

		VDE 0472, SEN 4241475, ANSI MC 96.1, IS-8784, IS-10810 (latest editions) and their amendments read along with this specification.
3.	Continuous operation suitability	At 70 deg. C for all types of cables
4.	Progressive automatic on-line sequential marking of length in meters	To be provided at every one meter on outer sheath.
5.	Marking to read 'FRLS	To be provided at every 5 meters on outer sheath
6.	Allowable Tolerance on overall diameter	+/- 2 mm (maximum) over the declared value in data sheet
7.	Variation in diameter	Not more than 1.0 mm throughout the length of cable.
8.	Ovality at any cross-section	Not more than 1.0 mm
10.	Color	The outer sheath shall be of blue Blue

3.2 Specific Requirement

S No.	Property	Requirement
	Type of Cable	F and G Type cables
A. Conductors		
1.	Cross section area	0.5 sq. mm
2.	Conductormaterial	HighconductivityAnnealed bare copper
3.	Colour code	As per VDE-815
4.	Conductor Grade	Electrolytic
5.	No & dia of strands	7x0.3 mm (nom)
6.	No. of Pairs	4,8,12,16,24,48
7.	Max. conductor resistance per Km (in ohm) at 20 deg. C	73.4 (loop)
8.	ReferenceStandard	VDE 0815
B. Insulation		
1.	Material	Extruded PVC type YI 3
2.	Thickness in mm (Min/Nom/Max)	0.25/0.3/0.35
3.	Volume Resistivity (Min) in ohm-cm	1 x 10 ¹⁴ at 20 deg. C & 1x10 ¹¹ at 70 deg. C.
4.	Reference	VDE 0207 Part 4
5.	Core diameter above insulation	Suitable for cage clamp connector
C. Pairing & Twisting		
1.	Single layer of binder tape on each pair provided	Yes
2.	Bunch(Unit formation) for more than 4P	To be provided
3.	Conductor identification as per VDE081	To be provided

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D. Shielding			
1.		Type of shielding	Al-Mylar tape
2.		Individual pair shielding	To be provided for F-type cabl
3.		Minimum thickness of Individual pair shielding	28 micron
4.		Overall cable assembly shielding	To be provided
5.		Minimum thickness of Overall cable assembly shielding	55 micron
6.		Coverage Overlapping	100% coverage with 20% overlapping
7.		Drain wire provided for individual shield	Yes (for F-type) Size=0.5 mm ² , No. of strands=7, Dia of strands =0.3 mm, Annealed Tin coated copper
8.		Drain wire provided for overall shield	Yes. Size=0.5 mm ² , No. of strands=7, Dia of strands=0.3mm Annealed Tin coated copper
E. FILLERS			
1.		Non-hygroscopic, flame retardant	To be provided
F. Outer Sheath			
1.		Material	Extruded PVC compound YM1 with FRLS properties
2.		Minimum Thickness at any point	1.8 mm
3.		Nominal Thick-ness at any point	>1.8 mm
4.		Resistant to water, fungus, termite & rodent attack	Required
5.		Minimum Oxygen index as per ASTMD-2863	29%
6.		Minimum Temperature index as per ASTMD-2863	250 deg.C
7.		Maximum acid gas generation by weight as per IEC-60754-1	20%
8.		Maximum Smoke Density Rating as per ASTMD-2843	Maximum 60% To be provided (defined as the average area under the curve when the results of smoke density test plotted on a curve indicating light absorption vs. time as per ASTMD-2843)
9.		Reference standard	VDE207 Part 5, VDE-0816
G. Electrical Parameters			
1.		Mutual Capacitance Between Conductors At 0.8 Khz (Max.)	120 nF/km for F type

			100 nF/km for G-type
2.		Insulation Resistance(Min.)	100 M Ohm/Km
3.		Cross Talk Figure (Min.) At 0.8 Khz	60 dB
4.		Characteristic Impedance (Max) At 1 Khz	320 OHM FOR F-TYPE 340 OHM FOR G-TYPE
5.		Attenuation Figure At 1 Khz (Max)	1.2 db/km
H. Complete Cable			
1.		Complete Cable assembly	Shall pass Swedish Chimney test as per SEN-SS 4241475 class F3.
2.		Flammability	Shall pass flammability as per IEEE-383 read in conjunction to this specification
I. Tests			
1.		Routine & Acceptance tests	Refer Type Test requirement of Specification for C & I System
2.		Type tests	
J Cable Drum			
1.		Type	Wooden drum (wooden drum to be constructed from seasoned wood free from defects with wood preservative applied to the entire drum) or steel drum.
2.		Outermost layer covered with waterproof paper	Yes
3.		Painting	Entire surface to be painted
4.		Length	1000 m + 5% for up to & including 12 pairs 500 m + 5% for above 12 pairs

B-6 EARTHING AND LIGHTNING SYSTEM

1.0 GENERAL REQUIREMENTS

This specification is intended to outline the requirement of earthing (grounding) and lightning for BESS, Solar array (DC) side and AC Power block side of Solar PV Project. It is not the intent of the specification to specify all details of design and construction since the bidder has full responsibility for engineering and implementation of earthing system meeting the intent of the specification and functional requirement. Any additional equipment, material, services which are not specifically mentioned herein but are required for successful installation, testing and commissioning of earthing system for safe and satisfactory operation of the plant shall be included under scope of the bidder.

Electrical Resistivity Test (ERT) of the soil is included in the scope of bidder.

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2.0 EARTHING DESIGN REQUIREMENT

The object of protective earthing system is to provide as nearly as possible a surface under and around a station which shall be at a uniform potential and as nearly zero or absolute earth potential as possible. The purpose of this is to ensure that, in general, all parts of apparatus other than live parts, shall be at earth potential, as well as to ensure that operators and attendants shall be at earth potential at all times. Also by providing such an earth surface of uniform potential under and surrounding the station, there can exist no difference of potential in a short distance big enough to shock or injure an attendant when short-circuits or other abnormal occurrences take place.

Care must be taken for equipment with functional earthing that its service is not disrupted due to undesired disturbances in protective earthing system.

3.0 CODES AND STANDARD

The equipment/product furnished for earthing system shall meet the requirements of all the applicable relevant National/International codes and standards or their latest amendment Codes and Standards. Product certification has to be CE/UL/BIS/TUV or equivalent. The relevant codes and standard for earthing system are tabulated below.

IS: 3043	Code of practice for Earthing.
IEEE: 80	IEEE guide for safety in AC substation grounding
IEEE: 837	Standard for qualifying permanent connections used in substation grounding
IS: 2309	Code of Practice for the protection of building and allied structures against lightning.
IS: 802	Code of practice for the use of Structural Steel in Overhead Transmission Line Towers.
IS: 2629	Recommended practice for hot dip galvanizing of iron & steel
IS: 2633	Method for testing uniformity of coating on zinc coated articles
IS: 513	Cold rolled low carbon steel sheets and strips
IS: 6745	Methods for determination of mass of zinc coating on zinc coated iron & steel articles.
IS 2062	HOT ROLLED MEDIUM AND HIGH TENSILE STRUCTURAL STEEL — SPECIFICATION
IS: 4736	Hot-dip Zinc coating for MS Tubes.
IS: 458	Precast Concrete Pipes (With and Without Reinforcement)
UL-467	Grounding and Bonding Equipment
IEC 62561-7	Requirements for earthing enhancing compounds
	CEA regulations for electrical safety-2010
	Indian Electricity Rules/ Indian Electricity Act.

All standards, specifications and codes of practice referred to herein shall be the latest editions including all applicable official amendments and revisions as on date of opening of bid. In case of

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conflict between this specification and those (codes and standards, etc.) referred to herein, the former shall prevail. All work shall be carried out as per the above standards/ codes as applicable.

4.0 TECHNICAL DETAILS FOR AC EARTHING SYSTEM

This section outlines the requirements of protective and functional earthing system to discharge AC fault current to earth and provide equipotential bonding for Transformer, HT and LT Switchgear Panel and other similar electrical equipment, Transformer neutral and shield.

The Contractor shall furnish the detailed design and calculations as per IEEE 80/IS 3043 for Employer's approval for equipment earthing.

1. Conductors above ground level and in built up trenches - Galvanized steel
 2. Conductors buried in earth - Mild steel rod of 40 mm dia
 3. Earth electrodes - Mild steel rod of diameter 40mm or Copper bonded steel rod of dia not less than 17 mm
 4. Life Expectancy - 25 years
 5. Fault Level - Mentioned Elsewhere
 6. Min. Steel corrosion - As per IS 3043
 7. Soil Resistivity - Actual as per site condition
 8. The size of earthing conductor for 33 kV switchgear and 415 V switchgear shall be 65 x 8 mm GS flat and for other system 50 x 6 mm or 25 x 6 mm as required.
- 4.1 Contractor shall ensure there at least two earth pits each dedicated for earthing of each Transformer, HT/LT Switchgear panel, transformer neutral, Battery Charger/UPS/Control Panel etc. shall be provided. Earth electrode shall be located near to the equipment and all earth electrodes shall be interconnected with parallel conductor buried in earth surrounding the equipment.
 - 4.2 Earthing system of different locations such as Inverter room/Pooling Switchgear/Sub pooling switchgear/Inverter shelter etc. shall be interconnected in single network of earthing with buried conductor of the size 65X8 MS Flat laid at 600 mm depth to achieve equipotential grounding of the electrical equipment. Contractor shall submit the calculation based on the system of earth conductor and electrode connected in single network. Location and manner of interconnection shall be approved during detail engineering.
 - 4.3 Bidder shall also interconnect the earthing system of Solar PV plant with NTPC existing earthing system wherever available.
 - 4.4 For functional earthing of electronic component such as SCADA, contractor shall provide 1 no. (Min) isolated earth electrode near to the equipment connected with 2 run of copper cable of size not less than 25 sqmm. Contractor shall comply to the recommendation of OEM (Original Equipment Manufacturer) for electronic earthing and electrode can be connected with other earth electrode as per recommendation of OEM.
 - 4.5 Each inverter duty transformer having shield between HV and LV winding shall be provided with 2 nos. Isolated earth electrode connected with each other for functional earthing of transformer shield. Each electrode shall be connected with transformer shield with separate 25X6 Cu flat. .

5.0 TECHNICAL DETAIL SOLAR ARRAY (DC) AND BESS EARTHING

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This section outlines the earthing requirement for discharging DC fault current to earth of Solar PV plant and provide equipotential bonding for Module Mounting Structure (MMS), SMB Mounting structure, Module Frames etc.

System Requirement for the solar array DC earthing:

Conductors buried in earth	-	GS Flat or CCS
Conductors above ground level	-	GS Flat or CCS
Earth Electrode	-	32 mm or higher dia MS Rod or Copper bonded Steel rod of dia. not less than 14 mm
Life Expectancy	-	25 Years
System fault level	-	5 KA for 1 Sec.
Soil resistivity	-	Actual as per site conditions
Min. Steel corrosion	-	As per IS 3043

- 5.1** Each Module mounting structure (MMS), SPV Module frames, mounting arrangement for String Monitoring Boxes, Metallic Junction Boxes, Metal frames/Panel, Metallic Pipes of the solar array shall be effectively earthed by two separate and distinct connections to earthing system. Earthing system for solar array shall consist interconnected earth pits electrodes connected by 25X6 GS flat (Min.) or Copper Clad Steel (CCS) earthing Conductor of size not less than 120 SQMM laid at the depth of 600 MM below the ground. Minimum size of riser conductor to connect the structures to buried earthing conductor and structure to structure in the solar farm shall be 25X3 GS Flat or CCS of Min. 70 SQ MM size.
- 5.2** The Contractor shall furnish the detailed design and calculations for Owner's approval as per IS 3043 to determine the number of earth pit and size of earth conductor.
- 5.3** Buried earth conductor shall be laid all around periphery of solar array farm. GS flat above the ground for structure earthing shall be connected to the nearest buried conductor or electrode. All the earth electrodes shall be interconnected in single network/mesh and no electrode or group of electrodes shall be isolated/islanded. These electrodes shall be uniformly distributed in the solar farm at maximum practical extent and location of earth electrode shall be approved during detail engineering. A continuous earth path is to be maintained throughout the PV array.
- 5.4** Connection of DC earthing system and AC earthing system with location and manner of connection shall be approved during detail engineering. Contractor shall submit the design calculation of earthing system of AC and DC side as standalone (no interconnection) system.
- 5.5** Connection of riser to the structures shall be bolted or welded type. Portion of galvanized structure which undergoes welding at site shall be coated with two coats of cold galvanizing and anti-corrosion paint afterwards.
- 5.6** Connections between equipment earthing leads and between main earthing conductors shall be of welded type. For rust protection, welds should be treated with red lead compound and afterwards thickly coated with bitumen compound. All welded connections shall be made by electric arc welding.
- 5.7** Each PV Module frame shall be earthed in accordance with module manufacturer guidelines. In case module frame earthing is to be separately provided, it shall be earthed with minimum 2.5 SQMM flexible copper cables with lug at suitable location of module frame. Nos. of PV modules in single loop of earthing connection to module frame shall be as per Module manufacturer

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recommendation. Both ends of the loop of copper cable for earthing shall be connected with nearest earthed structure or earth conductor.

- 5.8** Contractor shall seek owner's approval for connecting solar array earth mesh with any other earth mat/earth grid of the solar PV plant.
- 5.9** Size of earth conductor, nos. of earth pits given in this clause is applicable for solar array earthing only. Relevant method and practice of laying of earthing conductor, earth pits and riser not mentioned herewith but given elsewhere in this specification is applicable to solar array earthing also.
- 5.10** Inverter functional earthing (Negative earthing, Anti PID Earthing) shall be carried out as per guideline of OEM. Contractor shall submit complete detail of such earthing from OEM and implement the earthing accordingly
- 5.11** BESS shall have separate earthing system as per the relevant standard and CEA guidelines/ Electricity rules and recommendation of the OEM.

6.0 TECHNICAL DETAIL FOR LIGHTNING PROTECTION DESIGN REQUIRMENT

The object of a lightning protection system is to protect buildings/structure and equipments from direct lightning strikes, potential fire as well as the effects of injected lightning currents (non-incentive flash). It consists of termination systems for direct lightning, down conductors and an earth-termination system.

Care must be taken for while designing the lightning protection that surges are prevented in the electrical system to reduce failure of electrical and electronic equipments.

6.1 CODES AND STANDARD

The equipment/product furnished for earthing system shall meet the requirements of all the applicable relevant National/International codes and standards or their latest amendment Codes and Standards. Product certification has to be CE/UL/BIS/TUV or equivalent. The relevant codes and standard for earthing system are tabulated below.

IS/IEC 62305	PROTECTION AGAINST LIGHTNING
IEEE: 80	IEEE guide for safety in AC substation grounding
IEEE: 837	Standard for qualifying permanent connections used in substation grounding
IS: 2629	Recommended practice for hot dip galvanizing of iron & steel
IS: 2633	Method for testing uniformity of coating on zinc coated articles
IS: 513	Cold rolled low carbon steel sheets and strips
IS: 6745	Methods for determination of mass of zinc coating on zinc coated iron & steel articles.
IS 2062	HOT ROLLED MEDIUM AND HIGH TENSILE STRUCTURAL STEEL — SPECIFICATION
IS: 458	Precast Concrete Pipes (With and Without Reinforcement)
UL-467	Grounding and Bonding Equipment
IEC 62561-7	Requirements for earthing enhancing compounds

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NFC 17 -102	Early streamer emission lightning protection systems
CEA regulations for electrical safety-2010 Indian Electricity Rules/ Indian Electricity Act.	

The lightning protection system includes lightning terminal, Down conductor, test link, earth electrode, installation of lightning terminal, down conductor and earth electrode in suitable pit size, construction of earth pit with cover for the installation, connection of earth electrode with lightning terminal.

Testing link shall be made of galvanized steel of size 25x 6mm.

6.2 LIGHTNING PROTECTION SYSTEM FOR SOLAR ARRAY

Complete Solar Array with associated structure shall be protected from Direct Lightning Stroke. Lightning Protection for solar array shall be achieved with any or both of the following two systems as per specification provided in the following section.

- Single Rod Air Terminal (Faraday Rods)
- Early Streamer Emission (ESE) Air Terminal

Suitable earthing and equipotential bonding shall be ensured for the lightning protection Air Terminal as per applicable standard/Equipment manufacturer guidelines.

Current carrying parts and accessories such as clamps, fasteners, down conductor, Test links and earth termination etc. shall be preferably procured from OEM of Air Terminals if it is supplied by them as part of lightning protection system.

6.3 LIGHTNING PROTECTION SYSTEM FOR BESS

Contractor shall provide suitable lightning protection for BESS area as per IS/IEC 62305. Earth pits for BESS area shall be maintenance free and earth fill compound shall be certified from an accredited lab.

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B-7 METERING SYSTEM

1.0 GENERAL

- 1.1 Energy meter (0.2s accuracy class) shall be provided for both BESS and SPV system as per SLD
- 1.2 Meter shall be suitable for interfacing for synchronizing the built-in clock of the meter by GPS time synchronization equipment. Bidder shall synchronize the meter using GPS time synchronization equipment. All the hardware required for synchronization shall be in scope of bidder.
- 1.3 Meters shall be microprocessor-based MWH meters conforming to IEC 62052-11, IEC 62053-22, IS 14697 and having an accuracy class of 0.2S or better.
- 1.4 These meters shall have provision for downloading of data through an optical port and /or through RS 232/485 port.
- 1.5 Shall carry out measurement of active energy (both import and export) and reactive energy (both import and export) by 3-phase, 4 wire principle suitable for balanced/ unbalanced 3 phase load.
- 1.6 Shall have an optical port on the front of the meter for data collection from either a hand held meter reading instrument (MRI) having a display for energy readings or from a notebook computer with suitable software . The contractor shall supply the MRI and/or notebook complete with all optical interface unit required.
- 1.7 CT and PT required for Energy meter shall have accuracy class of 0.2S and 0.2 respectively and is in the bidder's scope.

C. INDUCTION COOKING SYSTEM

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INDUCTION COOKING SYSTEM

1.0 SCOPE OF WORK

Detailed design of Induction based cooking system including civil and electrical works if any along with preparation of foundations, drainage, and ventilation and cleaning system etc. All the relevant drawings and documents required for engineering of all facilities within this scope are covered under contractor's scope of work. The system furnished shall be complete in every respect for safe reliable and durable operation. Items, if any, which are not listed in the Scope of Work but are necessary for completion of the project shall be listed by the bidder and included in the prices quoted.

2.0 TECHNICAL SPECIFICATION FOR INDUCTION COOKING SYSTEM

The Induction Cooktop of various sizes shall be provided as per following specification

S No	Product	Min Technical Specification	Power
1	Induction Cook Top Flat	Top Size : 24"X 24" X 24" Frame Material: S/S 304, Thickness : not less than 1.6 mm, adjustable bolt, with complete power electronics, adjustable temperature range, power knob , over heat control with induction on/ off/ trip/ overheat indicators, pan detection feature etc Power Supply : 230/440V AC	7 kW
2	Induction Dosa/ Roti Tawa	Top Size : 22"X 28" X 32" Material : SS 430, Thickness : 12 mm Frame Material: S/S 304, Thickness : not less than 1.6 mm complete with adjustable bolt, With complete power electronics, adjustable temperature range upto 300 deg C, power knob , over heat control, with induction on/ off/ trip/ overheat indicators etc Power Supply : 230/440V AC	7 kW
3	Induction Puffer	Material : SS 430, Thickness : 12 mm Frame Material: S/S 304, Thickness : not less than 1.6 mm complete with adjustable bolt, With complete power electronics, adjustable temperature range upto 300 deg C, power knob , over heat control, with induction on/ off/ trip/ overheat indicators etc Power Supply : 230/440V AC	7 kW
4	Induction Idly Steamer	Size : 22"X 24" X 28" , Capacity : 100- 125 idly per batch Material : SS 430, Thickness : 12 mm Frame Material: S/S 304, Thickness : not less than 1.6 mm, front loading, complete with adjustable bolt, With complete power electronics, safety features such as pressure gauge safety valves , power knob , over heat control, with induction on/ off/ trip/ overheat indicators etc	7 kW