test of soil samples to find out the various parameters as detailed in this specification and submission of detailed reports in 6 copies along with specific recommendation regarding suitable type of foundation for each bore-hole along with recommendation for soil improvement where necessary.

7.2 TEST BORING

The boring shall be done at the major locations / crossing of special towers. However, it is desirable that all special towers in river X-ing spans, sub-soil investigation bore-hole will be required.

The test boring through different layers of all kinds of soil shall have to be carried out by the contractor through the approved soil consultant as briefed hereunder.

- (a) Method of boring, selection of sampling tubes, sampling, recording of boring, protection, handling, leveling of samples shall be done as specified in IS: 1892/1977, The contractor/consultant shall furnish in the soil report the, the equipment and method of boring adopted.
- (b) Depth of boring below ground level shall be normally 15 Mts to 25 Mts., in river crossing locations. In other location it shall be 4 mtr .

- (c) Undisturbed soil samples shall be obtained for the initial 4M depths at every 1.5M interval and at change of strata. After these initial 4M depths, samples shall be obtained preferably at every 3M or where there is a change of strata, or as advised by the Owner.
- (d) In case collection of undisturbed samples becomes difficult/impossible detailed soil testing on remolded soil samples is to be considered and reported in the soil report.
- (e) Standard penetration test as per IS: 2131 with latest amendment shall have to be conducted in different strata and recorded properly.
- (f) The ground water table shall be recorded during boring operation and incorporated in the bore log. If possible, the position of the water table just after monsoon period be ascertained from local people and indicated in the report.

7.3 LABORATORY TESTS

The method and procedure of testing of soil sample to be followed shall be as per relevant IS codes. Adequate volume of test samples shall be collected from site. Sample shall be properly sealed immediately after recovery as specified in relevant IS code and transported carefully to laboratory for carrying out necessary laboratory tests. Date and time of taking of the sample shall be recorded in the test report.

7.4 REPORT ON SUB-SOIL INVESTIGATION

The contractor shall make analysis of soil samples collected by him in the field and approved by the Owner. A comprehensive report shall have to be prepared by him, finally incorporating all the data collected in proper tabular forms or otherwise along with the analysis.

Three copies of report in the draft form shall be submitted for Owner's approval. Three copies of final report incorporating Owner's comments, if any, shall be submitted within one week after completion of this work.

8.0 CONDUCTOR

AAAC conductors of 100 Sq mm (7/4.26) AAAC will be used in 11 KV trunk lines and that of 55 sq mm mm (7/3.15) AAAC will be used in 11 KV spur lines.

8.1 CLEARANCE FROM GROUND, BUILDING, TREES ETC.

8.2 Clearance from ground, buildings, trees and telephone lines shall be provided in conformity with the Indian Electricity Rules, 1956 as amended up

to date. The bidder shall select the height of the poles such that all electrical clearances are maintained.

8.3 Guarding mesh shall be used in all electric line / telecom line / road / drain / canal crossing and at all points as per statutory requirements. The bidder shall provide & install anti climbing devices and danger plates on all poles. Where there is no such provision in the existing line.

8.4 Pole accessories like danger plates, and number plates shall be provided as per REC Standard.

8.5 TOWERS/ POLES

Support Structures may be of lattice type or joist or PSC poles. The total steel structures to be inducted to the existing or as additional features should be Galvanized with minimum zinc coating of 610 gms / Sq. Mts. In case of 11KV lines the conventional PSC poles shall be used in rural areas . No more MS poles without Galvanization will be used. For easy transportation two pieces of galvanized poles with single splice joint using galvanized sections of channels/angles/plates of adequate size along with required size GI bolt nuts & spring washers is to be adopted. Full length welding is to be done on either side in the base level. The materials must conform to IS: 800. All the test on materials and fabrication etc will be as per the relevant Indian standards

In different crossings the contractor shall take into consideration the prevailing regulations of the respective authorities before finalizing type and location of the towers. While carrying out survey work, the contractor has to collect all relevant data, prepare and submit drawings in requisite number for obtaining clearance from road, aviation, railways, river and forest authorities.

9.0 ERECTION WORK

When the survey is approved, the contractor shall submit to the Owner a complete detail schedule of all materials to be used in the line. Size and length of conductor etc. are also to be given in the list. This schedule is very essential for finalizing the quantities of all line materials. The contractor shall furnish the same.

9.1 SCHEDULE OF ERECTION PROGRAMME

After due approval of the detailed and check survey, the contractor shall submit to the Owner a complete detailed schedule of erection programme with a Bar-Chart for construction of the lines indicating therein the target date of completion.

9.2 DRAWINGS FOR TOWER AND FOUNDATIONS

Indicative drawings of poles, structures etc with foundation have been provided by OWNER in the bid document. Other drawings shall be submitted by the contractor for approval by the OWNER.

10.0 CONSTRUCTION OF FOUNDATION FOR TOWER, G.I (RS Joist) POLES AND PSC POLES

10.1 ERECTION OF POLE, CONCRETING OF POLES AND COMPACTION OF SOIL

Drawing for the excavation of pits, Foundation of soil is enclosed which are to be adopted. If better design with less volume approved or tested by any other distribution agencies will also be acceptable.

10.2 Following arrangement shall be adopted for proper erection of poles wherever necessary and properly compacting of the soil around the base / foot of the poles, under this package.

- (a) Excavation has to be done as per the drawing to the required depth and size. After final excavation the pit should be dressed properly so that uneven portion and loose soil should be removed before PCC (**M-7.5**) of thickness 75 mm is laid. The base footing of the PSC pole concreting shall be PCC (1:2:4) and for RS Joist it shall be (1:1.5:3) with proper alignment and verticality.
- (b) The verticality and leveling of pole/structure should be done by the help of plumbob or with theodolite and leveling instrument.
- (c) In case of Joist pole Base clits and in case of PSC pole GI base plate(500x500x10)mm shall to be provided over the Lean concrete.

10.3 CEMENT CONCRETE (PLAIN OR REINFORCED), STUB SETTING GROUNDING AND BACK FILLING etc.

A) Materials

All materials whether to be consumed in the work or used temporarily shall conform to relevant IS specification, unless stated otherwise, and shall be of the best approved quality.

B) Cement

Cement to be used in the work under the contract shall generally conform to IS:269/455-1989. Cement bags shall be stored by the contractor in a water tight well ventilated store sheds on raised wooden platform (raised at least 150

mm above ground level) in such a manner as to prevent deterioration due to moisture or intrusion of foreign matter. Cements to be used within three months from the date of manufacture. Sub-standard or partly set cement shall not be used and shall be removed from the site by the contractor at his cost .

- C) Coarse Aggregates i.e Stone chips or stone ballast. For M15 concrete (mix 1:2:4) the aggregate will be in the ranges from 12mm to 20mm.size and for M7.5 concrete (mix 1:4:8) these will be from 25mm to 40mm size.

D) **Pole erection**

1. **After proper alignment**, checking of verticality and leveling, the pole or structure should be properly tied before placing of base concrete of required height. Again the verticality and leveling should be checked.
2. **The RCC pedestal concrete** (M-15) is to be done by providing good quality of shutters, so that there will no leakage of cement slurry during concreting. The cooping height should be **450** mm/750 mm above the existing ground level in urban area and in cultivated lands respectively. The top portion of the cooping should be made tapered.
3. **Above** the cooping 450 mm of pole or structure should be painted with double layer of Black Bituminous paints.
4. **All the bolted joints** should be tightened properly by providing suitable size GI Bolt Nuts and Spring washers. After completion of erection works all the bolts should be spot welded in order to avoid theft of members.
5. **The back filling** of locations should be done by using the excavated soil only in layers (each layer should not be more than 500 mm) by putting water and ramming by using wooden rammers. In no case stone of size more than 75mm used for back filling.Back-filling has to be done 75mm above ground level or as specified
6. **Curing of concrete** should be done for 28 day continuously. Curing should not be done within 24 Hours of concreting.
7. **All the excess** excavated materials and other unused materials from the concreting site should be disposed of to a suitable site by the contractor.
 - a) Mixer (Running time-2 min.)
 - b) **In case of** hand mixing, 10% extra cement has to be provided.
Hand mixing should be done on GI sheet platform only.
 - c) **Poking rod** may be used for compacting in locations at PSC poles only

- d) **Use of vibrator** for compacting is mandatory.
- e) **Clean water** (free from saline and alkaline) should be used for concreting.
- f) **Aggregates** (both coarse and fine) used should be free from foreign materials.
- g) **Shutters** used should not be removed before 24hrs. of casting.
- h) **In case of** black cotton soil borrowed earth (morum soil mixed with sand is preferable) may be used for back filling.
- i) **Sufficient qty. of water** should be sprinkled over backfilled earth and chimney kept wet by using wet gunny bags.

10.4 All the persons working on tower shall wear safety helmet, safety belt and safety shoes, Similarly all the persons working on ground shall wear safety helmet and safety shoes.

10.5 If there is any LT/HT power line near the vicinity of tower erection, necessary shutdown of the power line shall be obtained in writing from the concerned Agency in order to avoid electrical hazards caused by accidental touching of stay/Guy ropes with power line.

10.6 Safety precaution Safety shall be given utmost importance during stringing. The following need to be ensured.

10.7 Safe working conditions shall be provided at the stringing site.

10.8 Full proof communication through walky- talkie / mobile phones shall be used in order to avoid any damage to workmen or public on ground.

10.9 11Mtr 300 kg PSC pole in straight line and GI RS Joist in DP structure shall be used .

ALUMINIUM BINDING WIRE TECHNICAL SPECIFICATION

1.0 SCOPE :

Scope covers manufacture, testing and supply of 3.53 mm dia Aluminium Binding Wire as per IS 398.

2.0 MATERIALS :

The material comprising the wire shall have the following chemical composition:

Aluminium 99.5% minimum Copper, silicon and iron 0.5% maximum

The surface of the wire shall be smooth and free from all irregularities and imperfections. Its cross sections shall closely approximate that of true circle.

Characteristics of Aluminium Binding wire

Diameter of wire			Cross sectional area of nominal dia. Wires (mm)	Weight of wire kg/km	Breaking Load (kN)
Minimum	Nominal	Maximum			
3.15	3.53	3.55	9.787	26.45	1.57

Inspection and Tests

The following routine checks and tests shall be carried out on 10% of the coils of aluminium binding wire. If any one sample fails to pass any one of the test nominated for that wire, then samples shall be taken from every coil in the consignment and any coil from which a sample proves defective shall be rejected. On no account shall any rejected material be presented for test again unless with the written approval of, and under conditions determined by the Purchaser.

Physical properties

The surface of the finished wires shall be checked to ensure that it is smooth , free from all irregularities, imperfections and inclusions and that its cross section approximates closely that of true circle.

The wire shall be checked to ensure that its diameter and weight are within the values given I the table above characteristic of a aluminium binding wire.

Ultimate tensile strength

When tested on a standard tensile testing machine, the value obtained for the ultimate tensile stress shall not be less than 1.57kN

Wrapping test

The wire shall withstand one cycle of a wrapping test as follows:

The wire shall be closely wrapped round a wire of its own diameter form a close helix of eight turns. Six turns shall then be unwrapped and again closely rewrapped in the same direction as the first wrapping. The wire shall not break or crack when subjected to this test.

Packing & Delivery

The aluminium binding wire shall be delivered in 30m coils, with a permitted tolerance of +5%. Random or non standard lengths shall not be permitted.

Each coil shall be adequately guarded against damage due to transportation and handling and shall have an outer layer of tightly wound polythene tape or be contained in a suitable, transparent plastic bag.

The internal diameter of the wound coil shall not be such as to result in a permanent set in the conductor.

The coils shall be contained in non returnable wooden cases, with a gross weight not in excess of 300 kg. The number of coils contained shall be marked on the outside of each case.

3.0 INSTALLATION OF LINE MATERIALS

3.0.1 Insulator and Bindings- These materials are to be procured from the approved vendors only after type test subsequent to the design approval of OPTCL.

1. In angle locations single tension fittings to be used with 2 nos. 70 KN disc insulators.
2. Suitable pre formed armoured rods should be used in all suspension fittings **in case of higher size Conductors.**
3. Guarding / pilotinsulators at the sharp angle points has to be provided.
4. Four **pair** bolted type (**suitable for M-16 bolts**) tension fittings for AAA conductors has to be used.
5. The “distribution tie “ meant for pin insulator binding should be of no. 6 size and that of soft annealed wire having a minimum length of 3 mtr.
6. Compression type jointing sleeves should be used for jointing of conductors only.

3.0.2 Checking of Suspension Fitting

- a) It shall be checked that there is no damage to any component of hardware fittings.
- b) It shall be verified that all nuts and bolts are tightened properly.

- c) It shall be made sure that all the necessary security pins (split pins) are fixed properly as per approved drawings.

3.0.3 Insulator hoisting

- a) Insulators shall be completely cleaned with soft and clean cloth.
- b) It shall be verified that there is no crack or any other damage to insulators.
- c) It is very important to ensure that 'R' clips in insulator caps are fixed properly.
This is a security measure to avoid disconnection of insulator discs.
- d) Both Arcing horns (both at top & bottom) of each insulators string has to be provided.

Where change of insulators required, prior to fixing, all insulators shall be cleaned in a manner that will not spoil, injure or scratch surface of the insulator, but in no case shall any oil be used for that purpose.

OR (If specified in areas where tower structures can not be used)

Pin insulators shall be used on all poles in straight line and disc insulators on angle and dead end poles. Damaged insulators and fittings, if any, shall not be used. The insulator and its pin should be mechanically strong enough to withstand the resultant force due to combined effect of wind pressure and weight of the conductor in the span.

The pins for insulators shall be fixed in the holes provided in the cross-arms and the pole top brackets. The insulators shall be mounted in their places over the pins and tightened. In the case of strain or angle supports, where strain fittings are provided for this purpose, one strap of the strain fittings is placed over the cross-arm before placing the bolt in the hole of cross-arms. The nut of the straps shall be so tightened that the strap can move freely in horizontal direction.

All materials, which are to be supplied by the contractor should be procured from the approved Manufactures of OWNER 's only. Procurement from any suppliers will not permitted. All the related drawings of materials has to be approved by department. All the materials has to be tested in presence of authorized representative of department as well as officers of third party engaged by Government if any also.

4.0 Handling of Conductor

The Conductor will be supplied by the department from the designated stores of OWNER which the contractor has to lift for the work at their cost. All cares should be taken not to damage conductor surface during transit. Necessary tools and plants for the same has to be effectively used by the agency.

4.0.1 Running Out of the Conductors:

The contractor shall be entirely responsible for any damage to the pole or conductors during stringing. Care shall be taken that the conductors do not touch and rub against the ground or objects, which could scratch or damage the strands.

4.0.2 The sequence of running out shall be from the top to down i.e. the top conductor shall be run out first, followed in succession by the side conductors. Unbalanced loads on poles shall be avoided as far as possible. When lines being erected run parallel to existing energized power lines, the Contractor shall take adequate safety precautions to protect personnel from the potentially dangerous condition.

4.0.3 Monitoring of Conductors during Stringing

- a) The conductor shall be continuously observed for loose or broken strands or any other damage during the running out operations. Repair to conductors, if necessary, shall be carried out with repair sleeves. The final conductor surface shall be clean, smooth and free from projections, sharp points, cuts, abrasions, etc. The Contractor shall be entirely responsible for any damage to the poles during stringing.
- b) Conductor shall be checked constantly as it is unwound from Conductor drum for any broken, damage or loose strand. If any major defect is noticed then the defective portion has to be removed and mid span joint provided. However if the defect is of minor nature i.e. number of damaged strands is not more than $1/6^{\text{th}}$ of the total strands in outer layer, a repair sleeve shall be provided.
- c) M.S.(mid span) Joint shall be provided at least 15 meters away from the line pole..
- d) There shall not be any Mid-Span joint over Rly / River / Main Road Crossing.
- e) Not more than one mid span Joint shall be provided in one span for each conductor.

Rough sagged conductors of one phase shall be simultaneously tightened by which machine fixed on tower till the desired final sag is achieved.

5.0 STRINGING OF CONDUCTOR

- 5.0.1** The works include spreading of conductors without any damage and stringing with proper tension without any kinks/ damage Jumpering at cut points by using two nos., three bolted, PG claps has to be done. **No binding of two conductors with aluminium wires will be allowed.** In each and every joints three bolted very good quality PG clamps should be used wrapping of suitable aluminium tapes if required as per the decision of the EE/DE. The ground & line clearances at road crossings along roads other crossings shall be as mentioned in this specification.(which also should not be less than the relevant clearances mentioned in I.E. rules.)
- 5.0.2** While transporting conductors' drums to site, precautions are to be taken so that the conductor does not get damaged. The drum shall be mounted on cable drum support. The direction of rotation of the drum shall be according to the mark in the drum so that the conductor could be drawn. While drawing the conductor, it shall not rub against surface causing damage. The conductor shall be passed over poles on rubberized or aluminum snatch block (pulley) mounted on the poles for this purpose.
- 5.0.3** The conductor shall be pulled through come-along clamps to string the conductor between the tension locations.
- 5.0.4** Conductor splices shall not crack or otherwise be susceptible to damage in the stringing operation. The Contractor shall use only such equipment / methods during conductor stringing which ensures complete compliance in this regard. All the joints including mid span joints on the conductor shall be of the compression type, in accordance with the recommendations of the manufacturer.
- 5.0.5** All the joints or splices shall be made at least 15 meters away from the pole. No joints or splices shall be made in spans crossing over main roads, railways and small river spans. Not more than one joint per sub-conductor per span. After compressing the joint, the aluminum sleeve shall have all corners rounded; burrs and sharp edges removed and smoothened

The contractor shall remain fully responsible for the exact alignment of the line. If after erection, any tower is found to be out of alignment, the same shall have to be dismantled and re-erected after correction by the contractor at his own cost, risk and responsibility, including installation of fresh foundation, if felt necessary by the Owner.

NB:- 0.5% is the non-accountable allowable wastage (for both sag &wastage) will be permitted

6.0 SUPPLY OF TOWER STRUCTURES FOR THE TRANSMISSION LINES

14.0.1 SCOPE

This specification provides for design, proto fabrication, galvanizing and delivery FOR (destination) of line towers, tower structures(Narrow base& Mini-base in Urban areas and in cross country except special locations) / G.I (RS Joist) poles/ PSC pole, stubs, tower extensions, stub-templates, tower accessories (Hangers, U-bolts, bird guards, anti-climbing devices), bolts and nuts, step bolts, flat and spring washers etc. as described hereinafter in this volume.**For easy in transportation all GI joist/ channels should be made into two pieces (6&4, 6&5, 7&6 mts) with jointing GI channels plates etc as per sample drawing (which is indicative) subject to approval of OPTCL.**

7.0 TAKING OVER

Tower and tower accessories received at site stores are to be stored item-wise and mark-wise to facilitate joint inspection of the materials (with reference to packing list and detailed order).

If the materials/equipment or any part thereof is damaged or lost during the transit, the replacement of such materials shall be effected by the contractor timely so as to maintain programme of work. However, the line under erection shall be taken over by the purchaser only when the entire line is completed in all respect and made ready for commissioning at rated voltage. Partly erected line will not be taken over.

Taking over of the line shall be in no way relieve the contractor from his responsibility for satisfactory operation of the erected line in terms of the guarantee clause of the specification.

8.0 MATERIALS HANDLING AND INSURANCE

The contractor shall deliver all equipment/materials against this contract to his site stores under cover of Transit Insurance to be taken in his name. Cost of such insurance is to be borne by the contractor.

Cost of transportation of all materials from contractor's store to the site of work as well as department supply items like Transformers, Breakers, CT, PT, ACDB, Isolators, Conductors, AB cables, etc shall be borne by the contractor irrespective of mode of transportation and site condition.

The contractor has to bear the cost of premiums on insurance for all materials, tower accessories and total erection cost of the line including cement, rods for foundation.

It will be the responsibility of the contractor to report to the concerned Police Station about all incidents of thefts and lodge, pursue and settle all claims with Insurance Company in case of damage/loss due to theft, pilferage, flood and fire etc. and the Owner of the work shall be kept informed promptly in writing about all such incidents. The loss, if any, on this account shall be recoverable from the contractor if the claims are not lodged and properly pursued in time or if the claims are not settled by the insurance company due to lapses on the part of the contractor. The contractor shall have to replenish promptly damaged, stolen tower members and accessories conductors, earth wire, hardware's etc. and repair/re-erect the damaged lines, free of cost to the Owner so as to maintain the programme of work. The Owner will not be responsible in any way for such loss of materials.

9.0 Check List

Before the line is offered for taking over and disbursement of final payment subsequent to the materials reconciliations a comprehensive format in shape of check list as shown at schedule C-2 must be filled up and signed by the executing agency.

Schedule C 1 - Earth Wire (In River crossing Spans)

Description (Complete earth conductor)	Unit	GSW
Appropriate Indian Standard No		398(Part-2)
Appropriate British Standard No		183
Material of earth conductor		galvanized steel
Number and diameter of wires	No./mm	7/3.15
Overall diameter of conductor	mm	9.45
Mass of conductor per kilometer	kg	428
Ultimate strength of conductor	Newton	56000
Lay length	mm	160 +/- 15
Direction of the lay of the outer layer		Right hand
Chemical composition of the steel wire	%	
Carbon		not more than 0.55
Manganese		0.4 to 0.9
Phosphorous		not more than 0.04
Sulphur		not more than 0.04
Silicon		0.15 to 0.35
Purity of Zinc for galvanizing	%	99.95
Galvanizing after stranding		
a) Minimum weight of Zinc coating per sq. m. of the uncoated wire surface	gms	240
b) Minimum no. of one minute dips that the galvanized wire can withstand in Standard Preece Test		3 and ½
Maximum length of conductor on drum #	km	4 +/- 5%
D.C. resistance at 20 ° C	ohms/km	3.375

SCHEDULE C - 2

CHECK FORMAT

1. Excavation has been done as per approved drawing of Normal soil. **Yes/ No**
2. PCC has been done as per approved drawing. **Yes/ No**
3. RCC has been done as per approved drawing and as per required Qty. **Yes/ No**
Rods has been provided.
4. laping of rods has been done as per standard (Minimum 40 D). **Yes/ No**
6. Good quality of shutters has been used. **Yes/ No**
6. Is there any honey-combs after removal of shutters observed. **Yes/ No**
7. If honey-combs observed, has been repaired by providing rich Concrete **Yes/ No**
mixture after removal of loose ingredients.
8. Is there any deviation in alignment related to tangent tower. **Yes/ No**
9. Is there any deviation in verticality after concreting.(If any deviation **Yes/ No**
In verticality of pole or tower, the contractor should re-cast the
Foundation free of cost, otherwise it will not to be accepted)
10. Is there any deviation in bi-section of angles of the Angle tower **Yes/ No**
before taking up the concreting of pole or structure.
11. All the GI bolts-nuts of required size with required spring washer **Yes/ No**
has been provided.
12. All the bolts-nuts has been properly tightened (after full tight 3 Nos. **Yes/ No**
threads will be projected out)
13. Cooping of required height (in case of Urban area it is 30 cm, in **Yes/ No**
Cross country it is 75cm) has been done.
14. Painting of pole or structures has been done as per specification. **Yes/ No**
15. Split pins & "I" clips has been provided in each H/W fittings & **Yes/ No**
Insulator strings.
16. All the accessories in each locations has been fixed properly. **Yes/ No**
17. Bird guard has been provided in each tangent towers. **Yes/ No**
18. Anti climbing devices has been provided in each locations. **Yes/ No**
19. All the jumpers has been properly tightened by providing **Yes/ No**
Required nos. of PG clamps(2 nos. PG clamps has to be
Provided per each side)
20. All the insulators and H/W fittings used has been free from all Defects. **Yes/ No**
21. Equal phase to phase clearance has been maintained. **Yes/ No**
22. Minimum ground clearance from bottom most conductor **Yes/ No**
(7 mts. in cross country & 9 mts. In road crossings) has been
maintained in each span.
23. Curing has been done for 28 days. **Yes/ No**
24. Proper back filling has been done as per specification. **Yes/ No**

- | | |
|---|----------------|
| 25. Required earthing has done in every locations. | Yes/ No |
| 26. Material utilization accounts has been furnished.(In each and every Bills should have material accounts of both departmental supply items And contractor's supply items, except civil items, otherwise the bills Will not accepted). | Yes/ No |
| 27. Stay | Yes/ No |
| 28. Guarding at Road Crossing. | Yes/ No |
| 29. Clearance with intercepting lines. | Yes/ No |
| 30. Proper Jumpering. | Yes/ No |

CIVIL WORKS (SUB-STATION)

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1.0 ERECTION WORK

1.1 CIVIL WORKS

Civil works includes the following items:

The scope shall generally cover sub- station structures, including gantries and equipment support structures and their foundations, cable trenches along with covers, cable trench crossings of road and rails, sump pits, marshalling box/control cubicle foundations, switchyard dressing and levelling, site clearance, soil investigation, fencing, gravel filling and, transformer foundations, Any other items, not specifically mentioned here but required for the commissioning of substation shall be deemed to be included in the scope of this Specification. The scope shall further cover design, engineering, erection, testing and commissioning of all civil works at each substation. All civil works shall also satisfy the General Technical Clauses specified in other sections of this specification and as detailed below.

Excavation, dewatering, carriage of excavated earth, plain cement concrete (PCC), casting of reinforced cement concrete (RCC) foundations, super-structures for sub- station structures, equipment supports, their control cubicles, bus post supports, lighting poles and panels, brick and stone masonry, cable trenches, pipe trenches with necessary pre cast RCC removable covers, with lifting facility(In every 5 th slab) and sump pits, cable supports and their embedment in cable trenches and cable trench crossings road or rail track with backfilling complete as per drawings approved by OPTCL, shall be carried out by the contractor.

The Contractor shall furnish all designs, (unless otherwise specified) drawings, labour, tools, equipment, materials, temporary works, constructional plant and machinery, fuel supply, transportation and all other incidental items not shown or specified but as may be required for complete performance of the Works in accordance with approved drawings, specifications and as per direction of the Engg In-charge .

The work shall be carried out according to the design/drawings to be developed by the Contractor, and approved by ODAFFP of 33/11 kV PMU under OPTCL. For all buildings, structures, foundations etc. necessary layout, levels and details shall be developed by the Contractor keeping in view the functional requirement of the plant and facilities and providing enough space and access for operation, use and maintenance based on the Existing Provision. Certain minimum requirements are indicated in this specification for guidance purposes only. However, the Bidder shall quote according to the complete requirements.

2.0 SOIL INVESTIGATION

General

The Contractor shall perform a detailed soil investigation to arrive at sufficiently accurate general as well as specific information about the soil

profile/strata and the necessary soil parameters of the site in order that the foundations of the various structures can be designed and constructed safely and rationally. Foundation systems adopted by the contractor shall ensure that relative settlement shall be as per provision in IS 1904 and any latest IS and other Indian Standards.

A report to the effect will be submitted by the Contractor for the Engg In-charge specific approval giving details regarding his assumed data for Civil structures design.

Any variation in soil data shall not constitute a valid reason for any additional cost and shall not affect the terms and condition of the Contract. Nothing extra what so ever shall be paid to the Contractor on account of any variation in subsoil properties /or conditions. Tests must be conducted under all the critical locations i.e. Control room building & transformer location etc. However, some of the soil parameters given below for substations have to be determined and submitted to Engg In-charge .

- **Recommendation** The report should contain specific recommendations for the type of foundation for the various structures envisaged at site. The Contractor shall acquaint himself about the type of structures and their functions from the Engg In-charge. The observations and recommendations shall include but not be limited to the following :
- Recommended type of foundations for various structures. If piles are recommended the type, size and capacity of pile shall be given.
- Recommendations regarding slope of excavations and dewatering schemes, if required.

Recommendations for additional investigation beyond the scope of the present work, if Contractor considers such investigation necessary

2.1 EXCAVATION AND BACKFILL

Excavation and backfill for foundations shall be in accordance with the relevant Code. Back filled materials in the pit to be levelled maximum up to a height of 200-250 mm and then to be compacted to 150mm after sprinkling of required quantity of water.

Whenever water table is met during the excavation, it shall be dewatered and water table shall be maintained below the bottom of the excavation level during excavation, concreting and backfilling.

blasting for loosening materials, but this will not any way entitle the material to be classified as hard rock.

2.2 Excavations for foundations and other purposes

Excavations shall be of the minimum sizes necessary for the proper construction of the works, and excavations shall not be kept open for periods longer than that reasonably required to construct the works. The Contractor shall take all precautions necessary to ensure that the bottoms of excavations are protected from deterioration and that the excavations are carried out in such a manner that adjacent foundations, pipes or such like are not

undermined, damaged or weakened in any way. Any excavation taken out below the proper level without approval shall be made good at the expense of the Contractor using concrete or other material as directed.

2.3. Support of excavations

The Contractor shall be responsible for the stability of the sides of the excavations. Excavation surfaces shall be close timbered or sheeted, planked and strutted as and when necessary during the course of the work and shall ensure the safety of personnel working within them. If any slips occur, they shall, as soon as practicable, be made good in an approved manner at the expense of the Contractor. Shoring shall not be removed until the possibility of damaging the works by earth pressure has passed. No payment for shoring or timber left in shall be made, unless agreed in writing by the Engg In-charge .

2.4 Works to be in dry

All excavations shall be kept free from water and the Contractor shall take whatever action is necessary to achieve this. Pumping, hand dewatering and other means necessary to maintain the excavations free from water shall be at the expense of the Contractor, and carried out in an approved manner.

2.5 Backfill

As soon as possible after the permanent foundation works are sufficiently hard and have been inspected and approved, backfill shall be placed where necessary and thoroughly consolidated in layers not exceeding two hundred (200) millimetres in depth.

On completion of structures, the earth surrounding them shall be accurately finished to the line and grade as shown on the drawings. Finished surfaces shall be free of irregularities and depressions.

The soil to be used for back filling purposes shall be from the excavated earth or from borrowed pits, as directed by the Engg In-charge .

2.6 Disposal of surplus

Surplus excavated material not required or not approved for backfilling shall be loaded and deposited either on or off site as directed. The Contractor shall not delay disposal of surplus material after receipt of instructions from the Engg In-charge .

2.7 Requirement for fill material under foundations

The thickness of fill material under the foundations shall be such that the maximum pressure from the footing, transferred through the fill material and distributed onto the original undisturbed soil will not exceed the allowable soil bearing pressure of the original undisturbed soil.

Where compacted fill is required it shall consist of suitable sand, or other selective inorganic material, RRHG mixed with sand subject to approval by the Engg In-charge . The filling shall be done with locally available sand. The filled in sand shall be kept immersed in water for sufficient time to ensure compaction, if so desired by the Engg In-charge .

3.0 SITE LEVELLING

3.1 Scope of Work

The contractor shall furnish all labour, equipment and materials required for complete performance of the work in accordance with the drawings, specification and direction of the Engg In-charge .Contour survey of proposed sub-station area has to be done by taking levels at an interval of two meters in both the ways in the presence of Engg-in -charge. The detail contour survey should be traced over the tracing graph paper and to be submitted to Engineer-In-Charge for approval .

3.2 General Requirement

The material required for site surfacing/gravel filling shall be free from all types of organic materials and shall be of standard approved quality, and as directed by the Engg In-charge .

The Contractor shall furnish and install the site surfacing to the lines and grades as shown in the drawing and in accordance with the requirements and direction of the Engg In-charge . The soil of the entire switchyard area shall be levelled before placing the site surfacing/gravel fill material. After all the structures and equipment have been erected and accepted the site shall be maintained to the lines and grades indicated in the drawing and rolled or compacted with suitable water sprinkling to form a smooth and compact surface condition, which shall be matching with finished ground level of the switchyard area. After due compaction of the surface of the entire switchyard area shall be provided with plain cement concrete of 75 mm thickness (1:3:6) mix. after proper compaction. Care shall be taken for proper gradient for easy discharge of storm water.

After the PCC is applied and surface prepared to the required slope and grade a base layer of uncrushed/crushed broken gravel of 20 mm nominal size shall be spread, rolled and compacted to a thickness 100 mm. The 20 -40 mm. nominal size (for both layers) shall pass 100% through IS sieve designation 37.5 mm and nothing through 16.0 mm. IS sieve.

4.0 CABLE TRENCHES

4.1 General

The cable trenches should be primarily of Brick masonry `supported with RCC pillars 250*250mm at an interval of 2500mm over 75 mm RCC base. In each pillar, 2 nos of MS flats of 50*6*200mm shall be suitably embedded to hold 2nos of cable racks. The cable trench wall inside the control room will be of 100mm thick RCC only. The top of the cable trench should be RCC to hold the RCC covers (as per the approved drawing, enclosed). For main power cables separate cable trench should be made.

Cable trenches and pre-cast removable RCC covers (with lifting arrangement) shall be constructed using RCC of M20 grade.

The cable trenches shall be designed for the following loads.

- Dead load of 155 kg/ m length of cable support plus 75 kg on one tier at the end.
- Cable trench covers shall be designed for (i) self weight of top slab plus concentrated load of 200 kg at centre of span on each panel and a surcharge load of 2 tonnes per sq. metre.

Cable trench crossings of roads should be designed accordingly and to be submitted to EE/DE for approval. Trenches shall be drained. Necessary sumps be constructed and sump pumps shall be supplied. Cable trenches shall not be used as storm water drains.

The top of trenches shall be kept at least 300 mm above the finished ground level (FGL). The FGL means the finish level of the soil but not the top of metalling surface. The top of cable trench shall be such that the surface rain water does not enter the trench.

All metal parts inside the trench shall be connected to the earthing system.

Cables from trench to equipments shall run in hard conduit pipes (GI pipe and necessary G.I bends and sockets)

A suitable clear gap shall be maintained between trench walls and foundations.

A clear (vertical) space of at least 200 mm shall be available for each tier in cable trench. From trench bed to lowest tier, a minimum clearance of 100 mm shall be available for all tier trench. The spacing between stands (cable tray supports) shall be 2000mm. No sharp bending of cable trench is permissible, it should be done as per 15D principle.

The trench bed shall have a slope of 1/500 along the run and 1/250 perpendicular to the run.

Cable tray supports (all galvanised structures) shall be designed and constructed to be a single complete fabrication or assembly such that every layer of the horizontal cable tray supports are fixed, either bolted or welded, to a vertical steel support that is embedded in the concrete wall of the cable trough. It shall not be permitted to embed a horizontal support beam directly into the wall of the trough in order to use the concrete wall as a means of load bearing.

Concrete troughs shall be provided with concrete covers of suitable load bearing strength. Where the cable troughs are run across or within 3 m of substation roads, the trough covers shall be capable of bearing an accidental wheel load of 20 kN. The drawings showing the details of fixing of cable racks in concrete cable trench walls, fixing of cable tray, no. of layers to be provided has to be provided by the contractor and to be get approved by the GM o/o CPIO.

The thickness of the RCC wall of the trench shall be 100mm and thickness of the raft shall be 75mm. All the frames for fixing of cable trays shall be of hot dip galvanized. A running earth strip has to run all through the cable trench for proper earthing of the cable trays and stand (frame). The size of the earth strip

is of 50X6mm G.I flats. Welding the GI flats to the frame to be carried out. Earthing strips to be welded with the running earth mat at 10mtrs interval.

The bidder also to supply and fix G.I perforated cable trays (of thickness 2mm) of appropriate size before laying of cables on the cable tray stand.

The covers of the slab are also of RCC with ratio mixing 1:2:4. The thickness of the slab shall be 50 mm (MS Rods to be used 8mm), The MS rods to be used shall be placed at 100 mm centre to centre both way and properly bided. The cover slab shall have provision of lifting hooks at two points for easy lifting of the slabs. Slabs having lifting hooks shall be placed at every 10th slabs, it should remain inside the top of concrete surface of the slab.

The covers for the cable trench inside the control room shall be provided with GI chequered plate with MS angle stiffeners at the bottom for proper mechanical strength.

Once the trench covers have been made they are to be stored and not laid until all trench cabling, is finished. Any covers laid before this time which become damaged shall be replaced at the Contractor's expense.

Trench covers and bridging beams for covers, except where heavy duty, shall be light enough for two men to lift.

5.0 FOUNDATION DESIGN

5.1 General

The design and construction of RCC structures shall be carried out as per IS 456 and minimum grade of concrete shall be M 20 corresponding to 1:1.5:3 nominal mix ratio with 12-20 mm coarse aggregate. Higher grades of concrete than specified above may be used at the discretion of the Bidder without any financial implication to the owner.

Limit state method of design shall be adopted unless stated otherwise in the Specification.

For design and construction of steel-concrete composite beams IS: 11384 shall be followed.

For detailing of reinforcement IS 2502 shall be followed. Cold twisted deformed bars ($F_y = 415 \text{ N/sq mm}$) conforming to IS 1786 shall be used as reinforcement. However, in specific areas, mild steel (Grade I) conforming to IS 432 can also be used. Two layers of reinforcement (on inner and outer face) shall be provided for wall and slab sections having thickness of 150 mm and above. Clear cover to reinforcement towards the earth face shall be minimum 40 mm.

The procedure used for the design of the foundations shall be the most critical loading combination of the steel structure and /or equipment and /or superstructure, and other conditions which produce the maximum stresses in the foundation or the foundation component, and as per the relevant IS Codes of foundation design. The design calculations shall be submitted by the bidder showing complete details of piles/pile groups proposed to be used.

All foundations shall rest below virgin ground level and the minimum depth of foundation below the virgin ground level (minimum one meter below the virgin ground level) shall be maintained.

Design shall consider any sub-soil water pressure that may be encountered.

Necessary protection to the foundation work, if required, shall be provided to take care of any special requirements for aggressive alkaline soil, black cotton soil or any other type of soil which is detrimental or harmful to the concrete foundations.

5.2 Other Foundations

All foundations shall be designed in accordance with the provisions of the relevant parts of latest revisions of IS 2911 and IS 456.

Type of foundation system i.e. isolated footing, raft or piling shall be decided based on the load intensity and soil strata.

Twin Pole foundations shall be designed for an additional factor of safety of 1.1 for normal/ broken wire conditions and for short circuit condition.

Circuit breaker foundations shall be designed for impact loading and shall be strictly in accordance with the Manufacturer's recommendations.

Switchyard foundation plinths and building plinths shall be minimum 300 mm and 500 mm above finished ground level respectively or as per minimum required safety electrical clearance stipulated in IE Rule.

5.3 Cement

The cement to be used shall be the best quality of its type and must not be more than 3 months old in stock.

All cement shall be sampled and tested in accordance with Indian Standards.

The Portland cement used in concrete shall conform to IS 269.

Requirement of sulphate resistant cement (SRC) for sub structural works shall be decided in accordance with the Indian Standards based on the findings of the detailed soil investigation to be carried out by the contractor.

High Alumina cement shall NOT be used.

5.4 Aggregate

Coarse and fine aggregate shall conform to the requirements of IS 383-1970.

Sampling and testing of aggregates shall be in accordance with the relevant Indian Standard.

Fine and coarse aggregates shall be obtained from the same source and the Contractor shall ensure that material from the source is known to have a good service record over a long period of time.

Aggregate shall be hard and dense and free from earth, clay, loam and soft, clayey, shaley or decomposed stone, organic matter and other impurities.

5.5 Storage of aggregates

Coarse and fine aggregates shall be stored on site in bins or on clean, dry, hard surfaces, and be kept free from all sources of contamination. Aggregates of different gradings shall be stored separately, and no new aggregate shall be mixed with existing stocks until tested, and approved by the Engg In-charge .

5.6 Water

Water used for mixing concrete and mortar shall be clean, fresh water obtained from an approved source and free from harmful chemicals, oils, organic matter and other impurities. Normally potable water may be considered satisfactorily for mixing and curing concrete and masonry work.

5.7 Steel bar reinforcement

Reinforcement shall comply with the appropriate Indian Standards.

All bar reinforcement shall be hot rolled steel except where the use of cold worked steel is specified on the drawings or otherwise approved.

The bars shall be round and free from corrosion, cracks, surface flaws, laminations, rough, jagged and imperfect edges and other defects.

The bar reinforcement shall be new, clean and of the lengths and diameters described on the Drawings and Schedules. Bars shall be transported and stored so that they remain clean, straight, undamaged and free from corrosion, rust or scale. Bars of different diameters shall be separately bundled.

5.8 Welding of reinforcement

Spot or tack welding for positioning bars in heavily reinforced areas will only be allowed with the express permission of the Engg In-charge . Extension of lengths of reinforcement by welding will not be permitted.

Welding will be approved only in low stress members, and lap welding will not be approved in any circumstances.

5.9 Fixing of reinforcement

Before fixing in the works bars shall be seen to be free from pitting, mud, oil, paint, loose rust or scale or other adherents harmful to the bond or strength of the reinforcement. Bars shall be fixed rigidly and accurately in position in accordance with the working drawings, unless otherwise approved by the Engg In-charge . Reinforcement at all intersections shall be securely tied together with 1.5 mm soft annealed tying wire the ends of which shall be cut and bent inwards. Cover to the reinforcement shall be in accordance permissible standard and sufficient spacers and chairs of precast concrete of approved design shall be provided to maintain the specified cover and position. No insertion of bars in previously placed concrete shall be permitted. Projecting bars shall be adequately protected from displacement. The fixing of reinforcement in the works shall be approved by the Engg In-charge before concrete is placed. Measurement will be based on the calculated weights of steel actually used in tonnes corrected to second place of decimal.

Concrete cover to reinforcement

For durability the minimum concrete cover to any reinforcing bar shall be as follows:

Concrete above ground.

- | | |
|---|-------|
| • Internal faces of slabs | 25 mm |
| • Internal faces of beams and walls | 30 mm |
| • Exposed faces of slabs, beams and walls | 50 mm |
| • All faces of columns | 50 mm |

Concrete below ground (including piles).

- Faces in contact with soil including blinding concrete 75 mm
- All other faces (i.e. internal faces of basement wall) 50 mm

Only concrete or steel spacers shall be used to achieve the required minimum thickness of concrete cover to reinforcement. Concrete spacers shall have non metallic ties. Timber blocks for wedging the steel off the formwork will not be allowed.

5.10 Formwork

Formwork shall be constructed from timber, metal, lined as necessary for special finishes and designed with the quality and strength required to ensure rigidity throughout placing, ramming, vibration and setting of the concrete, without detrimental effect.

Formwork shall be erected true to line, level and shapes required using a minimum of approved internal ties. Faces in contact with the concrete shall be true and free from defect, jointed to prevent loss of water or fines, in panels or units which permit easy handling. Ties or spaces remaining embedded shall have the minimum cover specified for reinforcement. Forms for exposed concrete beams, girder casings and columns shall provide for a twenty five millimetre chamfer on external corners.

Wedges and clamps shall be kept tight during vibration operations. Before commencement or resumption of concreting, the interior of forms shall be cleaned and free of sawdust, shavings, dust, mud or other debris and openings shall be formed to facilitate this cleaning and inspection. The inside of the forms shall be treated with a coating of an approved substance to prevent adhesion. Care shall be taken to prevent this substance being in contact with the reinforcement.

5.11 Grades of concrete

Concrete shall be either ordinary or controlled and in grades designated M10, M15, M20 and M25 as specified in IS: 456 (latest edition). In addition, nominal mixes of 1:3: 6 and 1: 4: 8 of nominal size 40 mm maximum, or as indicated on drawings, or any other mix without any strength requirements as per mix design shall be used where specified.

Ordinary concrete

Ordinary concrete shall be used for all plain cement concrete work and where shown on drawings or allowed by the Engg In-charge . Ordinary concrete shall not require preparation of trial mixes.

In proportioning concrete, the minimum quantity of cement shall be as specified in of this clause and the amount to be used shall be determined by actual weight. The quantities of fine and coarse aggregate may be determined by volume, but preferably by weight.

The water cement ratio shall not be more than those specified in IS 456.

Grade of Concrete	Minimum cement content per c.m. of finished concrete
M 10	236 kg
M 15	310 kg
M 20	400 kg

As a guide to perform the mix design properly, the relationship between water cement ratio, aggregate to cement ratio, workability and strength of concrete will be as per relevant IS.

The cement /total aggregate ratio is not to be increased beyond 1: 9.0 without specific permission of the Engg In-charge . It should be noted that such high aggregate/cement ratios will be required for concretes of very low slump and high water cement ratios which may be required to be used in mass concrete work only.

The actual cement aggregate ratios are to be worked out from the specific gravities of coarse aggregates and sand being used, and from trial mixes.

5.12 Strength requirements

The mix proportions for all grades of concrete shall be designed to produce the grade of concrete having the required workability and a characteristic strength not less than the value given below:

Grade Designation	Characteristic Compressive Strength at 28 days
M 10	10 N / sq. mm
M 15	15 N / sq. mm
M 20	20 N / sq. mm

The strength of concrete given above is the 28 days characteristic compressive strength of 15 cm cube.

The placing of concrete shall be a continuous operation with no interruption in excess of 30 minutes between the placing of continuous portions of concrete. When fresh concrete is required to be placed on previously placed and hardened concrete, special care should be taken to clean the surface of all foreign matter. For securing a good bond and water tight joint, the receiving surface should be made rough and a rich mortar placed on it unless it has been poured just before. The mortar layer should be about 15 mm thick with cement and sand proportion as that of the mix in use, and have the same water-cement ratio as the concrete to be placed.

After the concrete has been placed it shall be thoroughly compacted by approved mechanical vibration to a maximum subsidence without segregation and thoroughly worked around reinforcement or other embedded fixtures into the correct form and shape. Vibrators must be operated by experienced men

and over vibration shall not be permitted. Care should be taken to ensure that the inserts, fixtures, reinforcement and formwork are not displaced or disturbed during placing of concrete. No concrete shall be placed in open while it rains. If there is any sign of washing of cement and sand, the concrete shall be entirely removed immediately. Slabs, beams and similar structure shall be poured in one operation normally. In special circumstances with the approval of Engg In-charge these can be poured in horizontal layers not exceeding 50 cm. in depth. When poured in layers, it must be ensured that the under layer is not hardened. Bleeding of under layer if any shall be effectively removed.

5.13 Compaction of Concrete

Compaction is necessary for production of good concrete. After the concrete has been placed it shall be thoroughly compacted by approved mechanical vibrator to a maximum subsidence without segregation and thoroughly worked around reinforcement or other embedded fixtures into the correct form and shape. Vibrators must be operated by experienced men. Care should be taken to ensure that the inserts, fixtures, reinforcement and formwork are not displaced or disturbed during the vibration of the concrete. The Contractors shall provide standby vibrators. Vibration is commonly used method of compaction of concrete, the use of mechanical vibrators complying with IS 2505, IS 2506, IS 2514 and IS 4656 for compacting concrete is recommended. For all practical purposes, the vibration can be considered to be sufficient when the air bubbles cease to appear and sufficient mortar appears to close the surface and facilitate easy finishing operations. The period of vibration required for a mix depends upon the workability of the mix.

5.14 Curing of Concrete

In order to achieve proper and complete strength of the concrete, the loss of water from evaporation should be prevented. Eighty to eighty five per cent of the strength is attained in the first 28 days and hence this 28-day strength is considered to be the criterion for the design and is called characteristic strength. The concrete after setting for 24 hours shall be cured by keeping the concrete wet continuously for a period of 10 days after laying.

The curing increases compressive strength, improves durability, impermeability and abrasion resistance. Failure to carry out satisfactory curing can lead to cracking in the concrete. This in turn can lead to salt attack of the reinforcement and consequential failure of the structure. If cracks occur in a structure which are severe enough to affect the structure, the Contractor shall cut out and replace the defective concrete at his own cost. The Contractor's attention is, therefore, drawn to this particular aspect of proper and adequate curing

5.15 Removal of formwork

Formwork shall be kept in position fully supported, until the concrete has hardened and gained sufficient strength to carry itself and any loads likely to be imposed upon it. Stripping must be effected in such a manner and at such a time

that no shock or other injury is caused to the concrete. The responsibility for safe removal rests with the Contractor but the Engg In-charge may delay the time of striking if he deems it necessary.

Minimum periods, in the absence of agreement to the contrary, between completion of concreting and removal of forms are given below but due regard must be paid to the method of curing and prevailing conditions during this period.

Removal of forms are to be done as under

- | | |
|---|--------|
| i) Sides of foundations, columns, beams and wall | 2days |
| ii) Under side of slabs up to 4.5 m span | 7days |
| iii) Under side of slabs above to 4.5 m span | |
| and underside of beams and arches up to 6m span | 14days |
| iv) Under side of beams and arches above 6m and up to 9m span | 21days |

6.0 EARTHING :

Earth Grid should not be more than TWO meters square. This should be done by using 75x10 mm GI flats. Earth risers should be 50x6 mm GI flats. All equipments & metal parts of the Sub-Station should be connected with main earth grid by using 50x6 GI flats at two different places. The main earth grid should be laid not less than 600 mm below the finished ground level. The lap welding should not less than 100 mm. The welding of joints should be done after removal of Zinc by using Blow lamps. Welding should be done in all four sides and should be double layer continuous. Before taking up the second layer welding the deposited flux should be removed. During welding the two flats should be tightened properly by using ' C ' clamps. Immediately after welding two layers of anti-corrosive paints should be painted over the welded portion along with two coats of Black bituminous paints. Before back filling of earth trenches the welded portion should be covered by wrapping with bituminous tape properly and also jointing portion should be covered with PCC (1:2:4) mix. The backfilling of earth pits and trenches should be done with powered loam soil mixed with Bentonate powder (10:1) mix.

All equipments, steel structures etc should be connected with Main earth mat at two rows separately. All LAs, PTs , Columns having spikes should individually connected with individual Pipe electrodes and again should be connected with main earth grid at two separate places. The Neutral of Power Transformer should be connected with two separate pipe electrodes and again connected with main earth electrodes at two separate places. The separation distance between each pipe electrodes should not be less than 2 mts. The back filling of pipe electrodes should be done in layer of Charcoal, Salt & loam soil mixed with Bentonate power.

There should be a closely spaced earth grid (1.5 mts square having .5 mts spacing) below the mechanism boxes of each Isolators & AB switches. In Sub-station the diameter of pipe electrode should not be less than 50 mm. The

Flange(50x6) mm GI flat should be welded in all sides with Pipe electrode. In each face of Flange there should be two nos 17.5 mm hole to accommodate 16 mm GI Bolt nut with 1 no spring washer.

The fencing of sub-station should not directly connected with main earth grid. There should be a separate earth grid (75x10) mm GI flat 2 mts away from fence and should be connected rigidly with the fence at an interval of 5 mts. There should be one 50x6 mm earth flat run over the cable rack and should be connected with main earth grid at an interval of 5 mts The jointing portion of earth flats over the ground should be painted with two coats of Anti-corrosive paints and two coats of good quality of Aluminium paints (Berger/Asian paints).

The water hydrant system should be provided in the areas where earth resistivity more and soil is latetarite and sandy in nature (Areas like BBSR, Khurda , Puri etc) as per the direction of Engineer in charge. Each handles of Isolators/AB switches etc should be connected with earth grid by using flexible Tinned Copper earth bonds. In each earth switches TWO nos flexible earth bonds should be provided. Each earth pits having pipe electrodes should be provided 250 mm Brick wall chambers with RCC cover Slab.

6.1 (A) G.I. Flat (75x 10 mm) & G.I.Flat (50 x 6 mm)

The specification covers manufacture, testing and supply of Galvanized Steel flat for Earthing arrangements.

I. APPLICABLE STANDARDS:

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 M.S Channel & M.S. Flat
2	IS:2062	Chemical and Physical Composition of material
3	IS:1852	Rolling and Cutting Tolerances for Hot Rolled Steel products

II. RAW MATERIAL :

The steel section shall be re-rolled from the BILLETS/INGOTS of tested quality as per latest version of IS: 2830 or to any equivalent International standard and shall be arranged by the bidder from their own sources. The chemical composition and physical properties of the finished materials shall be as per the relevant standards.

III. PHYSICAL & CHEMICAL PROPERTIES

Length

The GS Flat to be supplied shall be in 5.5 meters to 13 meters lengths.

Weighment

The weighment of GS Flat 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.

Chemical composition and physical properties of M.S.Channels and M.S.Flat conforming to IS: 2062/84L composition.

Chemical Composition		For Fe 410 WA Grade
1	C -	0.23% MAX.
2	Mn -	1.5% MAX.
3	S -	0.050% MAX.
4	P -	0.050% MAX.
5	SI -	0.40% MAX.
6	CE -	0.42% MAX.
(Carbon Equivalent)		

IV. Mechanical Properties

1.	Tensile strength Kgf/mm ²	- 410
2.	Yield stress Min. for thickness/diameter	
	<20 mm	26 Kgf/mm ² OR 250N/mm ²
	20-40 mm	24Kgf/mm ² OR 240N/mm ²
	40 mm	23Kgf/mm ² OR 230N/mm ²
3.	Elongation %	23%
4.	Bend Test (Internal Dia)	Min-3t (this the thickness of the material)

V. MARKING

As per the General Technical Clause & Design (E2), It is desirable that the Bidders should put his identification marks on the finished materials.

VI. METHOD OF GALVANISING:

Sl. No.	Tests	For GI Flat
1	Dip test	6 dips of 1 min each
2	Mass of Zinc coating	610 gram/sq.m minimum

Pre dispatch inspection shall be performed to witness following tests:

Freedom from defects,
Verification of dimensions
Galvanization tests
Mechanical tests

Chemical composition tests

These tests are to be performed and certified at Govt. recognized laboratory.

MS flat shall conform to IS 2062 & its latest amendments for steel & Galvanization as per IS 4759 & its Latest amendments.

The flat shall be coated with Zn 98 Zinc grade.

The minimum Zinc coating shall be 610 gm/sqm for thickness more than 5 mm and 460 gm/sqm for item thickness less than 5 mm.

VII. Inspection & Rejection :

The representative of Purchaser shall pick up samples at random from the GI Flats offered for carrying out routine tests as per specified IS.

The representative shall make visual inspection on each & every GI flats.

The purchaser reserves the right to reject on inspection after the same is received at destination.

6.2 (C) Earth Electrode (50/40 NB 3.0 Mtr Length)

I. Qualification Criteria of sub vendor / Manufacturer:-

The prospective bidder may source Earth Electrode from sub vendors / manufacturers who must qualify all the following requirements :

a) The sub vendor /manufacturer must have successfully carried out Type Test of similar item from any NABL Accredited Laboratory within the last 5 years, prior to the date of submission of the bid.

b) The manufacturer should have supplied at least 200 no.s to electricity supply utilities / PSUs. The bidder should enclose Performance Certificates

from the above users issued in the name of the manufacturer / sub vendor as proof of successful operation in field.

II. Scope :-

This specification provides for design, manufacturing, testing before dispatch, supply & delivery of Earthing Device (Heavy Duty) (for use in line (40x3000) mm & SS(50x3000 mm), as per enclosed Drawing.

III. APPLICABLE STANDARDS :-

The Earthing Device must be made out of 50 mm for S/S, 40 mm for line (Heavy Gauge- No minus Tolerance allowed) Wall thickness Hot Dip G.I. Pipe (as per IS :- 1239, Part-1, 1990 of reputed Make (TATA/Jindal) & 3.0 mtrs length tapered finished smooth at one end for a length of 75 mm & Clamp at the other end.

Staggered drills hole of 12 mm Dia of interval of 150mm shall be made before galvanization.

The GI Earthing Clamp/ Strip (C- Clamp Type) is to be of 50mm width, 6mm thickness & flange length of 65 mm in each side. This should be suitable for termination of 4 nos of GI Flat earth electrodes. The Clamp/ Strip & Earthing pipe after fabrication will be hot dip galvanized confirming to IS: 2629/85 with latest amendments. The clamp shall have two holes in both sides suitable for 16 mm GI Bolts & Nuts.

6.3 . (D)

Metal parts of all equipment other than those forming part of an electrical circuit shall be connected directly to the main earth system via two separate conductors of adequate capacity at two different points.

All main members of structural steelworks shall be earthed by galvanised iron flat connections bonded by welding or bolting to the steelworks.

Connections to apparatus and structures shall be made clear of ground level, preferably to a vertical face and protected as appropriate against electrolytic corrosion. They shall be made between clean surfaces and of sufficient size and pressure to carry the rated short circuit current without damage.

Earth bars installed directly into the ground should normally be laid bare and the trench back-filled with a fine top soil. Where the soil is of a hostile nature, special precautions must be taken to protect the earth bar. Wherever required to achieve the required resistance bentonite powder to be mixed in lom/ black cotton crushed soil in 1: 6 proportion is permissible, the method used being

subject to the agreement of the Engg. Incharge . In the event of bentonite powder being adopted, water supply through conduit to the area must be supplemented and regulated to keep the surface / mat moisture absorbent.

Joints in earth bars+ shall be welded and then coated with a suitable anti-corrosion protection treatment.

Facilities shall be provided on the earth bar run between equipment and the base of structures, comprising a looped strip, so as to permit the attachment of portable earth connections for maintenance purposes.

The cross sectional area of the earth bar and connections shall be such that the current density is not greater than 100 A/mm^2 for a 3 second fault duration.

7.0 WIRING, CABLING AND CABLE INSTALLATION

7.1 Cubicle wiring

Panels shall be complete with interconnecting wiring between all electrical devices in the panels. External connections shall be achieved through terminal blocks. Where panels are required to be located adjacent to each other all inter panel wiring and connections between the panels shall be carried out internally. The Contractor shall furnish a detailed drawing of such inter panel wiring. The Contractor shall ensure the completeness and correctness of the internal wiring and the proper functioning of the connected equipment.

All wiring shall be carried out with **1.1 kV** grade, **PVC** insulated, single core, stranded copper wires. The PVC shall have oxygen index not less than '**29**' and Temperature index not less than **250C**. The wires shall have annealed copper conductors of adequate size comprise not less than three strands.

The minimum cross sectional area of the stranded copper conductor used for internal wiring shall be as follows :

- a) All circuits excepting CT circuits and energy metering circuit of VT 2.5 sq.mm
- b) All CT circuits and metering circuit of VT 2.5 sq. mm

All internal wiring shall be supported, neatly arranged, readily accessible and connected to equipment terminals and terminal blocks. Wiring gutters and troughs shall be used for this purpose.

Cubicle connections shall be insulated with PVC to IEC 227. Wires shall not be jointed or teed between terminal points.

Bus wires shall be fully insulated and run separately from one another. 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 panel suite. Longitudinal troughs extending throughout the full length of panel shall be preferred for inter panel wiring.

All inter connecting wires between adjacent panels shall be brought to a separate set of terminal blocks located near the slots of holes meant for the passage of the interconnecting wires. Interconnection of adjacent panels on site shall be straightforward and simple. The bus wires for this purposes shall be bunched properly inside each panel.

Wire termination shall be made with solderless 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. Numbers 6 and 9 shall not be included for ferrules purposes unless the ferrules have numbers underscored to enable differentiation. (i.e. 6 and 9).

Fuses and links shall be provided to enable all circuits in a cubicle, except a lighting circuit, to be isolated from the bus wires.

The DC trip and AC voltage supplies and wiring to main protective gear shall be segregated from those for back-up protection and also from protective apparatus for special purposes. Each such group shall be fed through separate fuses from the bus wires. There shall not be more than one set of supplies to the apparatus comprising each group. All wires associated with the tripping circuits shall be provided with red ferrules marked "**Trip**".

It shall be possible to work on small wiring for maintenance or test purposes without making a switchboard dead.

The insulation material shall be suitably coloured in order to distinguish between the relevant phases of the circuit.

When connections rated at 380 volt and above are taken through junction boxes they shall be adequately screened and "**DANGER**" notices shall be affixed to the outsides of junction boxes or marshalling kiosk.

Where connections to other equipment and supervisory equipment are required the connections shall be grouped together.

7.2 LV power cabling

LVAC cable terminals shall be provided with adequately sized, hot pressed, cast or crimp type lugs. Where sweating sockets are provided they shall be without additional clamping or pinch bolts. Where crimp type lugs are provided they shall be applied with the correct tool and the crimping tool shall be checked regularly for correct calibration. Bi-metallic joints between the terminals and lugs shall be provided where necessary.

Terminals shall be marked with the phase colour in a clear and permanent manner.

A removable gland plate shall be provided by the Contractor. The Contractor shall be responsible for drilling the cable gland plate.

Armoured cables shall be provided with suitable glands for terminating the cable armour and shall be provided with an earthing ring and lug to facilitate connection of the gland to the earth bar.

7.3 Multi-core cables and conduit wiring

External multi-core cabling between items of main and ancillary equipment shall form part of the Contract Works and shall consist of un-armoured multi-core cable with stranded copper conductors PVC insulated and PVC over sheathed complying with the requirements of IEC 227 and 228 as applicable.

Multi-core cable for instrumentation and control purposes shall be supplied with 2.5 mm² stranded copper cores. Multi-core cables for CT and VT circuits shall be supplied with two by 2.5 mm² stranded copper cores and the cores shall be identified by the phase colour.

Where conduit is used the runs shall be laid with suitable falls and the lowest parts of the run shall be external to the equipment. All conduit runs shall be adequately drained and ventilated. Conduits shall not be run at or below ground level.

Multi-core cable tails shall be so bound that each wire may be traced to its cable without difficulty. All multi-core cables shall be provided with 20 % spare cores and the spare cores shall be numbered and terminated at a terminal block in the cubicle. Where cables are terminated in a junction box and the connections to a relay or control cubicle are continued in conduit, the spare cores shall be taken through the conduit and terminated in the cubicle. The dc trip and ac voltage circuits shall be segregated from each other as shall the circuits to main protective gear be segregated from those for back-up protection.

The screens of screened pairs of multi-core cables shall be earthed at one end of the cable only. The position of the earthing connections shall be shown clearly on the diagram.

All wires on panels and all multi-core cable cores shall be crimped with the correct size of crimp and crimping tool and will have ferrules which bear the same number at both ends. At those points of interconnection between the wiring carried out by separate contractors where a change of number cannot be avoided double ferrules shall be provided on each wire. The change of numbering shall be shown on the appropriate diagram of the equipment. The same ferrule number shall not be used on wires in different circuits on the same panels.

The Contractor shall provide a two (2) metre loop of spare cable at both ends of all multi-core cable runs and shall leave sufficient lengths of tails at each end of the multi-core cables to connect up to the terminal boards. The

Contractor shall also strip, insulate, ring through and tag the tails and shall also seal the cable boxes. The Contractor shall be responsible for re-checking the individual cores and for the final connecting up and fitting of numbered ferrules within all equipment provided on this contract.

The drilling of gland plates, supply and fitting of compression glands and connecting up of power cables included in the Contract scope of work shall be carried out under this contract.

8.0 Laying and Installing of cables

8.1 General

For cable laying the following shall apply:

- a) Switchyard area In concrete cable troughs (cable trench having cable racks with cable trays)
- b) Control Room On cable racks consisting of slotted type and ladder type cable trays
- c) Buildings Conduits

Directly buried cables shall be used wherever necessary with the approval of Engg. Incharge .

8.2 Laying of cable

Cables shall be laid in concrete troughs provided under this contract or drawn into pipes or ducts or on cable racks or directly buried as may be required by the Engg. Incharge . Concrete troughs shall be designed so that the cables are supported on cable support systems and the supports shall be arranged so as to allow the segregation of power, control (including CT and VT circuits) and communications cables onto different layers of cable supports. All cable supports shall be earthed in accordance with IS 3043. The minimum vertical separation between layers of cable tray shall be not less than 300 mm.

The cable support system shall be designed and constructed to carry the required cables without undue crowding of the supports and without overloading the supports. The maximum number of layers of cable that shall be permitted on a single cable support shall be three. The width of the cable supports shall be selected to ensure that the supports are not crowded, the cable supports are not overloaded and that sufficient space is provided in the cable trough to allow for personnel access during and after cable installation. The width of cable supports should not exceed 750 mm.

Cables shall be laid direct in the ground only at the discretion of the Engg. Incharge . All cables laid direct in the ground outside buildings shall be laid in a trench and protected by reinforced concrete slabs or cable tiles.

For auxiliary cables the top of the slab or tile shall be at a depth not less than 300 mm below the surface of the ground and there shall be a layer of fine well packed riddled earth 75 mm thick in between the cable and the bottom of the trench and between the top of the cable and the underside of the slab.

The Contractor shall be responsible for the proper laying of all cables in the ground. Where cables in the same trench are laid over each other, they shall be separated by not less than 75 mm of riddled earth. The riddled earth used for this purpose shall have been passed through a screen having a 12 mm square mesh.

Where cables pass under roadways they shall be laid in pipes at a depth not less than 800 mm below the surface.

The Contractor shall be responsible for the excavation of trenches which shall include all pumping and baling required and the provision of all necessary labour, plant, tools, water, additional soil, fuel or motor power for such purposes.

Cables in trenches will be inspected by the Engg. Incharge before the trenches are backfilled.

The running of communications and power cables along the same route shall be avoided as far as possible. Where this is not possible they shall be segregated, the one group from the other. Power and communication cables shall be laid in separate tiers. For other than directly buried cables the order of laying of various cables shall be as follows:

- a) Power cables on top tiers.
- b) Control/ instrumentation and other service cables in bottom tiers.

8.3 Cable tags and markers

Each cable and conduit run shall be tagged with numbers that appear in the cable and conduit schedule.

The tag shall be of aluminum with the number punched on it and securely attached to the cable conduit by not less than two turns of 20 SWG GI wire conforming to IS 280. Cable tags shall be of rectangular shape for power cables and of circular shape for control cables.

Location of cables laid directly in the ground shall be clearly indicated with cable marker made of galvanised iron plate.

Location of buried cable joints shall be indicated with a cable marker having an additional inscription "**Cable joint**".

Cable markers shall project 150 mm above ground and shall be spaced at an interval of 30 meters and at every change in direction. They shall be located on both sides of road and drain crossings.

Cable tags shall be provided on all cables at each end (just before entering the equipment enclosure), on both sides of a wall or floor crossing, on each duct, conduit entry and at every twenty meters (20 m) in cable tray/trench runs. Cable tags shall be provided inside switchgear, motor control centres,

control and relay panels etc. and wherever required for cable identification when a number of cables enter together through a gland plate.

The price of cable tags and markers shall be included in the installation rates for cables/conduits quoted by the Bidder.

8.4 Cable supports and cable tray mounting arrangements in control room

The control room will normally be provided with embedded steel inserts on concrete floors/walls for the purpose of cabling in the control room. The supports shall be secured by welding to these inserts or available building steel structures. However, in cases where no such embedded steel inserts are available, the same shall have to secure to the supports on walls or floors by suitable anchoring.

8.5 Cable support structure in switchyard cable trenches

The contractor shall fabricate and install cable support structures in cable trenches. These supports shall be provided at 750 mm spacing along the run of cable trenches.

Cable supports and cable racks shall be fabricated from standard structural steel members, channels, angles and flats of required size. The fabrication, welding and erection of these structures shall conform to the relevant clauses of this Specification, in addition to the specification given herein.

8.6 Termination of cables and wires

Where cables leave the apparatus in an upward direction the cable boxes shall be provided with a barrier joint to prevent leakage of cable oil or compound into the apparatus. Where cable cores are liable to contact with oil or oil vapour the insulation shall be unaffected by oil.

PVC sheathed cables shall be terminated by compression glands complying with BS 6121 (or equivalent).

Auxiliary PVC insulated cables shall be terminated with compression type glands, clamps or armour clamps complete with all the necessary fittings.

Colours shall be marked on the cable box, cable tail ends and single core cables at all connecting points and/or any positions the Engg. Incharge may determine. Cable boxes shall be provided with suitable labels indicating the purpose of the supply where such supply is not obvious or where the Engg. Incharge may determine.

All cables shall be identified and shall have phase colours marked at their termination.

All incoming and outgoing connections shall be terminated at a terminal block. Direct termination into auxiliary switches will not be accepted.

9.0 SUPPLY VOLTAGE

The auxiliary supply voltages on site shall be as follows:

Nominal Voltage V	Variation	Frequency Hz or DC	Phase	Wires	Neutral Connection
430	±10%	50±5%	3	4	Solidly earthed
230	±10%	50±5%	1	2	Solidly earthed
24		DC	DC	2	

10.0 Contractor's field operation

10.1 General

The Contractor shall inform the Engg. Incharge in advance of field activity plans and schedules for carrying-out each part of the works. Any review of such plans or schedules or methods of work by the Engg. Incharge shall not relieve the Contractor of any of his responsibilities towards the field activities. Such reviews shall not be considered as an assumption of any risk or liability by the Employer or any of his representatives, and no claim of the Contractor will be entertained because of the failure or inefficiency of any such plan or schedule or method of work reviewed. The Contractor shall be solely responsible for the safety, adequacy and efficiency of plant and equipment and his erection methods.

10.2 Facilities to be provided by the contractor

10.3 Unloading

Contractor shall make his own arrangement for unloading the equipment at site.

10.4 Tools, tackle and scaffoldings

The Contractor shall provide all the construction equipment tools, tackle and scaffoldings required for offloading, storage, pre-assembly, erection, testing and commissioning of the equipment covered under the Contract. He shall submit a list of all such materials to the Engg. Incharge before the commencement of pre-assembly at Site. These tools and tackles shall not be removed from the Site without the written permission of the Engg. Incharge .

The Contractor shall maintain an accurate and exhaustive record detailing all equipment received by him for the purpose of erection and keep such record open for the inspection of the Engg. Incharge .

All equipment shall be handled carefully to prevent any damage or loss. All equipment stored shall be properly protected to prevent damage. Equipment from the store shall be moved to the actual location at an appropriate time so as to avoid damage of such equipment at Site.

All the materials stored in the open or dusty location shall be covered with suitable weather-proof and flameproof covering material.

The Contractor shall be responsible for making suitable indoor facilities for the storage of all equipment which requires to be kept indoors.

11.0 SITE CLEARANCE

11.1 Clearing and uprooting of tree

The work shall also consist of numbering of trees, removing and disposing of all materials such as trees, bushes, woods, shrubs, grass, stumps, rubbish, rank vegetation, roots, foreign materials, etc., which in the opinion of the Engg In-charge are unsuitable for incorporation in the works, from within the limits and such other areas as may be specified on the drawings or directed by the Engg In-charge. Clearing and uprooting of tree shall be performed in advance of earthwork operations and in accordance with the requirements of these Specifications and taking prior permission from forest department. During clearing and grubbing, the contractor shall take all adequate precautions against soil erosion, water pollution etc., and where required undertake additional works to that effect.

11.2 Programme

The Contractor shall construct the works in compliance with the outline programme appended to the Bidding Document, and shall submit for the approval of the Engg In-charge a detailed programme in accordance with the requirements of this Specification.

11.3 Inclement weather

As per relevant Code, during hot weather, precautions shall be taken to avoid premature stiffening of the fresh concrete mix and to reduce water absorption and evaporation losses. During hot weather (atmospheric temperature above 40 degree C) or cold weather (atmospheric temperature at or below 5deg.C) concreting shall be done as per the procedure set out in IS 7861.

11.4 STANDARDS

All Civil works shall be carried out as per applicable Indian Laws, latest revision of International Standards and Codes. All materials shall be of best quality confirming to relevant Indian Standards and Codes.

Civil works shall be designed to the required service conditions and /or loads as specified elsewhere in this Specification or implied as per National and International Standards.

12.0 MATERIALS AND WORKMANSHIP

12.1 General

All materials used in the works shall be new and of the best quality of their respective kinds. They shall comply with the requirements of the latest edition of any relevant Indian Standard or Code of Practice where such exist, and current at the date of tendering.

All workmanship shall be of the highest standard, and shall be executed by competent men skilled in their respective trades.

12.2 Samples

In addition to the special provisions made in this specification for sampling and testing of materials by particular methods, samples of any materials and workmanship proposed to be used in the Works may be called for at any time during the Contract by the Engg In-charge and shall be furnished by the

Contractor without delay and at the expense of the Contractor. Samples when approved, shall be regarded as the acceptable standard, and any material or workmanship subsequently not complying with that standard shall be rejected and replaced by those of acceptable standard at the expense of the Contractor. Sample storage boxes shall be provided by the Contractor free of cost if requested by the Engg In-charge .

12.3 Tests

Whenever considered desirable by the Engg In-charge , Inspectors may be sent to manufacturer's or subcontractors' premises to test materials or supervise their manufacture.

Where specified or requested the Contractor shall obtain from the manufacturer and send to the Engg In-charge certificates of test, proof sheets, mill sheets, etc., showing that materials have been tested in accordance with this Specification or the relevant Indian Standard.

Notwithstanding any tests which may be directed to be carried out at a manufacturer's and/or subcontractor's works, the Engg In-charge may carry out any tests or further tests he considers necessary or desirable after delivery of materials to the Site.

The Contractor shall provide all labour, equipment and facilities necessary for carrying out the tests both in works and on site.

The cost of routine tests required by IS and this Specification shall be borne by the Contractor. The cost of other tests shall be borne in accordance with the Conditions of Contract.

12.4 Names of suppliers and copies of orders

If so required, and before ordering material of any description, the Contractor shall submit for approval the names of makers or suppliers proposed. Copies of orders shall also be submitted if so required. The Engg In-charge may at any time withdraw his previously given approval to obtaining materials from any maker or supplier should such maker or supplier fail to supply materials of the specified quality or quantity in the requisite time.

12.5 Rejection of materials and workmanship

The Engg In-charge shall at any time have power to reject materials and workmanship not complying with this Specification or with the approved Drawings. Materials so rejected shall be immediately removed from site and replaced by materials of an approved standard at the expense of the Contractor. Rejected workmanship shall be broken out and replaced by work of an acceptable standard including the supply of new materials by the Contractor, at the expense of the Contractor, and without delay.

13.0 Erection of Station Transformers

13.1 General

As a part of this scheme, there is a provision to install station Transformer in the Source Sub-Station and distribution transformers on 11 kV line. The contractor shall transport the transformer along with the distribution board (OSM) then install, test and commission.

- a. The contractor's scope is to install distribution transformers on DP structures up to 100 KVA and Station Transformer on plinth foundation including all support structures, channels, clamps, nut & bolts etc for ST and all other accessories. On 11 kV side, the accessories would be LA, A.B. Switch & HG fuse as specified while on LT side the contractor shall install LT Distribution Box. The construction of foundation is in the scope of contractor as per the approved drawings. Any other item, not specifically mentioned but necessary for safe operation of the distribution transformer is deemed to be included in the scope of the contractor.
- b. The mounting of LTDB shall be same as that for ST and provision shall be kept for it. LTDB shall be used to take off LT feeders and service connections as well. Distribution box shall have proper locking arrangement.
- c. The location for installation of ST shall be specified by the owner.
- d. In rural areas 9 mtr DP structure using PSC poles should be considered where as 150x150 RS Joist are to be used in place of PSC poles in urban areas.
- e. All steel structures including nuts bolts, fasteners etc should be hot dip galvanized.

13.2 Erection of Distribution Transformers

All distribution transformers shall be installed on 11 kV line DP structures / Plinths. Bimetallic connectors shall be provided on HT side of ST. The connectors shall be as per REC specifications.

The HT side connections shall be made with AAA conductor. LT side connections from transformer bushing to MCCB of LTDB shall be made by providing single core Al. un-armoured XLPE LT cable of suitable size and support. The outgoings from MCCB of LTDB to the overhead line are also to be made by providing single core Al. un-armoured XLPE LT cable of suitable size. In both the cases suitable clamping (made from 50x6mm GI Flats with GI Bolts & nuts) arrangement (3nos. at transformer side & 4 nos. at line side) with cushioning, cable gland and end termination kit at both ends shall be provided. The outgoing cable of LTDB has to be connected to the overhead LT line by providing minimum 2 nos. of 3-bolted (M-12) type PG clamps. Required layers of ampere tape and PVC tape are to be wrapped as per requirement.

In case of AB cables directly emanating from the LTDB to LT lines, suitable clamping arrangement with the pole as mentioned above shall be made. Necessary tension clamps, dead end clamps etc. shall be provided on the pole for holding the AB cable properly so that the load of the cable shall not be transferred to LTBD. The contractor shall provide all such clamps, nuts & bolts at no extra cost to the owner.

The contractor shall provide and install a Sign Board of 1ft x 1 ft size at each DT location. The sign board shall be mounted on the pole with suitable

clamps. The board shall be of 1.6 mm (min) thick GI sheet and epoxy painted (minimum paint thickness 75 micron) The lay out & the content to be written on the board shall be decided during detailed engineering. The boards shall be prepared through screen printing or better technology. The cost of providing and installing the board shall be included in the quoted rates for ST erection.

All materials required for completion of job in all respect beyond owner supply has to be approved by the owner prior to procurement. During procurement, contractor supply items should also be inspected and tested including third party unless otherwise waived out.

13.3 Sub-station Fencing

Goat mesh fencing as per BoQ details of size 4.5x4.75x 1.6 meter for plinth mounted S/s & 4.5x2.5x1.6 meter for DP mounted S/s shall be constructed with provision for a Grill gate of size 1.5x1 meter height.

13.4 Earthing of Distribution Sub-stations

Five nos. 50mm dia, 3 mtr. Long, heavy gauge Pipe (Jindal / Tata) earthings shall be provided for the distribution Sub-station complying with relevant IS. Adequate quantity of charcoal and salt shall be used to keep the earth resistance low. Two connections from transformer neutral, two nos. from HV side LAs, one from handle of AB switch, transformer body & DP structure shall be provided to the pipe earths. All the five pits shall be connected to an earth grid with 24mtr. long 50x10mm size GI Flats at a depth of 600mm below the ground level for plinth mounted S/s and for DP mounted the same is of 14 mtr. long. The earth risers should be with 50x6 mm GI Flats requiring 34mtrs in both type of S/s.

E14 - VENDOR LIST FOR MAJOR BOUGHT OUT ITEMS

The List is Subject to modification on the suggestions of prospective bidders and scrutinisation thereof

SL No	Description	Name Of Vendor
1	Transformer	ABB/CGL/Schnider/BHEL/Siemens/Silchar Technology, Vadodara/ ECE, Hyderabad/ Vijai Electric, Hyderabad/ Tesla Transformers, Bhopal/ Technical Associates/ Volt Amp, Ahmedabad
2	Indoor Switchgear panel with VCB, CT, IVT, Bus bar	Siemens/ABB/CGL/Schnider/ BHEL
3	SURGE ARRESTOR	CGL/OBLUM/LAMCO/ELPRO International
4	Relays	ABB/SIEMENS/Schnider/CGL/Easun Reyrole
5	ISOLATORS	ABB/SIEMENS/SWITCHGEAR & STRUCTURALS/CGL
6	CONDUCTOR	APAR/GPIL/ERITECH/STERLITE/VIJAYA/LUMINO/CABCON /TIRUPATI/ Gamon/ Vijaya
7	DISC INSULATORS/ POST INSULATORS/PIN INSULATORS	BHEL/WS Insulator/MODERN INSULATOR/ADITYA BIRLA INSULATORS /SRAVANA,M/s Insulators & Electricals Company, Mandeep ,M.P / Gold Stone
8	PVC INSULATED POWER AND CONTROL CABLES	NICCO/GLOSTER / CCI/KEI/CRYSTAL/ POLYCAB/ GPIL/ FINOLEX/Universal/ Havells India Ltd./ KEI/ KEC International Ltd.
9	STATION TRANSFORMER /DISTRIBUTION (BEE STANDARD)	AREVA/ALFA/TESLA/OTPL/TECHNO ASSOCIATE/ SILCHAR TECHNOLOGY/ VIJAYA ELECTRIC
10	LIGHTING FIXTURES	PHILIPS/CGL/BAJAJ/HAVELLS
11	CEMENT OPC GRADE	ACC/ULTRATECH/KONARK/LAFARGE
12	STEEL	SAIL/TATA/RINL
13	GI PIPE	TATA/JINDAL
14	SWITCHES	ANCHOR/ABB/CONA/HAVELLS/ INDOASIAN
15	MCB	L & T /ABB/SIEMENS/MDS/HAVELLS/ INDOASIAN
16	ACB/MCCB	L & T /SIEMENS/MERLIN GERIN
17	CLAMPS / CONNECTORS	ELECTROMECH TRANSTECH /RASTRAUDYOG /TYCO/IAC/ASWINI KUMAR & CO. CUTTACK
18	GI BOLTS & NUTS	NEXO /GKW/ASP/MAHESWARI(P)FASTENERS & BRIGHT PVT . LTD ,MEDCHAL
19	METERS	SECURE LTD/ L&T/ GENUS, Gujarat/ L&G
20	FIRE FIGHTING EQUIPMENT	MINIMAX/CEASE FIRE
21	CABLE JOINT KIT	RPG RECHEM/FRONTECH/3M
22	HARD WARE FITTINGS	RASTODYAGA/IAC/MODERN MALLEABLE/JAINCO/ERITECH/SUPREME/ELECTROMECH