

# Section 3- Purchaser's Requirements

This Section contains the Specification, the Drawings, and supplementary information that describe the Works to be procured.

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# Section 3 Purchaser's Requirements

#### 3.0. Scope of Works

The brief description of scope of Works covered under this Bidding Document is furnished below:

- i. The work involves design, engineering, manufacture, assembly, inspection, testing at manufacturer's works before dispatch, packing, supply, including insurance during transit, delivery at site, subsequent storage, civil work, erection, commissioning of various equipment and associated works at site for strengthening of the bus system at 132kV APM GSS as specified in BoQ and subsequent Clauses and Sections.
- ii. It is not the intent to specify completely herein all details of design and construction of the equipment and accessories. However, the equipment and accessories shall conform in all respects to high standards of engineering, design and workmanship and be capable of performing in continuous operation up to the bidder's guarantees in a manner acceptable to the Employer. The Employer will interpret the meaning of drawings and specifications and shall be entitled to reject any work or material, which in his judgment is not in full accordance therewith.
- iii. Whether called for specifically or not, all accessories and work required for the completion of the work are deemed to be considered as a part of the Bidder's scope, unless and until mentioned very clearly as excluded.
- iv. It is also responsibility of the Contractor to obtain any road permits and any other permits or licenses to execute the works.

#### 3.1. Bill of Materials

- 3.1.1. The Bill of Quantities is furnished in relevant Schedule (at Bid Volume-I).
- 3.1.2. The items mentioned in these Schedules shall only be used while quoting the bid prices. If any item which is not specifically mentioned in these Schedules but required to complete the works as per Specification shall deemed to be included in any of the items of these schedules. No modifications/ additions/ deletions shall be made by the bidder to the items and quantities given in these schedules.

## 3.2. Contractor to Inform Himself Fully

- 3.2.1. The contractor should ensure that he has examined the Specifications and Schedules as brought out in this Section as well as other Sections of The Bidding document and has satisfied himself as to all the conditions and circumstances affecting the contract price and fixed his price according to his own views on these matters and acknowledge that no additional allowances except as otherwise provided therein will be levied.
- 3.2.2. The Purchaser shall not be responsible for any misunderstanding or incorrect information obtained by the contractor other than information given to the contractor in writing by the Purchaser.

#### 3.3. Service Conditions

d)

- 3.3.1. The plant and materials supplied shall be suitable for operation under the following climatic and other conditions:
  - a) Peak ambient day temperature in still air: 45°C
  - b) Minimum night temperatures: 0°C
  - c) Reference ambient day temperature: 45°C
    - Relative Humidity a) Maximum: 100 %
      - b) Minimum: 10 %
  - e) Altitude: Below1000 M above MSL
  - f) Maximum wind pressure: As per IS: 802 latest code
  - g) Seismic Intensity: ZONE-V as per IS 1893.

#### 3.4. Conformity with Indian Electricity Rules & Other Local Regulations

- 3.4.1. The Contractor shall note that all substation works shall comply with the latest provisions of Indian Electricity Rules and with any other regulations. Local authorities concerned in the administration of the rules and regulation relating to such works shall be consulted, if necessary, about the rules and regulations that may be applicable.
- 3.4.2. The Contractor shall also comply with the Minimum Wages Act 1948 and the payment of Wages Act (both. of the Government of India and State of Assam) and the rules made there under in respect of any employee or workman employed or engaged by him or his Sub-Contractor.
- 3.4.3. 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.

#### 3.5. STANDARDS

- 3.5.1 The equipment covered by this specification shall, unless otherwise stated be designed, constructed and tested in accordance with the latest revisions of relevant Indian Standards and shall conform to the regulations of local statutory authorities.
- 3.5.2 In case of any conflict between the standards and this specification, this specification shall govern.
- 3.5.2.1 Equipment conforming to other international or authoritative Standards which ensure equivalent or better performance than that specified under Clause 3.5.1 above shall also be accepted. In that case relevant extracts of the same shall be forwarded with the bid.

#### 3.6. Contractor's Requirement

- 3.6.1. The Contractor should be in possession of a valid E.H.V. Electrical Contractor Licence and Electrical Supervisory Licence issued by the Chief Electrical Inspector, Govt. of Assam, as per the provision of Law. An attested copy of the aforementioned Licence must be handed over to the Owner for his record prior to handing/ taking over of sites.
- 3.6.2. All the works shall also be inspected by the Chief Electrical Inspector, Govt. of Assam or his authorised representatives. It is the responsibility of the Contractor to obtain pre-requisite commissioning clearance of any equipment from the said Inspectorate. The Contractor will pay necessary fees to the Inspectorate, which it may levy.

#### 3.7. Engineering Data

- 3.7.1. The furnishing of engineering data by the Contractor shall be in. accordance with the Bidding Document. The review of these data by the Employer will cover only general conformance of the data to the specifications and not a thorough review of all dimensions, quantities and details of the materials, or items indicated or the accuracy of the information submitted. This review by the Employer shall not be considered by the Contractor, as limiting any of his responsibilities and liabilities for mistakes and deviations from the requirements, specified under these specifications.
- 3.7.2. All engineering data submitted by the Contractor after review by the Employer shall or part of the contract document.

#### 3.8. Drawings and Documents for Approval

- 3.8.1. All necessary drawings and documents required for completion of the project is to be submitted by the contractor for approval. The drawings provided with bid (if any) are for indicative purpose only and fresh drawings are to be prepared by the contractor as per actual site condition after survey. The drawings and documents are to be approved by AEGCL. All drawings submitted by the Contractor including those submitted at the time of Bid shall be with sufficient detail to indicate the type, size, arrangement, dimensions, material description, Bill of Materials, weight of each component break-up for packing and shipment, fixing arrangement required, the dimensions required for installation and any other information specifically requested in these specifications.
- 3.8.2. Each drawing submitted by the Contractor shall be clearly marked with the name of the Employer, the specification title, the specification number and the name of the Project. All titles, noting, markings and writings on the drawing shall be in English. All the dimensions should be to the scale and in S.I. units.
- 3.8.3. The drawings submitted for approval to the Employer shall be in quadruplicate. One print of such drawings shall be returned to the Contractor by the Employer marked "approved/approved with corrections". The contractor shall there upon furnish the Employer additional prints as may be required along with one reproducible in original of the drawings after incorporating all corrections.
- 3.8.4. The Contractor shall perform the work strictly in accordance with these drawings and no deviation shall be permitted without the written approval of the Employer, if so required.
- 3.8.5. All manufacturing, fabrication and erection work under the scope of Contractor prior to the approval of the drawings shall be at the Contractor's risk. The contractor may make any changes in the design which are necessary to conform to the provisions and intent of the contractor and such changes will again be subject to approval by the Employer.
- 3.8.6. The approval of the documents and drawings by the Employer shall mean that the Employer is satisfied that: a) The Contractor has completed the part of the Works covered by the subject document (i.e., confirmation of progress of work).

b) The Works appear to comply with requirements of Specifications.

In no case the approval by the Employer of any document does imply compliance with neither all technical requirements nor the absence of errors in such documents. If errors are discovered any time during the validity of the contract, then the Contractor shall be responsible of their consequences.

- 3.8.7. All drawings shall be prepared using AutoCAD software version 2000 or later only. Drawings, which are not compatible to AutoCAD software version 2000 or later, shall not be acceptable. After final approval all the drawings shall be submitted to the Employer in readable CD's.
- 3.8.8. The following is the general list of the documents and drawings that are to be approved by the Employer:
  - a) Work Schedule (Master Network) Plan with linkages prepared on latest version of Microsoft Projects.
  - b) General Layout of Switchyard: Plan and Sections.
  - c) Detail design calculations and drawings for Control Room including elevation, sections etc.
  - d) Earthing layout and details.
  - e) Cable Trench Layout and details.
  - f) Foundation layouts and details of main and auxiliary structures
  - g) Detail design calculations and drawings for structures, equipment supports and foundations including transformer pad.
  - h) Cable Schedule, as applicable
  - i) For equipment and items in the scope of supply:
    - (i) General arrangement drawing with full dimensions.
    - (ii) Electrical schematic diagram, where applicable.
    - (iii) Wiring diagram, where applicable.
- 3.8.9. All Designs/Drawings/Calculations/Data submitted by the contractor, from time to time shall become the property of the Employer and Employer has the right to use or replicate such designs for future contracts/ works without the permission of the Contractor. The Employer has all rights to use/ offer above designs/drawings/data sheets to any other authority without prior Permission of the Contractor.

#### 3.9. Final Drawings and Documents

- 3.9.1. The successful Contractor shall require to provide following drawings and documents for each bay constructed in printed form:
  - (a) All approved drawings (AS BUILD) of equipment and works related to a particular bay in three (3) copies.
  - (b) Instruction manuals of all equipment related to a particular bay in three (3) copies.
  - These instruction manuals shall generally consist of-
    - (i) Operation Manuals,
    - (ii) Maintenance Manuals and
    - (iii) Spare Parts Bulletins.
  - (c) Copies of routine test reports (in triplicate) of relevant equipment.
  - (d) Final Guaranteed and Other technical particulars of relevant equipment.
- 3.9.2. In addition to the above the Contractor shall provide five (5) sets of all the drawings and documents to Employer in printed form for his reference and record.

#### 3.10. Application System Software

3.10.1. Contractor shall provide copies of licensed copies of application software / configuration & system software in the form of CD (in duplicate) for all IEDs, meters, SAS etc.

#### 3.11. Quality Assurance, Inspection & Testing

- 3.11.1. To ensure that the supply and services under the scope of this Contract whether manufactured or performed within the Contractor's works or at his Sub Contractor's premises or at site or at any other place of work are in, accordance with the specifications, the Contractor shall adopt suitable quality assurance programme to control such activities at all points necessary. Such programme shall be outlined by the Contractor and shall be finally accepted by the Employer after discussions before the award of Contract. A quality assurance programme of the Contractor shall generally cover but not limited to the following:
  - a) His organization structure for the management and implementation of the proposed quality assurance programme
  - b) Documentation control System.
  - c) Qualification data for Contractor's key personnel.
  - d) The procedure for purchases of materials, parts components and selection of sub-Contractors services including vendor analysis, source inspection, incoming raw material inspection, verification of material purchases etc.
  - e) System for shop manufacturing including process controls and fabrication and assembly controls.
  - f) Control of non-conforming items and system for corrective action.
  - g) Control of calibration and testing of measuring and testing equipment.
  - h) Inspection and test procedure for manufacture.

- i) System for indication and appraisal of inspection status.
- j) System for quality audits.
- k) System for authorizing release of manufactured product to the Employer.
- I) System for maintenance of records.
- m) System for handling storage and delivery and
- n) A quality plan detailing out the specific quality control procedure adopted for controlling the quality characteristics relevant to each item of supply.

The Quality plan shall be mutually discussed and approved by the Employer after incorporating necessary corrections by the Contractor as may be required.

#### 3.11.2. Quality Assurance Documents

The Contractor shall be required to submit all the Quality Assurance Documents as stipulated in the Quality Plan at the time of Employers inspection of equipment/material.

The Employer or his duly authorized representatives reserves the right to carry out Quality Audit and quality surveillance of the systems and procedures of the Contractors/his vendors Quality Management and Control Activities.

#### 3.12. Inspection and Inspection Certificate

- 3.12.1. The Employer, his duly authorized representative and/or outside inspection agency acting on behalf of the Employer shall have, at all reasonable times, access to the premises and works of the Contractor and their sub-contractor(s)/sub-vendors and shall have the right, at the reasonable times, to inspect and examine the materials and workmanship of the product during its manufacture.
- 3.12.2. All routine and acceptance tests whether at the premises or works of, the Contractor or of any Sub Contractor, the Contractor except where otherwise specified shall carry out such tests free of charge. Items such as labour, materials, electricity, fuel, water, stores apparatus and instruments as may be reasonably demanded by the Employer/inspector or his authorized representative to carry out effectively such tests in accordance with the Contract shall be provided by the Contractor free of charge.
- 3.12.3. If desired by the Employer, the Contractor shall also carry out type tests as per applicable Standards for which Employer shall bear the expenses except in cases where such tests have to be carried out in pursuance to *Clause 3.13.3*. The Contractor is required to quote unit rates of type test charges in a separate Schedule (if such schedule is provided in the Bidding Document) in pursuance to this Clause. However, these type test charges shall not be taken into account in comparing Price Bid.
- 3.12.4. The inspection by Employer and issue of Inspection Certificate thereon shall in no way limit the liabilities and responsibilities of the Contractor in respect of the agreed Quality Assurance Programme forming a part of the Contract.

#### 3.12.5. Tests

The type, acceptance and routine tests and tests during manufacture to be carried-out on the material and equipment shall mean as follows:

- i) Type Tests shall mean those tests, which are to be carried out to prove the process of manufacture and general conformity of the material to this Specification. These tests shall be carried out on samples prior to commencement of commercial production against the order. The Bidder shall indicate his schedule for carrying out these tests.
- ii) Acceptance Tests shall mean those tests, which are to be carried out on samples taken from each lot offered for pre-dispatch inspection, for the purposes of acceptance of that lot.
- iii) Routine Tests shall mean those tests, which are to be carried out on the material to check requirements, which are likely to vary during production.
- iv) Tests during Manufacture shall mean those tests, which are to be carried out during the process of manufacture and end inspection by the Contractor to ensure the desired quality of the end product to be supplied by him.
- v) The norms and procedure of sampling for these tests will be as per the Quality Assurance Programme to be mutually agreed to by the Contractor and the Employer.
- 3.12.6. The standards and norms to which these tests will be carried out are specified in subsequent Sections of this Specification. Where a particular test is a specific requirement of this Specification, the norms and procedure of the test shall be as specified or as mutually agreed to between the Contractor and the Employer in the Quality Assurance Programme.

3.12.7. For all type and acceptance tests, the acceptance values shall be the values specified in this Specification or guaranteed by the Bidder or applicable Standards, as applicable.

# 3.13 Type Test Reports

- 3.13.1. Materials, which have never been tested for critical performance, shall not be accepted. In such cases, a promise or agreement by a bidder to have the equipment tested after award of a contract is not acceptable.
- 3.13.2. All Bids must be accompanied by the Type Test Certificates of materials offered (refer Clause 3.13.5 below). Such type test certificates shall be acceptable only if: -
  - (a) Tests are conducted in an independent testing laboratory having NABL accreditation, or
  - (b) Tests are conducted in manufacturer's own laboratory.
    - In this case (i) the laboratory must have NABL accreditation; and
      - (ii) tests have been witnessed by technically qualified representatives of earlier clients or purchaser.
- 3.13.3. Test reports to be acceptable must be related directly to the equipment offered i.e., it is fully identical in design, rating and construction with the equipment for which the type test certificates have been submitted. Test reports for higher class (by capacity/voltage etc.) of equipment are acceptable with commitment to perform the type tests free of any charge on the particular equipment after the award of contract.
- 3.13.4. The Validity of type test report shall be as per CEA's "Guideline for Validity period of Type Tests conducted on Major Electrical Equipment in power transmission system", file No CEA-PS-14-80/1/2019-PSETD Division- Part (2) dated 17<sup>th</sup> September, 2021.
- 3.13.5. Full Type Test Reports of at least the following equipment must be submitted along with the Bid: -
  - 1. Circuit Breaker
  - 2. Current & Potential Transformers
  - 3. Lightning Arrester
  - 4. Isolators
  - 5. Numerical Relays (in addition to type tests KEMA Certificate for GOOSE Messaging & Publishing are to be submitted)
  - 6. BCU and Substation Automation System
  - 7. Gateway/ Ethernet switch(s)

8. CVT

3.13.6. This clause has reference to bid document Clause 1.1, Appedix-2 of ITB, Section-1, 'Evaluation and Qualification Criteria'.

#### 3.14 Guaranteed Technical Particulars

- 3.14.1. The Guaranteed Technical Particulars of the various items shall be furnished by the Bidders with the Technical Bid in the prescribed Schedules attached in Volume-2 of the bidding document. The Bidder shall also furnish any other information's as in their opinion is needed to give full description and details to judge the item(s) offered by them.
- 3.14.2. The data furnished in Guaranteed Technical Particulars should be the minimum or maximum value (as per the requirement of the specification) required. A Bidder may guarantee a value more stringent than the specification requirement. However, for testing purpose or from performance point of view, the material shall be considered performed successfully if it achieves the minimum/maximum value required as per the technical specification. No preference what so ever shall be given to the bidder offering better/more stringent values than those required as per specification except where stated otherwise.

#### 3.15 Construction Tools, Equipment Etc.

3.15.1. The Contractor shall provide all the construction equipment, tools, tackle and scaffoldings required for construction, erection, testing and commissioning of the works covered under the Contract. He shall submit a list of all such materials to the Employer before the commencement of work at site. These tools and tackle shall not be removed from the site without the written permission of the Employer.

#### 3.16 Materials Handling and Storage

- 3.16.1. All the supplies under the Contract as well as Employer supplied items (if any) arriving at site shall be promptly received, unloaded and transported and stored in the stores by the Contractor.
- 3.16.2. Contractor shall be responsible for examining all the shipment and notify the Employer immediately of any damage, shortage, discrepancy etc. for the purpose of Employer's information only. The Contractor shall submit to the Employer every week a report detailing all the receipts during the week. However, the

Contractor shall be solely responsible for any shortages or damages in transit, handling and/or in storage and erection at site. Any demurrage, and other such charges claimed by the transporters, railways etc., shall be to the account of the Contractor.

- 3.16.3. The Contractor shall maintain an accurate and exhaustive record-detailing out the list of all items received by him for the purpose of erection and keep such record open for the inspection of the Employer.
- 3.16.4. All items shall be handled very carefully to prevent any damage or loss. The materials stored shall be properly protected to prevent damage. The materials from the store shall be moved to the actual location at the appropriate time so as to avoid damage of such materials at Site.
- 3.16.5. All the materials stored in the open or dusty location must be covered with suitable weather-proof and flameproof covering material wherever applicable.
- 3.16.6. The Contractor shall be responsible for making suitable indoor storage facilities, to store all items/materials, which require indoor storage.
- 3.16.7. The Contractor shall have total responsibility for all equipment and materials 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.

#### 3.17 Contractor's Materials brought on to Site

- 3.17.1. The Contractor shall bring to Site all equipment, components, parts, materials, including construction equipment, tools and tackles for the purpose of the work under intimation to the Engineer. All such goods shall, from the time of their being brought vest in the Employer, but may be used for the purpose of the Works only and shall not on any account be removed or taken away by the Contractor without the written permission of the Engineer. The Contractor shall nevertheless be solely liable and responsible for any loss or destruction thereof and damage thereto.
- 3.17.2. The Employers shall have a lien on such goods for any sum or sums, which may at any time, be due or owing to him by the Contractor, under in respect of or by reasons of the Contract. After giving a fifteen (15) days' notice in writing of his intention to do so, the Employer shall be at liberty to sell and dispose of any such goods, in such manner, as he shall think fit including public auction or private treaty.
- 3.17.3. After the completion of the Works, the Contractor shall remove from the Site under the direction of the Employer's site representative, the materials such as construction equipment, erection tools and tackles, scaffolding etc. with the written permission of the Employer's site representative. If the Contractor fails to remove such materials within fifteen (15) days of issue of a notice by the Employer's site representative, the Employer's site representative shall have the liberty to dispose of such materials as detailed under clause 3.17.2 above and credit the proceeds thereto to the account of the Contractor.

#### 3.18 Commissioning Spares

- 3.18.1. It will be the responsibility of the Contractor to provide all commissioning spares required for initial operation till the Employer declares the equipment as ready for commissioning. All commissioning spares shall be deemed to be included in the scope of the Contract at no extra cost to the Employer.
- 3.18.2. These spares shall be received and stored by the Contractor **at least 1 month** prior to the schedule date of commencement of commissioning of the respective equipment and utilized as and when required. The unutilized spares and replaced parts, if any, at the end of successful completion of performance and guarantee test shall be the property of the Contractor and he will be allowed to take these parts back at his own cost with the permission of Employer's Representative.

#### 3.19 Specification

- 3.19.1. The technical specifications for plant and services are covered in a separate volume (*Volume-2, Technical Specification*) of this Bidding Document.
- 3.19.2. The following Sections are included in the Technical Specification:
  - (i) Scope and General Technical Conditions
  - (ii) Technical Specification for Construction Works in Substations
  - (iii) Specification for Design and Fabrication of Substation Steel Structures
  - (iv) Technical Specification of Power Transformers (Not Included)
  - (v) Technical Specification of 132 and 33 kV Outdoor SF6 Circuit Breakers (Not Included)
  - (vi) Technical Specification of Outdoor Current and Potential Transformers
  - (vii) Technical Specification of Control and Relay Panels (with Automation) (Not Included)
  - (viii) Technical Specification for Substation Automation System (Not Included)
  - (ix) Technical Specification of Control and Relay Panels (without Automation)(Not Included)

(x) Technical Specification of Isolators

- (xi) Technical Specification for Surge Arresters (Not Included)
- (xii) Technical Specification of Power and Control Cable.
- (xiii) Technical Specification of Power Line Carrier Communication Equipment (Not Included)
- (xiv) Technical Specification of Remote Terminal Unit (RTU) (Not Included)
- (xv) Technical Specification ACSR Conductors & Accessories For Conductors
- (xvi) Technical Specification of Battery Bank and Charger
- (xvii) Drawings (Not Included)
- (xviii) Schedules: Guaranteed Technical Particulars

#### **GENERAL TECHNICAL REQUIRMENT (GTR)**

#### 3.20.1 GENERAL

The following provisions shall supplement all the detailed technical specifications and requirements brought out in accompanying Technical Specifications. The Contractor's proposal shall be based upon the use of equipment and materials complying fully with the requirements specified herein. It is recognized that the Contractor may have standardized on the use of certain components, materials, processes or procedures different to those specified herein. Alternate proposals offering similar equipment based on the manufacturers standard practice will also be considered, provided such proposals meet the specified design standard and performance requirement and are acceptable to AEGCL.

S. No.	Description of Parameters	400KV System	220KV System	132KV System	33 KV System
1.	System Operating Voltage	400 KV	220 KV	132 KV	33 KV
2.	Maximum operating voltage of the system (rms)	420 KV	245 KV	145 KV	36 KV
3.	Rated Frequency	50 Hz	50 Hz	50 Hz	50 Hz
4.	No. of phase	3	3	3	3
5.	Rated Insulation levels				
i	Full wave impulse withstand voltage (1.2/50 Microsecs.)	1425 kVP	1050kVP	650 kVP	250 kVP / 170 kVP
ii	Switching impulse withstand voltage (250/ 2500 micro sec.) dry and wet	1050kVP	-	-	-
iii	One-minute power frequency dry / wet withstand voltage (rms)	650 KV / 520 KV	460 KV	275 KV	95KV/ 70KV
6	Corona extinction voltage	320 KV	156 KV	105 KV	-
7	Max. radio interference voltage for frequency between 0.5MHz & 2 MHz at 508 kV	1000 microvolt	1000 microvolt	500 microvolt	

# 3.20.2 SYSTEM PARAMETERS

	rms for 765kV, 320 kV rms for 400 KV system, 156 KV rms				
	& 92 KV rms for132				
8	KV system Minimum creepage distance @ 31 mm/KV	13020 mm	7595 mm	4495 mm	1116 mm
9	Min. Clearances	I	I		
i	Phase to spacing for installation	7000 mm	4500 mm	3000 mm	1500 mm
ii	Ground clearances from lowest live terminal of equipment from ground level	8200 mm	7000 mm	5000 mm	4000 mm
10	Rated short circuit current /for three sec. duration	63 KA for three seconds	50 KA for three seconds	40 KA for three seconds	31.5 KA for three seconds
11	System Neutral earthing	Effectively Earthed	Effectively Earthed	Effectively Earthed	Effectively Earthed

# 3.20.3 DESIGN AND STANDARDISATION

- i. The Works covered by the specification shall be designed, manufactured, built, tested and commissioned in accordance with the Act, Rules, Laws and Regulations of India. The Equipment(s) shall also conform to the requirements detailed in the referred standards, which shall form an integral part of the Specification, in addition to meeting the specific requirements called for elsewhere in the Specification. The Contract works shall be designed to facilitate inspection, cleaning and repairs, and for operation where continuity of supply is the first consideration. Apparatus 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 synchronizing and short circuit.
- ii. The design shall incorporate all reasonable precautions and provisions for the safety of those concerned in the operation and maintenance of the Contract Works and of associated works supplied under other contracts.
- iii. Where the Specification does not contain characteristics with reference to workmanship, equipment, materials and components of the covered equipment, it is understood that the same must be new, of highest grade of the best quality of their kind, conforming to best engineering practice and suitable for the purpose for which they are intended.
- iv. In case where the equipment, materials or components are indicated in the specification as 'similar' to any special standard, AEGCL shall decide upon the question of similarity. When required by the Specification; or when required by AEGCL the Contractor shall submit, for approval, all the information concerning materials or components to be used in manufacture. Machinery, equipment, materials and components supplied, installed or used without such approval shall run the risk of subsequent rejection, it being understood that the cost as well as the time delay associated with the rejection shall be borne by the Contractor.
- v. The design of the Works shall be such that installation, future expansions, replacements and general maintenance may be undertaken with a minimum of time and expense. Each component shall be designed to be consistent with its duty and suitable factors of safety, subject to mutual agreements and shall be used throughout the design. All joints and fastenings shall be so devised, constructed and documented that the component parts shall be accurately positioned and restrained to fulfil their required function.
- vi. All outdoor apparatus 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.
- vii. All water and oil pipe flanges shall be to IS 6392/BS 4504 or other equivalent standard, as regards both dimensions and drilling, unless otherwise approved.

- viii. Cast iron shall not be used for chambers of oil filled apparatus or for any part of the equipment which is in tension or subject to impact stresses.
- ix. Kiosks, cubicles and similar enclosed compartments shall be adequately ventilated to restrict condensation. All contractor or relay coils and other parts shall be suitably protected against corrosion.
- x. All apparatus shall be designed to obviate the risk of accidental short circuit due to animals, birds, insects, mites, rodents or micro-organisms.

Corresponding parts shall be interchangeable. Where required by AEGCL the Contractor shall demonstrate this quality. **3.20.4 QUALITY ASSURANCE** 

# 3.20.4.1 General

- i. To ensure that the supply and services under the scope of this Contract, whether manufactured or performed within the Contractor's works or at his Sub-Contractor's premises or at Site or at any other place of work are in accordance with the Specification, with the Regulations and with relevant Indian or otherwise Authorized Standards the Contractor shall adopt suitable Quality Assurance Programmes and Procedures to ensure that all activities are being controlled as necessary.
- ii. The quality assurance arrangements shall conform to the relevant requirements of ISO 9001 or ISO 9002 as appropriate.
- iii. 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.
- iv. 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."

AEGCL written approval is required to authorize 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."

v. If AEGCL does not attend after receiving documented notification in accordance with the agreed procedures and with the correct period of notice, then work may proceed.

#### 3.20.4.2 Quality assurance programme

- i. Unless the Contractor's Quality Assurance System has been audited and approved by AEGCL, a Quality Assurance Program for the Works shall be submitted to AEGCL for approval a minimum of one month prior to commencement of the works, or such other period as shall be agreed upon by AEGCL. The Quality Assurance Program shall give a description of the Quality System for the Works and shall, unless advised otherwise, include details of the following:
- The structure of the Contractor's organisation
- The duties and responsibilities assigned to staff ensuring quality of work
- The system for purchasing, taking delivery and verification of materials
- The system for ensuring quality of workmanship
- The system for the control of documentation
- The system for the retention of records
- The arrangements for the Contractor's internal auditing
- A list of the administration and work procedures required to achieve and verify the Contract's Quality requirements. These procedures shall be made readily available to AEGCL for inspection on request.

#### 3.20.4.3 Quality plans

The Contractor shall draw up for each section of the work Quality Plans which shall be submitted to AEGCL 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:

- An outline of the proposed work and program sequence
- The structure of the Contractor's organisation for the Contract
- · The duties and responsibilities assigned to staff ensuring quality of work for Contract
- Hold and Notification points
- Submission of engineering documents required by the Specification
- The inspection of materials and components on receipt
- · Reference to the Contractor's work procedures appropriate to each activity
- Inspection during fabrication/construction
- Final inspection and test

#### 3.7.4.4 Inspection and testing

- i. The prime responsibility for inspection and testing rests with the Contractor. The inspection or its waiver by AEGCL does not relieve the Contractor of any obligations or responsibilities to carry out the work in accordance with the Contract.
- ii. The inspection and testing shall be documented such that it is possible to verify that it was performed. Records of inspection shall include as a minimum the contract identity, operation/inspection, technique used, acceptance standard, acceptability, identity of inspector/tester and date of inspection/test.

#### 3.20.4.5 Non-conforming product

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

#### 3.20.4.6 Monitoring of quality arrangements

During the course of the Contract AEGCL may 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 any facilities, including access, which may be required by AEGCL for monitoring activities.

AEGCL may participate on an agreed basis in the Contractor's monitoring of a sub- contractor's Quality Assurance arrangements.

#### 3.20.4.7 Method statement

Prior to commencing work, the Contractor shall submit a method statement setting out full details of his method of working. This is a Hold Point.

Details of the Contractor's method of working shall also be submitted at the time of Bidding.

#### 3.20.5 HEALTH, SAFETY AND ENVIRONMENT (HSE) PLAN

#### 3.20.5.1 General

The contractor/subcontractor should adhere to the Environmental and Social Management Plan (ESMP). The payment is linked towards compliance to responsibility specified under the generic ESMP attached in Chapter-38 of Vol-II. The overall responsibility for compliance of ESMP will stand with the Project

Manager with support of Health and safety Specialist. The contractor is abided to comply with the project

specific ESMP which can be issued by AEGCL to contractor during the complete tenure of project. Within one month of award of contract the Contractor shall produce a HSE Plan for the contract and submit for the approval of AEGCL. The HSE Plan is described in the following sections. The same is to submit to CGM (PP&D) and ESIA Consultant for approval.

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 and Social management of both his own employees, those of the Employer and anyone who may be affected by his activities and in full compliance with the ESMP.

Special arrangements shall be made to accommodate for gender-inclusive engagements and participation of vulnerable people, to ensure the implementation of the social development and gender relevant features included in the design of the project, including monitoring of occupational and community health and safety, community awareness activities, compliance of core labour standards, prevention of Gender-based violence (GBV) and Sexual exploitation (SE) risks.

#### 3.20.5.2 Content of HSE Plan

The general structure of the HSE Plan is outlined in 3.20.4.3. The HSE Plan will comprise two parts i.e.:

- Part: I: Sections 1 to 5, covering general HSE management and controls. The following would be attached as appendices, where appropriate:
  - Organisation chart showing the proposed Contractors HSE organisational structure
  - The CV<sup>\*\*</sup>s, duties and responsibilities of the following personnel:
    - (i) Contract Manager
    - (ii) Contractors Site Representatives
    - (iii) Environment, Social, Health and Safety Officer
    - (iv) Site Environment, Social, Health and Safety Officers

Part: II: Section 6, providing a summary of hazards and controls.

#### 3.20.5.3 General structure of HSE Plan

The HSE Plan shall conform to the following general structure:

1. Contractors Policy Statement

- 2. Health
  - 2.1 First Aid
  - 2.2 Primary health care
  - 2.3 Occupational and community health
- 3. Safety
  - 3.1 Objectives and targets
  - 3.2 Organisation and responsibilities
  - 3.3 HSE meetings
  - 3.4 Motivation, communication and community awareness.
  - 3.5 HSE training
  - 3.6 Audits and inspections
  - 3.7 Emergency response
  - 3.8 Safety function
  - 3.9 Accident investigating and reporting
  - 3.10 Standards
  - 3.11 Personal protective equipment
- 4 Environment
  - 4.1 Waste management
  - 4.2 Chemicals management
  - 4.3 Environmental impacts on Air, Noise, and Waterbody
  - 4.4 Fuels and Hazardous Substances Management
  - 4.5 Water Resources Management
  - 4.6 Drainage Management
  - 4.7 Soil Quality Management
  - 4.8 Topography and Landscaping
  - 4.9 Borrow Areas Management
  - 4.10 Protection of Flora and Fauna
  - 4.11 Protection of Fisheries
  - 4.12 Construction Camp Management, including GBV and SE risk prevention measures
  - 4.13 Cultural, Religious Issues, Chance find procedures
  - 4.14 Critical areas
  - 4.15 Subcontractors
  - 4.16 Summary of hazards and controls

#### 3.20.5.4 Section 6 of HSE Plan

In addition to general hazards and their controls, the following hazards have been identified as specific to this contract and therefore the contractor should demonstrate that he is capable of providing the necessary controls for the work:

- Working within a Permit to Work system
- · Working adjacent to live high voltage equipment
- · Working adjacent to, and in the vicinity of, live high voltage overhead lines
- Working at elevation
- Lifting operations
- Use of explosives
- · Use of heavy machinery including cranage, pile rigs and concrete mixers
- Excavation works
- Work in confined spaces
- Working with insulating oil
- Working with compressed gas
- Rotating machinery

The Contractor should demonstrate his understanding of these hazards by either proposing specific controls for each of them or by giving supporting documentation which demonstrates that such controls already exist.

#### 3.20.6 PROGRESS REPORTING

i. The Contractor shall submit for approval, within four weeks of the issue of letter of award, an outline of the design, engineering, material procurement, production, site mobilisation, man and machine deployment,

delivery, erection, testing, commissioning, and handing over Programme as mentioned earlier. Within a further period of 4 weeks the Contractor shall provide a detailed programme scheduling the future activities in the form of Bar chart and/or any other form to be agreed upon by AEGCL.

- ii. The Contractor shall submit monthly progress reports to AEGCL office not later than the fifth day of the following month. The reports shall show clearly and accurately the position of all activities associated with design, material procurement, manufacture, works tests, shipping, site erection, testing and commissioning with regard to the agreed contract programme.
- iii. In addition to the routine monthly progress report the Contractor shall also submit to AEGCL 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 programme is MS Project version 4.0 or any latest. The programme and monthly updates shall be submitted on Email/CD/Hard copy.
- iv. The design aspect of the progress report shall include a comprehensive statement on drawing and calculations submitted for approval. 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 effect on the contract programme the Contractor shall state the remedial action taken to ensure that delays do not occur. The position on manufacture shall indicate the arrival of material, the progress of manufacture and date at which the equipment will be ready for transport.
- v. Any events that may adversely affect completion in the manufacturer's works shall also be reported. All works, tests executed shall be listed and the test-results shall be remarked upon. Any test failures shall be highlighted, and the Contractor shall detail the necessary steps taken in order to avoid any adverse effect on the contract completion dates. The dispatch of each order shall be monitored on the progress report giving the date by which the equipment will be available for transport, the estimated time of arrival on site and the dates actually achieved.
- vi. The site works shall be segregated into civil, mechanical and electrical works for reporting purposes and each section of the site works shall be monitored giving the percentage completion and the estimated completion date in accordance with the contract programme. The number of men working on site, both labour and supervisory staff, shall be reported together with any incidents or events that may affect the progress of site works.
- vii. 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.
- i. The contractor shall provide two copies of the progress report to AEGCL office. All other activities listed in other sections of bid document also shall be provided.

#### 3.20.7 STANDARDS

- i. 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 technically equivalent National Standards. In such cases copies of the relevant Standards or part thereof, in the English language shall be submitted with the Tender. In case of conflict the order of precedence shall be (1) IEC, (2) IS and (3) other alternative standard.
- ii. The supply and 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.
- iii. 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.
- iv. The list of standards provided in the Chapter 1 of this Specification is not to be considered exhaustive and the Contractor shall ensure that equipment supplied under this contract meets the requirements of the relevant standard whether or not it is mentioned therein.

#### 3.20.8 LANGUAGE AND SYSTEM OF UNITS

- i. The English language shall be used in all written communications between the Employers, AEGCL 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 Employer.
- ii. It is required that danger plates, equipment designation labels or plates, instruction notices on plant and general substation notices be written in English. Control switch and lamp labels, indicator lamp and annunciator inscriptions shall be in English only.

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

# 3.20.9 MASS AND SIZE OF PARTS AND QUANTITIES OF OIL

The mass and dimensions of any item of equipment shall not exceed the figures stated in the Schedules.

Each item shall be labeled to indicate its mass, quantity of oil (if any) and any special handling instructions.

#### 3.20.10 GENERAL REQUIREMENTS

#### 3.20.10.1 Bolts and nuts

- All bolts, studs, screw threads, pipe threads, bolt heads and nuts shall comply with the appropriate national standards for metric threads, or the technical equivalent.
- 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 4. 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.

# 3.20.11 Galvanising

# 3.20.11.1 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.

### 3.20.11.2 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 4. 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. A
  die shall not be used for cleaning the threads unless specially approved by AEGCL. 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.
  - Coating thickness
  - Uniformity of zinc
  - Adhesion test
  - 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.

#### 3.20.12 Cleaning, painting and topicalization

#### 3.20.12.1 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 AEGCL, and such powders shall comply with the requirements of IEC 455. The Contractor shall provide full details of the coating process to AEGCL 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.

#### 3.20.12.2 Works painting processes

- i. All steelworks, plant supporting steelworks and metalwork, except galvanised surfaces or where otherwise specified, shall be shot blasted to BS 7079 or the equivalent 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.
- ii. All rough surfaces of coatings shall be filled with an approved two pack filler and rubbed down to a smooth surface.
- iii. The interior surfaces of all steel tanks and oil filled chambers shall be shot blasted in accordance with BS 7079 or the equivalent 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 AEGCL.
- iv. 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 AEGCL, to a light or white colour. A minimum overall paint film thickness of 150 microns shall be maintained throughout.
- v. 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.
- vi. Galvanised surfaces shall not be painted in the works.
- vii. All nuts, bolts, washers etc., which may be fitted after fabrication of the plant shall be painted as described above after fabrication.

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

# 3.20.12.3 Site painting

- i. 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.
- ii. 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.
- iii. 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.
- iv. All paint work shall be left clean and perfect on completion of the works.

# 3.20.13 Colour Schemes

- i. The Contractor shall propose a colour scheme for the sub-station for the approval of AEGCL. The decision of AEGCL shall be final. The scheme shall include:
- Finishing colour of indoor equipment
- Finishing colour of outdoor equipment
- Finish colour of all cubicles
- Finishing colour of various auxiliary system equipment including piping.
- 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 Employer's electrical equipment in Employer's switchyard is painted with shade 631 of IS: 5 and Employer will prefer to follow the same for this project also. All indoor cubicles shall be of same colour scheme and for other miscellaneous items colour scheme will be subject to the approval of AEGCL.

		Application Environment				
SL		Indoor		Outdoor		
No.	Equipment	Colour	Code IS:5	Colour	Code IS:5	
	400kV/220kV/	132kVClassEquipmo	ent		•	
1	Transformers	—		Light grey	631	
2	Marshalling boxes, CTs, PT's, CVT's,	Light Admiralty grey.	697	Light Admiralty	697	
	surge counter casings, junction boxes etc.			grey.		
3	Control and relay panels, PLCC cabinets	Smoke grey	692	—	—	
	etc.					
4	Porcelain parts i.e., insulators	Dark brown	412	Dark brown	412	
5 All structures/metallic parts exposed to		Hot din galvanised				
	atmosphere		riot ap gain			
	33kV0	Classequipment				
6	Switch gear cubicles	Smoke grey	692	Light grey	631	
7	Control and relay panels	Smoke grey	692	—	—	
	LT switchgear					
8	LT switch gear exterior	Smoke grey	692	Light grey	631	
9	ACDB/MCC	Smoke grey	692	Light grey	631	
10	DCDB	Smoke grey	692		—	
11	LT busduct in side enclosure	Matt Paint		—	—	
12	LT busduct 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 arev	692	_	_
18	Mimic diagram				
	400kV	Dark violet Golden	796	—	_
	220kV	yellow	356	—	—
	132kV	Sky blue	101	_	_
	33kV	Signal red	537	—	_
	11kV	Canary yellow	309	—	—
	415V	Middle brown	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	Waterpipes	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

Table: Recommended colour schemes

The above specifications are general guidelines. If specific requirement is made for individual items, that will supersede the above details.

#### 3.20.14 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 equipment located in non-air-conditioned areas shall also be of same type.

### 3.20.14.1 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 10C, above the outside air temperature to prevent condensation. This shall be demonstrated by tests.

### 3.20.14.2 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.
The varnish shall not be applied to any surface or part where the treatment will interfere with the operation or
performance of the equipment. Such surfaces or parts shall be protected against the application of the varnish.

#### 3.20.14.3 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.

## 3.20.14.4 Labels and plates

- All apparatus 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 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. 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 English and Assamese 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 lamicoid. 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 AEGCL for approval.
- The nameplates of the apparatus shall include, at least, the information listed below, together with any other relevant information specified in the applicable standards:
  - Concise descriptive title of the equipment
  - Rating and circuit diagrams
  - Manufacturer's name, trademark, model type, serial number
  - Instruction book number
  - Year of manufacture
  - Total weight (for capacitor racks indicate weight, for capacitors indicate quantity of liquid)
  - Name of the project.
- 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 prominently marked with manufacturers name, manufacturer's 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.

#### 3.20.14.5 Pad Locks

- For each item of plant, the Contractor shall provide a pad lockable 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.

#### 3.20.14.6 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 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 backfilled 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 AEGCL.
- 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 or shall be decided based on the system fault rating & conductor sizing calculations as per relevant standards.

## 3.20.14.7 Lubrication

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

# 3.20.15 PRODUCTION PROCESS REQUIREMENTS

## 3.20.15.1 Castings

# 3.20.15.1.1. 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 AEGCL 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.

#### 3.20.15.1.2. Iron castings

 Iron casting material shall be in accordance with ASTM A 126 Class B. A copy of the ladle analysis shall be sent to AEGCL. Each casting shall have a test bar from which tension test specimens may be taken. Test specimen shall be in accordance with ASTM A 370 and tested in accordance with ASTM E8. The Contractor shall submit his procedures for testing and acceptance for iron castings for approval by AEGCL.

#### 3.20.15.1.3. Steel castings

- Steel castings shall be manufactured in accordance with ASTM A 27 and shall be subjected to appropriate tests and inspection as detailed herein.
- Copies of mandatory documentation, such as ladle analyses and mechanical test results, shall be sent to AEGCL. (Non-ferrous casting material and castings shall be manufactured in accordance with the appropriate ASTM standards for the material concerned).

#### 3.20.15.2. Forgings

- When requested by AEGCL, forgings will be subjected to inspection in the regions of fillets and changes of section by suitable method. Magnetic particle, dye-penetration, radiographic or ultrasonic, or any combination of these methods may be used to suit material type and forging design.
- The testing is to be carried out after the rough machining operation and is to be conducted according to the appropriate ASTM standards.
- MPI test on forging shall be carried out to detect both radial and axial cracks. Ferrous forgings shall be demagnetised after such tests.
- Any indentations which prove to penetrate deeper than 2.5% of the finished thickness of the forging shall be reported to AEGCL giving location, length, width and depth. Any indentations which will not machine out during final machining shall be gouged out and repaired using an approved repair procedure.
- Repair of rotating elements by welding will only be accepted subject to detailed examination of the proposal by AEGCL prior to the repair being carried out.
- The forging shall be tested for mechanical and metallographic tests as per ASTM. The details shall be mutually discussed/agreed upon.

#### 3.20.15.3. Fabricated components

- All components machined or fabricated from plate, sheet or bar stock shall meet the material requirements of ASTM or material specification approved by AEGCL.
- Structural steel, rolled shapes, bars, etc. shall comply with the latest ASTM for A36.
- Plate steel shall be of a designation and quality suitable for the function it is intended to perform. Insofar as it is compatible with its function, it shall comply with ASTM A283 structural quality.
- All, or a representative number of such components, shall be subjected to one or more of the following tests: visual, dye penetration, magnetic particle (transverse and longitudinal), ultrasonic or radiographic. These tests shall be in accordance with the recommended practices of the ASTM. The terms of reference for acceptance shall be the applicable ASTM Specifications.

#### 3.20.15.4. Welding and welder's qualifications

#### 3.20.15.4.1. General

• All welding shall be carried out by qualified welders only. All welding shall be in accordance with the corresponding standards of the American Welding Society or the American Society of Mechanical Engineers. Other standards to determine the quality of welding process and qualifications of welders may

be considered, provided that sufficient information is first submitted for the approval of AEGCL. Prior to the start of fabrication, the Contractor shall submit to AEGCL for approval, a description of each of the welding procedures which he proposes to adopt, together with certified copies of reports of the results from tests made in accordance with these procedures.

The Contractor shall be responsible for the quality of the work performed by his welding organisation. All
welding operators, to be assigned work, including repair of casting, shall pass the required tests for
qualification of welding procedures and operators. AEGCL reserves the right to witness the qualification
tests for welding procedures and operators and the mechanical tests at the samples. The Contractor shall
bear all his own expenses in connection with the qualification tests. If the work of any operator at any time
appears questionable, such operator will be required to pass appropriate pre- qualification tests as
specified by the Inspector and at the expense of the Contractor.

# 3.20.15.4.2. Welding

- All welding shall be performed in accordance with the appropriate standards. The design and construction of welded joints subject to hydraulic pressure shall conform to the applicable requirement of ASME "Boiler and Pressure Vessel Code" shall be qualified in accordance with Section IX of this Code. The design and construction of welded joints not subjected to hydraulic pressure shall, as a minimum, conform to the requirements of AWS "Specification for Welded Highway and Railway
- Bridge" D2.0. Except for minor parts and items specifically exempted from stress relieving, all shop- welded joints shall be stress relieved in accordance with the requirements of the ASME "Boiler and Pressure Vessel Code" Section VIII.
- In addition to satisfying the procedural and quality requirements set forth in the applicable code and/or these Specifications, all welding shall meet the following requirements for workmanship and visual quality:
  - > Butt welds shall be slightly convex, of uniform height and shall have full penetration.
  - > Fillet welds shall be of the specified size, with full throat and legs of equal length.
  - Repairing, chipping and grinding of welds shall be done in a manner which will not gouge, groove or reduce the thickness of the base metal.
  - The edges of the member to be joined shall expose sound metal, free from laminations, surface defects caused by shearing or flame-cutting operations or other injurious defects.
- Welded joints subject to critical working stress shall be tested by approved methods of non-destructive testing, such as radiographic and ultrasonic examination, magnetic particle and liquid penetration inspection. All expenses in connection with these tests shall be borne by the Contractor. The extent of testing shall be as stipulated by the ASME "Boiler and Pressure Vessel Code", Section VIII, but without prejudice to the rights of the Inspector or AEGCL to ask for additional tests,
- The arc-welding process to be used and the welding qualifications of the welders employed on the work shall be used in accordance with AWS requirements and Section VIII and IX of the ASME (American Society of Mechanical Engineers) Code, latest edition, as they may apply. All welding rods shall conform to the requirements of the latest issue of Section It, part C of the ASME Code.
- Gas shielded welding (TIG or MIG) used as appropriate for aluminium, stainless steel or other material shall be carried out in accordance with the best commercial practice and the following standard specifications:
  - Specifications for copper and copper-alloy welding rods (AWS A5.7, ASTM B259)
  - Specification for corrosion-resisting chromium and chromium-nickel steel welding rods and bare electrodes (AWS A5.9, ASTM A371)
  - Specifications for aluminium and aluminium alloy rods and bare electrodes (AWS A5.10, ASTM B285).
  - > Specifications for nickel and nickel-base alloy bare welding filler metal (AWS A5.14, ASTM B304).
- Gas welding will not normally be used in the equipment. When a particular equipment manufacture requires
  the use of gas welding, the proposed process and the welder's qualification shall be in accordance with AWS
  B3.0. Welding of galvanised components will not be allowed in the equipment. Strict measures of quality
  control shall be exercised throughout the Equipment/ Works. AEGCL may call for an adequate NDT test of
  the work of any operator, who in his opinion is not maintaining the standard of workmanship. Should this NDT
  test prove defective, all work done by that operator, since his last test shall be tested at the Contractor's
  expense. If three or more of these tests prove defective, the operator shall be removed from the project. A
  procedure for the repair of defects shall be submitted to AEGCL for his approval prior to any repairs being
  made.

#### 3.20.15.4.3. Welding of pipes

- Before welding, the ends shall be cleaned by wire brushing, filing or machine grinding. Each weld-run shall be cleaned of slag before the next run is deposited. Welding at any joint shall be completed uninterrupted. If this cannot be followed for some reason, the weld shall be insulated for slow and uniform cooling. Welding shall be done by manual oxy-acetylene or manual shielded metal are process. Automatic or semiautomatic welding processes may be done only with the specific approval of AEGCL. As far as possible, welding shall be carried out in flat position. If not possible, welding shall be done in a position as close to flat position as possible.
- Downward technique is not allowed while welding pipes in horizontal position, unless permitted by AEGCL. Combination of welding processes or usage of electrodes of different classes or makes in a particular joint shall be allowed only after the welding procedure has been duly qualified and approved by AEGCL. No backing ring shall be used for circumferential butt welds. Welding carried out in ambient temperature of 5C or below shall be heat treated.
- A spacer wire of proper diameter may be used for weld root opening but must be removed after tack welding and before applying root run.
- Tack welding for the alignment of pipe joints shall be done only by qualified welders. Since tack welds form part of final welding, they shall be executed carefully and shall be free from defects. Defective welds shall be removed prior to the welding of joints.
- Electrodes size for tack welding shall be selected depending upon the root opening. Tack welds should be equally spaced.
- Root run shall be made with respective electrodes/filler wires. The size of the electrodes shall not be greater than 3.25 mm (10 SWG) and should preferably be 2.3 mm (12 SWG). Welding shall be done with direct current values recommended by the electrode manufacturers.
- Upward technique shall be adopted for welding pipes in horizontally fixed position. For pipes with wall thickness less than 3 mm, oxyacetylene welding is recommended.
- The root run of butt joints shall be such as to achieve full penetration with the complete fusion of root edges. The weld projection shall not exceed 3 mm inside the pipe.
- On completion of each run craters, weld irregularities, slag etc. shall be removed by grinding or chipping.
- During the process of welding, all movements, shocks, vibration or stresses shall be carefully avoided in order to prevent weld cracks.
- Fillet welds shall be made by shielded metal arc process regardless of thickness and class of piping. Electrode size shall not exceed 10 SWG. (3.25 mm). At least two runs shall be made on socket weld joints.

# 3.20.16 WIRING, CABLING AND CABLE INSTALLATION

#### 3.20.16.1 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/XLPE insulated, single core, stranded copper wires. The PVC shall have oxygen index not less than '29' and Temperature index not less than 250°C (for XLPE cable). 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:
  - i. All circuits excepting CT circuits and energy metering circuit of VT 2.5 sq.mm
  - ii. All CT circuits and metering circuit of VT 2.5sq. 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 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.

# The above specifications are general guidelines. If specific requirement is made for individual items, that will supersede the above details.

#### 3.20.16.2 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.

# The above specifications are general guidelines. If specific requirement is made for individual items, that will supersede the above details.

#### 3.20.16.3 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 armoured multi-core cable with stranded copper conductors PVC/XLPE 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 multicore 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) meters 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.

# 3.20.16.4 Laying and installing of cables

#### 3.20.16.4.1. General

For cable laying the following shall apply:

- Switchyard area in concrete cable troughs (cable trench having cable racks with cable Trays)
- Control Room On cable racks consisting of slotted type and ladder type cable trays
- Buildings Conduits

Directly buried cables shall be used wherever necessary with the approval of AEGCL.

#### 3.20.16.4.2. 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 AEGCL. 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 AEGCL. 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 AEGCL before the trenches are backfilled. Backfilling of cable trenches should be carried out as per relevant IS standards.
- 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/Communication and other service cables in bottom tiers.

#### 3.20.16.4.3. 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.

#### 3.20.16.4.4. 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 secure to the supports on walls or floors by suitable anchoring.

#### 3.20.16.4.5. 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.

# 3.20.16.5. 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 AEGCL may determine. Cable boxes shall be provided with suitable labels indicating the purpose of the supply where such supply is not obvious or where AEGCL 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.

# The above specifications are general guidelines. If specific requirement is made for individual items, that will supersede the above details.

#### 3.20.17 DEGREES OF PROTECTION

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

- ➢ For outdoor applications, IP 55/ IP 65.
- For indoor applications where purpose-built accommodation is provided, e.g., switch and control and relay rooms in auxiliary plant buildings, IP 41/42.
- > Where dust can adversely affect equipment within the enclosure, this equipment should be separately housed with a degree of protection of IP 51.
- 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 AEGCLs approval.

# The above specifications are general guidelines. If specific requirement is made for individual items, that will supersede the above details.

#### 3.20.18 SUPPLY VOLTAGE

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

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
220	187V-242V	DC	DC	2	Isolated2wires
110	100V-121V	DC	DC	2	Isolated2wires
50	45V-55V	DC	DC	2	+ve earthed

The auxiliary supply voltages on site shall be as follows:

#### **3.20.19 MAINTENANCE TELEPHONE POSITIONS**

• Telephone jack plug points shall be provided at each circuit breaker, at each power transformer marshalling kiosk and, on each control, and relay panel. At each substation these plug points are to be connected in parallel to form a site telephone circuit for use during maintenance and testing operations.

# 3.20.20 ERECTION CONDITIONS

#### 3.20.20.1 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.

#### 3.20.20.2 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 Assam) and the rules made there under in respect of any employee or workman employed or engaged by him or his Sub-Contractor.
- The Contractor shall ensure that he obtains, from the Government of Assam, 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 Assam, for engagement in the Contract Works.

#### 3.20.20.3 Inspection, testing and inspection certificates

The provisions of the General Conditions of Contract shall also be applicable to the erection portion of the Works. AEGCL 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.

#### 3.20.20.4 Contractor's field operation

#### 3.20.20.4.1 General

The Contractor shall inform AEGCL 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 AEGCL 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.

## 3.20.20.5 Facilities to be provided by the contractor

#### 3.20.20.5.1 Unloading

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

### 3.20.20.5.2 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 AEGCL before the commencement of pre-assembly at Site. These tools and tackles shall not be removed from the Site without the written permission of AEGCL.

#### 3.20.20.6 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 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 AEGCL. 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 AEGCL. Under no circumstances shall waste oil be dumped into uncontrolled drains.

#### 3.20.20.7 Security

 The Contractor shall have total responsibility for all equipment and material in his custody, stored, loose, semiassembled 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.

#### 3.20.20.8 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 AEGCL immediately of any damage, shortage, discrepancy etc. for the purpose of AEGCL's information only. The Contractor shall submit to AEGCL 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, wharf age 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 AEGCL.
- 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.

#### 3.20.20.9 Construction Management

#### 3.20.20.9.1 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 AEGCL, providing evidence that his action will compensate for the delay. The Contractor shall not be allowed any extra compensation for such action.

#### 3.20.20.10 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 AEGCL in the required number of copies.

#### 3.20.20.11 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 AEGCL 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.

#### 3.20.21 EMPLOYER'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 Employer and without prejudice the Contractor shall proceed
  to comply with the Employer's decision.
- The work shall be performed under the direction and supervision of AEGCL& PMC. The scope of the duties
  of AEGCL, pursuant to the contract, will include but not be limited to the following:
  - o Interpretation of all the terms and conditions of these documents and specifications.
  - Review and interpretation of all the Contractors drawing, engineering data etc.
  - Witness or authorize 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.
  - o Inspect, accept or reject any equipment, material and work under Contract.
  - o Issue certificate of acceptance and/or progressive payment and final payment certificates.
  - Review and suggest modification and improvements in completion schedules from time to time.
  - Supervise the Quality Assurance program implementation at all stages of the Works.

#### 3.20.22 TESTING AND INSPECTION

#### 3.20.22.1 General Conditions of Type Test

- 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 AEGCL 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. However, in the absence of relevant regulations in IEC / IS, other appropriate international
  standards may be accepted at AEGCL's discretion. 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 excluding GIS being supplied by him (as per IEC standard) which, shall not be older than five (5) years, as on date of bid opening for AEGCL's approval. AEGCL may also give instruction to carry out Type Tests, routine tests or acceptance tests. No charges shall be paid by AEGCL for any Type Test.

#### 3.20.22.2 Mandatory Type Test for GIS Equipments (If applicable)

- The manufacturer shall furnish the certificates confirming successful conduction of the following Type Tests for GIS. The tests carried out shall not be older than Ten (10) years from the date of issue of LOA.
- 1. Tests to verify the insulation level (Lightning impulse, switching impulse and ac withstand test with PD) test on each GIS device (CB, Disconnector, bus etc.)
- 2. Dielectric tests on auxiliary circuits.
- 3. Tests to prove the radio interference voltage (RIV) level.
- 4. Tests to prove the temperature rise of any part of the equipment and measurement of the resistance of the main circuit.
- 5. Tests to prove the ability of the main and earthing circuits to carry the rated peak and the rated short time withstand current.
- 6. Tests to verify the making and breaking capacity of the included switching devices.
- 7. Tests to prove the satisfactory operation of the included switching devices.
- 8. Tests to prove the strength of enclosures.

- 9. Verification of the degree of protection of the enclosure.
- 10. Gas tightness tests
- 11. Electromagnetic compatibility tests (EMC).
- 12. Additional tests on auxiliary and control circuits.
- 13. Tests on partitions.
- 14. Tests to prove the satisfactory operation at limit temperatures.
- 15. Tests to prove performance under thermal cycling and gas tightness tests on insulators.
- 16. Corrosion test on earthing connections (if applicable).
- 17. Tests to assess the effects of arcing due to an internal fault.
- 18. Tests on solid dielectric components (operating rods, spacers, etc.)
- 19. Seismic test
- 20. Test on Auxiliary switches (Electrical & Mechanical Endurance, Heat run, IR & HV test)
  - 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 in all such tests.
  - All tests shall be carried out to the satisfaction of AEGCL, in presence of authorised representative of AEGCL, at such reasonable times as AEGCL may require, unless agreed otherwise. Not less than three weeks' notice of all tests shall be given to AEGCL in order that AEGCL may be represented if AEGCL so desires. As many tests as possible shall be arranged together. Six copies of the Contractor's test report and test sheets shall be supplied to AEGCL for approval.
  - Measuring apparatus shall be approved by AEGCL and if required shall be calibrated at the expense of the Contractor at an approved laboratory.
  - The Contractor shall be responsible for 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 apparatus, instruments and connections required for the above tests shall be provided by the Contractor, but AEGCL may permit the use for the tests on site, any instruments and apparatus 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 AEGCL. If required by AEGCL, test specimens shall be prepared for check testing and forwarded at the expense of the Contractor to an independent testing authority selected by AEGCL.
  - Any costs incurred by the Employer 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 Employer, shall be to the account of the Contractor.
  - No inspection or lack of inspection or passing by AEGCL 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.

# The above specifications are general guidelines. If specific requirement is made for individual items, that will supersede the above details.

# 3.20.23 FIRE PRECAUTIONS

- All apparatus, 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 Contractors' 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 firefighting.

• 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.

# 3.20.24 PACKING, SHIPPING AND TRANSPORT

- The Contractor shall be responsible for the packing, loading and transport of the plant and equipment from the place of manufacture, whether this is at his own works or those of any Contractor, to Site, and for off-loading at site.
- All apparatus and equipment shall be carefully packed for transport by air, sea, rail and road as necessary
  and in such a manner that it is protected against tropical climate conditions and transport in rough terrain and
  cross-country road conditions. The method of packing shall provide complete protection to all apparatus and
  equipment during transport and storage at site in heavy rain. The method of packing shall provide adequate
  protection to main items of plant and those parts contained within and attached without, for transportation.
- Precautions shall be taken to protect parts containing electrical insulation against the ingress of moisture.
- All bright parts liable to rust shall receive a coat of anti-rusting composition and shall be suitably protected. The machined face of all flanges shall be protected by means of a blank disc bolted to each face.
- Where appropriate all parts shall be boxed in substantial crates or containers to facilitate handling in a safe and secure manner. Each crate or container shall be marked clearly on the outside of the case to show "TOP" and "BOTTOM" positions with appropriate signs, and where the mass is bearing and the correct position for slings. Each crate or container shall also be marked with the notation of the part or parts contained therein, contract number and port of destination. It shall be the Contractor's responsibility to dispose of all such packing.
- Any damage due to defective or insufficient packing shall be made good by the Contractor at his own expense
  and within reasonable time when called upon by AEGCL to do so. Four (4) copies of complete packing lists
  showing the number, size, marks, mass and contents of each package shall be delivered to AEGCL
  immediately after the material is dispatched.
- The Contractor shall inform himself fully as to all relevant transport facilities and requirements and loading
  gauges and ensure that the equipment as packed for transport shall conform to these limitations. The
  Contractor shall also be responsible for verifying the access facilities specified.
- The Contractor shall be responsible for all costs of repair or replacement of the equipment, including those
  incurred by the Employer, arising from damage during transport, off-loading or erection on site, until take-over
  by the Employer.
- The Contractor 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. Any cost of claim towards damages, if any, caused to Bridges and Highways during transportation of the materials shall be borne by the contractor.

#### 3.20.25 ERECTION MARKS

- Before leaving the Contractor's Works all apparatus and fittings shall be painted or stamped in two places with a distinguishing number and/or letter corresponding to the distinguishing number and/or letter on an approved drawing and material list. All markings shall be legible; weatherproof tags, where used, shall be durable, securely attached and duplicated.
- The erection marks on galvanised material shall be stamped before galvanising and shall be clearly legible after galvanising.

#### 3.20.26 SPECIAL TOOLS & EQUIPMENTS

- A complete set of spanners shall be supplied for each station to fit every nut and bolt head on the apparatus supplied under this Contract, together with all special tools required for the adjustment and maintenance of the equipment. These tools shall be mounted in a lockable cabinet at each substation, also to be provided under this Contract. Eye bolts which have to be removed after use shall be accommodated in the cabinets.
- Spanners and other maintenance equipment provided under the Contract shall not be used for the purpose of erection of the contract Works.
- Any special devices, slings or tackle necessary for the complete overhaul of the plant shall be handed over to AEGCL in working order on completion of the Contract.
- On delivering any or all of these tools to AEGCL, a signature shall be obtained from AEGCL's representative. Any tools not signed for shall be deemed not to have been delivered.

# The above specifications are general guidelines. If specific requirement is made for individual items, that will supersede the above details.

## 3.20.27 RUNWAY BEAMS, EYE BOLTS AND LIFTING TACKLE

- Runway beams shall comply with the requirements of BS 2853, or its equivalent, and shall be tested after erection in accordance with this standard and this Specification. The Contractor shall be responsible for the provision of the appropriate test certificates which must be in accordance with Appendix C of BS 2853.
- All slings, eye bolts and other lifting tackle provided shall be proof tested to twice the safe working load and suitably marked with embossed labels to show clearly the safe working loads.

## 3.20.28 EARTHING SYSTEM

- Electrical measurements of the subsoil at various depths up to 20 meters shall be made at the site of each substation in order to determine the layered effects of the ground from which the effective ground resistivity and hence the expected resistance of the proposed earth grid system may be predicted. Wenner's 4 Electrode method as per IEEE-Std. 81 may be followed for measurement of earth resistivity. The earthing system shall comprise a mesh grid formed by hot dip galvanised iron flat bar (GI flat) of 75 X 12 mm(for 220/132 KV & 132/33 KV) and 40 mm MS rod (for 400 KV) buried directly in the ground and arranged so as to utilise fully the available site area.
- A continuous conductor shall be laid outside the periphery of the substation site at a distance of two meters from the switchyard fence and at a depth of at least 0.7 meters (the earth mat top shall be at 700 mm below the finished ground level) below the surface. A mesh system shall be formed by interconnection at various points to the perimeter conductor. The distance between two buried Earth Mat (flat/rod) shall be maximum 5 meters both ways. The mesh system shall be designed such that the grid potential rise limits the touch voltage to a value not greater than the maximum tolerable touch potential; the fault clearance time to be used in the earthing calculations shall be taken as one second. The earthing system shall be designed to meet the requirements of this specification and shall be in accordance with IEEE 80 and IS 3043. The Contractor shall present calculations to show the earthing system meets these requirements and can be shown to be safe in terms of touch, step and transferred potentials. The calculations shall be carried out considering a layer of crushed metals of thickness 100mm and without the same; and if applicable recommend suitable site surfacing. The resistance of the earth mat shall not exceed 0.5.
- Each substation shall be provided with safety grounding mat as per clause relevant clauses of this section. While designing the ampacity of the buried conductor suitable corrosion allowance shall be considered for Thirty-Five (35) years. The conductors shall be buried at a depth of 700 mm from finished formation level. The conductors shall be welded suitably for maintaining a high degree of mechanical rigidity and electrical connectivity.
- The substation earth mat shall be designed to provide a ground potential rise within safe limits of tolerable touch and step potential. The margins of limits shall confirm the international practices. The design of earth mat shall be in accordance with IEEE-80/1986 and shall be submitted to AEGCL approval.
- In the event of the substation resistance obtained with the foregoing installation being of a magnitude unacceptable to AEGCL, then where practicable, the ground area enclosed by the earth system should be increased by installing directly in the ground a GI flat /MS rod conductor in the form of a ring around the site at a significant distance from the boundary fence. Alternatively, earth conductors can be directly buried radially outside the substation perimeter fence. The use of earth plates as current carrying electrodes is not acceptable.
- The earthing system shall be designed so as to include all overhead line terminal towers, which shall be earthed by extending the system so as to envelope all towers within the earth system. Each tower shall be bonded directly to the earth system from at least two locations. Structures and masts for lighting and security surveillance equipment shall also be within the perimeter of the earth grid. No fixed low voltage equipment, with the exception of a warning or alarm button and intruder alarms which shall be of the double insulation type, shall be erected outside the perimeter of the earth grid.
- Where a metal substation fence is provided, this shall be bonded electrically to the earthing grid on each side at spacing not exceeding 0.25r (where r is the equivalent circular plate radius), at points adjacent to each corner and immediately below any overhead line entering or leaving the Site. The location of the mesh conductors shall be such as to enable all items of equipment to be connected to the earth system via the shortest possible route.

- Gate posts forming part of the substation fence shall be bonded together with below ground connections and the gates themselves shall be electrically bonded to the posts at two points through flexible braids.
- The current density of the earth conductor shall be not greater than 100A/mm2. Single connections between
  equipment and the earth system shall carry the total short circuit current, but the cross-sectional area of
  branch connections may be reduced to take account of current distribution in two or more conductors. A
  distribution of 60 per cent shall be assumed for this purpose, i.e. the cross-sectional area of branch
  connections may be reduced to 60 per cent of the corresponding single conductor.
- The earth conductor may be sized as per IEEE 80 and sufficient allowance for corrosion may be taken into account.
- The grid voltage rise under fault conditions shall not exceed 15 kV. If the calculated grid voltage rise exceeds 430V, the local Telephone Authority shall be advised, by the Contractor, of the grid voltage rise and the distance of the 650V contour from the substation grid periphery.
- The alternative approach of independently earthing the fence and placing it outside the earth grid area shall only be adopted if the above-mentioned procedures prove insufficient or impracticable. The Contractor shall provide calculations to show that this approach produces safe touch voltages at the fence and shall ensure that the fence is isolated from all other buried metalwork.
- Metal parts of all equipment, other than those forming part of an electrical circuit, shall be connected directly
  to the main earth system at two points. For the same the size of the G.I. flats shall also be 75X10mm. This is
  the raiser of the earth to the structures of column, beam and all equipment structures. The arrangement of
  the mesh earth system shall be such as to minimise the length of these connections.
- A separate set of earth electrodes (at least two), GI pipe, perforated, 50mm dia, heavy duty having 3000mm long in a treated earth pit, shall be provided for the earthing for high frequency coupling equipment (CVT etc), surge arresters, IVT, each neutral of the transformers and reactors at a position immediately adjacent to the equipment being earthed in addition to the normal earth connection.
- All main members of structural steelworks shall be earthed by GI flat (size 75X10mm) earthing connections being bonded to the steelworks. The Contractor shall be responsible for earthing of the transformers and circuit breakers installed on the substation site as per recommended. Connections to apparatus and structures shall be made clear of ground level, preferably to a vertical face and protected against corrosion. Earth bars installed directly into the ground should normally be laid bare and the trench backfilled with a fine top soil. Where the soil is of a hostile nature, precautions must be taken to protect the earth bar.
- All exposed joints shall be at a minimum height of 150 mm above floor or ground level. A facility shall be provided on the earth bar run between the equipment and the base of the structure, comprising a looped copper strip (test link), so as to permit the attachment of portable earth connections for maintenance purposes.
- After installation of the earth system the Contractor shall measure the resistance of the substation. The
  method used shall preferably be the "fall of potential" method, requiring the availability of a local low voltage
  supply, but other methods using an earth resistance meter will be acceptable in the event of a local supply
  being unavailable.
- The fencing of the switch yard also to be earthed by using G.I flats of size 75x10mm to each post and a continuous earth strip of size 50x6mm shall run all through the fence. The periphery of the switch yard shall be provided with non-treated earth pit at a distance of 5 mtrs all along the periphery. The size of the non-treated pit conductor shall be 40 mm dia MS rod of length 3000mm. The said earth MS Rod to be placed in earth pit as per standard practice and the pit shall be filled with Bentonite powder mixed with lomy soil at a ratio 1:10. There shall be provided to each pit. The pipe shall be connected to the overhead tank provided on the control room building and proper water control valve should be provided. Contractor shall prepare a detail earthing provision considering as per specification and shall obtain approval from AEGCL and the top of the MS rod shall be welded to the buried earth mats.

# 3.21 TECHNICAL SPECIFICATION ACSR CONDUCTORS AND ACCESSORIES FOR CONDUCTORS

# 3.21.1.0 SCOPE

3.21.1.1 This Section of the Specification covers the technical parameters for design, manufacture, testing at manufacturer's works and supply of Conductor, and accessories for Power Conductors.

## 3.21.2.0 POWER CONDUCTOR

#### 3.21.2.1 TYPE OF CONDUCTOR

The ACSR Conductor shall generally conform to IEC: 61089/ IS: 398 (relevant part)/ ASTM:B-232 except where otherwise specified herein.

Conductor conforming to a standard other than the Indian Standard specification then an English version of the Standard in addition to the original standard if written in a language other than English should be submitted indicating clearly the advantage, if any, that would be obtained by the Employer for adopting this standard instead of the said India Standard.

#### 3.21.2.2 STANDARD TECHNICAL PARTICULARS

All ACSR Conductor shall satisfy all the parameters as furnished in Technical Data Sheet.

All the aluminium and steel 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.

The steel strands shall be hot dip galvanised and shall have a minimum zinc coating.

#### 3.21.2.3 MATERIAL

The aluminium strands shall be hard drawn from electrolytic aluminium rods having purity and copper content as per the values indicated in the STP. They shall have the same properties and characteristics as prescribed in IEC: 60889. The steel wire strands shall be drawn from high carbon steel wire rods produced by either the acid or the basic openhearth process, the electric furnace process, or the basic oxygen process and shall conform to the chemical composition indicated in the STP.

The Steel wire strands shall have the same properties and characteristics as prescribed for regular strength steel wire in IEC: 60888.

The zinc used for galvanizing shall be electrolytic High-Grade Zinc of purity. It shall conform to and satisfy all the requirements of IS:209.

#### 3.21.2.4 JOINTS IN WIRE

In the Aluminium wires no joints shall be permitted in the individual wires in the outer most layer of the finished conductor. However, joints are permitted in the inner layer of the conductor unavoidably broken during stranding provided such breaks are not associated with either inherently defective wire or with the use of short lengths of aluminium wires. Such joints shall not be more than four (4) per conductor length and shall not be closer than 15 meters from joint in the same wire or in any other aluminium wire of the completed conductor.

Joints shall be made by cold pressure butt welding and shall withstand a stress of not less than the breaking strength of individual strand as per STP.

In the Steel wires there shall be no joint of any kind in the finished wire entering into the manufacture of the strand. There shall also be no strand joints or strand splices in any length of the completed stranded steel core of the conductor.

#### 3.21.2.5 STRANDING

The wires used in construction of a ACSR conductor shall, before and after stranding, satisfy all requirements of IS 398 with latest amendments thereof.

The lay ratio of the different layers shall be within the limits as per the said Standard. In all constructions, the successive layers shall have opposite directions of lay, the outer most layer being right-handed. The wires in each layer shall be evenly and closely stranded. In aluminium alloy stranded conductors having multiple layers of wires, the lay ratio of any layer shall not be greater than the lay ratio of the layer immediately beneath it.

# 3.21.2.6 TYPE/ROUTINE/ACCEPTANCE TESTS Type Test:

The following tests shall be conducted on a sample/sample of the conductor(s) required under the package from each stranding machine from which the conductor is to be manufactured & supplied:

- a) DC resistance test on stranded conductor
- b) UTS test on stranded conductor
- c) Corona extinction voltage test (dry)
- d) Radio interference voltage test (dry)

#### Acceptance Test:

- a) Visual and dimensional check on drum
- b) Visual check for joints, scratches etc. and length measurement of conductor by rewinding
- c) Measurement of diameters of individual Steel and Aluminium strands
- d) Galvanizing test on steel strands
- e) Check for lay Ratios of various layers
- f) Torsion and Elongation tests on steel strands
- g) Breaking load test on steel and Aluminium strands
- h) Wrap test on Steel & Aluminium strands
- i) DC resistance test on Aluminium strands
- j) Procedure qualification test on welded joint of Aluminium strands
- k) Drum strength test (steel drum)
- I) Barrel Batten strength test (wooden drum)

The above acceptance tests shall be repeated on one conductor sample taken from site in presence of AEGCL's representative for each 500km progressive supply. The tests shall be carried out by the supplier at his cost at its own premises or any other tests centre having required facilities. The sample shall be selected by AEGCL's site representative and the tests shall be witnessed by AEGCL's representative.

#### Routine Tests:

- a) Check to ensure that the joints are as per Specification
- 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 aluminium and steel strands of 20% of drums

#### Tests During manufacture:

- a) Chemical Analysis of Zinc used for galvanising
- b) Chemical Analysis of Aluminium used for making Aluminium Strands
- c) Chemical Analysis of Steel used for making Steel Strands.

#### 3.21.2.7 REJECTION AND RETESTS

Stipulations made in the IS 398 (Part-IV) on Rejection and Retests shall be followed.

#### 3.21.2.8 PACKING

All conductor reels shall conform to latest edition of IS: 1778 and be of dimensions approved by the Employer and made of seasoned wood sufficiently strong to ensure arrival at site, intact withstanding normal handling and hazards inland and ocean transit. The reels shall be of such size as to provide at least 12.5 mm clearance at all points from the conductor to the inner surface of the laggings.

All reels shall have two coats of aluminium paint on both inside and outside surface and shall be fitted with malleable iron Hub-bushings.

All reels shall be a layer of waterproof paper around the hub under the cable and another layer over the outermost layer of the cable, that is next to the lagging.

The reels shall be properly reinforced with galvanized steel wires or iron straps over the lagging in two places in an approved manner.

The wooden drums shall preferably be given protective coating of a reliable organic wood preservative before painting with Aluminium paint and the laggings shall also be given a similar treatment before being fixed on the drum. There shall be one standard length of Conductor in each drum.
# 3.21.2.9 TECHINCAL DATA SHEET FOR CONDUCTOR

# ACSR Zebra

1.	Code Name	ZEBRA
2.	Equivalent area of Aluminium (sq.mm.)	418.6
3.	Wire Strand (Al./Steel)	54/7
4.	Nominal diameter of strand (Al./Steel) (mm.)	3.18/3.18
5.	Weight (Kg/Km)	1621
6.	Co-eff. of linear expansion per <sup>o</sup> C	19.30x10 -6
7.	Ultimate Tensile Strength (kgf.)	13316
8.	Maxm. DC resistance at 20°C (I/Km) (Calculated from maxm. Value of resistivity and min. Cross-sectional area)	0.0680
9.	Zinc coating of steel:	
	i) No. of one minute dip	3
	ii) Min. wt. of zinc. (gm.m <sup>2</sup> )	260
	III) Purity of zinc (%)	99.95
10.	Diameter of conductor (mm)	28.62
11.	Standard Length (meter)	1100

# 3.22TECHNICAL SPECIFICATION FOR ISOLATORS

#### 3.22.1 SCOPE

- 3.22.1.1 This section of the specification is intended to cover design specifications for design, manufacture, testing at manufacturer's works of **gang operated Isolators** with all fittings and accessories, including mounting structures as applicable.
- 3.22.1.2 Loading at manufacturer's works, transportation and delivery at respective substation site, including unloading at destination site.
- 3.22.1.3 Erection, Testing and Commissioning of Isolators.

#### STANDARD

3.22.1.4 The Isolators and accessories shall conform in general to IS 9921 (or IEC: 62271-102) except to the extent explicitly modified in specification.

#### 3.22.2 GENERAL

- 3.22.2.1 The Isolators are for outdoor installation suitable for horizontally mounting on mounting structures and for use at sub-stations.
- 3.22.2.2 Isolators shall be outdoor, off-load type. Earth switches shall be provided on the isolators as and where specified with possibility of being mounted on any side of the isolator.
- 3.22.2.3 All isolating switches and earthing switches shall have rotating blades and pressure releasing contacts. All isolating and earth switches shall operate through 900 angle from closed position to fully open position.
- 3.22.2.4 The bidder shall offer ac motor operated Isolators and earth switches.
- 3.22.2.5 Complete isolator with all the necessary items for successful operation shall be supplied including but not limited to the following:
  - (i). Isolator assembled with complete base frame, linkages, operating mechanism, control cabinet, interlocks etc.
  - (ii). All necessary parts to provide a complete and operable isolator installation, control parts and other devices whether specifically called for herein or not.
  - (iii) The isolator shall be designed for use in the geographic and meteorological conditions as given in Section 1.

#### 3.22.3 DUTY REQUIREMENTS

- 3.22.3.1 Isolators and earth switches shall be capable of withstanding the dynamic and thermal effects of the maximum possible short circuit current of the systems in their closed position. They shall be constructed such that they do not open under influence of short circuit current.
- 3.22.3.2 The earth switches, wherever provided, shall be constructionally interlocked so that the earth switches can be operated only when the isolator is open and vice versa. The constructional interlocks shall be built in construction of isolator and shall be in addition to the electrical and mechanical interlocks provided in the operating mechanism.
- 3.22.3.3 In addition to the constructional interlock, isolator and earth switches shall have provision to prevent their electrical and manual operation unless the associated and other interlocking conditions are met. All these interlocks shall be of failsafe type. Suitable individual interlocking coil arrangements shall be provided. The interlocking coil shall be suitable for continuous operation from DC supply and within a variation range as stipulated elsewhere in this specification.
- 3.22.3.4 The earthing switches shall be capable of discharging trapped charges of the associated lines.

- 3.22.3.5 The isolator shall be capable of making/breaking normal currents when no significant change in voltage occurs across the terminals of each pole of isolator on account of make/break operation.
- 3.22.3.6 The isolator shall be capable of making/breaking magnetizing current of 0.7A at 0.15 power factor and capacitive current of 0.7A at 0.15 power factor at rated voltage.

#### 3.22.4 CONSTRUCTIONAL DETAILS

3.22.4.1 All isolating switches and earthing switches shall have rotating blades and pressure releasing contacts. All isolating and earth switches shall operate through 90° angle from closed position to fully open position.

#### 3.22.5 Contacts:

- 3.22.5.1 The contacts shall be self-aligning and self-cleaning and so designed that binding cannot occur after remaining closed for prolonged periods of time in a heavily polluted atmosphere.
- 3.22.5.2 No undue wear or scuffing shall be evident during the mechanical endurance tests. Contacts and spring shall be designed so that readjustments in contact pressure shall not be necessary throughout the life of the isolator or earthing switch. Each contact or pair of contacts shall be independently sprung so that full pressure is maintained on all contacts at all time.
- 3.22.5.3 Contact springs shall not carry any current and shall not lose their characteristics due to heating effects.
- 3.22.5.4 The moving contact of double break isolator shall have turn-and -twist type or other suitable type of locking arrangement to ensure adequate contact pressure.

#### 3.22.6 Blades:

- 3.22.6.1 All metal parts shall be of non-rusting and non-corroding material. All current carrying parts shall be made from high conductivity electrolytic copper/aluminium. Bolts, screws and pins shall be provided with lock washers. Keys or equivalent locking facilities if provided on current carrying parts, shall be made of copper silicon alloy or stainless steel or equivalent. The bolts or pins used in current carrying parts shall be made of non-corroding material. All ferrous castings except current carrying parts shall be made of malleable cast iron or cast-steel. No grey iron shall be used in the manufacture of any part of the isolator.
- 3.22.6.2 The live parts shall be designed to eliminate sharp joints, edges and other corona producing surfaces, where this is impracticable adequate corona shield shall be provided. Corona shields/rings etc., shall be made up of aluminium/aluminium alloy.
- 3.22.6.3 Isolators and earthing switches including their operating parts shall be such that they cannot be dislodged from their open or closed positions by short circuit forces, gravity, wind pressure, vibrations, shocks, or accidental touching of the connecting rods of the operating mechanism.
- 3.22.6.4 The switch shall be designed such that no lubrication of any part is required except at very infrequent intervals i.e., after every 1000 operations or after 5 years whichever is earlier.

#### 3.22.7 Insulators:

- 3.22.7.1 The insulator shall conform to IS: 2544 and/or IEC-60168. The insulators shall have a minimum cantilever strength of 600/400 Kgs. for 145/33 kV insulators respectively.
- 3.22.7.2 Pressure due to the contact shall not be transferred to the insulators after the main blades are fully closed.

## 3.22.8 Base:

Each isolator shall be provided with a complete galvanised steel base provided with holes and designed for mounting on a supporting structure.

#### 3.22.9 EARTHING SWITCHES

- 3.22.9.1 Where earthing switches are specified, these shall include the complete operating mechanism and auxiliary contacts.
- 3.22.9.2 The earthing switches shall form an integral part of the isolator and shall be mounted on the base frame of the isolator.
- 3.22.9.3 The earthing switches shall be constructionally interlocked with the isolator so that the earthing switches can be operated only when the isolator is open and vice versa. The constructional interlocks shall be built in construction of isolator and shall be in addition to the electrical interlocks.
- 3.22.9.4 Suitable mechanical arrangement shall be provided for de-linking electrical drive for mechanical operation.
- 3.22.9.5 Each earth switch shall be provided with flexible copper/aluminium braids for connection to earth terminal. These braids shall have the same short time current carrying capacity as the earth blade. The transfer of fault current through swivel connection will not be accepted.
- 3.22.9.6 The frame of each isolator and earthing switches shall be provided with two reliable earth terminals for connection to the earth mat.
- 3.22.9.7 Isolator design shall be such as to permit addition of earth switches at a future date. It should be possible to interchange position of earth switch to either side.
- 3.22.9.8 The earth switch should be able to carry the same fault current as the main blades of the Isolators and shall withstand dynamic stresses.

# 3.22.10 OPERATING MECHANISM

- 3.22.10.1 The bidder shall offer **motor operated** Isolators and earth switches. Earth Switches of 36 kV shall only be motor operated.
- 3.22.10.2 Control cabinet/operating mechanism box shall be made of aluminium sheet of adequate thickness (minimum 3 mm).
- 3.22.10.3 A "Local/Remote" selector switch and a set of open/ close push buttons shall be provided on the control cabinet of the isolator to permit its operation through local or remote push buttons.
- 3.22.10.4 Provision shall be made in the control cabinet to disconnect power supply to prevent local/remote power operation.
- 3.22.10.5 Suitable reduction gearing shall be provided between the motor and the drive shaft of the isolator. The mechanism shall stop immediately when motor supply is switched off. If necessary, a quick electromechanical brake shall be fitted on the higher speed shaft to effect rapid braking.
- 3.22.10.6 Manual operation facility (with handle) should be provided with necessary interlock to disconnect motor.
- 3.22.10.7 Gear should be of forged material suitably chosen to avoid bending/jamming on operation after a prolonged period of non-operation. Also, all gear and connected material should be so chosen/surface treated to avoid rusting.

#### 3.22.11 OPERATION

- 3.22.11.1 The main Isolator and earth switches shall be gang operated.
- 3.22.11.2 The design shall be such as to provide maximum reliability under all service conditions. All operating linkages carrying mechanical loads shall be designed for negligible deflection. The length of inter insulator and interpole operating rods shall be capable of adjustments, by means of screw thread which can be locked with a lock nut after an adjustment has been made. The isolator and earth switches shall

be provided with "over center" device in the operating mechanism to prevent accidental opening by wind, vibration, short circuit forces or movement of the support structures.

- 3.22.11.3 Each isolator and earth switch shall be provided with a manual operating handle enabling one man to open or close the isolator with ease in one movement while standing at ground level. Detachable type manual operating handle shall be provided. Suitable provision shall be made inside the operating mechanism box for parking the detached handles. The provision of manual operation shall be located at a height of 1000 mm from the base of isolator support structure.
- 3.22.11.4 The isolator shall be provided with positive continuous control throughout the entire cycle of operation. The operating pipes and rods shall be sufficiently rigid to maintain positive control under the most adverse conditions and when operated in tension or compression for isolator closing. They shall also be capable of withstanding all torsional and bending stresses due to operation of the isolator. Wherever supported the operating rods shall be provided with bearings on either ends. The operating rods/ pipes shall be provided with suitable universal couplings to account for any angular misalignment.
- 3.22.11.5 All rotating parts shall be provided with grease packed roller or ball bearings in sealed housings designed to prevent the ingress of moisture, dirt or other foreign matter. Bearings pressure shall be kept low to ensure long life and ease of operation. Locking pins wherever used shall be rustproof.
- 3.22.11.6 Signaling of closed position shall not take place unless it is certain that the movable contacts, have reached a position in which rated normal current, peak withstand current and short time withstand current can be carried safely. Signaling of open position shall not take place unless movable contacts have reached a position such that clearance between contacts is at least 80% of the isolating distance.
- 3.22.11.7 The position of movable contact system (main blades) of each of the Isolators and earthing switches shall be indicated by a mechanical indicator at the lower end of the vertical rod of shaft for the Isolators and earthing switch. The indicator shall be of metal and shall be visible from operating level.
- 3.22.11.8 The Supplier shall furnish the following details along with quality norms, during detailed engineering stage.
  - (i) Current transfer arrangement from main blades of isolator along with milli volt drop immediately across transfer point.
  - (ii) Details to demonstrate smooth transfer of rotary motion from motor shaft to the insulator along with stoppers to prevent over travel.

# 3.22.12 TEST AND INSPECTION

- 3.22.12.1 The switches shall be subjected to the following type test in accordance to with IS: 9920.
  - i. Dielectric test (impulse and one minute) power frequency withstands voltage.
  - ii. Temperature rise test
  - iii. Rated off load breaking current capacity
  - iv. Rated active load breaking capacity
  - v. Rated line charging breaking capacity
  - vi. Rated short time current
  - vii. Rated peak withstand current
  - viii. Mechanical and Electrical Endurance
- 3.22.12.2 The equipment shall be subjected to the following routine test.
  - (i) Power frequency voltage dry test
  - (ii) Measurement of resistance of the main circuit
  - (iii) Operating test.
- 3.22.12.3 The porcelain will have pull out test for embedded component and beam strength of porcelain base.

# 3.22.13 AUXILIARY SWITCHES

3.22.13.1 All isolators and earth switches shall be provided with 220/110 volts, 6 Ampere auxiliary switches for their remote position indication on the control board and for electrical interlocking with other equipment.

In addition to the auxiliary switches required for remote position indications and for their operation. There shall be six pairs of NO and six pairs of NC contacts for each isolating switch and three pairs of NO and three pairs of NC contacts for each earthing switch. All contacts shall be brought out to terminal blocks

## 3.22.14 CONNECTORS

3.22.14.1 Each isolator shall be provided with appropriate number of bimetallic clamping type connectors as detailed in the schedule of requirement. The maximum length of jumper that may be safely connected or any special instruction considered necessary to avoid under loads on the post isolators should be stated by the bidder.

#### 3.22.15 MOUNTING STRUCTURES

3.22.15.1 All isolators and earthing switches shall be rigidly mounted in an upright position on their own supporting structures. Details of the supporting structures shall be furnished by the successful tenderer. The isolators should have requisite fixing details ready for mounting them on structures.

#### 3.22.16 PRE-COMMISSIONING TESTS

Contractor shall carry out following tests as pre-commissioning tests. Contractor shall also perform any additional test based on specialties of the items as per the field instructions of the equipment Supplier or Employer without any extra cost to the Employer. The Contractor shall arrange all instruments required for conducting these tests along with calibration certificates and shall furnish the list of instruments to the Employer for approval.

- i. Insulation resistance of each pole.
- ii. Manual and electrical operation and interlocks.
- iii. Insulation resistance of control circuits and motors.
- iv. Ground connections.
- v. Contact resistance.
- vi. Proper alignment so as to minimise to the extreme possible the vibration during operation.
- vii. Measurement of operating Torque for isolator and Earth switch.
- viii. Resistance of operating and interlocks coils.
- ix. Functional check of the control schematic and electrical & mechanical interlocks.
- x. 50 operations test on isolator and earth switch.

#### 3.22.17 TECHNICAL DATA SHEET FOR ISOLATORS

No. Technical Particulars			Isolators class		
110.		220 kV	132 kV	33 kV	
1	Nominal system voltage, kV	220	132	33	
2	Highest system voltage, kV	245	145	36	
3	Rated frequency, Hz.	50	50	50	
4.	Type of Isolator	Single Centre Break	Single Centre Break	Double Break, centre pole rotating	
5	Rated continuous current, A	1250	1250	1250	
6	Rated short time current, kA	40	31.5	25	
7	Rated duration of short time current, (second)	1	1	1	
8	Rated lightning impulse withstand voltage, kV (peak)				
	i) To earth & between poles	1050	650	170	
	ii) Across isolating distance	1200	750	195	
9	Rated 1 minute power frequency withstand voltage, kV (rms)				
	i) To earth & between poles	315	275	70	
	ii) Across isolating distance	530	460	80	
10	Minimum Creepage distance of insulators, mm	6125	3625	900	
11	Temperature rise	As per r	elevant IEC 62	2271 -102/ IS 9921	

# 3.23 TECHNICAL SPECIFICATION FOR POWER & CONTROL CABLES

#### 3.23.1.0 GENERAL REQUIREMENT

- 3.23.1.1 Aluminium conductor PVC insulated armoured power cables shall be used for various other applications in switchyard area/control room except for control/protection purposes.
- 3.23.1.2 For all control/protection/instrumentation purposes PVC insulated armoured control cables of minimum 2.5 sq. mm Size with stranded Copper conductors shall be used.

3.23.1.3 Cables shall be laid conforming to IS: 1255.

- 3.23.1.4 While preparing cable schedules for control/protection purpose following shall be ensured:
  - i. Separate cables shall be used for AC & DC.
  - ii. For different cores of CT & PT separate cable shall be used.
  - iii. At least one (1) core shall be kept as spare in each copper control cable of 4C, 5C or 7C size whereas minimum no. of spare cores shall be two (2) for control cables of 10 core or higher size.
- 3.23.1.5 For control cabling, including CT/VT circuits, 2.5 sq.mm size copper cables shall be used per connection. However, if required from voltage drop/VA burden consideration additional cores shall be used. Further, for potential circuits of energy meters separate connections by 2 cores of 2.5sq.mm size shall be provided.
- 3.23.1.6 Standard technical data sheets for cable sizes up to and including 1100V are enclosed at Clause 3.23.3. Cable sizes shall be offered /manufactured in accordance with parameters specified in standard technical data sheets. Technical data sheet for any other cores/sizes required during detailed engineering shall be separately offered for Employer's approval by the contractor/supplier.

# 3.23.2.0 TECHNICAL REQUIREMENTS

- 3.23.2.1 General
- 3.23.2.1.1 The cables shall be suitable for laying in racks, ducts, trenches, conduits and underground buried installation with uncontrolled back fill and chances of flooding by water.
- 3.23.2.1.2 The XLPE insulated cables shall be capable of withstanding a conductor temperature of 250°C during a short circuit without any damage. The PVC insulated cables shall be capable of withstanding a conductor temperature of 160°C during a short circuit.
- 3.23.2.1.3 The Aluminium/Copper wires used for manufacturing the cables shall be true circular in shape before stranding and shall be uniformly good quality, free from defects. All Aluminium used in the cables for conductors shall be of H2 grade. In case of single core cables, armours shall be of H4 grade Aluminium.
- 3.23.2.1.4 The fillers and inner sheath shall be of non-hygroscopic, fire-retardant material, shall be softer than insulation and outer sheath shall be suitable for the operating temperature of the cable.
- 3.23.2.1.5 Progressive sequential marking of the length of cable in metres at every one metre shall be provided on the outer sheath of all cables.
- 3.23.2.1.6 Strip wire armouring method shall not be accepted for any of the cables. For control, cables only round wire armouring shall be used.

3.23.2.1.7 The cables shall have outer sheath of a material with an oxygen index of not less than 29 and a temperature index of not less than 250°C.

- 3.23.2.1.8 All the cables shall pass fire resistance test as per IS:1554 (Part-I)
- 3.23.2.1.9 The normal current rating of all PVC insulated cables shall be as per IS:3961.
- 3.23.2.1.10 Repaired cables shall not be accepted.
- 3.23.2.1.11 Allowable tolerance on the overall diameter of the cables shall be plus or minus 2 mm.

#### 3.23.2.2 XLPE Power Cables

The XLPE (90°C) insulated cables shall be of FR type, C1 category conforming to IS: 7098 (Part-I) and its amendments read along with this specification. The conductor shall be stranded aluminium circular/sector shaped and compacted. In multicore cables, the core shall be identified by red, yellow, blue and black coloured strips or colouring of insulation. A distinct inner sheath shall be provided in all multicore cables. For XLPE cables, the inner sheath shall be of extruded PVC of type ST-2 of IS: 5831. When armouring is specified for single core cables, the same shall consist of aluminium wires/strips. The outer sheath shall be extruded PVC of Type ST-2 of IS: 5831 for all XLPE cables.

#### 3.23.2.3 PVC Power Cables

3.23.2.3.1 The PVC (70°C) insulated power cables shall be of FR type, C1 category, conforming to IS: 1554 (Part- I) and its amendments read along with this specification and shall be suitable for a steady conductor temperature of 70°C. The conductor shall be stranded aluminium. The Insulation shall be extruded PVC to type-A of IS: 5831. A distinct inner sheath shall be provided in all multicore cables. For multicore armoured cables, the inner sheath shall be of extruded PVC. The outer sheath shall be extruded PVC to Type ST-1 of IS 5831 for all cables.

#### 3.23.2.4 PVC Control Cables

- 3.23.2.4.1 The PVC (70°C) insulated control cables shall be of FR type C1 category conforming to IS: 1554 (Part-1) and its amendments, read along with this specification. The conductor shall be stranded copper. The insulation shall be extruded PVC to type A of IS: 5831. A distinct inner sheath shall be provided in all cables whether armoured or not. The over sheath shall be extruded PVC to type ST-1 of IS: 5831 and shall be grey in colour.
- 3.23.2.4.2 Cores shall be identified as per IS: 1554 (Part-1) for the cables up to five (5) cores and for cables with more than five (5) cores the identification of cores shall be done by printing legible Hindu Arabic Numerals on all cores as per clause 10.3 of IS 1554 (Part-1).

# 3.23.3 DATA SHEET FOR CABLES 1. Power Cables

SI.	Description	3 ½ C 300mm2	Other Powe	er Cables
No.			70 mm2, 35 mm2,	6 mm2& 4mm2
			25mm2, 16 mm2	
	Applicable Standard	IS: 7098/PT-I & its	IS: 1554/PT-I8	& its referred
1		referred standards	stand	ards
2	Type Designation	A2XWY	AYFY	AYWY
3	Rated Voltage(volts)	1100	1100	1100
4	Type & Category	FR & C1	FR & C1	FR & C1
5	Suitable for earthed or unearthed system		Suitable for both	
	Conductor			
	a) Material	Strande	d Aluminium as per IS	: 8130
	b) Grade	Н	2 (Electrolytic grade)	
	c) Number of wires(No.)		As per IS 8130	
6	d) Form of Conductor	Stranded compacted circular/sector shaped	Stranded compacted circular/sector shaped	Non- compacted Stranded circular
	e) Direction of lay of stranded layers	Outermost layer shall	be R.H lay & opposite	in successive layers
7	Insulation			
	a) Composition of insulation	Extruded XLPE as per IS-7098 Part(1)	Extruded PVC type A as per IS- 5831	Extruded PVC type A as per IS-5831
	b) Thickness of insulation(mm)	As	per applicable Standar	d
8	Inner Sheath material	Extruded PVC type ST-2 as per IS-5831	Extruded PV as per IS	C type ST-1 S- 5831
9	Type and material of armour	Gal. Steel wire	Gal. Steel Strip	Gal. Steel wire
10	Outer Sheath (PVC)	ST-1 & FR	ST-2 & FR	ST-2 & FR
11	Overall diameter of cable	As r	per applicable Standar	d

# 2. Control Cables

		•
SI. No.	Description	Particulars
1	Applicable Standard	IS: 1554/PT-I & its referred standards
2	Type Designation	YWY
3	Rated Voltage(volts)	1100
4	Type & Category	FR & C1
5	Suitable for earthed or unearthed system	Suitable for both
6	Conductor	
	a) Material	Plain annealed High Conductivity stranded Copper (as per IS 8130)
	b) Grade	Electrolytic
	c) Number of wires(No.)	As per IS 8130
	d) Form of Conductor	Non-compacted Stranded circular
	e) Direction of lay of stranded layers	Outermost layer shall be R.H lay
7	Insulation	
	a) Composition of insulation	Extruded PVC type A as per IS-5831
	b) Thickness of insulation(mm)	As per applicable Standard
8	Inner Sheath material	Extruded PVC type ST-1 as per IS-5831
9	Type and material of armour	Gal. Steel wire
10	Outer Sheath (PVC)	ST-1 & FR
11	Overall diameter of cable	As per applicable Standard
12	No. of Cores	As per Bill of Materials

# 3.24 TECHNICAL SPECIFICATION FOR CONSTRUCTION WORKS IN SUBSTATIONS

# 3.24.1.0 GENERAL

3.24.1.1 The intent of this Section of the Specification is to cover requirements which are to be followed in construction of switchyards including civil works in the switchyard. Irrespective of whether mentioned or not all the equipment shall be supplied at site, erected, tested and commissioned. The prices quoted in the Price Schedule are deemed to include for these activities.

3.24.1.2 The work shall be carried out according to the design/drawings to be developed by the Contractor and approved by the Employer based on Drawings supplied to the Contractor by the Employer with this specification. For all structures, foundations, etc., necessary layout and details shall be developed by the Contractor keeping in view the functional requirement of the substation facilities and providing enough space and access for operation, use and maintenance based on the input provided (drawings and design parameters) by the Employer in this Technical Specification. Certain minimum requirements are indicated in this Section for guidance purposes only. However, the Contractor shall quote according to the complete requirements.

3.24.1.3 The contractor shall maintain the overall dimensions of the substation, buildings, bay length, bay width, phase to earth clearance, phase to phase clearance, ground clearances, sectional clearances, clearances between buses and bus heights but may alter the spacing between equipment based on actual dimensions equipment offered to obtain the statutory electrical clearances required for the substation and to suite the physical requirements of available land for the substation etc.

# 3.24.2.0 Surface Preparation and Stone Spreading

3.24.2.1 Before taking up PCC base (pro-1:4:8) and stone filling at the location in the construction site, the area shall be thoroughly de-weeded including removal of roots as directed by the Engineer-in-Charge.

3.24.2.2 After all the structures, equipment & earthing system are erected and after construction of cable trenches, the surface of the switchyard area shall be maintained, rolled/ compacted to the lines and grades as decided by Engineerin-Charge. De-weeding including removal of roots shall be done before rolling is commenced. Engineer-in-Charge shall decide final formation level so as to ensure that the site appears uniform devoid of undulations. The final formation level shall however be very close to the formation level indicated in the drawing using half ton roller with suitable water sprinkling arrangement to form a smooth and compact surface.

3.24.2.3 A base layer of PCC of 80 mm thickness with proportion of 1:4:8 shall be provided before spreading of crushed rocks. PCC base shall be done in panels of 4 m x 4 m with expansion gap of 25 mm between panels. The gap shall be filled with bitumen. Each panel shall be provided with four (4) numbers of PVC pipes (per panel) of 100 mm dia of length 450 mm for soaking of water. The pipes will be provided with gratings at the top and the same will be flushed with the PCC top.

3.24.2.4 Over the PCC layer, a surface course of minimum 100mm thickness of 20mm nominal size river pebbles or (single size ungraded) broken stone shall be spread.

# 3.24.3.0 Cable Trenches and Cable Trays

3.24.3.1 Design and construction of cable trenches with pre-cast removal R.C.C cover (with lifting arrangement) shall be carried out by the Contractor as per approved drawings.

# 3.24.3.2 Cable Trays

(i). The cable trays shall be of G.S. sheet and minimum thickness of sheet shall be 2mm.

(ii). Finished Cable Trays shall have a standard width of 300 mm.

(iii). The Contractor shall perform all tests and inspection to ensure that material and workmanship are according to the relevant standards. Contractor shall have to demonstrate all tests as per specification and equipment shall comply with all requirements of the specification.

a) Test for galvanising (Acceptance Test)

The test shall be done as per approved standards.

b) Deflection Test: (Type Test)

A 2.5 metre straight section of 300mm, wide cable tray shall be simply supported at two ends. A uniform distributed load of 76 kg/m shall be applied along the length of the tray. The maximum deflection at the mid-span shall not exceed 7mm.

3.24.3.3 The Contractor shall provide embedded steel plates of adequate size on the walls of concrete cable trench for supports for cable trays. Insert plates will be provided at an interval of 2000 mm.

3.24.3.4 The cable trench walls shall be designed for following loads: (a) Dead load of 155 kg/M length of cable support (tray) + 75 kg on one tier at the end.
(b) Triangular earth pressure + uniform surcharge pressure of 2T/m2.

3.24.3.5 RCC cable trench cover shall be designed for self-weight of slab + UDL of 2000 kg/m2 + a concentrated load of 200 kg at center of span on each slab panel.

3.24.3.6 Cable trench inside the Control Room shall be covered with 6 mm thick chequered plates with lifting arrangement.

3.24.3.7 Cable trench crossing the road/rails shall be designed for class AA. Loading of IRC/relevant IS Code and should be checked for transformer loading.

3.24.3.8 Trenches shall be drained. Necessary sumps be constructed and sump pumps, if necessary, shall be supplied. Cable trenches shall not be used as storm water drains.

3.24.3.9 The top of trenches shall be kept at least 100 mm above the finished ground level. The top of cable trench shall be such that the surface rainwater does not enter the trench.

3.24.3.10 All metal parts inside the trench shall be connected to the earthing system.

3.24.3.11 Cables from trench to equipment shall run in hard conduit pipes.

3.24.3.12 Trench wall shall not foul with the foundation. Suitable clear gap shall be provided.

3.24.3.13 The trench bed shall have a slope of 1/500 along the run and 1/250 perpendicular to the run.

3.24.3.14 All the construction joints of cable trenches i.e., between base slab to base slab and the junction of vertical wall to base slab as well as from vertical wall to wall and all the expansion joints shall be provided with approved quality PVC water stops of approx. 230 x 5 mm size for those sections where the ground water table is expected to rise above the junction of base slab and vertical wall of cable trenches.

3.24.3.15 Cable trenches shall be blocked at the ends if required with brick masonry in cement sand mortar 1:6 and plaster with 12 mm thick 1:6 cement sand mortar.

# 3.24.4.0 Foundation and RCC Construction

#### 3.24.4.1 General

3.24.4.1.1. Work covered under this Clause of the Specification comprises the design and construction of foundations and other RCC constructions for switchyard structures, equipment supports, trenches, drains, jacking pad, control cubicles, bus supports, transformer, marshalling kiosks, auxiliary equipment and systems, buildings, tanks, boundary wall or for any other equipment or service and any other foundation required to complete the work.

3.24.4.1.2. Concrete shall conform to the requirements mentioned in IS: 456 and all the tests shall be conducted as per relevant Indian Standard Codes as mentioned in Standard field quality plan appended with the specification.

A minimum grade of M15 concrete (1:2:4 mix) shall be used for all structural/load bearing members as per latest IS 456.

3.24.4.1.3. If the site is sloppy, the foundation height will be adjusted to maintain the exact level of the top of structures to compensate such slopes.

3.24.4.1.4. The switchyard foundation's plinths and building plinths shall be minimum 300 mm and 500 mm above finished ground level respectively.

3.24.4.1.5. Minimum 75 mm thick lean concrete (1:4:8) shall be provided below all underground structures, foundations, trenches, etc., to provide a base for construction.

3.24.4.1.6. Concrete made with Portland slag cement shall be carefully cured and special importance shall be given during the placing of concrete and removal of shuttering.

3.24.4.1.7. The design and detailing of foundations shall be done based on the approved soil data and sub-soil conditions as well as for all possible critical loads and the combinations thereof.

The Spread footings foundation or pile foundation as may be required based on soil/subsoil conditions and superimposed loads shall be provided.

3.24.4.1.8. If pile foundations are adopted, the same shall be cast-in-situ driven/bored or pre cast or under reamed type as per relevant parts of IS Code 2911. Only RCC piles shall be provided. Suitability of the adopted pile foundations shall be justified by way of full design calculations. Detailed design calculations shall be submitted by the bidder showing complete details of piles/pile groups proposed to be used. Necessary initial load test shall also be carried out by the bidder at their cost to establish the piles design capacity. Only after the design capacity of piles has been established, the Contractor shall take up the job of piling. Routine tests from the piles shall also be conducted. All the work (design & testing) shall be planned in such a way that these shall not cause any delay in project completion.

# 3.24.4.2 Design

3.24.4.2.1. All foundation shall be of reinforced cement concrete. The design and construction of RCC structures shall be carried out as per IS: 456 and minimum grade of concrete shall be M-15. Higher grade of concrete than specified above may be used at the discretion of Contractor without any additional financial implication to the Employer.

3.24.4.2.2. Limit state method of design shall be adopted unless specified otherwise in the specification.

3.24.4.2.3. For detailing of reinforcement IS: 2502 and SP: 34 shall be followed. Cold twisted deformed bars (Fe-415 N/mm2) 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.

3.24.4.2.4. RCC water retaining structures like storage tanks, etc., shall be designed as uncracked section in accordance with IS: 3370 (Part I to IV) by working stress method. However, water channels shall be designed as cracked section with limited steel stresses as per IS:3370 (Part I to IV) by working stress method.

3.24.4.2.5. 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 produces the maximum stresses in the foundation or the foundation component and as per the relevant IS Codes of foundation design. Detailed design calculations shall be submitted by the bidder showing complete details of piles/pile groups proposed to be used.

3.24.4.2.6. Design shall consider any sub-soil water pressure that may be encountered following relevant standard strictly.

3.24.4.2.7. 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/harmful to the concrete foundations.

3.24.4.2.8. RCC columns shall be provided with rigid connection at the base.

3.24.4.2.9. All sub-structures shall be checked for sliding and overturning stability during both construction and operating conditions for various combinations of loads. Factors of safety for these cases shall be taken as mentioned in relevant IS Codes or as stipulated elsewhere in the Specifications. For checking against overturning, weight of soil vertically above footing shall be taken and inverted frustum of pyramid of earth on the foundation should not be considered.

3.24.4.2.10. Earth pressure for all underground structures shall be calculated using co-efficient of earth pressure at rest, co-efficient of active or passive earth pressure (whichever is applicable). However, for the design of sub-structures of any underground enclosures, earth pressure at rest shall be considered.

3.24.4.2.11. In addition to earth pressure and ground water pressure etc., a surcharge load of 2T/Sq.m shall also be considered for the design of all underground structures including channels, sumps, tanks, trenches, sub-structure of any underground hollow enclosure, etc., for the vehicular traffic in the vicinity of the structure.

3.24.4.2.12. Following conditions shall be considered for the design of water tank in pumps house, channels, sumps, trenches and other underground structures:

a) Full water pressure from inside and no earth pressure and ground water pressure and surcharge pressure from outside (application only to structures, which are liable to be filled up with water or any other liquid).

b) Full earth pressure, surcharge pressure and ground water pressure from outside and no water pressure from inside.
c) Design shall also be checked against buoyancy due to the ground water during construction and maintenance stages. Minimum factor of safety of 1.5 against buoyancy shall be ensured ignoring the superimposed loadings.

3.24.4.2.13. The foundations shall be proportioned so that the estimated total and differential movements of the foundations are not greater than the movements that the structure or equipment is designed to accommodate.

3.24.4.2.14. The foundations of transformer and circuit breaker shall be of block type foundation. Minimum reinforcement shall be governed by IS: 2974 and IS: 456.

3.24.4.2.15. The tower and equipment foundations shall be checked for a factor of safety of 2.0 for normal condition and 1.50 for short circuit condition against sliding, overturning and pullout. The same factors shall be used as partial safety factor overloads in limit state design also.

# 3.24.4.2.16 SUBMISSION

The following information shall be submitted for review and approval to the Employer as far as Civil Works are concerned:

- (a) Design criteria shall comprise the codes and standards used, applicable climatic data including wind loads, earthquake factors maximum and minimum temperatures applicable to the building locations, assumptions of dead and live loads, including equipment loads, impact factors, safety factors and other relevant information.
- (b) Structural design calculations and drawing (including constructions / fabrication) for all reinforced concrete and structural steel structures.
- (c) Any other data, drawings and information required to be submitted as per various clauses of the specification. Approval of the above information shall be obtained before ordering materials or starting fabrication or construction as applicable

#### 3.24.4.3 Admixtures & Additives

3.24.4.3.1 Only approved admixtures shall be used in the concrete for the Works. When more the one admixture is to be used, each admixture shall be batched in its own batch and added to the mixing water separately before discharging into the mixer. Admixtures shall be delivered in suitably labelled containers to enable identification.

3.24.4.3.2 Admixtures in concrete shall conform to IS: 9103. The water proofing cement additives shall conform to IS: 2645. Employer shall approve concrete Admixtures/Additives.

3.24.4.3.3 The Contractor may propose and the Employer may approve the use of a water-reducing retarding admixture in some of the concrete. The use of such an admixture will not be approved to overcome problems associated with inadequate concrete plant capacity or improperly planned placing operations and shall only be approved as an aid to overcoming unusual circumstances and placing conditions.

3.24.4.3.4 The water reducing set-retarding admixture shall be an approved brand of Ligno sulphonate type admixture.

3.24.4.3.5 The water proofing cement additives shall be used as required/advised by the Employer.

#### 3.24.5.0 Bus Bars and Bus Bar Supports

3.24.5.1 The bus bars shall be outdoor strung bus bars with ACSR conductor supported on lattic.

3.24.5.1 If asked for, the substation steel structures shall be designed as per Section-3 of this specification.

#### 3.24.6.0 ACSR Conductors

3.24.6.1 The Conductor shall conform to IS: 398 (latest edition) except where otherwise specified herein.

3.24.6.2 The details of the ACSR Moose, ACSR Zebra and ACSR Panther conductors are tabulated below:

SI.	DESCRIPTION	ACSR 'MOOSE'	ACSR 'ZEBRA'	ACSR
No.		NOON MOODE	AGON LEBIN	'PANTHER'
1	Code name	MOOSE	ZEBRA	PANTHER
2	Number of strands & size	Al: 54/ 3.53 mm	Al: 54/ 3.18 mm	Al: 30/ 3.00 mm
		St: 7/ 3.53 mm	St: 7/ 3.18 mm	St: 7/ 3.00 mm
3	Overall diameter	35.05 mm	28.62 mm	21.00 mm
4	Breaking load	136.38 kN	130.32 kN	130.32 kN
5	Weight of conductor	2004 Kg/km	1621 kg/km	974 kg/km
6	Co-efficient of linear expansion	23x10 <sup>−6</sup> / ºC	19.35x10 <sup>-6</sup> / ⁰C	19.35x10 <sup>−6</sup> / °C
7	Number of strands			
	Steel centre	1	1	1
	1st Steel Layer	6	6	6
	1st Aluminium Layer	12	12	12
	2nd Aluminium Layer	18	18	18
	3rd Aluminium Layer	24	24	-
8	Sectional area of Aluminium	528.50 mm <sup>2</sup>	428.90 mm <sup>2</sup>	212.10 mm <sup>2</sup>
9	Total sectional area	597.00 mm <sup>2</sup>	484.50 mm <sup>2</sup>	261.50 mm <sup>2</sup>
10	Calculated D.C. resistance at 20° C	0.05552 ohm/km	0.06869 ohm/km	0.1400 ohm/km
11	Ultimate tensile strength	161.2 kN	130.32 kN	89.67

#### 3.24.7.0 Electrical Clearances

3.24.7.1 Following minimum electrical clearances (outdoor) shall be maintained in the switchyard:

SI. No.	Clearance	220 KV	132 kV	33 KV
1	Phase to Phase	2400 mm	1300 mm	320 mm
2	Phase to Earth	2400 mm	1300 mm	320 mm
3	Sectional Clearance	5000 mm	4000 mm	2800 mm
4	Live part to ground	5500 mm	4600 mm	3700 mm
5	Base of insulator (supporting live part) to ground	2500 mm	2500 mm	2500 mm

# 3.24.8.0 Earthing System

- (a) Earthing system shall be installed as per drawings provided with this bidding document.
- (b) The main earthing system for the switch yard shall consist of a mesh made out of Galvanised MS flats of size not less than 65 mm in width and12 mm thick covering the entire switchyard area and earth electrodes distributed all over the mesh. The earth electrodes shall also be placed all around the periphery of the mesh at regular intervals.
- (c) The earth mat shall be created by laying the earthing conductor (Galvanised MS flats) in both directions perpendicularly. The mesh points so created and all other joints shall be welded and painted and painted with rust proof paint after welding.
- (d) Minimum depth of burial of main earthing conductors shall be 600 mm from FGL.
- (e) Wherever earthing conductor crosses cable trenches, underground service ducts, pipes, tunnels, railway tracks etc., it shall be laid minimum 300 mm below them and shall be circumvented in case it fouls with equipment/structure foundations.
- (f) The earthing system must conform to requirements of the Indian Electricity Rules and the provisions of IS: 3043.
- (g) All earth electrodes and risers for equipment and other earthing must be connected at mesh points of the earth mat. All such connections shall be welded.
- (h) All metallic supporting structures and non-current carrying metallic parts of all equipment shall be provided with double earthing.
- (i) All LAs, VTs, CVTs and all transformer neutrals must be earthed through separate earth electrodes and in turn these electrodes shall be connected to the main earth grid.
- (j) One number 40mm dia, 3000 mm long MS earth electrode with test link, CI frame and cover shall be provided to connect each down conductor of surge arresters, capacitive &inductive voltage transformers, lightning masts and towers with peak.
- (k) 50mm x 6mm MS flat shall run on the top tier and all along the cable trenches and the same shall be welded to each of the racks. Further this flat shall be earthed at both ends and at an interval of 30 mtrs. The M.S. flat shall be finally painted with two coats of Red oxide primer and two coats of Post Office red enamel paint.
- (I) The earthing system in the Control Room must also be connected to the main station grid. For this purpose, earthing conductor around the building shall be buried in earth at a minimum distance of 1500 mm from the outer boundary of the building which in turn shall be connected to the main earth grid by two runs of 65mm x 12mm GI flats.
- (m) Each earthing lead from the neutral of the power transformers shall be directly connected to two pipe electrodes in treated earth pit (as per IS) which in turn, shall be buried in Cement Concrete pit with a cast iron cover hinged to a cast iron frame to have an access to the joints. All accessories associated with transformer like cooling banks, radiators etc. shall be connected to the earthing grid at minimum two points. These electrodes must also be connected to the Main Earth Mat of the substation.

SI. No.	Item	Size	Materials
1.	Main Earthing Conductor to be buried in ground	50mm x 10 mm	GI Flat
2.	Conductor above ground & earthing leads (for equipment)	50mm x 10 mm	GI Flat

#### 3.24.9.0 Summary of Earthing System

3.	Conductor above ground & earthing leads (for columns & aux. structures)	50mm x 10 mm	GI Flat
4.	Earthing of indoor LT panels, Control panels and outdoor marshalling boxes, MOM boxes, Junction boxes & Lighting Panels etc.	50mm x 10 mm	GI Flat
5.	Rod Earth Electrode	40mm dia, 3000 mm long	Mild Steel
6.	Pipe Earth Electrode (in treated earth pit) as per IS 3043	40mm dia, 3000 mm long	Galvanised Steel

## 3.24.10.0 Protection Against Direct Lightning

- 3.24.10.1 Protection against direct lightning shall be provided by stringing GI shield wires and/or by lightning masts (SPIKES) as per layout drawings attached.
- 3.24.10.2 Conductors of the lightning protection system shall not be connected with the conductors of the safety earthing system above ground level.
- 3.24.10.3 Down conductors shall be cleated on the structures at 2000 mm interval. For grounding of lightning spikes and shield wires, 7/3.66 mm GI steel wires shall be used.
- 3.24.10.4 Connection between each down conductor and rod electrodes shall be made via test joint (pad type compression clamp) located approximately 1500 mm above ground level. The rod electrode shall be further joined with the main earth-mat.
- 3.24.10.5 Two runs of down conductors shall be used for grounding of each Lightning Spikes. For that, lugs with bolts shall be provided at base of spikes.

G.I. wires for shielding shall conforming to IS 2141.Parameters of galvanised steel wires shall be as follows:

a) No of Strand: 7

b) Diameter of single strand: 3.66 mm

- c) Minimum Breaking Load: 6970 KG
- d) Overall Diameter: 10.98 mm
- e)Area: 72.25 mm2

# 3.24.11.0 Bay Marshalling Kiosks

3.24.11.1 (One) number of bay marshalling kiosk shall be provided for each 132 kV bay under present scope. In addition to the requirements specified elsewhere in the specification, the bay marshalling kiosk shall have two distinct compartments for the following purpose: -

- Incoming: To receive 2(two) incoming 415V, 3 phase, 63Amps, AC supply with auto changeover and MCB unit and
- (ii) Outgoing:
- (a) To distribute 4(four) outgoing 415V, 16 Amps 3 phase AC supplies to be controlled by MCB.
- (b) To distribute **3(three)** outgoing 240V, 16 Amps single phase supplies to be controlled by MCB.
- (c) To distribute 3(three) outgoing 240V, 10 Amps single phase supplies to be controlled by MCB

3.24.11.2 The steel sheet thickness of BMK shall be minimum 3.15 mm and painting shall be as per Clause 3.25.0.

- 3.24.11.3 The BM shall be protective Class of IP 55.
- 3.24.11.4 The BMK shall have a minimum of 700 mm clearance to switchyard floor.

#### 3.24.12.0 Insulator and Hardware Fittings

#### 3.24.12.1 General

a) The Contractor shall supply insulators of suspension, tension and post type as required complete with all necessary hardware and accessories, including fittings for fixing insulators to steel structures as required.

b) The porcelain shall be sound, free from defects, thoroughly vitrified and smoothly glazed.

c) Unless otherwise specified, the glaze shall be brown colour. The glaze shall cover all the porcelain parts of the insulators except those areas which serve as support during firing or are left unglazed for purpose of assembly.

d) The design of the insulator shall be such that stress due to expansion and contraction in any part of the insulator shall not lead to deterioration. The porcelain shall not engage directly with hard metal.

e) Cement use in the construction of insulator shall not cause fracture by expansion or loosening by contraction and proper care shall be taken to locate the individual parts correctly during cementing. The cement shall not give rise to chemical reaction with metal fitting and its thickness shall be as uniform as possible.

f) Pins and caps shall be made of drop forged steel, duly hot dip galvanized as per IS 2629. These shall not be made by jointing, welding, shrink fitting or any other process.

g) Security clips/split pins shall be made of good quality of stainless steel.

h) Suspension and tension insulators shall be wet process porcelain with ball and socket connection. Insulators shall be interchangeable and shall be suitable for forming either suspension or tension strings.

i) Post type insulators shall be of long rod type or solid core type and preferably of single piece type for all voltage classes. These shall be complete with necessary fittings to hold Aluminium tubes or ACSR conductor as required.

j) The items of hardware and fittings shall make complete assemblies which are necessary for their satisfactory performance. Such parts shall be deemed to be within the scope of this specification.

#### 3.24.12.2 Disc Insulator Strings

Each insulator string shall consist of following numbers of Disc & parameters.

SI.	Description	No of	Disc Insulator	Unit for
No.		220 kV	132 kV	33 kV
1	No. of Disc, Suspension String	14	9	3
2	No. of Disc, Tension String	15	10	4
3	Creepage Distance of complete String (min)	6125 mm	3625 mm	900 mm

#### 3.24.12.3 Parameters

3.24.12.3.1 Disc Insulators

- a) Type
- b) Colour
- c) Surface
- d) Locking Device
- e) Size of Disc
- f) Size of Pin Ball
- g) Creepage Distance (Min)
- h) Electro mechanical Strength
- i) Power frequency withstand test voltage
- j) Minimum dry Impulse withstand
- k) Puncture Voltage

- : Ball and Socket
- : Brown
- : Glazed
- : W or R type security clip
- : 255 mm x 145 mm
- : 16 mm
- :320 mm
- : 70 KN
- : 75 KV Dry, 45 KV Wet
- : 125 KV peak Test voltage (+/- wave)
- : 1.3 X actual dry flash over voltage.

3.24.12.3.2. Post Insulators

SI. No.	Parameters	220 kV	132 kV	33 kV
1	Highest system voltage	245 kV	145 kV	36 kV
2	Dry one minute power frequency test Voltage	510 kV	275 kV	75 kV
3	Wet one minute power frequency test Voltage	460 kV	275 kV	75 kV
4	Impulse voltage withstand test	1050 kV	650 kV	170 kV
5	Minimum Creepage Distance	6125 mm	3625 mm	900 mm
6	Minimum Bending Strength (upright)	6 kN	4 kN	3 kN

# 3.24.13.0 Clamps, Connectors and Spacers

3.24.13.1 Clamps and connectors shall conform to IS 2121 unless otherwise mentioned hereunder.

3.24.13.2 Clamps and connectors shall be made of materials listed below: -

- (i) For connecting ACSR: Aluminium alloy casting conforming to designation A6 of IS 617.
- (ii) For connecting equipment: Bimetallic connectors made from aluminium alloy terminals made of copper casting conforming to designation A 6 of IS 617.
- (iii) For connecting GI Shield wire: Malleable iron casting.
- (iv) Expansion Connectors: Copper lamination to grade FRTP-2 of IS 191.
- (v) Bolts, nuts, plain washers: Hot dip galvanised mild steel and spring washers for items (i), (ii) and (iii).
- 3.24.13.3 Spacers

Spacers shall conform to IS 10162. Spacers for bundle conductors (where specified) shall be provided at but not limited to the following locations:

- (i) At intervals not exceeding 2.5 meters in case of strung bus bars or other bundled strung conductors.
- (ii) At one meter interval in case of jumper connections.

No magnetic material shall be used in fabrication of spacers except for the GI bolts and nuts.

3.24.13.4 <u>T Clamp and Equipment Clamps</u>

- a) <u>T Clamps:</u>
- i. Standard Specification and tests shall be as per IS:5561.
- ii. For connecting ACSR conductor aluminium alloy casting conforming to designation A 6 of IS 617.
- iii. Bolts, nuts and washers shall be made of mild steel and hot dip galvanized as per IS 2629. Small fittings like spring washers, nuts etc. may be electrogalvanized.
- iv. The quality of HDG ferrous components shall be determined by the test given in IS:2633 and shall satisfy the requirement of that standard.
- v. The rated short time current shall be one of the standard values laid down in Indian Standards for the associated circuit breakers, Switches etc.
- vi. Current carrying capacity same as conductor full current rating. For two different conductors, conductor with smaller rating shall be considered.
- vii. No part of a clamp shall be less than 12 mm thick for fittings suitable up to size of ACSR Panther conductor, no part of a clamp shall be less than 15 mm thick for fittings suitable for ACSR Zebra conductor and ACSR Moose conductor.
- viii. All sharp edges and corners shall be blurred and rounded off.
- ix. For bimetallic connectors, copper alloy liner of minimum thickness of 2 mm shall be cast integral with aluminium body.

- x. From outermost hole edge to nearest edge of any clamps and connectors the distance shall not be less than 10 mm.
- b) Equipment Clamps (CB, ISOLATOR, CT and PI):
- i. Standard Specification and tests shall be as per IS:5561.
- ii. For connecting ACSR conductor aluminium alloy casting conforming to designation A 6 of IS 617.
- iii. Bolts, nuts and washers shall be made of mild steel and hot dip galvanized as per IS 2629. Small fittings like spring washers, nuts etc. may be electrogalvanized.
- iv. The quality of HDG ferrous components shall be determined by the test given in IS:2633 and shall satisfy the requirement of that standard.
- v. The rated short time current shall be one of the standard values laid down in Indian Standards for the associated circuit breakers, Switches etc.
- vi. Current carrying capacity same as conductor full current rating. For two different conductors, conductor with smaller rating shall be considered.
- vii. No part of a clamp shall be less than 12 mm thick for fittings suitable up to size of ACSR Panther conductor, no part of a clamp shall be less than 15 mm thick for fittings suitable for ACSR Zebra conductor and ACSR Moose conductor.
- viii. All sharp edges and corners shall be blurred and rounded off.
- ix. For bimetallic connectors, copper alloy liner of minimum thickness of 2 mm shall be cast integral with aluminium body.
- x. From outermost hole edge to nearest edge of any clamps and connectors the distance shall not be less than 10 mm.

# 3.24.14.0 Supply of Construction Materials by The Contractor

3.24.14.1 The contractor has to make his own arrangements for procurement, supply and use of construction materials like cement, M.S. rounds, H.B.G. metal and sand.

#### 3.24.14.2 Cement

The contractor has to make his own arrangements for the procurement of cement to required specifications required for the work subjected to the follows:

- a) The contractor shall procure cement (approved BSI marked of OPC or PPC), required for the work sonly from reputed cement factories (Main producer) acceptable to the Engineer-in-Charge. The contractor shall be required to be furnished to the Engineer-in-Charge bills of payment and test certificates issued by the manufacturers to authenticate procurement of quality cement from the approved cement factory. The contractor shall make his own arrangement for adequate storage of cement.
- b) The contractor shall procure cement in standard packing of all 50 kg per bag from the authorized manufacturers. The contractor shall make necessary arrangement at his own cost to the satisfaction of Engineer-in-Charge for actual weighment of random sample from the available stock and shall conform with the specification laid down by the Indian Standard Institution or other standard foreign institutions laid down by the Indian Standard Institution or other standard foreign institutions as the case may be. Cement shall be got tested for all the tests as directed by Engineer-in-Charge at least one month in advance before the use of cement bags brought and kept on site Stores. Cement bags required for testing shall be supplied by the contractor free of cost. If the tests prove unsatisfactory, then the charges for cement will be borne by the Contractor.
- c) The Contractor should store the cement of 60 days requirement at least one month in advance to ensure the quality of cement so brought to site and shall not remove the same without the written permission of the engineer-in-Charge. The Contractor should store the cement of 60 days requirement at least one month in advance to ensure the quality of cement so brought to site and shall not remove the same without the written permission of the engineer-in-Charge. The Contractor should store the cement of 60 days requirement at least one month in advance to ensure the quality of cement so brought to site and shall not remove the same without the written permission of the engineer-in-Charge. The Contractor shall forthwith remove from the works area any cement that the Engineer-in-Charge may disallow for use, an account of failure to meet with required quality and standard.
- d) The contractor shall further, at all times satisfy the Engineer-in-Charge on demand, by production of records and books or by submission of returns and other proofs as directed, that the cement is being used as tested and approved by Engineer-in-Charge for the purpose and the Contractor shall at all

times, keep his records up to date to enable the Engineer-in-Charge to apply such checks as he may desire.

e) Cement which has been unduly long in storage with the contractor or alternatively has deteriorated due to inadequate storage and thus become unfit for use in the works will be rejected by the department and no claim will be entertained. The Contractor shall forthwith remove from the work area, any cement the Engineer-in-Charge may disallow for use on work and replace it by cement complying with the relevant Indian Standards.

#### 3.24.14.3 Steel

The Contractor shall procure mild steel reinforcement bars, high yield strength deformed (HYSD) bars, rods and structural steel, etc., required for the works, only from the main or secondary producers manufacturing steel to the prescribed specifications of Bureau of Indian Standards or equivalent and licensed to affix ISI or other equivalent certification marks and acceptable to the Engineer-in-Charge. Necessary ISI list certificates are to be produced to Engineer-in-Charge before use on works. The unit weight and dimensions shall be as prescribed in the relevant Indian Standard specification for steel.

#### 3.24.15.0 Supply of Construction Materials by The Employer

As it is a single responsibility contract supply, and/or arrange all materials and services including construction and testing equipment to complete the works in all respects described in the specification, shall be under the scope of the Contractor unless otherwise specifically mentioned elsewhere in the bidding document.

#### 3.24.16.0 Miscellaneous General Requirements

3.24.16.1 Dense concrete with controlled water cement ratio as per IS-code shall be used for all underground concrete structures such as pump-house, tanks, water retaining structures, cable and pipe trenches etc. for achieving water-tightness.

3.24.16.2 All joints including construction and expansion joints for the water retaining structures shall be made water tight by using PVC ribbed water stops with central bulb. However, kicker type (externally placed) PVC water stops shall be used for the base slab and in other areas where it is required to facilitate concreting. The minimum thickness of PVC water stops shall be 5 mm and minimum width shall be 230 mm.

3.24.16.3 All steel sections and fabricated structures which are required to be transported on sea shall be provided with anti-corrosive paint to take care of sea worthiness.

3.24.16.4 A screed concrete layer not less than 100 mm thick and of grade not weaker than M10 conforming to IS:456-1978 shall be provided below all water retaining structures. A sliding layer of bitumen paper or craft paper shall be provided over the screed layer to destroy the bond between the screed and the base slab concrete of the water retaining structures.

3.24.16.5 Bricks having minimum 75 kg/cm2 compressive strength can only be used for masonry work. Contractor shall ascertain himself at site regarding the availability of bricks of minimum 75 kg/cm2 compressive strength before submitting his offer.

3.24.16.6 Doors and windows on external walls of the buildings (other than areas provided, with insulated metal claddings) shall be provided with RCC sun-shade over the openings with 300 mm projection on either side of the openings. Projection of sunshade from the wall shall be minimum 450 mm over window openings and 750 mm over door openings.

3.24.16.7 All stairs shall have maximum riser height of 150 mm and a minimum tread width of 300 mm. Minimum width of stairs shall be 1500 mm. Service ladder shall be provided for access to all roofs. RCC fire escape staircase shall be provided in control buildings.

3.24.16.8 Angles 50 x 50 x 6 mm (minimum) with lugs shall be provided for edge protection all round cut outs/openings in floor slab, edges of drains supporting grating covers, edges of RCC cable/pipe trenches supporting covers, edges

of manholes supporting covers, supporting edges of manhole pre-cast cover and any other place where breakage of corners of concrete is expected.

3.24.16.9 Anti termite chemical treatment shall be given to column pits, wall trenches, foundations of buildings, filling below the floors etc. as per IS:6313 and other relevant Indian Standards.

3.24.16.10 Hand-railing minimum 900 mm high shall be provided around all floor/roof openings, projections/balconies, walk ways, platforms, steel stairs etc. All handrails and ladder pipes shall be 32 mm nominal bore MS pipes (medium class) and shall be galvanized (medium-class as per IS:277). All rungs for ladder shall also be galvanized as per IS: 277 medium classes.

For RCC stairs, hand railing with 20 mm square MS bars, balustrades with suitable MS flats shall be provided with black PVC sheathing.

3.24.16.11 The details given in tender drawings shall be considered along with details available in this section of the specification while deciding various components of the building.

3.24.16.12 Items/components of buildings not explicitly covered in the specification but required for completion of the project shall be deemed to be included in the scope.

#### 3.24.17.0 ILLUMINATION SYSTEM

3.24.17.1 The Contractor shall design, supply and install illumination system for the entire substation. The average illumination level and limiting glare index for different parts of the substation shall be as follows:

SI. No.	Location/Area	Average Illumination Level, 'Lux'	Limiting Glare Index
1	Control Room	300	19
2	Battery Room	100	19
3	Carrier Room	300	
4	Office/Conference Room	300	
5	Stairs and Corridors	100	
6	Air Conditioning Plant	150	
7	Outdoor Switchyard	20	
8	Approach Road	20	
9	Store Room	100	

3.24.17.2 The lighting system of a particular area whether indoor or outdoor shall be designed such a way that uniform illumination level is achieved. In outdoor switchyard illumination shall be aimed as far as possible towards transformers, circuit breakers, isolators etc.

3.24.17.3 Following types of lamps shall be used for various location of the substa
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	SI.No. Location/Area Type		Type of Lamp	Type of Fitting
ĺ	1	Control Room, Office, Carrier Room	LED	Decorative
	2	Battery Room	Fluorescent	Acid Proof, Industrial
ĺ	3	Outdoor Switchyard	LED	Water Tight Flood Light
	4	External Lighting on Buildings	LED	Water Tight Flood Light
	5	Gate Lighting	LED	Post type, water tight Flood Light

3.24.17.4 Provisions shall be made in the switchyard steel structures for mounting of lamps for switchyard.

#### 3.24.18.0 PAINITNG

3.24.18.1 All surfaces of ferrous materials used for construction of outdoor equipment and enclosures such as instrument transformer main tanks and equipment, marshalling boxes, kiosk, operating boxes, metallic

enclosures etc. shall be cleaned and painted as given below if not specified otherwise in respective Sections. The quality of paint such that its colour should not fade even if it is exposed to temperature up to 1200-degree C.

Description	Surface preparation	Primer coat	Intermediate undercoat	Finish coat	DFT	Colour Shade
CT & PT Main tanks of CT, PT and other oil filled equipment, etc. (External surface)	Shot Blast cleaning Sa 2½ (ISO 8501-1)	Epoxy base zinc primer (30- 40 mm)	Epoxy high build micaceous iron oxide (75 mm)	Aliphatic Polyurethane 2 coats (25 mm/coat)	Minimum 155 mm	Shade No. 631 of IS:5
do (Internal surfaces)	Shot Blast cleaning Sa 2½ (ISO 8501- 1)	Hot oil resistant, non- corrosive varnish or paint or epoxy			Minimum 30 mm	Glossy white or paint
Marshalling boxes, operating	Chemical/Shot Blast cleaning Sa	Epoxy base zinc primer (30- 40 mm)				

3.24.18.2 All paints shall be carefully selected to withstand heat, rain and extremes of weather. The paint shall not scale off or crinkle or be removed by abrasion due to normal handling.

3.24.18.3 In case finish paint chips off or crinkle during transit or installation, the contractor shall arrange for repainting transformer at site at his cost. The paint for repainting/touchup shall be supplied by the contractor.

3.24.18.4 The paint work done shall be guaranteed for a minimum period of 5 years from the date of receipt of the equipment.

3.24.18.5 1(One) coat of additional paint to the exposed exterior surfaces shall be given at site prior to commissioning in presence of the Employer's representative.

# 3.25 SPECIFICATION FOR DESIGN AND FABRICATION OF SUBSTATION STEEL STRUCTURES

## 3.25.1 SCOPE

3.25.1.1 This section covers the design parameters and specification for fabrication and galvanizing, of steel structures, bolts & nuts, tower accessories etc. for Substations covered under this Bid Document.

#### 3.25.2 MATERIALS

#### 3.25.2.1 Structural Steel

The structures shall be of structural steel conforming to any of the grade, as appropriate, of IS 2062 (latest edition) Steel conforming IS 8500 may also be used.

Medium and high strength structural steels with known properties conforming to any other national or international standards may also be used.

#### 3.25.2.2 Bolts

Bolts used shall conform to IS12427 or bolts of property class 4.6 conforming to IS 6639 may also be used. High strength bolts, if used (only with steel conforming to IS 8500) shall conform to property class 8.8 of IS 3757. Foundation Bolts shall conform to IS 5624. Step bolts shall conform to IS 10238

#### 3.25.2.3 Nuts

Nuts shall conform to IS 1363 (Part 3). The mechanical properties shall conform to property class 4 or 5 as the case may be as specified in IS 1367 (Part 6) except that the proof stress for nuts of property class 5 shall be as given in IS 12427.

Nuts to be used with high strength bolts shall conform to IS 6623.

#### 3.25.2.4 Washers

Washers shall conform to IS 2016. Heavy washers shall conform to IS 6610. Spring washers shall conform to type Bof IS 3663

Washers to be used with high strength bolts and nuts shall conform to IS 6649.

#### 3.25.2.5 Galvanisation

Structural members, plain and heavy washers shall be galvanized in accordance with the provisions of IS 4759. Spring washers shall be hot dip galvanized as per service grade 4 of IS 4759 or IS 1537.

#### 3.25.2.6 Other Materials

Other materials used in the construction of the supporting structures shall conform to appropriate Indian Standards wherever available.

#### 3.25.3 DESIGN PARAMETERS

3.25.3.1 Switchyard structures such as columns, beams and equipment mounting structures shall be designed as per drawing provided along with this bidding document.

# Note: Structures with earth peak shall assume to have four earth wires for design purpose in normal condition.

## 3.25.3.2 Spans: -

Following Spans shall be considered in design of all structures as applicable: -

a). Line gantries (structures to terminate lines):

(i)For 33 KV Switchyard: 50 Meter, wind & weight

#### span. b). All other Structures

(i) For 33 KV Switchyard: 20 Meter, wind & weight span.

#### 3.25.3.3 Deviation Angle

The design of line gantries shall only be checked for a maximum deviation angle of 300 from normal at centre of gantries to Dead End Tower.

#### 3.25.3.4 Conductors and Shield Wires

(i). The Conductor shall conform to IS: 398 (latest edition) except where otherwise specified herein. The details of the ACSR Moose, ACSR Zebra and ACSR Panther conductors are tabulated below:

	DESCRIPTION	ACSR 'MOOSE'	ACSR 'ZEBRA'	ACSR 'PANTHER'
1	Code name	MOOSE	ZEBRA	PANTHER
	Number of strands & size	Al: 54/ 3.53 mm	Al: 54/ 3.18 mm	AI: 30/ 3.00 mm
2		St: 7/ 3.53 mm	St: 7/ 3.18 mm	St: 7/ 3.00 mm
3	Overall diameter	35.05 MM	28.62 mm	21.00 mm
4	Breaking load	136.38 KN	130.32 kN	130.32 kN
5	Weight of conductor	2004 Kg/KM	1621 kg / km	974 kg / km
6	Co-efficient Of Linear	23x10-6 /0C	19.35x10-6 /0C	19.35x10-6 /0C
	Expansion			
7	Number of strand			
	Steel centre	1	1	1
	1st Steel Layer	6	6	6
	1st Aluminium Layer	12	12	12
	2nd Aluminium Layer	18	18	18
	3rd Aluminium Layer	24	24	-
8	Sectional area of Aluminium	528.50 mm2	428.90 mm2	212.10 mm2
9	Total sectional area	597.00 mm2	484.50 mm2	261.50 mm2
10	Calculated d.c. resistance at 20 C	0.05552ohm/km	0.06869 ohm/km	0.1400 ohm/km
11	Ultimate tensile strength	161.2 kN	130.32 kN	89.67

(ii). For protection against direct lightning G.I. wires of size 7/3.66 mm conforming to IS 2241 shall be considered for all switch yards.

# 3.25.4 DESIGN DRAWINGS

- 3.25.4.1 The relevant drawings for all the towers, beams and equipment mounting structures shall be furnished by the CONTRACTOR to the Purchaser which shall include structural/fabrication drawings, Bill of Materials including nuts and bolts.
- 3.25.4.2 The structural drawings, Bill of materials and shop fabrication drawings for all the structures shall be submitted in four copies and will be finally approved by the Purchaser. The fabrication shall be taken up from the approved shop drawings.

The overall responsibility of fabricating structure members correctly lies with the CONTRACTOR only and the CONTRACTOR shall ensure that all the members can be fitted while erecting without any undue strain on them.

# 3.25.5 ACCESSORIES

#### 3.25.5.1 Step Bolts

Each column/tower shall be provided with step bolts conforming to IS: 10238 of not less than 16mm diameter and 175mm long spaced not more than 450mm apart and extending from 2.5 meters above the ground level to the top. Each step bolt shall be provided with two nuts on one end to fasten the bolt securely to the tower and button head at the other end to prevent the feet from slipping away. The step bolts shall be capable of withstanding a vertical load not less than 1.5 KN.

#### 3.25.5.2 Insulator Strings and Conductor Clamps Attachments

- a) Single suspension and tension insulator string assemblies shall be used for stringing busbars. For the attachment of Suspension Insulator string, a suitable strain plate of sufficient thickness for transferring the load to the tower body shall be provided. To achieve requisite clearances, if the design calls for providing extra D-shackles, link plate etc. before connecting the insulator string the insulator string the same shall be supplied by the CONTRACTOR.
- b) At tension points strain plates of suitable dimensions placed on the beams, shall be provided for taking the

hooks or D-shackles of the tension insulator strings. To achieve requisite clearances, if the design calls for providing extra D-shackles, link plate etc. before connecting the insulator string the same shall be supplied by the CONTRACTOR.

#### 3.25.5.3 Earth wire Clamps Attachment

#### i. Suspension Clamp

The detailed drawing shall be submitted by the CONTRACTOR for Purchaser's approval. The CONTRACTOR shall also supply U- bolts, D-shackles wherever required.

#### ii. Tension Clamps

Earth-wire peaks of tension towers shall be provided with suitable plates to accommodate the shackle of tension clamps. The CONTRACTOR shall also supply the U-bolts wherever required and take Purchaser's approval for details of the attachments before the mass fabrication.

#### 3.25.6 FABRICATION

3.25.6.1 The fabrication of substation steel structures shall be in conformity with the following:

- 3.25.6.1.1 Except where hereinafter modified, details of fabrication shall conform to IS: 802 (Part-II) or the relevant international standards.
- 3.25.6.1.2 The tower structures shall be accurately fabricated to connect together easily at site without any undue strain on the bolts.
- 3.25.6.1.3 No angle member shall have the two leg flanges brought together by closing the angle.
- 3.25.6.1.4 The diameter of the hole shall be equal to the diameter of bolt plus 1.5mm.
- 3.25.6.1.5 The structure shall be designed so that all parts shall be accessible for inspection and cleaning. Drain holes shall be provided at all points where pockets of depression are likely to hold water.
- 3.25.6.1.6 All identical parts shall be made strictly inter-changeable. All steel sections before any work are done on them shall be carefully levelled, straightened and made true to detailed drawings by methods which will not injure the materials so that when assembled, the adjacent matching surfaces are in close contact throughout. No rough edges shall be permitted in the entire structure.
- 3.25.6.1.7 Minimum Thickness of Tower Members shall be as follows: -

ITEM	Minimum thickness in mm
Leg members & main chords of beams in compression	5
Other members	4

#### 3.25.6.2 Drilling and Punching

- 3.25.6.2.1 Before any cutting work is started, all steel sections shall be carefully strengthened and trued by pressure and not by hammering. They shall again be trued after being punched and drilled.
- 3.25.6.2.2 Holes for bolts shall be' drilled or punched with a jig but drilled holes shall he preferred. The punching may be adopted for thickness up to 16mm. Tolerances regarding punch holes are as follows:
  - a) Holes must be perfectly circular and no tolerances in this respect are permissible.
  - b) The maximum allowable difference in diameter of the holes on the two sides of plates or angle is 0.8mm. i.e., the allowable taper in punched holes should not exceed 0.8 mm on diameter.
  - c) Holes must be square with the plates or angles and have their walls parallel.
- 3.25.6.2.3 All burrs left by drills or punch shall be removed completely. When the tower members are in position the holes shall be truly opposite to each other. Drilling or reaming to enlarge holes shall not be permitted.

#### 3.25.6.3 Erection mark

3.25.6.3.1 Each individual member shall have erection mark conforming to the component number given to it in the fabrication drawings. The mark shall be marked with marking dies of 16mm size before galvanizing and shall be legible after galvanizing.

#### 3.25.7 GALVANIZING AND PAINTING

3.25.7.1 Galvanising of the various members of the structures shall be done only after all works of sawing, shearing, drilling, filling, bending and matching are completed. Galvanising shall be done by the hot dip process as recommended in IIS: 2629 or other such authoritative international standards and shall produce a smooth,

clean and uniform coating of not less than 61 0 gm per square meter. The preparation for galvanising and the galvanising process itself must not affect adversely the mechanical properties of the treated materials. No manual Galvanization process will be accepted.

- 3.25.7.2 All assembly bolts shall be thoroughly hot dip galvanised after threading. Threads shall be of a depth sufficient to allow for the galvanized coating, which must not be excessive at the root of the threads, so that the nut shall turn easily on the completed bolts without excessive looseness. The nut threads shall not be galvanised, but oiled only.
- 3.25.7.3 The outside surface shall be galvanised. Sample of galvanised materials shall be supplied to the galvanised test set out in IIS 729 or other such authoritative international standards.

# 3.25.8 EARTHING

3.25.8.1 To keep provision in the structures for earthling, holes shall be drilled on two diagonal opposite legs of the towers/columns/mounting structures. The holes shall be suitable for bolting 65 mm X 1 2 mm GII strips and shall be such that the lower hole is about 350 mm above the ground level, clear of the concrete muffing, for connecting the earthling strip.

# 3.25.9 TEST AND TEST CERTFICATE

- 3.25.9.1 Each consignment ready for transportation shall be offered to ASEB for inspection before dispatch giving a minimum time of not less than 30 days. Samples of fabricated structure materials shall be subjected to following tests:
  - Steel: The structural steel shall conform to IS 226 and IS 8500, BS 4360-1068 or ISO / R 630 other such authoritative international standards. Manufacturer's test certificate shall be submitted for all used steel.
  - 2. Galvanising: The galvanising shall be as per IS 2633 or BS 729 other such authoritative international standards. Zinc coating over the galvanised surfaces shall not be less than 610 gm per square meter.
  - 3. Bolts and nuts: Manufacturer's test certificate as per standard practice shall be submitted.

# 3.25.10 TEST AT CONTRACTOR'S PREMISES

- 3.25.10.1 The CONTRACTOR shall fabricate one specimen structure of each type as soon as possible after placement of order and before starting the bulk fabrication of the structures ordered. It shall be assembled on a foundation as nearly similar as practicable to site and tested with suitable test loads as per specified broken wire condition, multiplied by the corresponding factor of safety to ensure that the design and fabrication complies with the requirements. Each structure shall be capable of withstanding the above-mentioned tests without any injury or any permanent deflection at any part. If any member is found to be weak or damaged the design should be suitably modified and the tower re-tested.
- 3.25.10.2 After the first lot of the structures manufactured, the members forming one structure of each type shall be selected at random from the lots of similar members and assembled in exactly the same manner as to be done at site. The structure then shall be set on foundation as nearly similar as practicable to site and tested with equivalent test load for which the structure has been designed.
- 3.25.10.3 No structure or any member thereof, which failed under the test shall be supplied.

# 3.26 TECHNICAL SPECIFICATION OF OUTDOORCURRENT AND POTENTIAL TRANSFORMERS

# 3.26.1 SCOPE

- 3.26.1.1 his Section of the Specification covers general requirements for design, engineering, manufacture, assembly and testing at manufacturer's works of Live Tank type outdoor Current and Potential Transformers, also referred to as Instrument transformers.
- 3.26.1.2 Loading at manufacturer's works, transportation and delivery at respective substation site including unloading at destination site.
- 3.26.1.3 Erection, Testing and Commissioning of Instrument Transformers.

# 3.26.2 STANDARDS

3.26.2.1 The equipment covered by this specification shall, unless otherwise stated be designed, constructed and tested in accordance with the latest revisions of relevant Indian Standards or equivalent IEC and shall conform to the regulations of local statutory authorities.

3.26.2.2 In case of any conflict between the Standards and this specification, this specification shall govern.

3.26.2.3 The current transformer shall comply also with the latest issue of the following Indian standard.

- (i). IS: 2705(Part-I): Current transformers: General requirement.
- (ii). IS: 2705(Part-II): Current transformers: Measuring Current transformers
- (iii). IS: 2705(Part-III): Current transformers: Protective Current transformers
- (iv). IS: 2705(Part-IV): Current transformers: Protective Current transformers for special Purpose application.
- (ii). IS: 3156(Part-I): Potential transformers: General requirement.
- (iii). IS: 3156 (Part-II): Potential transformers: Measuring Potential transformers
- (iv). IS: 3156 (Part-III): Potential transformers: Protective Potential transformers

# 3.26.3 GENERAL REQUIREMENTS

- 3.26.3.1 The cores of the instrument transformers shall be of high grade, non-aging CRC steel of low hysteresis loss and high permeability.
- 3.26.3.2 Instrument transformers shall be of Live Tank design.
- 3.26.3.3 The instrument transformers shall be truly hermetically sealed to completely prevent the oil inside the tank coming into contact with the outside temperature. To take care of oil volume variation the tenderer is requested to quote the current transformers with stainless steel diaphragm (bellow).

# All parts of bellow shall be stainless steel only. A ground glass window shall be provided to monitor the position of the metal bellow.

- 3.26.3.4 The instrument transformers shall be completely filled with oil.
- 3.26.3.5 A complete leak proof secondary terminal arrangement shall be provided with each instrument transformers. All secondary terminals shall be brought out into weather, dust and vermin proof terminal box. Secondary terminal boxes shall be provided with facilities for easy earthing, shorting, insulating and testing of secondary circuits. The terminal boxes shall be suitable for connection of control cable gland.
- 3.26.3.6 All instrument transformers shall be of single-phase unit.
- 3.26.3.7 All Instrument transformers shall be suitable for upright mounting on latticed steel structures.
- 3.26.3.8 The Instrument Transformer shall be complete in all respects and shall conform to the modern practice of design and manufacture.
- 3.26.3.9 The instrument transformers shall be so designed to withstand the effects of temperature, wind load, short circuit conditions and other adverse conditions.
- 3.26.3.10 All similar parts, particularly removable ones, shall be interchangeable with one another.
- 3.26.3.11 All cable ferrules, lugs, tags, etc. required for identification and cabling shall be supplied complete for speedy erection and commissioning as per approved schematics.
- 3.26.3.12 The instrument transformers shall be designed to ensure that condensation of moisture is controlled by proper selection of organic insulating materials having low moisture absorbing characteristics.
- 3.26.3.13 All steel work shall be degreased, pickled and phosphate and then painted in accordance with as specified in the bid document.

- 3.26.3.14 The outer surface of metal tank shall be Hot Dip Galvanized, whereas, the inner portion shall be painted in accordance with as specified in bid document or hot dip galvanised.
- 3.26.3.15 The galvanising shall be as per applicable standard IS: 2629 and minimum thickness of zinc coating shall be 610 gm/sq.mt.

## 3.26.4 INSULATING OIL

3.26.4.1 The quantity of insulating oil for instrument transformers and complete specification of oil shall be stated in the tender. The insulating oil shall conform to the requirement of latest edition of IS: 335 / IEC 60296 (required for first filling)

#### 3.26.5 COMMON MARSHALLING BOXES

- 3.26.5.1 The outdoor type common marshalling boxes shall conform to the latest edition of IS 5039 and other general requirements specified hereunder.
- 3.26.5.2 The common marshalling boxes shall be suitable for mounting on the steel mounting structures of the instrument transformers.
- 3.26.5.3 1(One) common marshalling box shall be supplied with each set of instrument transformers. The marshalling box shall be made of sheet steel and weather proof. The thickness of sheet steel used shall be not less than 3.0 mm. It is intended to bring all the secondary terminals to the common marshalling.
- 3.26.5.4 The enclosures of the common marshalling boxes shall provide a degree of protection of not less than IP 55 (As per IS 2147).
- 3.26.5.5 The common marshalling boxes shall be provided with double hinged front doors with pad locking arrangement. All doors and removable covers and plates shall be sealed all around with neoprene gaskets or similar arrangement.
- 3.26.5.6 Each marshalling box shall be fitted with terminal blocks made out of moulded non-inflammable plastic materials and having adequate number of terminals with binding screws washers etc. Secondary terminals of the instrument transformers shall be connected to the respective common marshalling boxes. All out going terminals of each instrument transformer shall terminate on the terminal blocks of the common marshalling boxes. The terminal blocks shall be arranged to provide maximum accessibility to all conductor terminals.
- 3.26.5.7 Each terminal shall be suitably marked with identification numbers. Not more than two wires shall be connected to any one terminal. At least 20 % spare terminals shall be provided over and above the required number.
- 3.26.5.8 All terminal strips shall be of isolating type terminals and they will be of minimum 10 A continuous current rating.
- 3.26.5.9 All cable entries shall be from bottom. Suitable removable gland plate shall be provided on the box for this purpose. Necessary number of cable glands shall be supplied fitted on to this gland plate. Cable glands shall be screw on type and made of brass.
- 3.26.5.10 Each common marshalling box shall be provided with two numbers of earthing terminals of galvanised bolt and nut type.
- 3.26.5.11 All steel works of common marshalling boxes shall be hot dipped galvanized.
- 3.26.5.12 All steel, inside and outside work shall be degreased, pickled and phosphate and then applied with two coats of Zinc Chromate primer and two coats of finishing synthetic enamel paint. The colour of finishing paint shall be as follows: -
  - (i). Inside: Glossy White
  - (ii). Outside: Light Grey (Shade No. 697 of IS: 5)

# 3.26.6 BUSHINGS AND INSULATORS

- 3.26.6.1 Bushings and Insulators shall be of Porcelain, Solid core type. Porcelain used for the manufacture of bushings and insulators shall be homogeneous, free from defects, cavities and other flaws or imperfections that might affect the mechanical or dielectric quality and shall be thoroughly vitrified, tough and impervious to moisture.
- 3.26.6.2 Glazing of the porcelain shall be of uniform brown colour, free from blisters, burns and other similar defects. Bushings shall be designed to have sufficient mechanical strength and rigidity for the conditions under which they will be used. All bushings of identical ratings shall be interchangeable.

- 3.26.6.3 Puncture strength of bushings shall be greater than the dry flashover value. When operating at normal voltage, there shall be no electric discharge between the conductors and bushing which would cause corrosion or injury to conductors, insulators or supports by the formation of substances produced by chemical action. No radio interference shall be caused by the bushings when operating at the normal rated voltage.
- 3.26.6.4 The design of bushing shall be such that the complete bushing is a self-contained unit and no audible discharge shall be detected at a voltage up to a working voltage (Phase Voltage) plus 10%. The minimum creepage distance for severely polluted atmosphere shall be 25 mm/KV.
- 3.26.6.5 Sharp contours in conducting parts should be avoided for breakdown of insulation. The insulators shall be capable to withstand the seismic acceleration of 0.5 g in horizontal direction and 0.6g in vertical direction.
- 3.26.6.6 Bushings shall satisfactorily withstand the insulation level specified in data sheet.

# 3.26.7 TESTS

#### 3.26.7.1 Routine/Acceptance Tests (all units)

3.26.7.1.1 All routine tests shall be carried out in accordance with relevant Standards.

All routine/acceptance tests shall be witnessed by the Purchaser/his authorised representative.

3.17.1.1.2 In addition, following tests on Current Transformers shall also be carried out as Routine Tests:

- (i). Measurement of Capacitance.
- (ii). Oil leakage test.
- (iii).Measurement of tan delta at 0.3, 0.7, 1.0 Um/ $\sqrt{3}$  and 10 kV

3.17.1.1.3 At factory/works tests the Ten Delta shall not exceed 0.3% (at  $Um/\sqrt{3}$ ). The same shall not exceed 0.7% at the end of warranty period (refer SCC clause 5.10.0 of Vol-1). If tan delta value of CTs exceed prescribed limit of 0.7% within warranty period, it will be considered as failure within warranty period (Tan delta & capacitance test of CTs shall be measured at 10KV at site). The bidder has to replenish failed CTs within guarantee period without any cost implication to AEGCL.

#### 3.26.7.2 Type Tests

3.26.7.2.1 The bidder shall furnish type test certificates and results for the all tests as per relevant Standards along with the bid for current and potential transformers of identical design.

# 3.26.8 NAME PLATES

3.26.8.1 All equipment shall have non-corrosive name plates conforming to requirements of IS and fix at a suitable position and indelibly marked with full particular there on in accordance with the standard adapted. The rated current, extended current rating (if specified) along with year of manufacture must be clearly indicated on the name plate.

The rated thermal current in case of CT shall also be marked on the name plate.

#### 3.26.9 MOUNTING STRUCTURES

- 3.26.9.1 All the equipment covered under this specification shall be suitable for mounting on steel structures. Supply of mounting structures is also in the scope of this tender.
- 3.26.9.2 Each equipment shall be furnished complete with base plates, clamps, and washers etc. and other hardware ready for mounting on existing steel structures.

# 3.26.10 SAFETY EARTHING

3.26.10.1 The non-current carrying metallic parts and equipment shall be connected to station earthing grid. For these two terminals suitable for 40mm X 10mm GI strip shall be provided on each equipment.

# 3.26.11 TERMINAL CONNECTORS

3.26.11.1 The equipment shall be supplied with required number of terminal connectors of approved type suitable for ACSR. The type of terminal connector, size of connector, material, and type of installation shall be approved by the Purchaser, as per installation requirement while approving the equipment drawings.

# 3.26.12 PRE-COMMSIONING TESTS

3.26.12.1 Contractor shall carry out following tests as pre-commissioning tests. Contractor shall also perform any additional test based on specialties of the items as per the field instructions of the equipment Supplier or Employer without any extra cost to the Employer. The Contractor shall arrange all instruments required for conducting these tests along with calibration certificates and shall furnish the list of instruments to the Employer for approval:

#### (a) Current Transformers

- i) Insulation Resistance Test for primary and secondary.
- ii) Polarity test
- iii) Ratio identification test checking of all ratios on all cores by primary injection of current.
- iv) Dielectric test of oil (wherever applicable).
- v) Magnetising characteristics test.
- vi) Tan delta and capacitance measurement.
- vii) Secondary winding resistance measurement
- viii) Contact resistance measurement (wherever possible/accessible)

#### (b) Voltage Transformers

- i) Insulation Resistance Test for primary (if applicable) and secondary.
- ii) Polarity test.
- iii) Ratio test.
- iv) Dielectric test of oil (wherever applicable).
- v) Tan delta and capacitance measurement of individual capacitance stacks.
- vi) Secondary winding resistance measurement

#### 3.26.13 TECHNICAL DATA SHEET FOR CURRENT AND POTENTIALTRANSFORMERS

3.26.13.1 For 220,132 & 33 kV CTs the instrument security factor at all ratios shall be less than five (5) for metering core. If any auxiliary CTs/reactor are used in the current transformers then all parameters specified shall have to be met treating auxiliary CTs as an integral part of the current transformer. The auxiliary CTs/reactor shall preferably be inbuilt construction of the CTs. In case these are to be mounted separately these shall be mounted in the central marshalling box suitably wired up to the terminal blocks.

#### 3.26.14 TYPE AND RATING:

All instrument transformer shall be outdoor type, single phase, oil immersed, self-cooled suitable for mounting on steel structure. The instrument transformer shall have the following ratings and particulars.

Item	Ratings and Particulars		
(A) Nominal system voltage	220kV	132kV	33 kV
(B) Highest system voltage, kV	245	145	36
(C) Rated frequency, HZ	50	50	50
(D) System earthing	Solidly Earthed	Solidly earth	Solidly earth
(E) Insulation level			
(a) Impulse withstand voltage: kVp	1050	550	170
(b) One-minute p.f. Withstand voltage, kV (r.m.s.)	460	230	70
(F) Short time current for one second, kA	40	31.5	25
(G) Minimum creepage distance, mm	6125	3625	1800
(a) Tan Delta (for CTs only) at Um/ $\sqrt{3}$ ,(Max)	0.3%	0.3%	0.3%
(H) Temperature rise	As per ISS		
(I) Feeder/ BYPASS/ Bus Coupler CT			
(i) No. of Cores	5	3	3
(ii) Transformation Ratio	As per schedule of requirement		
(iii)Rated Output			

(a) Core-1	30 VA	30 VA	30 VA
(b) Core-2	-	15 VA	15 VA
(c) Core-3	-	-	-
(d) Core-4	-	N.A	N.A
(e) Core-5	-	N.A	N.A
(iv) Accuracy Class			
(a) Core-1	0.2	0.2	0.2
(b) Core-2	5P	5P	5P
(c) Core-3	PS	PS	PS
(d) Core-4	PS	N.A	N.A
(e) Core-5	PS	N.A	N.A
(v) Accuracy Limit Factor			
(a) Core-1	-		-
(b) Core-2	-	10	10
(c) Core-3	-	-	-
(d) Core-4	-	N.A	N.A
(e) Core-5	-	N.A	N.A
(vi) Instrument security factor			
(a) Core-1		<5	
(b) Core-2		10	10
(c) Core-3	-	-	-
(d) Core-4	-	N.A	N.A
(e) Core-5	-	N.A	N.A
(vii) Minimum Knee point voltage, Volts			
(a) Core-1	-	-	-
(b) Core-2	1600	-	-
(c) Core-3	1600	1200	1200
(d) Core-4	800	N.A	N.A
(e) Core-5	800	N.A	N.A
(viii) Maximum secondary resistance, ohm			
(a) Core-1	-	-	-
(b) Core-2	3	-	-
(c) Core-3	3	3	3
(d) Core-4	3	N.A	N.A
(e) Core-5	3	N.A	N.A
(ix) Maximum exciting current, at Vk/4 mA			
(a) Core-1	-	-	-
(b) Core-2	20	-	-
(c) Core-3 (at Vk/4)	20	20	20
(d) Core-4	20	N.A	N.A
(e) Core-5	20	N.A	N.A
(J) Transformer CT			
(i) No. of Cores	5	4	3
(ii) Transformation Ratio	As per schedule of requirement		
(iii)Rated Output			
(a) Core-1	30 VA	30 VA	30 VA
(b) Core-2	-	15 VA	15 VA

(c) Core-3	-	-	-
(d) Core-4	-	-	N.A
(e) Core-5	-	N.A	N.A
(iv) Accuracy Class			
(a) Core-1	0.2	0.2	0.2
(b) Core-2	PS	5P	5P
(c) Core-3	PS	PS	PS
(d) Core-4	PS	PS	N.A
(e) Core-5	PS	N.A	N.A
(v) Accuracy Limit Factor			
(a) Core-1	-		-
(b) Core-2	-	10	10
(c) Core-3	-	-	-
(d) Core-4	-	-	N.A
(e) Core-5	-	N.A	N.A
(vi) Instrument security factor			
(a) Core-1	-	-	-
(b) Core-2	10	10	10
(c) Core-3	-	-	-
(d) Core-4	-	-	N.A
(e) Core-5	-	N.A	N.A
(vii) Minimum Knee point voltage, Volts			
(a) Core-1	-	-	-
(b) Core-2	-	-	-
(c) Core-3	1600	1200	1200
(d) Core-4	800	800	N.A
(e) Core-5	N.A	N.A	N.A
(viii) Maximum secondary resistance, ohm			
(a) Core-1	-	-	-
(b) Core-2	-	-	-
(c) Core-3	30	30	30
(d) Core-4	20	20	N.A
(e) Core-5	20	N.A	N.A
(ix) Maximum exciting current, at Vk/4 mA			
(a) Core-1	-	-	-
(b) Core-2	3	-	-
(c) Core-3 (at Vk/4)	3	3	3
(d) Core-4	3	3	N.A
(e) Core-5	3	N.A	N.A
POTENTIAL TRANSFORMER			
(i) No. of secondary windings	3	2	2
(II) I ransformation ratio	(220 1/1/2)	(12010)(1-2)	2210/1/2
(a) winding i	(ZZU KV/√3)	(IJZKV/VJ)	33KV/√3

(b)	Winding II	/ (110 V/√3)	/ (110V/√3)	/ 110V/√3
(C)	Winding III		-	
(iii) Rated out put				
(a) Winding I			500	200
(b) Winding II			200	100
(vi) Accuracy class				
(a) Winding I			0.2	0.2
(b) Winding II			3P	3P
(v) Rated voltage factor			1.2	1.2

#### Note:

- (i) It is intended to use different ratios of the same CT at the same time for various protections and metering cores.
- (ii) The CTS should therefore be suitable for the above purpose by secondary tapings only.
- (iii) The ratio change by secondary taps is acceptable as long as the required CT specifications are achieved at all ratios.
- (iv) The knee point voltage specified above shall be at higher ratio/ taps.

# 3.27 TECHNICAL SPECIFICATION OF BATTERY BANK AND CHARGER

# 3.27.1.0. SCOPE

3.27.1.1. This Section of the Specification covers the design, manufacture, and testing at manufacturer's work, of stationary type sealed, Valve Regulated Lead Acid Battery Bank, Dual FCBC Battery Charger, DC Distribution Boards and LTAC Panels complete with all required accessories for various Sub-stations.

# 3.27.2.0. BATTERY BANK

# 3.27.2.1. TYPE AND RATING

A. For Substation with highest voltage of 145 kV (if not specifically mentioned in the Schedule of Quantities)

For 220 KV, 132 KV & 66 KV sub-stations, DC System shall consist of One (1) float cum-boost charger and one (1) battery set for 220V system. DC scheme shall consist of one (1) battery.

i) Stationary type, sealed, valve regulated lead acid battery tank suitable for operation on 110 Volts D.C. system to meet loads like emergency lightning, control and signaling circuits, relays, breaker operations, indicating circuits, etc. shall be required. The stationary battery shall comply with the provisions of IEC 60896.

ii) The Ampere-hour capacity of the battery bank at 27°C at 10 hours discharge rate shall be 300 AH.

iii) The nominal voltage of the battery bank shall be 110 Volts D.C.

iv) The number of cells in a complete battery bank set shall be 55 plus 2 spares.

# B. For Substation with highest voltage of 245 kV (if not specifically mentioned in the Schedule of Quantities)

(i). Stationary type, sealed, valve regulated lead acid battery tank suitable for operation on 220 Volts D.C. system to meet loads like emergency lightning, control and signaling circuits, relays, breaker operations, indicating circuits, etc. shall be required. The stationary battery shall comply with the provisions of IEC 60896.

(ii). The Ampere-hour capacity of the battery bank at 27°C at 10 hours discharge rate shall be 300 AH.

(iii). The nominal voltage of the battery bank shall be 220 Volts D.C.

(iv). The number of cells in a complete battery bank set shall be 110 plus 2 spares.

# C. 48V Battery Bank

 i) Stationary type, sealed, valve regulated lead acid battery tank suitable for operation on 48 Volts D.C. system to meet loads like emergency lightning, control and signalling circuits, relays, breaker operations, indicating circuits, etc. shall be required. The stationary battery shall comply with the provisions of IEC 896, Part 2 / ANSI T1.330.
 ii) The Ampere-hour capacity of the battery bank at 27°C at 10 hours discharge rate shall be 150 AH.

iii) The nominal voltage of the battery bank shall be 48 Volts D.C.

iv) The number of cells in a complete battery bank set shall be 24 plus 2 spares.

# 3.27.2.2. PLATES

Positive plates shall be made of flat pasted type using lead-cadmium antimony alloy for durability, high corrosion resistant, maintenance free, long life both in cyclic as well as in, float applications. Negative plates shall be heavy duty, durable flat plate using lead calcium alloy pasted box grid. Negative plates shall be designed to match the life of positive plates and combination of negative and positive plates shall ensure long life, durability and trouble-free operation of battery. PLC operated equipment should be deployed for preparation of paste to ensure consistency in paste quality. Conventional / manual type of paste preparation is not allowed.

# 3.27.2.3. CONTAINER AND LID

The containers and lids shall be made of a special grade polypropylene copolymer plastic material. They shall be sufficiently robust and not liable lo deformation under internal operating pressures and within the temperature range naturally encountered, leak proof, non-absorbent and resistant to the acid with low water vapour permeability.

# 3.27.2.4. VENT PLUGS

Each cell shall be equipped with one-way safety valve with opening pressure of  $5\pm1$  psi and closing pressure  $4\pm1$  psi. The vent plug shall be made with suitable grade of fire-retardant plastic material. Each valve opening shall be covered with flame barrier capable in preventing the ingress of flame into the cell interior when the valve opens and hydrogen / oxygen gas mixture is released.

# 3.27.2.5. SEPARATORS

Separator shall be made of spun glass, micro porous matrix and shall be resistant to Sulphuric Acid. It shall be capable of keeping the entire electrolyte and shall be electrically insulated. Sufficient separator overlap and PVC shield protection to top and bottom edges of the plates is to be provided to prevent short circuit formation between the edges of adjacent plates.

## 3.27.2.6. CONNECTORS

The connectors shall be lead coated copper of suitable size to join the cells. The connectors shall be suitably designed and coated to withstand corrosion due to sulphuric acid. The coating should be adequate and tenacious. All the copper inter cell connectors shall be provided with heal shrinkable sleeves except at the connecting points.

#### 3.27.2.7. ELECTROLYTE:

The electrolyte shall be prepared from the battery grade Sulphuric Acid confirming to ISS: 266. The batteries shall be supplied in factory filled and charged condition.

#### 3.27.2.8. WATER

Water required for preparation of electrolyte shall conform to IS: 1069.

#### 3.27.2.9. PLATE CONNECTION

Lugs of plates of like polarity shall be connected by lead burning to a horizontal strap having an upstanding terminal post adopted for connection to external circuit. Strap and post shall be caste with lead alloy. The positive and negative terminal posts shall be clearly marked for unmistakable identification.

#### 3.27.2.10. BOLTS AND NUTS

Nuts and Bolts for connecting the cells shall be of superior grade passivated Stainless steel.

#### 3.27.2.11. TERMINALS

Terminals shall be of integral lead terminal with solid copper core with M6 threading for fastening. The junction between terminal posts and cover and between the cover and container shall be hermetically sealed.

# 3.27.2.12. BATTERY RACKS

Batteries shall be installed on MS racks to be supplied by the Contractor to fit in the battery room. Racks/Trays shall be powder coated with anti-corrosive paint. Rack shall accommodate 55/110 cells plus 2 spares. Racks/Tray shall be suitably treated before painting for protection against fungus growth and other harmful effects due to tropical environment.

The colour of the supporting racks shall conform to shade 631 of IS: 5.

# 3.27.3.0. BATTERY CHARGING EQUIPMENTS

#### 3.27.3.1. GENERAL DESCRIPTION

- i. The battery charging equipment shall have two separate Boost-cum Trickle Charger sections. Each section shall have its own rectifier transformer, rectifier bridge and other equipment so that each section can operate independent of each other. The charger-I shall normally be in float mode and will supply load while Charger-II remains as hot standby. In case charger in boost mode, the Charger-II shall supply the normal load.
- ii. Each section of the battery chargers shall be capable of continuous operation at itsrated load in float charging mode, i.e., Float charging the associated Batteries at 2.13 to 2.27 Volts per cell while supplying the DC load. The chargers shall also be capable of Boost charging the associated DC Battery at 2.28 to 2.32 volts per cell at the desired rate.
- iii. Each charger section shall regulate the float/boost voltage in case of prescribed temperature rise of battery as per manufacturer's recommendation to avoid thermal runaway. Necessary temperature sensors shall be provided in mid location of battery banks and shall be wired up to the respective charger for feedback control. The manufacturer shall demonstrate this feature during testing of each charger.

# 3.27.3.2. OPERATION AND CONTROL

i. During normal operation of the one of the charger sections shall supply the normal direct current
requirements of the substation and the station battery shall be floating on the other charger section. In the event of failure of A.C. supply or failure of the both sections of the charger itself the battery shall come automatically across the load without any interruption. Similarly in case of failure of any one section of the charger the DC load or the battery as the case may be, shall come automatically change over to the healthy charger section without any interruption.

- ii. All Battery Chargers shall be provided with facility for both automatic and manual control of output voltage and current. A selector switch shall be provided for selecting the mode of output voltage/current control, whether automatic or manual. When on automatic control mode during Float charging, the Charger output voltage shall remain within +1% of the set value, for AC input voltage variation of +10%, frequency variation of +5%, a combined voltage and frequency variation of +10%, and a DC load variation from zero to full load. All battery chargers shall have a constant voltage characteristic throughout the range (from zero to full load) at the floating value of the voltage so as to keep the battery fully charged but without harmful overcharge.
- iii. All chargers shall have load limiters having drooping characteristic, which shall cause, when the voltage control is in automatic mode, a gradual lowering of the output voltage when the DC load current exceeds the Load limiter setting of the Charger. The Load-limiter characteristics shall be such that any sustained overload or short circuit in DC System shall not damage the Charger, nor shall it cause blowing of any of the Charger fuses. The Charger shall not trip on overload or external short circuit. Uniform and step less adjustments of voltage setting (in both manual and automatic modes) shall be provided on the front of the Charger panel covering the entire float charging output range specified. Step less adjustments of the Load limiter setting shall also be possible from 80% to 100% of the rated output current for charging mode. During Boost Charging, the Battery Charger shall operate on constant current mode (when automatic regulator is in service).
- iv. It shall be possible to adjust the Boost charging current continuously over a range of 50 to 100% of the rated output current for Boost charging mode. The Charger output voltage shall automatically go on rising, when it is operating on Boost mode, as the Battery charges up. For limiting the output voltage of the Charger, a potentiometer shall be provided on the front of the panel, whereby it shall be possible to set the upper limit of this voltage anywhere in the output range specified for Boost Charging mode. The Charger manufacturer may offer an arrangement in which the voltage setting device for Float charging mode is also used as output voltage limit setting device for Boost charging mode and the Load-limiter of Float charging mode is used as current setting device in boost charging mode. Suitable filter circuits shall be provided in all the chargers to limit the ripple content (Peak to Peak) in the output voltage to 1%, irrespective of the DC load level, when they are not connected to a Battery.

# 3.27.3.3. MCCB

All Battery Chargers shall have 2 Nos. MCCBs on the input side to receive cables for two charger sections. It shall be of P2 duty and suitable for continuous duty. MCCB's should have auxiliary contacts for annunciation. Rectifier Transformer. The rectifier transformer shall be continuously rated, dry air cooled (A.N) and of class F insulation type. The rating of the rectifier transformer shall have 10% overload capacity.

# 3.27.3.4. Rectifier Assembly

The rectifier assembly shall be fully/half-controlled bridge type and shall be designed to meet the duty as required by the respective Charger. The rectifier shall be provided with heat sink having their own heat dissipation arrangements with natural air cooling. Necessary surge protection devices and rectifier type fast acting HRC fuses shall be provided in each arm of the rectifier connections.

# 3.27.3.5. Instruments

One AC voltmeter and one AC ammeter along with selector switches shall be provided for each charger sections. One DC voltmeter and DC ammeter (with shunt) shall be provided for all Charger sections. The instruments shall be flush type, dust proof and moisture resistant. The instruments shall have easily accessible means for zero adjustment. The instruments shall be of 1.5 accuracy class. In addition to the above a center zero voltmeter with selector switch shall also be provided for each charger sections for testing purpose.

# 3.27.3.6. Air Break Switches

One DC output switch shall be provided in each charger sections. They shall be air break type suitable for 500 volts

AC/ 250 DC. The contacts of the switches shall open and close with a snap action. The operating handle of the switch shall be fully insulated from circuit. 'ON' and 'OFF' position on the switch shall be clearly indicated. Rating of switches shall be suitable for their continuous load. Alternatively, MCCB's of suitable ratings shall also acceptable in place of Air Break Switch.

# 3.27.3.7. Fuses

All fuses shall be HRC Link type. Fuses shall be mounted on fuse carriers which are in turn mounted on fuse bases. Wherever it is not possible to mount fuses on carriers, fuses shall be directly mounted on plug-in type base. In such case one insulated fuse pulling handle shall be supplied for each charger. Fuse rating shall be chosen by the Bidder depending on the circuit requirement. All fuses in the chargers shall be monitored. Fuse failure annunciation shall be provided on the failure of any fuse.

# 3.27.3.8. Blocking Diode

Blocking diode shall be provided in the positive pole of the output circuit of each charger to prevent current flow from the DC Battery into the Charger.

# 3.27.3.9. Annunciation System

Audio-visual indications through bright LEDs shall be provided in each Charger sections for the following abnormalities:

- a) AC power failure
- b) Rectifier/chargers fuse blown.
- c) Over voltage across the battery when boost charging.
- d) Abnormal voltage (High/Low)

e) Any other annunciation if required.

Potential free NO Contacts of above abnormal conditions shall also be provided for common remote indication "CHARGER TROUBLE" in Employer's Control System. Indication for charger in float mode and boost mode through indication lamps shall be provided for chargers. A potential free contact for float/boost mode shall be provided for external interlocks.

# 3.27.3.10. Charger Construction

- i. The Chargers shall be indoor, floor-mounted, self-supporting sheet metal enclosed cubicle type. The Contractor shall supply all necessary base frames, anchor bolts and hardware. The Chargers shall be fabricated from 2.0mm cold rolled sheet steel and shall have folded type of construction. Removable gland plates for all cables and lugs for power cables shall be supplied by the Contractor. The lugs for power cables shall be made of electrolytic copper with tin coat. Power cable sizes shall be advised to the Contractor at a later date for provision of suitable lugs and drilling of gland plates. The Charger shall be tropicalized and vermin proof. Ventilation louvers, if provided shall be backed with screens. All doors and covers shall be fitted with synthetic rubber gaskets. The chargers shall have hinged double leaf doors provided on front and on backside for adequate access to the Charger's internals. All the charger cubicle doors shall be properly earthed.
- ii. The degree of protection of Charger enclosure shall be at least IP-42 as per IS: 13947 Part I. All indicating instruments, control switches and indicating lamps shall be mounted on the front side of the Charger. Each Charger shall be furnished completely wired upto power cable lugs and terminal blocks and ready for external connections. The control wiring shall be carried out with PVC insulated, 1.5 sq.mm. stranded copper wires. Control terminals shall be suitable for connecting two wires, with 2.5 sq.mm stranded copper conductors. All terminals shall be numbered for ease of connections and identification. Each wire shall bear a ferrule or tag on each end for identification. At least 20% spare terminals shall be provided for control circuits. The insulation of all circuits, except the low voltage electronic circuits shall withstand test voltage of 2 KV AC for one minute. An air clearance of at least ten (10) mm shall be maintained throughout for such circuits, right up to the terminal lugs. Whenever this clearance is not available, the live parts shall be insulated or shrouded.

# 3.27.3.11. Painting

All sheet steel work shall be pre-treated, in tanks, in accordance with IS:6005. Degreasing shall be done by alkaline cleaning. Rust and scale shall be removed by pickling with acid. After pickling, the parts shall be washed in running

water. Then these shall be rinsed in slightly alkaline hot water and dried. The phosphate coating shall be `Class-C' as specified in IS:6005. Welding shall not be done after phosphating. The phosphating surfaces shall be rinsed and passivated prior to application of stoved lead oxide primer coating. After primer application, two coats of finishing synthetic enamel paint of shade-692 (smoke grey) of IS:5 shall be applied, unless required otherwise by the Employer. The inside of the chargers shall be glossy white. Each coat of finishing synthetic enamel paint shall be glossy white. Each coat of finishing synthetic enamel paint shall be properly staved. The paint thickness shall not be less than fifty (50) microns.

# 3.27.3.12. CHARGER RATING

Each charger section shall have the following ratings:

## A) For 220 Volt DC System

(i). Input Voltage: 415+/- 10% volts three phase, 4 wire, 50 Hz A.C.

- (ii). Output Voltage: 220 Volt (Nominal).
- (iii). Output DC Current: 45 A

# B) For 110 Volt DC System

(i). Input Voltage: 415+/- 10% volts three phase, 4 wire, 50 Hz A.C.

- (ii). Output Voltage: 110 Volt (Nominal).
- (iii). Output DC Current: 45 A

## C) For 48 Volt DC System

(i). Input Voltage: 415+/- 10% volts three phase, 4 wire, 50 Hz A.C.

- (ii). Output Voltage: 48 Volt (Nominal).
- (iii). Output DC Current: 50 A

## 3.27.3.13. TESTS AND INSPECTION

The battery charger and all the components of the charger shall be routine tested accordingly to their relevant standard. This shall include the following:

- a) Operational check for boost cum float charger.
- b) Input / Output test of the chargers.
- c) Performance test of the charger.
- d) Temperature rise test of the rectifier transformer.
- e) Power frequency H.V. test / Insulation tests.

The Contractor shall be required to demonstrate to the employer that the Chargers conform to the specification particularly regarding continuous rating, ripple free output, voltage regulation and load limiting characteristic, before dispatch as well as after installation at site. At site the following tests shall be carried out:

- (i). Insulation resistance test
- (ii). Checking of proper annunciation system operation.

The Contractor shall present for inspection, the type and routine test certificates for the following components whenever required by the Employer:

- (i) Switches.
- (ii) Relays/MCCBs
- (iii) Instruments.
- (iv) DC fuses.
- (v) SCR.
- (vi) Diodes.
- (vii) Condensers.
- (viii) Potentiometers.
- (ix) Semiconductor
- (x) Annunciator.
- (xí) Control wiring
- (xii) Push button sand contactors

Makes of above equipment shall be subject to Employer's approval.

# 3.27.4.0. DC DISTRIBUTION BOARD

## 3.27.4.1. General Features

The D.C. distribution boards shall be indoor, floor mounting of self-supporting, sheet metal clad, and cubicle type. The panels should be totally enclosed, dust tight and vermin proof and shall be made of 2.0 mm cold rolled sheet steel. The boards shall be provided with double leaf hinged doors at the back. All doors and covers shall be fitted with rubber gaskets. The doors shall be provided with locks and duplicated covers.

## 3.27.4.2. Bus bars

The bus bars shall be of electrolytic copper of ample cross-section. The bus bars shall be insulated from the structure by means of durable, non-hydroscopic, noncombustible and non-tracking materials.

## 3.27.4.3. Detail Requirements

The 110/220 Volts D.C. distribution boards shall be provided with the following:

- i. One mains failure alarm relay.
- ii. One earth fault alarm relay.
- iii. One 110/220 Volts D.C. bell to be operated by the mains failure alarm relay.
- iv. One 110/220 Volts D.C. buzzer to be operated by the earth failure alarm relay.
- v. One double pole air-break circuit breaker of 400 amp capacity with thermal overload tripping arrangement to act as incoming breaker of the load bus.
- vi. One 0-150/300 volts D.C. moving coil voltmeter to measure the bus-bar voltage. The display is to be in digital.
- vii. One pilot lamp to indicate D.C. on conditions.

viii. 250 volts, double pole MCBs of following ratings for outgoing feeders.

- a. 16 Amp, 6 Nos.(8 Nos. for 220 V system)
- b. 32 Amp, 6 Nos. (8 Nos. for 220 V system).
- c. 63 Amp, 2 Nos
- ix. One terminal Board/block for all feeder outlets including cable glands.

**3.27.4.4 4** DC Distribution Board will have 2 sections, each section will be fed from independent Battery charger. Busbar rating 150 A for 48 V DC, 16 kA / for 1 SEC, AL or Copper, IP 54, 2 mm COLD ROLLED / 3 mm HOT ROLLED

# 3.27.5.0. LTAC PANEL

### 3.27.5.1. General Arrangement

The 415 volts L.T.A.C. panels shall be indoor floor mountings sheet metal clad type comprising of MCCBs and MCBs and bulbar chambers and equipped with circuits and equipment as specified. The different circuits shall be mounted above and below the bus bar chamber to form a suitable arrangement, except that the incomings will be located at the front and mounted below the bus bar chamber. All equipment shall be suitable for the reception of the cables rising from the ground level. The switchboards shall be so designed as to be readily extensible.

### 3.27.5.2. Bus bars

The phase and neutral bus bars shall be of high conductivity Aluminium of adequate uniform cross section. The bus bars shall be insulated from the structure by means of durable non-hygroscopic, non-combustible and non-tracking materials. Bulbar joints shall be of bolted type.

# 3.27.5.3. Detail Requirements

The 415 Volts, L.T.A.C. Switchgears shall have two Bus Sections with following circuits and equipment:

### a) INCOMING: Two numbers each fitted with following (for each Bus Section):

- i. 630 Amp, electrically operated, TPN MCCB and cable glands suitable for 4-core P.V.C. cable labelled as 'INCOMING'.
- ii. One Voltmeter with VSS.
- iii. One Ammeter with ASS.
- iv. One K.W.H. meter with connected C.T.

## b) BUS COUPLER: One number fitted with following:

- i. 630 Amp, TPN MCCB and cable glands suitable for 4-core P.V.C. cable labelled as 'INCOMING'.
- ii. One Ammeter with ASS.

## c) OUTGOINGS: Each Bus Section shall have following numbers of MCCBs for outgoing feeders:

- i. One number 200 Amps T.P.N. MCCB.
- ii. Two number 100 Amps TPN MCCB.
- iii. Two numbers 63 Amps TPN MCCB.
- iv. Two numbers 32 Amps TPN MCCB.
- v. Three numbers 32 Amps SPN MCB.

## 3.27.5.4. Automatic AC Source Changeover

Automatic changeover between Incomer I and Incomer II is to be carried out during the failure of supply in any one of the incomers. After the restoration of the supply, system shall be restored to normal condition automatically. The requirement of changeover under various conditions are as below:

- a) Under normal conditions i.e., when supply is available in both the incomers, incomers I & II of 415 V LTAC Panel shall be in closed condition and Bus Couplers breaker shall be in open condition.
- b) In case of failure of either of the sources, the incomer of that source shall trip and Bus Coupler shall get closed. On restoration of supply, normal conditions described above are to be established automatically.
- c) To avoid unnecessary operation of switchgear for momentary disturbances all changeovers from one state to another shall be initiated after a time delay, after the conditions warranting such change has been detected.
- d) Any devices required to achieve the requirements above shall deem to be included in the scope of works.