



KPCL/BTPS/03/EPC 	<div> <div>KARNATAKA POWER CORPORATION LIMITED</div> <div>BELLARY TPS,UNIT-3 OF 700 MW</div> <div>TITLE ELECTRICAL EQUIPMENT INSTALLATION WORK</div> </div>	SECTION: D2.19 VOLUME-IV SHEET 1 OF 3
<div> <div>ANNEXURE-2</div> <div> <div>1.0 GUIDELINES FOR INSTALLATION OF ELECTRICAL EQUIPMENT</div> <div> <div>1.1 All electrical equipment shall be installed in a neat, workmanlike manner so that it is level, plumb, squat and properly aligned and oriented. Tolerances shall be as established in the Manufacturer's drawings.</div> <div> <div>1.2 Transformers</div> <div>Care shall be taken during handling of insulating oil to prevent ingress of moisture or foreign matter. In the testing, circulating, filtering or otherwise handling of oil, rubber hoses shall not be used. Circulation and filtering of oil, heating of oil by regulated short circuit current during drying runs and sampling and testing of oil shall be in accordance with the Manufacturer's instructions and specified Code of Practice.</div> </div> <div> <div>1.3 Switchgear, Control/Relay Panels</div> <div> <div>1.3.1 Switchgears and control relay panels/desks shall be installed in accordance with specified code of practice and the Manufacturer's instructions.</div> <div>1.3.2 In joining shipping sections of the switchgear/panels/control centres together, adjacent housing or panel sections provided shall be bolted together after alignment has been completed.</div> </div> <div> <div>1.4 Motors</div> <div>The installation, commissioning of the motors shall be as per the applicable code of practice and the Manufacturer's instructions.</div> </div> <div> <div>1.5 Battery and chargers</div> <div>Each cell of the battery bank shall be inspected for breakage and condition of cover seals as soon as received at site. Each cell shall be filled with electrolyte in accordance with the Manufacturers instructions. Battery shall be set up on racks as soon as possible after receipt, utilising lifting devices supplied by the MANUFACTURER. The cells shall not be lifted by the terminals.</div> </div> <div> <div>1.6 Switchyard</div> <div> <div>1.6.1 Switchyard equipment installation shall be carried out as required in the approved drawing/plan and elevation drawings of switchyard showing bus bar configurations, sizes, tensions, insulator details etc.</div> <div>1.6.2 The above shall include installation of complete set of bus bars and all bays, conductors, complete with tension/suspension insulator strings, bus post insulators, equipment connections, bus bar connections to equipment, lightning shield wires including downcomers where they shall be connected to the test links. Tube type conductor lengths shall be joined by welding procedure.</div> </div> </div> </div> </div> </div></div>		

- 3.0 In order to avoid hazards to personnel moving around the equipment such as switchgear etc. which is kept charged after installation before commissioning, such equipment shall be suitably cordoned off to prevent anyone accidentally going near it.

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	<div> <div>4.0</div> <div> It will be the responsibility of the Contractor to obtain necessary License / Authorisation permit for work from the Licensing board of the locality/state/ State Electricity Authority/Inspectorate where the installation is to be carried out. The persons deputed by the Contractor's firm shall also hold valid permits issued or recognised by the Licensing Board of the locality/state/ State Electricity Authority/Inspectorate where the work is to be carried out. </div> </div> <div> <div>5.0</div> <div> The approval of all drawings and inspection of all installations complete, by the Govt. approved Electrical inspector, shall be the responsibility of the Contractor. All necessary fees towards the same shall be paid by the contractor. Also any modification work, if required/ advised by the Electrical inspector, shall be carried out by the Contractor free of cost. </div> </div>	

SECTION-3

1.0 PROJECT DETAILS AND GENERAL SPECIFICATIONS

1.1 BIDDER'S QUALIFYING REQUIREMENTS

The equipment offered should have designed, manufactured, tested as per relevant IS/IEC or equivalent standard and supplied the same for the specified technical parameters for 2 years as on the date of award of contract.

1.2 PROJECT INFORMATION AND SYSTEM PARAMETERS

- | | | | |
|----|-------------------------|---|---|
| a) | Customer | : | M/s Karnatka Power Corporation Ltd. |
| b) | Project Title | : | 400/220kV Bellary Sub-station, Phase-III (1x700MW TPP) |
| c) | Site location | : | Kudatini village, 22 km from Bellary city and 40 km from Hospet town on Bellary - Hospet Road (NH-63) |
| d) | Transport facilities | : | Road |
| e) | Nearest Railway station | : | Bellary |

The following system parameters shall prevail:

Nominal system voltage	400 kV	220 kV
Highest system voltage	420 kV	245 kV
Frequency	50 Hz	50 Hz
Rated short time current	40 kA for 1 sec	40 kA for 1 sec
Dry and wet one minute power frequency withstand voltage	630 kV	460 kV
Dry and wet impulse withstand voltage positive and negative	1425 kVp	1050 kVp
Minimum total creepage	31 mm/kV	31 mm/kV
System Earthing	Effectively Earthed	Effectively Earthed

1.3 SITE CONDITIONS

1.3.1 Ambient Temperature

- | | | |
|-----------------------------|---|------------|
| a) Ambient air temp. (max.) | : | 42.5 deg C |
| b) Ambient air temp. (min.) | : | 14.6 deg C |
| c) Design ambient temp. | : | 50 deg C |

1.3.2	Relative humidity	:	70% Max.
1.3.3	Altitude	:	478m from mean Sea level
1.3.4	Pollution severity	:	Highly polluted
1.3.5	Earth quake data		
	a) Seismic zone	:	III
	b) Seismic acceleration	:	As per IS: 1893 latest revision
1.3.6	Average Annual rainfall	:	846 mm
1.3.7	Max. mean Wind speed	:	19 km/hr
1.3.8	Latitude	:	15°11' 58" N
1.3.9	Longitude	:	76°43' 23" E

1.4 MATERIAL/WORKMANSHIP

1.4.1 General Requirement

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 purposes for which they are intended.

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 expenses. 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 devised, constructed and documented so that the component parts shall be accurately positioned and restrained to fulfill their required function. In general screw threads shall be standard metric threads. The use of other thread forms will only be permitted when prior approval has been obtained from purchaser.

Whenever possible, all similar part of the Works shall be made to gauge and shall also be made interchangeable with similar parts. All spare parts shall be interchangeable with, and shall be made of the same materials and workmanship as the corresponding parts of the Equipment supplied under the Specification. Where feasible, common component units shall be employed in different pieces of equipment in order to minimize spare parts stocking requirements. All equipment of the same type and rating shall be physically and electrically interchangeable.

All materials and equipment shall be installed in strict accordance with the manufacturer's recommendation(s). Only first-class work in accordance with the best modern practices will be accepted. Installation shall be construed as being the erection of equipment at its permanent location. This, unless otherwise specified, shall include unpacking, cleaning and lifting into position, grouting, leveling, aligning, coupling of or bolting down to previously installed equipment bases/foundations, performing the alignment check and final adjustment prior to initial operation, testing and commissioning in accordance with the manufacturer's tolerances /instructions and the Specification. All factory assembled rotating machinery shall be checked for alignment and adjustments made as necessary to re-establish the manufacture's limits. Suitable guards shall be provided for the protection of personal on all exposed rotating and / or moving machine parts and shall be designed for easy installation and removal for maintenance purpose. The spare equipment(s) shall be installed at designated locations and tested

for healthiness.

The Contractor shall apply oil and grease of the proper specification to suit the machinery, as is necessary for the installation of the equipment. Lubricants used for installation purposes shall be drained out and the system flushed through where necessary for applying the lubricant required for operation. The Contractor shall apply all operational lubricants to the equipment installed by him.

All oil, grease and other consumables used in the Works/ Equipment shall be purchased in India unless the Contractor has any special requirement for the specific application of a type of oil or grease not available in India. If such is the case, he shall declare in the proposal where such oil or grease is available. He shall help purchaser in establishing equivalent Indian make and Indian Contractor. The same shall be applicable to other consumables too.

1.4.2 Provisions 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 favorable to the growth of fungi and mildew. The indoor equipments located in non-air conditioned areas shall also be of same type.

1.5 COLOUR SCHEME AND CODES FOR PIPE SERVICE

The contractor shall propose a color scheme for those equipment/Items for which the colour scheme has not been specified in the specification for the approval of purchaser. The decision of purchaser 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 electrical equipment in switchyard are painted with shade 631 of IS-5. All The indoor cubicles shall be of same colour scheme and for other miscellaneous items, colour scheme will be approved by the purchaser.

1.6 PAINTING

- a) All sheet steel work shall be phosphated in accordance with the following procedure and in accordance with IS:6005 "Code of practice for Phosphating Iron and Steel".
- b) Oil, grease, dirt and swerve shall be thoroughly removed from emulsion by cleaning.
- c) Rust and scale shall be removed by pickling with dilute acid followed by washing with running water, rinsing with slightly alkaline hot water and drying.
- d) After phosphating, thorough rinsing shall be carried out with clean water followed by final rinsing with dilute bichromate solution and over drying.
- e) The phosphate coating shall be sealed by the application of two coats of ready mixed, stoving type zinc chromate primer. The first coat may be "Flash dried" while the second coat shall be stoved.

- f) After application of the primer, two coats of finishing epoxy paint shall be applied, each coat followed by stoving. The panel shall have colour conforming to shade 631 of IS-5 for outside and inside of the panel with black colour for base frame.
- g) Each coat of primer and finishing paint shall be of a slightly different shade to enable inspection of the painting.
- h) Finished painted appearance of panel shall present an asthetically pleasing appearance free from dents and uneven surface.
- i) A small quantity of finishing paint shall be supplied for minor touching up required at site after the installation of the panels.

1.7 PROTECTION

- a) All coated surfaces shall be protected against abrasion, impact, discoloration and any other damages. All exposed threaded portions shall be suitably protected with either a metallic or a non-metallic protecting device. All ends of all valves, pipings and conduit equipment connections shall be properly sealed with suitable devices to protect them from damage.
- b) All equipment accessories and wiring shall have fungus protection, involving special treatment of insulation and metal against fungus, insects and corrosion.
- c) The parts which are likely to get rusted, due to exposure to weather should also be properly treated and protected in a suitable manner.
- b) Screens of corrosion resistant material shall be furnished on all ventilating louvers to prevent entry of insects.

1.8 FUNGISTATIC VARNISH

Besides the space heaters, special moisture and fungus resistant varnish shall be applied on the 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 of part where the treatment will interface with the operation or performance of the equipment. Such surfaces or parts shall be protected against the application to the varnish.

1.9 SURFACE FINISH

All interiors and exteriors of tanks, control cubicles and other metal parts shall be thoroughly cleaned to remove all rust, scales, corrosion, greases or other adhering foreign matter. All steel surfaces in contact with insulating oil as far as accessible, shall be painted with not less than two coats of heat resistant, oil insoluble, insulating paints.

All metal surfaces exposed to atmosphere shall be given two primer coats of zinc chromate and two coats of epoxy paint with epoxy base thinner. All metal parts not accessible for painting shall be made of corrosion resisting material. All machine finished or bright surfaces shall be coated with a suitable preventive compound and suitably wrapped or other wise protected. All paints shall be carefully selected to withstand tropical heat and extremes of weather within the limit specified. The paint shall not scale off or wrinkle or be removed by abrasion due to normal handling.

1.10 GALVANIZING

All ferrous parts including all sizes of nuts, bolts, Plain and spring washers, support channels, structures, shall be hot dip galvanised conforming to latest version of IS:2629 or any other equivalent authoritative standard.

However, hardware less than M12 size shall be electro-galvanized. Minimum weight of zinc coating shall be 610 gm/sq.mm and minimum thickness of coating shall be 85 microns for all items thicker than 6mm. For items lower than 6 mm thickness, requirement of coating shall be as per relevant ASTM.

1.11 AUXILIARY POWER SUPPLY

- 1.11.1 A.C power supply for auxiliaries will be available at 240 V, 50 C/s 1-phase, 2 wire and 415V, 50 C/s, 3-phase, 4 wire, neutral solidly earthed with variation in frequency of +/-5% and variation in voltage +/-10%
- 1.11.2 D.C. power supply at 220 V, 2-wire ungrounded will be available 187 V to 242 V.

1.12 INSPECTION AND TESTING

All tests and inspection of the equipment specified shall be performed to the extent and in the manner as stipulated in the relevant standards and in this specification. All type tests/routine tests/acceptance tests as specified shall be conducted in the presence of purchaser. Wherever equipment similar to the one being offered has already been type tested within 5 years from the date of opening the bid. Type tests done in an independent government laboratory or in the presence of representative of State Electricity Board or other reputed public undertakings, the type test reports of the same shall be submitted for scrutiny /approval. If these are found suitable and technically acceptable, conducting of type tests shall be waived off. Otherwise the subcontractor will have to carry out the type tests without any extra cost and without any delivery implications.

1.13 PACKAGING

Aluminium Tube shall be partially packed with Hessians cloths. Similar items shall be grouped and tied with steel wires/strip for convenient handling during transits.

Markings

The following details are to be clearly indicated in the material forwarding documents:

- a) Name and address of the consignee.
- b) Purchase order number.
- c) Name of supplier/s.
- d) Description of equipment / material.
- e) Tare weight.
- f) Gross weight.

All the equipments shall be suitably protected, coated, covered or boxed and crated to prevent damage or deterioration during transit, handling and storage at Site till the time of erection. On request of the purchaser, the Contractor shall also submit packing details/associated drawing for any equipment material under his scope of supply, to facilitate the purchaser to repack any equipment/ material at a later date, in case the need arises, while packing all the materials, the limitation from the point of view of availability of Railway wagon sizes in India should be taken account of. The Contractor shall be responsible for any loss or damage during transportation, handling and storage due to improper packing. Any demurrage wagons and other such charges claimed by the transporters, railways etc. shall be to the account of the Contractor. Purchaser takes no responsibility of the availability of the wagons.

1.14 HANDLING, STORING AND INSTALLATION

In accordance with the specific installation instructions as shown on manufacturer's drawings or as directed by the purchaser or his representative, the Contractor shall unload, store, erect, install, wire, test and place into commercial use all the equipment included in the contract. Equipment shall be installed in a neat, workmanlike manner so that it is level, plumb, square and properly aligned and oriented. Commercial use of switchyard equipment means completion of all site tests specified and energisation at rated voltage.

Contractor may engage manufacturer's Engineers to supervise the unloading, transportation to site, storing, testing and commissioning of the various equipment being procured by them separately. Contractor shall unload, transport, store, erect, test and commission the equipment as per instructions of the manufacturer's supervisory Engineer(s) and shall extend full cooperation to them.

In case of any doubt/misunderstanding as to the correct interpretation of manufacturer's drawings or instructions, necessary clarifications shall be obtained from the purchaser.

Contractor shall be held responsible for any damage to the equipment consequent to not following manufacturer's drawings/instructions correctly.

Where assemblies are supplied in more than one section, contractor shall make all necessary mechanical and electrical connections between sections including the connection between buses. Contractor shall also do necessary adjustments/alignments necessary for proper operation of circuit breakers, isolators and their operating mechanisms. All components shall be protected against damage during unloading, transportation, storage, installation, testing and commissioning. Any equipment damaged due to negligence or carelessness or otherwise shall be replaced by the contractor at his own expenses.

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

The Contractor shall be fully responsible, for the equipment/material until the same is handed over to the purchaser in an operating condition after commissioning. Contractor shall be responsible for the maintenance to the equipment/material while in storage as well as after erection until taken over by Purchaser, as well as protection of the same against theft, element of such nature, corrosion, damages etc.

The Contractor shall be responsible for making suitable indoor storage facilities, to store all equipment which require indoor storage.

The words erection and installation used in the specification are synonymous. Exposed live parts shall be placed high enough above ground to meet the requirements of electrical and other statutory safety codes.

The minimum phase to earth, phase to phase and section clearance along-with other technical parameters for the various switchyard voltage levels to be maintained shall be strictly as per the approved drawings.

The design and workmanship shall be in accordance with the best engineering practices to ensure satisfactory performance throughout the service life. If at any stage during the execution of the Contract, it is observed that the erected equipment(s) do not meet the above minimum clearances, the Contractor shall immediately proceed to correct the discrepancy at his risks and costs.

1.15 TOOLS AND TACKLES

The Contractor shall supply with the equipment one complete set of all special tools and tackles for the erection, assembly, dis-assembly and maintenance of the equipment. However, these tools and tackles shall be separately, packed and brought on to Site.

1.16 EQUIPMENT BASES

A cast iron or welded steel base-plate shall be provided for all rotating equipment, which is to be installed on a concrete base unless otherwise agreed to by the Purchaser. Each base-plate shall support the unit and its drive assembly, shall be of a neat design with pads for anchoring the units shall have a raised lip all around, and shall have threaded drain connections.

1.17 QUALITY

BHEL quality plan to be followed subject to TBEM / customer's approval.

1.18 DOCUMENTATION

1.18.1 Drawings

All drawings shall be prepared in AutoCad and ultimate documentation would include drawings/documents on CDs. All dimensions and data shall be in SI metric units.

All items of the equipment should be clearly identified by proper part nos. in the contract drawings. Such parts, which are to be dispatched to site from works in dispatchable units and are reassembled at site, should be marked by proper identification marks at works and indicated in the drawings and quantified. The shipping list should be sent along with the general arrangement drawings for engineer's approval. All the items of the shipping list should be identified in the drawing.

The drawing submitted by the supplier shall be reviewed by the purchaser as far as practicable within two weeks of receipt of drawings and shall be modified by the sub-contractor if any modifications and/or corrections are required by the purchaser. The sub-contractor shall incorporate such modifications and / or corrections and submit the final drawings for approval. Any delay arising out of failure of the subcontractor to rectify the drawings shall not alter the contract completion date.

Further work by the subcontractor shall be in strict accordance with these drawings and no deviation shall be allowed without the written approval of the purchaser.

All manufacturing and fabrication work in connection with the equipment prior to the approval of the drawings shall be at supplier's risk.

Approval of drawing or work by the purchaser/consultant shall not relieve the subcontractor of any of his responsibilities and liabilities under the contract.

In case of any modifications that may be necessary during erection or commissioning of the equipment, the subcontractor shall carry out modifications in the original drawing & submit 'As Built drawings' and required no. of prints thereof.

1.18.2 Instruction manuals

The supplier shall submit to the purchaser, draft instruction manuals for approval within 30 days of placement of order. The final instruction manuals complete in all respects shall be submitted 60 days before the first shipment of the equipment. The instruction manuals shall contain full details and drawings of all the equipment furnished, the erection procedures, testing, operation & maintenance procedures of the equipment.

If after the commissioning and initial operation of the plant, the instruction manuals require any modification/ addition / changes, the same shall be incorporated and the up- dated final instruction manuals shall be submitted as required.

1.18.3 Title Block & Drawing/ Document numbering scheme

Title block for drawing / document should be followed as per ANNEXURE-1

1.18.4 DOCUMENTATION SCHEDULE AT CONTRACT STAGE

A.	<u>For approval</u>	<u>No of Copies</u>
	Copies of all drawings with project details, dimension, shipping weights, No. of cases & dimensions, fixing details, tolerance etc.	3
	Copies of type test reports.	3
	Copies of works quality plan & field quality plan.	5
	Copies of installation operation & maintenance manual.	5
	Copies of drawings on floppies/CDs	1 set
B.	<u>After approval and for information / distribution</u>	
	Copies of all drawings	12
	Copies of installation, operation & maintenance manual including Routine test reports	12
	Sets of RTF of drawings	2
	CDs of Drgs.	4
C.	<u>As Built Drawings</u>	
	Hard copies of Drawings	12
	CDs	4



1.0 EARTHING SYSTEM

Earthing system shall consist of earth grids and electrodes buried in soil in the plant area, embedded in concrete inside the buildings to which all the electrical equipment, metallic structures are connected to have earth continuity for safety reasons.

2.0 DESIGN CRITERIA

2.1 Fault Current & Duration

For earth mat design, the size of earthing conductor shall be calculated considering maximum fault current of 50 kA for duration of 1 second.

2.2 Conductor Material

The earthing system conductors and accessories as proposed are to be as follows:

- (a) Conductors above ground level and in trenches : Galvanised steel
- (b) Conductors buried in ground or embedded in concrete : Mild Steel
- (c) Electrodes : GS Pipe / Rod
- (d) Lightning protection air termination and down conductors for buildings : GS Flat
- (e) Exposed lightning protection air termination : Lead coated copper chimney top

The CONTRACTOR shall undertake the soil resistivity measurements at site and select suitable type of conductors.


2.3 Size of Conductors


(i) Main Earthing Conductors


The earthing conductor sizes shall be calculated as per IS- 3043 and shall comply with IE rules and IEEE-80.


The calculated size shall be suitably (depending on the resistivity of soil) increased as per table below to account for the loss of material (steel) due to corrosion in soil.

Resistivity of soil Ohm– Metric	Reduction in thickness/diameter, mm
<10	8.0
>10 <25	7.0
>25 <50	5.5
>50 <75	4.5
>75 <100	3.0
>100	1.5

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	<p>(ii) Rod Electrodes</p> <p>Galvanised steel rod electrodes of suitable diameter and length shall be used as per the recommendation of IS-3043. For test pits electrodes shall be heavy duty type (Class – C) GI pipe of suitable diameter with perforations. Electrodes installed in the test pits will have disconnecting facilities.</p> <p>(iii) Equipment Earthing Leads</p> <p>The size of the earthing leads shall be decided based on the type of equipment and structure to be earthed and shall be provided generally as per IS-3043 and also with a view to minimise the number of sizes.</p> <p>(iv) Conductors for lightning protection system</p> <p>The size of conductors for lightning protection system shall be decided based on mechanical strength.</p> <p>3.0 EARTHING SYSTEM LAYOUT</p> <p>3.1 The earthing system design and installation shall generally comply with the following standards.</p> <p>(a) IS-3043 : Code of practice for Safety Earthing</p> <p>(b) IEEE-80 : Guide for safety in Alternating current sub-station grounding</p> <p>(c) Indian Electricity Rules</p> <p>3.2 General</p> <p>3.2.1 Metallic frames of all current carrying equipment, supporting structures adjacent to current carrying conductors, lightning protection system conductors and neutral points of various systems shall be connected to a single earthing system. Two earthing leads shall be used if rated voltage of equipment is above 250V. If the rated voltage is 250V or below, one earth lead shall be provided. Metallic structures adjacent to electrical equipment shall be earthed by one earthing lead. Main earthing in switchyard, Transformer yard, TG and boiler area, switchgear rooms, buildings shall be in form of grids.</p> <p>3.2.2 Earthing conductors in outdoor areas shall be installed at a minimum depth of 600 mm.</p> <p>3.2.3 All cable trays in the plant buildings as well as inside the trenches shall be connected to earth grid at an interval of about 10 m.</p> <p>3.3 Earthing Conductor Layout in Switchyard</p> <p>3.3.1 Main earthing conductors shall be laid in the form of a grid. Spacing between conductors, number of parallel conductors, etc., shall be decided such that step and touch potential are within safe limits.</p>	

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	<p>3.3.2 The maximum permissible step and touch potentials shall be calculated in accordance with the formula, given in IEEE-80. The detailed design / engineering calculations be furnished.</p> <p>3.3.3 Earthing conductors shall be provided around the outside edge of fence at a distance of approximately 6000 mm. This shall be connected to the switchyard earthing grid.</p> <p>3.3.4 An earthing mat comprising closely spaced (about 150 mm) conductors shall be provided below the operating handles of disconnecting switches and breaker operating kiosk for the additional safety of the operating personnel.</p> <p>3.3.5 Each earth leads of transformer neutral, lightning arrester earth leads, CVT's earth leads shall be directly connected to two separate treated earth pits. Lightning protection down conductor shall be directly connected to a separate earth electrode and inturn connected to earth grid.</p> <p>3.3.6 The earthing conductors of switchyard equipments shall be directly connected to earth grid. Equipment supports (structures/Pipe supports) will not be used as earth continuity conductors. All earth electrodes in turn shall be connected to station earthing system. The earth grids of different areas of the plant shall be interconnected through, test pits to enable measurement of earth resistance for each area separately.</p> <p>3.3.7 Earthing grid design shall be done in such a manner that the grid resistance is less than 0.5(zero point five) ohm.</p> <p>3.4 Earthing Conductors Inside Building</p> <p>3.4.1 Main earthing conductors shall be buried in earth around the building. Minimum two taps-off from this earthing loop shall be taken inside the building and connected to the earthing grid embedded in the floor slab with approximately 50 mm concrete cover. The earthing within the building shall be in form of grids.</p> <p>3.4.2 In case, the building has more than one floor, each floor shall be provided with earth grid as discussed earlier. Floor earthing grids shall be interconnected.</p> <p>3.4.3 Each RCC / Steel column of the building shall be interconnected to the floor earthing grid in the ground floor.</p> <p>3.4.4 Cable trays, steel pipes / conduits, steel columns, etc., shall not be used as earth continuity conductors.</p> <p>3.4.5 Instrumentation system and computer system shall be provided with a dedicated earthing system suitable for the equipment.</p> <p>3.4.6 Earthing grids of all the buildings, outdoor yards shall be interconnected to form a single grid for the plant.</p>	

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	<p>3.4.7 Earthing grid design shall be done in such a manner that the grid resistance is less than one ohm.</p> <p>4.0 EARTHING SYSTEM INSTALLATION</p> <p>4.1 The spacing between two electrodes shall be atleast equivalent to twice the length of the electrode.</p> <p>4.2 Earthing conductor running exposed on column, walls, etc., shall be supported by suitable cleating, at intervals of 750 mm.</p> <p>4.3 The earthing conductor crossing the road / track shall be laid in hume pipe or laid at a greater depth to avoid damage.</p> <p>4.4 When earth conductor passes through floors, walls, etc., suitable pipe sleeves shall be provided and the same shall sealed after installation.</p> <p>4.5 The connection between earthing pads / terminal to the earth grid shall be made short and direct and shall be free from kinks & splices.</p> <p>4.6 Metallic conduits and pipes shall not be used as earth continuity conductor.</p> <p>4.7 Street lightning poles, flood light poles & towers, their junction boxes shall be connected to the earthing conductor to be run along with supply cable. This earth conductor shall be in turn connected to earth grid at two extreme points.</p> <p>4.8 Flexible earth conductors shall be provided at expansion joints for earthing the gates, operating handles, etc..</p> <p>4.9 Equipment bolted connection after being checked and tested shall be painted with anti-corrosive paint / compound.</p> <p>4.10 Connection between the equipment earth lead and the grid conductor shall be welded. For rust protection, the welds shall be treated with zinc chromate primer and coated with zinc rich paint.</p> <p>4.11 The cable sheaths, screens armour shall be earthed at both ends for multi-core cables. For single core cables the same shall be done at one end (switchgear end) only.</p> <p>4.12 All bimetallic connections shall be treated with suitable compound to prevent moisture ingress.</p> <p>4.13 The contractor shall demonstrate the effectiveness of earthing system by measurement of earth resistance, step & touch potentials at different locations.</p> <p>5.0 LIGHTNING PROTECTION SYSTEM</p> <p>Lightning protection system shall consist of vertical air termination rods, horizontal roof conductors, downcomers, and pipe electrodes.</p>	

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5.1 Need for Protection

The need for providing the lightning protection system shall be established by calculating risk index value for each building structure, etc., as per procedure given in IS-2309 and any building whose risk index is more than 40 shall be provided with lightning protection.

5.2 Lightning Protection System Layout

5.2.1 The lightning systems design and installation shall generally comply with IS:2309/IEC-62305/NFPA-780 code of practice for the protection of building and allied structure against lightning.

5.2.2 For chimney air termination, rods interconnected by circumferential conductors will be provided at the apex of flue and also upon outer shell of the chimney. The air termination system will be formed by lead coated copper conductors to prevent corrosion of conductors due to flue gas.

5.2.3 For cooling towers, air termination system will comprise of horizontal circumferential conductors at the top.

5.2.4 For switchyard, lightning protection masts shall be provided and the down comers from the masts shall be run along the tower connected to rod / electrode. Calculations for sizing and determining topography and number of lightning masts shall be furnished for approval by OWNER.

5.2.5 Each down conductor shall be connected to a rod electrode, which in turn shall be connected to the station earthing system through test links.

5.2.6 Lightning protection shall also be provided for Boiler and station building as well as other buildings as required by the relevant codes and subject to OWNER's approval.

5.3 Lightning Protection System Installation

5.3.1 Conductors of lightning protection system shall not be connected with conductors of safety earthing system above ground level.

5.3.2 The down conductors shall be welded to steel structures at 1000 mm interval or cleated to wall at 750 mm interval. Wherever welded, the weld locations shall be treated to provide rust protection.

5.3.3 Each down conductor shall be provided with a test link at a height of about 1000 mm above ground level.

5.3.3 All the metallic structures within a vicinity of 2000 mm shall be connected to the lightning protection conductors.



5.4

MINIMUM SIZE AND MATERIAL OF MAIN EARTHING CONDUCTORS

SL NO / SYSTEMS	SIZE IN Sq.mm	RECOMMENDED SIZE	
		Buried in earth	Above ground or embedded in concrete
1	MAIN EARTHING CONDUCTOR		
a. 400KV system	500	32mm dia	50x10 mm GS flat
b. MV system	500	-Do-	-Do-
c. LV system	500	-Do-	-Do-
2.	EARTH ELECTRODES		
a. Rod Electrodes	32 mm dia, 3000mm long		
b. Pipe Electrodes	40 mm dia, 3000mm long galvanised steel, class 'C' pipe		
3.	MATERIAL		
a. Above ground	Galvanised steel-Galvanizing as per IS 2629-1985		
b. Below ground & Embedded in concrete	Mild steel		


2.0 MINIMUM SIZES OF EQUIPMENT EARTHING LEADS:-

SL.No	Equipment/Structure	Earth Lead Size
1	Equipment of HV/MV/LV system	50 x 10 mm flat
2	LT switch gears and Motor Control Centres	50 x 10 mm flat
3	LT Motors	
	a. Fractional HP	8 SWG GI wire
	b. Up to 40 KW	25 x 3 mm flat
	c. 41 to 70 KW	25 x 6 mm flat
	d. 71 KW and above	50 x 10 mm flat
4.	Isolated phase bus duct and accessories	50 x 10 mm flat
5.	Generator and accessories	50 x 10 mm flat
6.	Transformer and accessories	50 x 10 mm flat
7.	Control Desks, Control/relay panels, LDBs, PDBs, Lighting Panels, Power receptacles, Lighting Masts, Lighting Poles	25 x 6 mm flat
8	LPB stations, Limit/Pressure switches, Starters, CT/PT terminal Boxes	08 SWG GI wires
9	Columns, Fence, Gates, Cable trays etc	25 x 6mm flat
10	LT bus ducts	50 x 10 flat
11	Switchyard structure	50 x 10mm flat
12.	MATERIALS	
	a. Above Ground	Galvanized steel-Galvanizing as per IS 2629-1985
	b. Below ground & Embedded in concrete	Mild Steel



3.0 MINIMUM SIZES AND MATERIALS OF LIGHTNING SYSTEM CONDUCTORS:

Sr.No	Description	Sizes
1	Roof Conductors and down conductors building and boiler areas	25 x 6 mm GI flat
2	Horizontal Air termination for Chimney	70 mm ² tinned copper conductor coated with Lead
3	Vertical air termination for chimney	20mm dia copper rod coated with lead, approx. 2000mm long
4	Down Conductor for Chimney/Cooling Towers	25 x 6 mm galvanised steel conductor OR mild steel embedded in concrete
5	Pipe Electrodes	40mm dia 3000 mm long Galvanised steel
6	Rod electrodes	20-mm dia 3000mm long galvanised steel
Galvanizing as per IS 2629-1985		
NOTE:	(*) indicated above shall be filled by CONTRACTOR	
	(***) CONTRACTOR shall furnish the data after placement of order	

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	TITLE CABLING SYSTEM	

1.0 **CABLES**

1.1 **H T Cables**

MV system (11kV & 3.3kV system) cables shall be unearthed grade suitable for use in medium resistance earthed system, with stranded & compacted aluminium conductors, extruded semi-conducting compound screen, extruded XLPE insulated, Dry cured extruded semi-conducting compound with a layer of non-magnetic metallic tape for insulation screen, extruded PVC (Type ST – 2) FRLS inner sheath, Aluminium / galvanised steel round wire armoured, extruded PVC (Type ST – 2) FRLS outer sheathed, single / multicored conforming to IS 7098 (Part II) for constructional details and tests.

1.2 **L T Power Cables**

LV Power Cable shall be 1100 V grade, single / multicore, stranded aluminium conductor, XLPE insulated, Dry cured, with PVC inner sheath, Type ST – 2 and outer sheath made of FRLS PVC, Type ST-2 compound. The armouring shall be of Aluminium / galvanised steel round wire. The cable used for DC system shall be of single core type. All other details shall be as applicable. Minimum conductor cross section of power cables shall be 4 sq.mm.

1.3 **Control Cables**

Control cables shall be 1100V grade, multicore, minimum 2.5 sq.mm cross section, stranded copper conductor having 7 strands, PVC insulated, inner PVC sheathed, galvanised steel wire armoured and outer sheath made of FRLS PVC compound. In situations where accuracy of measurement or voltage drop in control circuit, warrant, higher cross sections as required shall be used. 4 sq.mm copper conductor cables shall be used for CT circuits all other specifications remaining same.


1.4 **Instrumentation Cables**


Instrumentation cables shall be with stranded high conductivity annealed, tinned copper, twisted pair (with min. 20 twists for meter) extruded PVC insulated with overall and / or individual screening, extruded PVC inner sheathed, extruded outer sheathed with FRLS PVC compound and aluminium/galvanised steel wire armoured complying to IEC60189 – Part I & II

The conductor size shall be minimum 0.5 sq.mm. Triplex cables similar to instrumentation cables can be used for RTDs.

1.5 **Lighting Wires**

1100V grade, single core, stranded, copper conductor, PVC insulated wires conforming to IS-694-1990 / IEC-60227 Part 1 to 5 (1979) / IEEE-719 (1981). Minimum cross section of copper wires shall be 2.5 sq. mm for lighting circuits and 4 sq. mm for receptacle circuits.

KPCL/BTPS/03/EPC 	<table border="1"> <tr> <td colspan="2" data-bbox="426 154 1225 221"> KARNATAKA POWER CORPORATION LIMITED BELLARY TPS, UNIT-3 OF 700 MW </td></tr> <tr> <td data-bbox="426 221 1225 315"> TITLE CABLING SYSTEM </td><td data-bbox="1225 154 1439 315"> SECTION: D2.14 VOLUME-IV SHEET 2 OF 6 </td></tr> </table>	KARNATAKA POWER CORPORATION LIMITED BELLARY TPS, UNIT-3 OF 700 MW		TITLE CABLING SYSTEM	SECTION: D2.14 VOLUME-IV SHEET 2 OF 6
KARNATAKA POWER CORPORATION LIMITED BELLARY TPS, UNIT-3 OF 700 MW					
TITLE CABLING SYSTEM	SECTION: D2.14 VOLUME-IV SHEET 2 OF 6				
<div>1.6</div> <div>2.0</div> <div>2.1</div> <div>2.2</div> <div>2.3</div> <div>2.4</div> <div>3.0</div> <div>3.1</div> <div>3.1.1</div>	<p>Trailing Power and Control cables for Mobile Equipment.</p> <p>11kV / 3.3 kV (UE) and 1100V (E) grade power & control flexible trailing, annealed tinned copper conductor, EPR insulated, EPR inner sheathed, CSP outer sheathed and shall have conductor screen of rubber. Cables shall conform to IS requirements and any other applicable standards.</p> <p>CABLE PROPERTIES</p> <p>All power, control and Instrumentation cable will be with armour. MV cables will be with FRLS PVC inner and outer sheath and other type of cables are with FRLS PVC, Outer sheath.</p> <p>All single core power cables will have wire armouring of aluminium, whereas multicore cables will have galvanised steel wire armouring.</p> <p>The outer sheath of all cables shall be of extruded layer of suitable synthetic material compatible with specified ambient and operating temperature of the cables. The sheath shall be resistant to water, UV radiation, fungus, termite and rodent attack.</p> <p>The inner and outer sheath of FRLS PVC compound shall meet the following performance requirements :</p> <ul style="list-style-type: none"> (a) The critical oxygen index value shall be minimum 29 when tested at 27± 2°C as per ASTM-D-2863-77 and the temperature index will be minimum 250°C at oxygen index value of 21 when tested as per NES-715. (b) The maximum acid gas generation as determined by titration shall be less than 20% by weight when tested as per IEC-60754-1 (1994). (c) The smoke generation under fire shall have maximum smoke density rating of 60% when tested as per ASTM-D-2843-7 (1988). (d) The cables will pass the hydraulic stability and ultraviolet tests as per DIN 53387. <p>The finished cable shall pass the flammability test as per IEC-60322-1 (1993) and IEEE-60383. In addition, it shall also pass flammability test as per Class F3 of Swedish Standard SS-424-1475 (1978).</p> <p>DESIGN CRITERIA FOR CABLE SIZING</p> <p>Power cables</p> <p>Power cable sizes shall be selected on the basis of current carrying capacity, short circuit rating, permissible voltage drop and standardization of cable sizes.</p> <p>Power cables shall carry the full load current of the circuit continuously under site conditions considering the various derating factors like Thermal resistivity of soil, ambient air/ground temperature, grouping, method of laying, etc. The</p>				

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	<p>design ambient air and ground temperatures shall be considered at 50° C & 30° C respectively.</p> <p>3.1.2 Power cables shall withstand the fault current of the circuit for the duration not less than the maximum time taken by the primary protective system to isolate the fault. Fault clearing times for 11000V / 3300V motor feeders and transformer feeders having high-set instantaneous protection shall be 0.16 secs., whereas tie between two 415V switchgear and any two 11000V / 3300V switchgear shall be 0.5 secs., and for incomers and tie feeders 1.0 sec.</p> <p>The short circuit withstand capacity of screen in case of HT cables shall be 300 amps for 2(two) seconds per core.</p> <p>3.1.3 For 11000V / 3300V motors controlled by vacuum contactors with back-up HRC fuses, the minimum cross-section of cables shall be based on the cut-off current of the fuses and their fusing time.</p> <p>3.1.4 For the cables to 415V motors and feeders protected by fuses, the cross section shall be chosen according to the cut-off current of the fuse and its fusing time.</p> <p>3.1.5 Voltage dip at motor terminals during starting of motors will be limited to the following values :</p> <ul style="list-style-type: none"> (i) For coal mill motors – 10% of the rated voltage. (ii) For all motors except BFP – 15% of the rated voltage. (iii) For BFP motors – 20% of the rated voltage. (iv) For LV motors – 15% of the rated voltage. <p>3.1.6 Voltage drop in feeder cables between the transformer & PCC and between PCC & MCC, for full load current, shall be limited to 2 %. Further, the Voltage drop in feeder cables between PCC/MCC to Motor terminals shall be limited to 3% during full load running condition.</p> <p>3.1.7 For power supply to valve actuator motors, actuators of various isolating and regulating dampers and exhaust fans, 3 core 2.5 sq. mm stranded copper conductor cable may be used in view of ease of termination. These cables shall be in other respects similar to cables described in Clause 1.2 above.</p> <p>3.2 Control Cables</p> <p>3.2.1 Current transformers leads shall be checked for the lead burden vis-a-vis the current transformer VA capacity and 4 sq.mm cables shall be used for connection of CT to loads. In case 4 sq.mm conductor impose unacceptable high burden on CTs, higher cross section of conductor shall be used.</p> <p>3.2.2 Voltage transformer leads shall be checked for voltage drop, which shall be limited to within 1% for all cases other than tariff metering. For tariff metering the voltage drop shall be limited to 0.2%. In case the voltage drop with 4 sq. mm Cu conductors exceed this value, higher conductor sizes shall be used.</p>	

Instrumentation cables shall comply with the Electrical Properties suitable for the Digital and Analogue signals.

All 11000V / 3300V termination kits shall be of heat shrinkable type and suitable for XLPE insulation and the same shall have been tested for a short circuit current as per relevant Standards


4.2 All 1100V termination for XLPE/PVC power cables and control cables shall be by crimping type tinned copper / aluminum lugs.


Cable joints shall be avoided to the extent possible. If joints are unavoidable due to circuit length, in excess of permissible maximum drum length, they shall be heat shrinkable type having a short circuit with stand capacity of 40kA for 0.5 sec. for 11kV / 3.3kV cables and 50kA for 0.5 sec. for 1100V grade cables.

3 phase, 4 pin, 63A power receptacles with switch shall be provided two in each floor of TG building, boiler platforms and one in each pump house. The receptacle shall be industrial heavy duty type and shall have suitable interlock facility for safety. The receptacle shall conform to IS 1293 and the switch to IS 4064.

The cable carrier system shall be designed considering the following :

- (a) Facility for easy laying of cables.
 - (b) Access to maintenance.
 - (c) Neat and aesthetic appearance.
 - (d) Safety of equipment & personnel.
 - (e) Ground water seepage.
- 7.2 Cables shall be laid in prefabricated ladder/ Perforated type trays and in conduits. Direct burial of cable shall be avoided as far as possible. In case cables are buried, length of burial shall be limited to about 10 M and depth of burial shall be about 750 mm. Cable route markers shall be provided at every 15 m intervals and at bends. Also joint markers shall be provided at each joint.
- 7.3 Cable tunnels are not acceptable. Cables shall necessarily be run in overhead racks.

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	<p>8.0 CABLE INSTALLATION AND ACCESSORIES</p> <p>8.1 All material and accessories required for cable installation like cable trays, tray covers, support steel, etc., shall be hot dip galvanised and conduits/pipes shall also be hot dip galvanised.</p> <p>The racks/trays, conduits/pipes, trenches required to route the cables to individual equipments shall be supplied and installed by the CONTRACTOR.</p> <p>8.2 Separate trays shall be provided for HV Power/LV Power (AC&DC)/Control & Instrumentation cables.</p> <p>9.0 CABLE TRAYS AND COVERS</p> <p>9.1 Cable trays shall be of ladder / perforated type complete with all necessary coupler plates, elbows, tees, bends, reducers, stiffeners and other accessories. Cable trays of ladder and perforated types and the associated accessories such as coupler plates, tees, elbows, etc., shall be fabricated from 12 gauge (2.5 mm thick) mild steel sheets, cable tray covers shall be fabricated from 16 gauge (1.7 mm thick) MS sheets. All the sheet steel shall be hot dip galvanised as per relevant standards.</p> <p>Cable trays shall be ladder type for power & control cables and perforated type for Instrumentation cables.</p> <p>9.2 Cables of sizes 120 sq.mm and above shall be laid in single layer. Single core cables used for 3 phase AC power circuits shall be laid in Trefoil form.</p> <p>10.0 FIRE-PROOF SEALING OF CABLE PENETRATION</p> <p>Cables / cable tray openings in walls and floors or through pipe sleeves from one area to another or one elevation to another, between the units and within the same unit, shall be sealed by a fire-proof sealing system. The fireproof sealing system (FPSS) shall effectively prevent the spread of fire from the flaming to the non-flaming side, in the event of a fire. The FPSS shall conform to relevant standard in addition to the following requirements :</p> <ul style="list-style-type: none"> (a) FPSS shall have a fire rating of two hours. (b) The FPSS shall be subjected to fire endurance test, hose stream test, temperature measurement of non-flaming side as per ASTM-E119. 'Standard method of fire tests of building construction and materials'. (c) The FPSS will also conform to the incombustibility test carried out in accordance with IS:3144-1992. (d) Under fire condition, the FPSS material shall not emit excessive smoke or any corrosive or toxic fumes. 	

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11.0 11.1 11.2 12.0	<div> FIRE BREAK Firebreak shall be provided by applying a suitable fire-resistant coating on cables for the required length to meet the fire rating of thirty minutes. Firebreak shall be provided at an interval of 15 metres in the straight portion of each of the cable tray above ground, at intervals of 30 metres in cable trenches and at 5M for all vertical trays. All cable inter section and tee offs shall be provided with firebreaks. TESTS All tests shall be carried out as per relevant standards and approved GTP/QAP. </div>	