

Bharat Heavy Electricals Ltd
Electronics Division
Mysore Road, Bangalore – 560 026

**Tender Documents for Engineering, Procurement and Construction of
132kV switchyards, transmission lines / towers, underground cables
for 15MWp Solar Photovoltaic Grid-connected Power plant
at NTPC-Singrauli, MP/UP**

**RFQ Ref: HBSMM20003 RFQ Date : 25.10.2013
RFQ Due Date: 18.11.2013**

This Tender Document Contains:

- (1) Request For Quotation
- (2) Technical Specifications : PS- 439-856
- (3) Enclosures B, B1 & B2 : Commercial Terms & Conditions , Unpriced Bid Format and Price Bid Format
- (4) General Terms and Conditions (Doc Ref : SCPV/BOS/01-Rev 00)
- (5) Integrity Pact

For all Technical Documents as per PS- 439-856, visit www.bheledn.com

Note:

Part – I: **To be submitted in a separate sealed cover.**

Part – II: **To be submitted in a separate sealed cover.**

Part-I & Part-II sealed covers should be put in outer envelope and super scribed with RFQ No., RFQ date and due date along with the Name & Address of the tenderer.

Tender document should be dropped in Tender drop box super scribed “**SC&PV-MM, Monday**”, kept in reception area of BHEL – Electronics Division, Bangalore.

For any clarification, the following may be contacted:

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REQUEST FOR QUOTATION

	BHARAT HEAVY ELECTRICALS LIMITED Electronics Division PB No. 2606, Mysore Road Bangalore - 560026 INDIA	RFQ NUMBER: HBSMM20003 RFQ DATE : 25.OCT.2013	Due Date 18.NOV.2013 Time: 13:00 HRS VENUE : NEW ENGG. BLDG
MMI:PU:RF:003			

	(for all correspondence) Purchase Executive : SRINIVAS H B Phone : 26998452 Fax : 00918026989217 E-mail: srinivasahb@bheledn.co.in
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Please submit your lowest quotation subject to our terms and conditions attached for the material mentioned below. The quotation must be enclosed in a sealed envelope / Fax superscribed with RFQ no. and due date, should reach us on or before the due date by **13.00** hours IST and will be opened on the same day at **13.30** hours at the venue mentioned above. **PLEASE DROP THE OFFER IN THE BOX PROVIDED AT RECEPTION.**

SI No.	Description	Qty	Unit	Delivery qty	Delivery Date
1	PS0679033750 Electrical eqpt. 132 KV s/yard SPV side Supply of all electrical equipments and materials of 132kV switchyard (of SPV power plant end) such as SF6 breaker, CTs, CVTs, surge arrestors, Bus post insulators / Bushings, Isolators / Disconnectors, Earth switches, Motors & related controls for disconnectors / earth switches, Lightning protection system, ABT meters & metering panels, ACSR conductors, Electrical cables & cable trays, Marshalling boxes / panels / distribution boards, Control and Relay panels, IPS tube conductors, GI earth strips etc together with all related accessories (disc insulators, clamps, connectors etc) and complete set of hardware required to meet the electrical requirements of the switchyard. (Scope shall also include supply of neutral CT for 33kV side of BHEL supplied 33/132kV transformer). Test Certificate	1	ST	1	17.FEB.2014
2	PS0679033769 Structure items for 132 KV Switchyard Supply of structural items of 132kV switchyards (of both SPV power plant and SSTPS put together) for construction of galvanized steel gantry towers / beams and structures for mounting the electrical equipments together with all related accessories and complete set of hardware required to meet the structural support requirements of the switchyards. Test Certificate	1	ST	1	17.FEB.2014
3	PS0679033777 Electrical eqpt. 132 KV S/yard Grid side Supply of all electrical equipments and materials of 132kV switchyard (of SSTPS end) such as SF6 breaker, CTs, CVTs, surge arrestors, Bus post insulators / Bushings, Isolators / Disconnectors, Earth switches, Motors & related controls for disconnectors / earth switches, Lightning protection system, ABT meters & metering panels, ACSR conductors, Electrical cables & cable trays, Marshalling boxes / panels / distribution boards, Control and Relay panels, IPS tube conductors, GI earth strips etc together with all related accessories (disc insulators, clamps, connectors etc) and complete set of hardware required to meet the electrical requirements of the switchyard. Test Certificate	1	ST	1	17.FEB.2014
	PS0679033785 I&C: 132 KV Switchyard SPV side	1	AU	1	19.NOV.2013

For and On behalf of BHEL.

Page 1 OF 5

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Sl No.	Description	Qty	Unit	Delivery qty	Delivery Date
4	Installation of 132kV switchyard at SPV plant end using vendor supplied electrical equipment (including ABT meters) and steel structures / towers #including laying of earthmat grid for the complete 33/132kV switchyard, foundations for all structures / towers / 132kV electrical equipments, cable trenches, laying of cables, electrical interconnections, earthing electrodes / chambers, earthing connections, stone jelly spreading, switchyard fencing & gate etc together with all related activities such as painting of structures, marking of all electrical equipment / cables, sign / danger boards, etc. Scope shall also include foundations and installation of (a) BHEL supplied transformer (16MVA, 33/132kV), (b) vendor supplied Neutral CT (33kV). Scope shall also include installation of (vendor supplied) control and relay protection panel within the control room (of BHEL scope) including all related electrical cable interconnections and earthing connections.				
5	PS0679033793 I&C: 132 KV Switchyard Grid side Installation of 132kV switchyard at SSTPS end using vendor supplied electrical equipment (including ABT meters) and steel structures / towers # including laying of earthmat grid for the allocated bay area, foundations for all structures / towers / 132kV electrical equipments, cable trenches, laying of cables, electrical interconnections, earthing electrodes / chambers, earthing connections, stone jelly spreading, switchyard fencing etc together with all related activities such as painting of structures, marking of all electrical equipment / cables, sign / danger boards, etc. Scope shall also include installation of (vendor supplied) control and relay protection panel within the control room (already existing at SSTPS end) including all related electrical cable	1	AU	1	19.NOV.2013

For and On behalf of BHEL. Page 2 OF 5

REQUEST FOR QUOTATION

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Sl No.	Description	Qty	Unit	Delivery qty	Delivery Date
	interconnections and earthing connections.				
6	PS0679033807 Supply of Spares Supply of spare items for 132kV switchyards: (a) MCBs # 5 % of total population (in each type) used in the contract (b) Surge protection device / MOV # 5% of total population (in each type) used in the contract (c) Fuses # 5% of total population (in each type) used in the contract (d) 132kV termination kits: 10% each type Note: Vendor shall provide list of spare items with individual quantity (in Nos) and item-wise unit price. Test Certificate	1	ST	1	17.FEB.2014
7	PS0679033815 Materials for 132 KV Transmission line Supply including design, drafting, procurement and testing of: (a) 132kV overhead transmission line items such as galvanized steel structures, ACSR conductors etc together with all related accessories (insulators, clamps, connectors etc) and complete set of hardware items required to meet the electrical and structural requirements of the transmission lines and, (b) 132kV underground cables with all related accessories (132kV termination kits, cable lugs etc) and complete set of hardware items required to meet the electrical and environmental requirements of underground cabling. 1 set = 10% of total supplies. Test Certificate	10	ST	10	17.FEB.2014
8	PS0679033823 I&C of 132 KV Transmission line Installation of: (a) 132kV transmission towers, overhead ACSR	10	AU	10	19.NOV.2013

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Page 3 OF 5

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	conductors with all related accessories (insulators, clamps, connectors etc) and hardware items including foundations, painting etc. and, (b) 132kV underground cables with all related accessories and hardware items including construction of cable trenches and laying of 132kV cables etc. 1 AU = 10% of total installation work.				
9	PS0679033831 I&C:Commissioning & State Dept Clearance Pre-commissioning inspections / checks / tests, MRT tests and coordination / liaison activities with state / central departments / CEIG etc for necessary approvals / clearances for commissioning, synchronization with grid and post-commissioning operation of the plan. Clearances shall include obtaining prior approvals for all applicable drawings / documents etc from concerned state / central departments / CEIG etc.	1	AU	1	19.NOV.2013
10	PS0679033840 Operation & Maintenance Operations and Maintenance of the portions of 132kV switchyards, transmission line towers and underground cables installed and commissioned by the vendor, for a period of one year from the date of successful completion of trial run. .	12	AU	12	19.NOV.2013


Total Number of Items - 10

Please note that the tender will be opened in the presence of the bidders or his authorised representatives (maximum two per organisation) who choose to be present with authorisation letters. Refer annexure for the terms and conditions.
 Preference will be given to vendors who accepts our standard payment terms i.e.100% payment - 30 days after receipt of material at our works subject to acceptance. Please specify Terms of delivery, Excise duty, sales tax, Ex-BHEL, Ex-works surcharge, Insurance,P&F, Freight and other taxes very clearly .
 For evaluation,exchange rate(TT selling rate of SBI) as on scheduled date of tender opening (Part-I bid incase of two part bid) shall be considered.
 The offers of the bidders who are on the banned list as also the offer of the bidders, who engage the services of the banned firms, shall be rejected.The list of banned firms is available on BHEL web site www.bhel.com


- i). This is only RFQ not an order.
- ii). In all correspondence quote RFQ No. & due date.
- iii). In Quotation BHEL material code / RFQ Sl. No. should be mentioned clearly.
- iv). Quotation Envelope / Fax not superscribed with RFQ No. and due date is liable for rejection.
- v). Quotation should remain valid for a minimum period of 90 days from due date.

For and On behalf of BHEL. Page 4 OF 5

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<p>vi). In case of non-receipt of Quotation or regret letter for 3 consecutive RFQs you are liable to be removed from our vendors list. vii). All Prices should be written in words and numbers. viii). Excise Chapter Heading should be mentioned for all items where VAT is applicable .</p>			

For and On behalf of BHEL.

	<p>Specification for design, supply, installation and commissioning, operations and maintenance of 132kV switchyards, transmission lines / towers, underground cables for 15 MWp solar power plant at NTPC-Singrauli (MP/UP)</p>	<p>PS-439-856 Rev 00 Page 1 of 171</p>
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Technical specification
for
Design, Supply, Installation, Commissioning, Operations and Maintenance
of 132kV switchyards, transmission lines / towers, underground cables
for 15MWp Solar Photovoltaic Grid-connected Power plant
at
NTPC-Singrauli, MP/UP

Approved by :			
Revision details :R 00	Prepared Varun Jain	Issued N. Harihara Krishnan	Date 18-10-2013


	<p>Specification for design, supply, installation and commissioning, operations and maintenance of 132kV switchyards, transmission lines / towers, underground cables for 15 MWp solar power plant at NTPC-Singrauli (MP/UP)</p>	<p>PS-439-856 Rev 00 Page 2 of 171</p>
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CONTENTS


1.0	Introduction	
	1.1	Overall project outline of 15MWp solar PV power plant construction
	1.2	Brief outline of vendor scope
	1.3	Address particulars of the power plant
	1.4	Enclosures to this specification
2.0	Pre-Qualification Criteria for vendors	
3.0	List of deliverables to be offered by vendor	
4.0	Instructions to vendor on bid submission	
5.0	Bill of Quantities – BHEL/NTPC scope and Vendor scope	
	5.1	132kV switchyard at SPV power plant end
	5.2	132kV switchyard at SSTPS end
	5.3	132kV Transmission line between SPV power plant and SSTPS substation
	5.4	Pre-commissioning / commissioning / State, CEIG clearances / Liaison etc
	5.5	General conditions applicable during supply, installation and commissioning phase
	5.6	Operations and maintenance for one year
6.0	Switchyard electrical	
	6.1	Scope and general information
	6.2	Clearances
	6.3	Services to be performed by the equipment supplied
	6.4	Site supervision of equipment
	6.5	System parameters
	6.6	Type test requirements for equipments and towers
	6.7	RIV tests
	6.8	Circuit breaker
	6.9	Disconnectors and earthswitches (Isolators and accessories)
	6.10	Instrument transformers (CTs, CVTs, Marshalling boxes)
	6.11	Surge arrester
	6.12	Post insulator
	6.13	Requirement of auxiliary items
	6.14	Installation
	6.15	Site testing and commissioning
7.0	Transmission line general	
	7.1	Scope
	7.2	Route and terrain
	7.3	Detailed survey
	7.4	Preliminary line schedule
	7.5	Check survey of tower locations
	7.6	Electrical system data
	7.7	List of standards
8.0	Tower line erection and stringing	
	8.1	General requirements

	<p>Specification for design, supply, installation and commissioning, operations and maintenance of 132kV switchyards, transmission lines / towers, underground cables for 15 MWp solar power plant at NTPC-Singrauli (MP/UP)</p>	<p>PS-439-856 Rev 00 Page 3 of 171</p>
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	8.2	Treatment of minor galvanizing damage
	8.3	Assembly
	8.4	Insulator hoisting
	8.5	Handling of conductor and earthwire
	8.6	Stringing of conductor and earthwire
	8.7	Replacement
	8.8	Final checking testing and commissioning
9.0		Transmission line towers
	9.1	General description of towers
	9.2	Spans and clearances
	9.3	Loading conditions
	9.4	Design of towers
	9.5	Tower materials
	9.6	Tower fabrication
	9.7	Tower earthing
	9.8	Inspection and tests
	9.9	Packing
	9.10	Design calculation and drawings
10.0		Tower line foundations
	10.1	Types of foundation
	10.2	Soil investigation
	10.3	Loads on foundations
	10.4	Stability analysis
	10.5	Properties of concrete
	10.6	Design of foundations
	10.7	Construction of tower foundation
11.0		Line material
	11.1	General
	11.2	Earthwire
	11.3	Conductor
	11.4	Conductor accessories
	11.5	Earthwire accessories
	11.6	Hardware fittings
	11.7	Insulator
	11.8	Test requirement
12.0		Control and protection of 132kV line bay at NTPC Singrauli
	12.1	Control panels for HV switchyard
	12.2	Annunciation system
	12.3	General requirements of protection system
	12.4	Operational requirements for numerical relays and auxiliary relays
	12.5	Interface with existing bus bar protection
	12.6	Panels
	12.7	Earthing

	<p>Specification for design, supply, installation and commissioning, operations and maintenance of 132kV switchyards, transmission lines / towers, underground cables for 15 MWp solar power plant at NTPC-Singrauli (MP/UP)</p>	<p>PS-439-856 Rev 00 Page 4 of 171</p>
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	12.8	Control cabling philosophy
	12.9	Site / commissioning tests
	12.10	Settings
13.0	EHV cables	
	13.1	Codes and standards
	13.2	General features
	13.3	Conductor
	13.4	Conductor screen (shield)
	13.5	Insulation
	13.6	Insulation screen (shield)
	13.7	Bedding
	13.8	Metallic sheath
	13.9	Outer sheath
	13.10	Cable identification / marking
	13.11	Cable drums
	13.12	Cable accessories
	13.13	Installation work at site
	13.14	Type, routine and acceptance tests
	13.15	Site tests
14.0	LT power and control cables	
	14.1	Codes and standards
	14.2	General technical requirements
	14.3	Cable selection & sizing
	14.4	De-rating factors
	14.5	Constructional features of LT power cables
	14.6	Constructional features of LT control cables
	14.7	Cable drums
	14.8	Tests on LT power and control cables
15.0	Cabling	
	15.1	Codes and standards
	15.2	Design and constructional features
	15.3	Cabling support system - cable trays, pipes, glands etc
	15.4	Installation
	15.5	Cable terminations & connections
16.0	Metering system	
	16.1	Technical requirements of ABT compliant energy meters
17.0	Earthing system	
18.0	Quality assurance chapters	
	18.1	132kV switchyard equipments
	18.2	Cabling, earthing, lightning protection
	18.3	LT control cable (1.1kV PVC cables)
	18.4	LT power cables (1.1kV & XLPE cables)
	18.5	132kV cables

	<p>Specification for design, supply, installation and commissioning, operations and maintenance of 132kV switchyards, transmission lines / towers, underground cables for 15 MWp solar power plant at NTPC-Singrauli (MP/UP)</p>	<p>PS-439-856 Rev 00 Page 5 of 171</p>
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1.0 Introduction

1.1 Overall project outline of 15MWp solar photovoltaic power plant

Bharat Heavy Electricals Limited (BHEL), Electronics Division, Bangalore is setting up a 15 MWp solar photovoltaic (SPV) power plant at NTPC-Singrauli with the overall project scope comprising of three major portions as follows:

(1) Solar power plant at Singrauli, MP

The SPV modules employed at the plant generates DC electricity that in turn is inverted to AC in the range 300-400V. The voltage is further stepped up to 33kV using 1.6MVA transformer. Twelve such transformers are employed to achieve 15MWp. Further, the combined output is stepped up to 132kV level using 16MVA transformer to facilitate energy export to 132kV grid.

The switchyard on the 132kV side of SPV plant comprises of outdoor-mounted equipment viz. SF6 breaker, CTs, CVTs, surge arrestors, GOS isolators, earth switches, lightning protection system, support structures, gantry towers / beams etc to facilitate line protection, 132kV transformer protection and metering. An indoor-type control and relay panel located in the control room of SPV plant provides control and annunciation for the switchyard.

BHEL drawing showing single line diagram of SPV power plant up to power export to 132kV grid is enclosed with the tender.

(2) Transmission line between SPV plant and SSTPS

The power generated at SPV plant is transported to SSTPS using 132kV overhead (OH) transmission line (supported by transmission towers). Wherever OH line is not feasible due to practical conditions en route, underground cables are laid. The distance between SPV plant and SSTPS is 10 Km approximately.

NTPC drawing showing transmission line route is enclosed herewith.


(3) 132kV switchyard at SSTPS, UP:

The transmission lines / cables get terminated at 132kV switchyard (SSTPS end) that comprises of equipment such as SF6 breaker, CTs, CVTs, surge arrestors, GOS isolators, earth switches, support structures, gantry towers / beams etc. The control and relay panel is kept within control room of the power plant.

BHEL drawing showing single line diagram of 132kV bay at SSTPS is enclosed with the tender.

1.2 Brief outline of vendor scope

The vendor scope is of design, supply, installation, commissioning, operations and

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maintenance kind that includes activities but not limited to design, engineering, drafting of drawings, manufacture / testing / inspection at manufacturer's works, packing, supply, transportation, transit insurance, delivery to site, unloading, storage and equipment erection including associated foundation and structural works for the following three specific portions of the 15MWp project. Additionally, the scope includes various coordination / liaison activities with concerned state / central authorities such as CEIG etc and also operations and maintenance of the complete 132kV portion of the project for a period of one year after successful trial run for cumulative 72 hours of trouble-free operation following successful commissioning of the plant (export of generated power to 132kV grid, transporting the same to SSTPS substation and hooking it up to 132kV buses at SSTPS) as certified by concerned authorities.

- (1) 132kV switchyard on SPV power plant end (with supply and installation of certain identified equipments in BHEL scope)
- (2) 132kV transmission line between SPV power plant (MP) and SSTPS (UP). All the activities in this area shall be in vendor scope.
- (3) Addition of 132kV switchyard bay to the existing SSTPS substation and interconnection to the existing buses. All activities in this area shall be in vendor scope.

Note: The above is only a broad outline of vendor scope for the sake of introduction. The detailed vendor scope is listed under sections 3.0 and 5.0 and elaborated in various other sections of this specification.


1.3 Address particulars of the power plant

Vendor shall note that the SPV power plant is located at MP, whereas the Singrauli Super Thermal Power Station (SSTPS) is at UP.

- (1) Address of SPV Power plant
NTPC Ltd,
Singrauli Solar PV Power Project,
Near Nehru Shatabdi Hospital
PO Jayant
District Singrauli
MP 486890
- (2) Address of SSTPS
NTPC Ltd,
Singrauli Super Thermal Power Station
PO Shaktinagar
District Sonebhadra
UP 231222

1.4 Enclosures to this specification

- 1) Geo study report on the soil within the boundary of SPV power plant at MP - **81 Pages**
- 2) Topography survey of SPV power plant at MP - **1 Page**
- 3) Transmission line / underground cable route map – **1 Page**
- 4) Single line diagram of SPV power plant at MP **36790500658**

	<p>Specification for design, supply, installation and commissioning, operations and maintenance of 132kV switchyards, transmission lines / towers, underground cables for 15 MWp solar power plant at NTPC-Singrauli (MP/UP)</p>	<p>PS-439-856 Rev 00 Page 7 of 171</p>
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- 5) Single line diagram of SSTPS bays at UP showing 132kV switchyard bay requirements **36790500655**
- 6) Typical drawing of NTPC showing existing earth mat at SSTPS substation **EL-0-PRJ-1273**
- 7) Layout of existing SSTPS substation showing bus-1, bus-2, cross section diagrams etc **031-FE-E-284**
- 8) Sketch showing central monitoring and control station (CMCS) room at SPV plant end **36790500657**
- 9) NTPC approved vendor lists- **31 Pages**
- 10) Indicative field quality plan – **16 Pages**

2.0 Pre-Qualification Criteria (PQC) for vendors

- 2.1 Vendor should have supplied and installed substations / switchyards with voltage rating of 110kV and above in India. Evidence of certificates from clients for successful completion and copies of purchase orders from clients shall be submitted along with technical offer.
- 2.2 Vendor should have supplied and installed transmission towers of 110kV and above in India. Evidence of certificates of installations from clients for successful completion and copies of purchase order from clients shall be submitted along with technical offer.
- 2.3 In case vendor has experience in substations / switchyards of 110kV and above (as per clause 2.1 above) but not in transmission towers of 110kV and above (as per clause 2.2 above), the vendor shall avail the services of a sub-vendor who has the experience in transmission towers of 110kV and above. In such a case, vendor shall submit evidence for the experience of sub-vendor in the form of certificates from clients and copies of purchase order from clients, along with technical offer.
- 2.4 The above vendor / sub-vendor for substation / switchyard / transmission tower should have design capability for which evidence of certificates from clients and copies of purchase orders shall be submitted along with technical offer.


In case they do not have design capability, the vendor should tie up with a design consultant. Evidence of client certificates and purchase orders for the design consultancy work in the area of substation / switchyard and transmission tower shall be submitted along with technical offer.

- 2.5 Vendor shall submit a declaration that materials for the present project shall be procured from NTPC-approved "A" or "N" category sub-vendors, for whichever the items NTPC has approved the sub-vendors. Sub-vendors with "DR" category status as on the day of tender opening shall not be considered.


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3.0 List of deliverables to be offered by vendor

#	Deliverables	Qty
3.1	<p>Supply of all electrical equipments and materials of 132kV switchyard (of SPV power plant end) such as SF6 breaker, CTs, CVTs, surge arrestors, Bus post insulators / Bushings, Isolators / Disconnectors, Earth switches, Motors & related controls for disconnectors / earth switches, Lightning protection system, ABT meters & metering panels, ACSR conductors, Electrical cables & cable trays, Marshalling boxes / panels / distribution boards, Control and Relay panels, IPS tube conductors, GI earth strips etc together with all related accessories (disc insulators, clamps, connectors etc) and complete set of hardware required to meet the electrical requirements of the switchyard. (Scope shall also include supply of neutral CT for 33kV side of BHEL supplied 33/132kV transformer).</p>	1 Set
3.2	<p>Supply of structural items of 132kV switchyards (of both SPV power plant and SSTPS put together) for construction of galvanized steel gantry towers / beams and structures for mounting the electrical equipments together with all related accessories and complete set of hardware required to meet the structural support requirements of the switchyards.</p>	1 Set
3.3	<p>Supply of all electrical equipments and materials of 132kV switchyard (of SSTPS end) such as SF6 breaker, CTs, CVTs, surge arrestors, Bus post insulators / Bushings, Isolators / Disconnectors, Earth switches, Motors & related controls for disconnectors / earth switches, Lightning protection system, ABT meters & metering panels, ACSR conductors, Electrical cables & cable trays, Marshalling boxes / panels / distribution boards, Control and Relay panels, IPS tube conductors, GI earth strips etc together with all related accessories (disc insulators, clamps, connectors etc) and complete set of hardware required to meet the electrical requirements of the switchyard.</p>	1 Set
3.4	<p>Installation of 132kV switchyard at SPV plant end using vendor supplied electrical equipment (including ABT meters) and steel structures / towers – including laying of earthmat grid for the complete 33/132kV switchyard, foundations for all structures / towers / 132kV electrical equipments, cable trenches, laying of cables, electrical interconnections, earthing electrodes / chambers, earthing connections, stone jelly spreading, switchyard fencing & gate etc together with all related activities such as painting of structures, marking of all electrical equipment / cables, sign / danger boards, etc.</p> <p>Scope shall also include foundations and installation of (a) BHEL supplied transformer (16MVA, 33/132kV), (b) vendor supplied Neutral CT (33kV).</p> <p>Scope shall also include installation of (vendor supplied) control and relay</p>	1 AU

	<p>Specification for design, supply, installation and commissioning, operations and maintenance of 132kV switchyards, transmission lines / towers, underground cables for 15 MWp solar power plant at NTPC-Singrauli (MP/UP)</p>	<p>PS-439-856 Rev 00 Page 9 of 171</p>
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	<p>protection panel within the control room (of BHEL scope) including all related electrical cable interconnections and earthing connections.</p>	
<p>3.5</p>	<p>Installation of 132kV switchyard at SSTPS end using vendor supplied electrical equipment (including ABT meters) and steel structures / towers – including laying of earthmat grid for the allocated bay area, foundations for all structures / towers / 132kV electrical equipments, cable trenches, laying of cables, electrical interconnections, earthing electrodes / chambers, earthing connections, stone jelly spreading, switchyard fencing etc together with all related activities such as painting of structures, marking of all electrical equipment / cables, sign / danger boards, etc.</p> <p>Scope shall also include installation of (vendor supplied) control and relay protection panel within the control room (already existing at SSTPS end) including all related electrical cable interconnections and earthing connections.</p>	<p>1 AU</p>
<p>3.6</p>	<p>Supply of spare items for 132kV switchyards:</p> <p>(a) MCBs – 5 % of total population (in each type) used in the contract</p> <p>(b) Surge protection device / MOV – 5% of total population (in each type) used in the contract</p> <p>(c) Fuses – 5% of total population (in each type) used in the contract</p> <p>(d) 132kV termination kits: 10% each type</p> <p>Note: Vendor shall provide list of spare items with individual quantity (in Nos) and item-wise unit price.</p>	<p>1 set</p>
<p>3.7</p>	<p>Supply including design, drafting, procurement and testing of:</p> <p>(a) 132kV overhead transmission line items such as galvanized steel structures, ACSR conductors etc together with all related accessories (insulators, clamps, connectors etc) and complete set of hardware items required to meet the electrical and structural requirements of the transmission lines</p> <p>and,</p> <p>(b) 132kV underground cables with all related accessories (132kV termination kits, cable lugs etc) and complete set of hardware items required to meet the electrical and environmental requirements of underground cabling.</p> <p>1 set = 10% of total supplies.</p>	<p>10 Sets</p>

	<p>Specification for design, supply, installation and commissioning, operations and maintenance of 132kV switchyards, transmission lines / towers, underground cables for 15 MWp solar power plant at NTPC-Singrauli (MP/UP)</p>	<p>PS-439-856 Rev 00 Page 10 of 171</p>
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3.8	<p>Installation of:</p> <p>(a) 132kV transmission towers, overhead ACSR conductors with all related accessories (insulators, clamps, connectors etc) and hardware items including foundations, painting etc.</p> <p>and,</p> <p>(b) 132kV underground cables with all related accessories and hardware items including construction of cable trenches and laying of 132kV cables etc.</p> <p>1 AU = 10% of total installation work.</p>	10 AU
3.9	<p>Pre-commissioning inspections / checks / tests, MRT tests and coordination / liaison activities with state / central departments / CEIG etc for necessary approvals / clearances for commissioning, synchronization with grid and post-commissioning operation of the plant. (Clearances shall include obtaining prior approvals for all applicable drawings / documents etc from concerned state / central departments / CEIG etc.)</p>	1 AU
3.10	<p>Operations and Maintenance of the portions of 132kV switchyards, transmission line towers and underground cables installed and commissioned by the vendor, for a period of one year from the date of successful completion of trial run.</p>	12 mon
3.11	<p>Warranty</p> <p>Vendor shall provide warranty for all the items for a period of 60 months from the date of commissioning or 63 months from the date of supply, whichever is earlier.</p>	-

4.0 Instructions to vendor on bid submission

4.1	<p>Offer shall be submitted in two-parts (Two part-bid).</p> <p>Both parts shall be in separate sealed envelopes as per instructions in tender.</p> <p>The individual envelopes shall be enclosed in a common envelope with markings (address, etc) on the envelope as per instructions in tender.</p>
4.2	<p>First-part shall be techno-commercial bid with following details:</p> <p>(a) List of installations of substations / switchyards / transmission towers of 110kV and above in last three years with client name, project name, rating of installation, scope of supply / installation and year of installation.</p> <p>(b) Technical offer</p> <p>(c) Filled-up enclosures as per BHEL formats provided in the tender.</p>

	<p>Specification for design, supply, installation and commissioning, operations and maintenance of 132kV switchyards, transmission lines / towers, underground cables for 15 MWp solar power plant at NTPC-Singrauli (MP/UP)</p>	<p>PS-439-856 Rev 00 Page 11 of 171</p>
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	<p>(d) Vendor company profile and brochure (e) Statement expressing compliance to this BHEL specification. (f) List of spares offered (with quantity) and without prices.</p>
4.3	<p>Second part shall be price bid with filled up enclosures as per BHEL format provided in the tender. Spares shall be quoted separately with unit price and quantity for each item.</p>
4.4	<p>In addition to the above instructions, tender document provides detailed instructions for bid submission. Vendor shall submit the bid based on instructions in tender document.</p>

5.0 Bill of quantities – BHEL / NTPC scope and Vendor scope

5.1 132kV switchyard on SPV power plant end


This switchyard is attached to the central monitoring control station (CMCS) room at SPV power plant end. The switchyard steps up 33kV level to 132kV. The yard comprises of complete set of 132kV equipment up to the point of export to 132kV grid, in addition to certain 33kV equipments such as (a) 2 Nos of 1.6MVA 33kV/xxx-xxx V transformers, (b) 200kVA auxiliary transformer and (c) neutral CT at 33kV side of 16MVA, 33/132kV transformer.

The size of control room (BHEL scope) is approximately 50m x 12m. The size of switchyard shall be decided by the vendor based on the space required to accommodate the electrical equipment, earth mat grid, earth chambers duly considering the spacing / clearances between the various electrical equipment as per relevant standards and Indian electricity rules (1956), CBIP, state electricity board / CEIG regulations etc.

Except for certain portions, the construction of this entire switchyard is in vendor scope. Accordingly, the respective scopes of BHEL and the vendor are listed as below, whereas detailed specifications are provided in other sections of this specification.

5.1.1 BHEL scope

#	Scope description	Quantity
1	Supply, foundation and installation of oil-immersion type, three-winding, ONAN, 1.6MVA, 33kV/xxx-xxxV (xxx represents LV voltage in the expected range 270-385V), Dyn11yn11 transformer.	2 Nos
2	Supply, foundation and installation of oil-immersion type, auxiliary transformer, ONAN, 200kVA, 33kV/433V, Dyn11 transformer.	1 No
3	Supply of oil-immersion type, ONAN, 16MVA, 33/132kV, Dyn11 transformer.	1 No
4	Supply, laying and interconnection of 33kV cables for the above transformers (cable trenches and supply of LT / control cables within vendor	Quantity as required


	<p>Specification for design, supply, installation and commissioning, operations and maintenance of 132kV switchyards, transmission lines / towers, underground cables for 15 MWp solar power plant at NTPC-Singrauli (MP/UP)</p>	<p>PS-439-856 Rev 00 Page 12 of 171</p>
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	scope).	
5	Construction of control room (CMCS) attached to 132kV switchyard is in BHEL scope. (Supply and installation of C&R panel in control room is in vendor scope).	-
6	Battery (220V, 300AH), battery charger together with DCDB panel with feeders – 2 sets (to be installed within control room)	
7	Metering panel with one ABT main energy meter for 33kV side of transformer – 1 No (to be installed within control room)	


5.1.2 Vendor scope

- (a) Supply, installation, testing and commissioning as per relevant standards, Indian electricity rules (1956), CBIP, State electricity board / CEIG regulations etc and as shall be approved by BHEL / NTPC. (Reference: Technical documents (SLD etc) enclosed with tender and various relevant clauses of this specification).

1	Supply and installation of earthmat and all related materials such as risers, electrodes, earth chambers, earthing interconnections, markings etc as per relevant standards for the earthing of control room panels and switchyard equipments of the 132 kV switchyard.
2	Foundation (including oil soak pits together with all related materials and works) and installation of BHEL-supplied oil-immersion type, ONAN, 16MVA, 33/132kV, Dyn11 transformer – 1 No
3	Supply and installation of control and relay panel with protections for power line as well as 33/132kV transformer – 1 No. Note: C&R panel shall be installed inside the control room attached to the 132kV switchyard.
4	Supply and installation of following items including all necessary mechanical and electrical connections, cabling, marshalling boxes, bay marshalling kiosks, other related panels and hardware: <ul style="list-style-type: none"> (a) Neutral CT for star-connected 33kV side of 33/132kV transformer – 1 No (b) 132kV CT – 3 Nos (c) 132kV SF6 breaker – 1 No (d) 132kV GOS Isolator / disconnecter, double break, central rotating type, with double earth switch, motor operated (locally and also remote controlled from C&R panel) – 2 sets (e) 132kV CVT – 3 Nos (f) 132kV class surge arrester – 6 Nos (g) 132kV bus post insulators – 3 Nos (h) Double stroke lightning protection system – 1 No (with tower for mounting on top) (i) Metering panel with one ABT main energy meter for 132kV side of transformer– 1 No

	<p>Specification for design, supply, installation and commissioning, operations and maintenance of 132kV switchyards, transmission lines / towers, underground cables for 15 MWp solar power plant at NTPC-Singrauli (MP/UP)</p>	<p>PS-439-856 Rev 00 Page 13 of 171</p>
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	<p>(to be installed within control room); Make of the meter: L&T (ER300P with RS485 Modbus RTU compatibility for SCADA interfacing) (j) ACSR conductors with all necessary attachments for interconnections.</p>
5	<p>Construction of RCC cable trenches with concrete lids, cable trays etc and laying of control cables from the 132kV switchyard equipments / bay marshalling kiosks, 33kV Neutral CT, 33/132kV transformer to C&R panel in the control room, as per relevant standards.</p>
6	<p>RCC foundations for mounting the GI structures, for the above electrical equipments: neutral CT (33kV side of 33/132kV transformer), 132kV CTs, SF6 breaker, Isolators / disconnectors / earth switches, CVTs, surge arrestors, bus post insulators.</p>
7	<p>RCC foundations for mounting (1) the tower for double stroke lightning protection system and (2) the gantry towers / beams.</p>
8	<p>Supply and erection of GI structures for mounting the above electrical equipment: neutral CT (33kV side of 33/132kV transformer), 132kV CTs, SF6 breaker, Isolators / disconnectors / earth switches, CVTs, surge arrestors, post insulators.</p>
10	<p>Supply and erection of necessary 132kV gantry towers and beams with all necessary accessories such as insulators, clamps, connectors etc.</p>
11	<p>Supply and erection of tower for lightning protection system with all necessary accessories such as down conductors, junction boxes, insulators, clamps, connectors etc.</p>
12	<p>Supply and erection of all other 132kV equipment / foundation / structures than the ones described above that will be essential for the purpose of meeting the functional / operational requirements of the 132kV switchyard at SPV plant end.</p>
13	<p>Supply of GI earth strips and earthing connections for the electrical equipment, structures, etc of 132kV switchyard of SPV power plant.</p>
14	<p>Supply and installation of other related accessories such as control cables, insulators, clamps, connectors etc as required for the electrical requirements of 132kV switchyard of SPV power plant.</p>
15	<p>Supply of complete set of hardware (cable lugs, cable glands, bolts, nuts, washers etc) required to make electrical terminations of all kinds.</p>
16	<p>Supply of complete set of hardware (bolts, nuts, washers etc) required to make mechanical interconnections of all kinds.</p>
17	<p>Carrying out electrical interconnections between the switchyard equipments, C&R panel and metering panels.</p>
18	<p>All necessary land development activities including suitable leveling / grading / drainage of 132kV switchyard to ensure (a) that the switchyard is at the right level with reference to</p>


	<p>Specification for design, supply, installation and commissioning, operations and maintenance of 132kV switchyards, transmission lines / towers, underground cables for 15 MWp solar power plant at NTPC-Singrauli (MP/UP)</p>	<p>PS-439-856 Rev 00 Page 14 of 171</p>
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	<p>control room plinth, (b) that water shall not get stagnated within the switchyard area and (c) that any water shall get drained away from the switchyard.</p>
19	<p>Other switchyard related activities such as (a) supply and laying of stone jelly of appropriate size to a layer thickness of 100 mm minimum, (b) chain link fencing all around the switchyard with two gates each of 5m wide and 3m tall, (c) marking / labeling of all the switchyard equipments and earthing locations, (d) all relevant danger and sign boards, (e) painting of civil foundations, steel structures etc for protection against erosions and corrosions.</p>
20	<p>Pre-dispatch inspection call shall be provided to BHEL/NTPC for all the supply items in vendor scope.</p>

(b) Design, drawings, guaranteed technical particulars, quality plan, manuals

Vendor shall submit the following documents for BHEL/NTPC approval within 10 days after receipt of purchase order or at every stage of project implementation as applicable and as mutually agreed with BHEL/NTPC.


1	<p>Design calculations, as per relevant standards, together with drawings and bill of materials shall be submitted for underground earthmat grid required for earthing of the control room panels, 132kV switchyard equipments of SPV power plant for BHEL / NTPC approval. Vendor shall also obtain approval from concerned state / central approval agency (such as CEIG etc).</p>
2	<p>Design calculations, as per relevant standards, together with drawings and bill of materials shall be submitted for all foundations and GI structures of 132kV switchyard of SPV power plant for BHEL / NTPC approval.</p>
3	<p>Layout drawing of complete 33/132kV switchyard of SPV power plant, showing locations of various electrical equipment (including transformers), earth chambers, cable trenches, marshalling boxes, other panels (if any), chain link fencing, stone jelly, steel gate etc shall be submitted to BHEL/NTPC for approval.</p>
4	<p>Cross section diagram of 132kV switchyard of SPV power plant, showing the overall dimensions (such as height, width, clearances etc) of various electrical equipment mounted on the structures, gantries / beams etc shall be submitted to BHEL/NTPC for approval.</p>
5	<p>Detailed bill of materials of 132kV switchyard of SPV power plant, with item description, rating, make, model number, item quantity shall be submitted for BHEL / NTPC approval.</p>
6	<p>Manufacturing quality plan with routine / type / acceptance tests, sampling plan, applicable test standards shall be submitted for BHEL/NTPC approval for all the vendor-supplied items including but not limited to 132kV switchyard equipments (SF6 breaker,</p>

	<p>Specification for design, supply, installation and commissioning, operations and maintenance of 132kV switchyards, transmission lines / towers, underground cables for 15 MWp solar power plant at NTPC-Singrauli (MP/UP)</p>	<p>PS-439-856 Rev 00 Page 15 of 171</p>
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	<p>CTs, CVTs, GOS isolators, Earth switches, surge arrestors, lightning protection system etc), neutral CT of 33kV side, TEM meters / metering panels, C&R panel, marshalling boxes of individual electrical equipment, bay marshalling kiosks, other panels (if any), control cables, ACSR conductors, steel structures, gantry towers, beams, motors & motor control panels and all related accessories such as insulators of all types, clamps, connectors etc.</p>
7	<p>Test reports of all the supply items – type / routine / acceptance test reports as per manufacturing quality plan approved by BHEL/NTPC.</p>
8	<p>Guaranteed technical particulars, datasheets, GA drawings, O&M manuals of all the electrical equipments, structures, towers, beams etc.</p>

5.2 132kV switchyard at SSTPS end


- (1) SSTPS substation has several bays as shown in SLD. Empty space is available adjacent to farthest end of the series of bays. The bay for the SPV power plant shall be constructed by the vendor at this designated location. Further, the bay shall be hooked up by the vendor to the existing buses (main bus-1 and main bus-2) as shown in SLD. Also, layout drawing of existing substation is enclosed with tender for reference.
- (2) Similarly, the same control room, as available at the substation and is presently used for control of existing bays, shall be used for installation of C&R panel, ACDB / DCDB panels / boards with necessary feeders.
- (3) Cable trenches exist for the other bays. Vendor shall construct extension of the cable trench from adjacent bay for laying the control cables up to control room.
- (4) Accordingly, supply and installation of all structural / mechanical / electrical equipments including civil foundations, earth mat, protection systems, C&R panels, ACDB / DCDB panels / boards, extended cable trenches, cabling, all other electrical / mechanical interconnections etc as per relevant standards, Indian electricity rules (1956), CBIP, state electricity board / CEIG regulations etc shall be within vendor scope of supply.
- (5) It shall be the absolute responsibility of the Vendor to make an accurate assessment of the exact requirements of supply and installation. **Accordingly, vendor shall visit the site prior to submission of offer.**
- (6) The vendor scope of supplies and works are listed here below, whereas detailed specifications of individual equipments / activities are provided in various sections of this specification.

	<p>Specification for design, supply, installation and commissioning, operations and maintenance of 132kV switchyards, transmission lines / towers, underground cables for 15 MWp solar power plant at NTPC-Singrauli (MP/UP)</p>	<p>PS-439-856 Rev 00 Page 16 of 171</p>
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5.2.1 Vendor scope

- (a) Supply, installation, testing and commissioning as per relevant standards, Indian electricity rules (1956), CBIP, State electricity board / CEIG regulations etc and as shall be approved by BHEL / NTPC. (Reference: Technical documents (SLD etc) enclosed with tender and various relevant clauses of this specification).

1	Supply and installation of earth mat (extension to the existing earth mat) and all related materials such as risers, electrodes, earth chambers, earthing interconnections, markings etc as per relevant standards for the earthing of all switchyard equipments of the bay at SSTPS end.
2	Supply and installation of control and relay panel with protections for power line – 1 No. Note: C&R panel shall be installed inside the existing control room at SSTPS end.
4	<p>Supply and installation of following electrical equipment including all necessary mechanical and electrical connections, cabling, marshalling boxes, bay marshalling kiosks, other related panels and hardware:</p> <ul style="list-style-type: none"> (a) 132kV CT – 3 Nos (b) 132kV SF6 breaker – 1 No (c) 132kV GOS Isolator / disconnecter, double break, central rotating type, with double earth switches, motor operated (locally and also remote controlled from C&R panel) – 1 set (d) 132kV GOS Isolator / disconnecter, double break, central rotating type, without earth switch, motor operated (locally and also remote controlled from C&R panel) – 1 set (e) 132kV GOS 3-phase Isolator / disconnecter, double break, central rotating type, with one earth switch, motor operated (locally and also remote controlled from C&R panel) – 1set (f) 132kV CVT – 3 Nos (g) 132kV class surge arrester – 3 Nos (h) 132kV bus post insulators – 3 Nos (k) Double stroke lightning protection system – 1 No (with tower and mounted on top) (i) IPS tube conductors – sizes / ratings and quantities as required (l) Metering panel with one ABT main energy meter – 1 No (to be installed within control room); Make of the meter: L&T (ER300P with RS485 Modbus RTU compatibility for SCADA interfacing) (m) ACSR conductors with all necessary attachments for interconnections. <p>Note: For 132kV switchyard at SSTPS substation end, existing DC power supply system (battery and charger) at SSTPS substation can be used but vendor shall supply and install at SSTPS end “Extension of existing 415 V Switchyard service LT switchgear at SSTPS end so as to provide 10 Nos of 63A SFU feeders and 6 Nos of 32A SFU feeders in the existing space of 220V DCDB”. This shall include supply of cables, accessories and hardware and carrying out interconnections and</p>

	<p>Specification for design, supply, installation and commissioning, operations and maintenance of 132kV switchyards, transmission lines / towers, underground cables for 15 MWp solar power plant at NTPC-Singrauli (MP/UP)</p>	<p>PS-439-856 Rev 00 Page 17 of 171</p>
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	<p>terminations.</p>
5	<p>Construction of extended portions of RCC cable trenches with cable trays etc and laying of control cables from the 132kV switchyard equipments / marshalling boxes to C&R panel in the control room.</p>
6	<p>RCC foundations for mounting the GI structures, for the above electrical equipment such as 132kV CTs, SF6 breaker, Isolators / disconnectors / earth switches, CVTs, surge arrestors, bus post insulators etc.</p>
7	<p>RCC foundations for (1) the tower for mounting double stroke lightning protection system and (2) the gantry towers / beams.</p>
8	<p>Supply and erection of GI structures for mounting the above electrical equipment, 132kV CTs, SF6 breaker, Isolators / disconnectors / earth switches, CVTs, surge arrestors, bus post insulators, etc.</p>
9	<p>Supply and erection of necessary gantry towers and beams that shall accommodate the width of two bays, although only one switchyard bay will be constructed in the SSTPS substation by the vendor.</p> <p>This is because NTPC has so far maintained one common set of gantry towers and beams for two bays and hence, desires to continue with this standardized protocol in the same way. Accordingly, the resulting empty space will be reserved by NTPC for construction of one more bay in future.</p> <p>Note: Approximate width of one bay: 12-13 m</p>
10	<p>Supply and erection of one tower for lightning protection system with all necessary accessories such as down conductors, junction boxes, insulators, clamps, connectors etc.</p>
11	<p>Supply and erection of all other 132kV equipment / foundation / structures than the ones described above that will be essential for the purpose of (a) extension of main buses 1 and 2 and (b) meeting the functional requirement of the 132kV switchyard bay of SSTPS substation.</p> <p>For this purpose, vendor shall identify the exact requirements during site visit prior to submission of offers.</p>
12	<p>Supply of GI earth strips and earthing connections for the electrical equipment, structures, etc of 132kV switchyard at SSTPS end.</p>
13	<p>Other related accessories such as control cables, insulators, clamps, connectors etc as required for the electrical requirements of 132kV switchyard at SSTPS end.</p>
14	<p>Complete set of hardware (cable lugs, cable glands, bolts, nuts, washers etc) required to make electrical terminations of all types.</p>


	<p>Specification for design, supply, installation and commissioning, operations and maintenance of 132kV switchyards, transmission lines / towers, underground cables for 15 MWp solar power plant at NTPC-Singrauli (MP/UP)</p>	<p>PS-439-856 Rev 00 Page 18 of 171</p>
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15	Complete set of hardware (bolts, nuts, washers etc) required to make mechanical interconnections of all type.
16	Removal of existing stone jelly, existing fencing adjacent to the bay area, leveling / grading of the allocated bay portion (if any and to the extent required) and all related land development works necessary to ensure that water does not get stagnated within the bay area and to ensure that water gets drained away from the switchyard.
17	Other switchyard related activities such as (a) supply and laying of stone jelly of appropriate size to a layer thickness of 100 mm minimum, (b) chain link fencing adjacent to the bay area (c) marking / labeling of all the switchyard equipments and earthing locations, (d) all relevant danger and sign boards, (e) painting of civil foundations, steel structures etc for protection against erosions and corrosions.
18	Pre-dispatch inspection call shall be provided to BHEL/NTPC for all the supply items in vendor scope.

(b) Design, drawings, guaranteed technical particulars, quality plan, manuals

Vendor shall submit the following documents for BHEL/NTPC approval within 10 days after receipt of purchase order or at every stage of project implementation as applicable and as mutually agreed with BHEL/NTPC.

1	Design calculations, as per relevant standards, together with drawings and bill of materials shall be submitted for the earthmat required for the allocated bay in SSTPS substation for BHEL / NTPC approval. Vendor shall also obtain approval from concerned state / central approval agency (such as CEIG etc as applicable for this project).
2	Design calculations, as per relevant standards, together with drawings and bill of materials shall be submitted for all the foundations and GI structures of the 132kV switchyard bay of SSTPS substation.
3	Layout drawing for the 132kV switchyard bay, showing locations of various electrical equipment, earth chambers, cable trenches, marshalling boxes, other panels (if any) etc shall be submitted to BHEL/NTPC for approval.
4	<p>Cross section diagram of 132kV switchyard bay, showing the overall dimensions (such as height, width, clearances etc) of various electrical equipment mounted on the structures, gantries / beams etc shall be submitted to BHEL/NTPC for approval.</p> <p>Note: Vendor shall ensure that the structures / gantry towers / beams etc are erected to the same level as in existing bays in order to main uniformity across the substation.</p>
5	Detailed bill of materials of 132kV switchyard bay of SSTPS substation, with item description, rating, make, model number, item quantity shall be submitted for BHEL / NTPC approval.

	<p>Specification for design, supply, installation and commissioning, operations and maintenance of 132kV switchyards, transmission lines / towers, underground cables for 15 MWp solar power plant at NTPC-Singrauli (MP/UP)</p>	<p>PS-439-856 Rev 00 Page 19 of 171</p>
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6	<p>Manufacturing quality plan with routine / type / acceptance tests, sampling plan, applicable test standards shall be submitted for BHEL/NTPC approval for all the vendor-supplied items including but not limited to 132kV switchyard equipments (SF6 breaker, CTs, CVTs, GOS isolators, Earth switches, surge arrestors etc), TEM meters / metering panels, C&R panel, marshalling boxes, other panels (if any), control cables, ACSR conductors, steel structures, gantry towers, beams, motors & motor control panels and all related accessories such as insulators of all types, clamps, connectors etc.</p>
7	<p>Test reports of all the supply items – type / routine / acceptance test reports as per manufacturing quality plan approved by BHEL/NTPC.</p>
8	<p>Guaranteed technical particulars, datasheets, GA drawings, O&M manuals of all the electrical equipments, structures, towers, beams etc.</p>

5.3 132kV Transmission line from SPV power plant (MP) to SSTPS substation (UP)


5.3.1 BHEL/NTPC scope

#	Scope description	
1	<p>NIL.</p> <p>Note: Vendor shall carry out the entire scope of work.</p>	

5.3.2 Vendor scope

(a) **Supply, installation, testing and commissioning** as per relevant standards, Indian electricity rules (1956), CBIP, State electricity board / CEIG regulations etc and as shall be approved by BHEL / NTPC.

1	<p>Jungle clearance (removal of vegetation, cutting of trees etc), land leveling / grading en route, wherever applicable, to enable erection of transmission towers and underground cables.</p>
2	<p>Topography survey of the transmission line route between SPV power plant and SSTPS substation. The survey shall bring out TBM points, railway tracks, railway crossings, bridges, culverts, river crossings, buildings, existing transmission towers / lines etc (along with coordinates) that are required to plan and finalize the desired locations of towers and underground cables. (Note: For this, vendor shall use the survey results enclosed with tender for reference purpose.)</p> <p>Based on the topography results, an approach plan shall be submitted to BHEL/NTPC for approval. The plan shall bring out number of towers, locations of towers, locations / stretches of underground cables, proposed methodology for underground cables, etc. Vendor shall commence construction works (of towers, lines, underground cables) only</p>


	<p>Specification for design, supply, installation and commissioning, operations and maintenance of 132kV switchyards, transmission lines / towers, underground cables for 15 MWp solar power plant at NTPC-Singrauli (MP/UP)</p>	<p>PS-439-856 Rev 00 Page 20 of 171</p>
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	<p>after BHEL/NTPC approval.</p>
3	<p>Testing of soil for all necessary parameters including soil strength, soil resistivity etc that will be required to compute the foundation and electrical earthing requirements of erection of transmission towers and laying of underground cables.</p>
4	<p>Supply of 132kV transmission towers, ACSR conductors, 132kV underground electrical cables with all necessary accessories such as insulators, supports, clamps, connectors, earth strips, fasteners, other hardware etc.</p>
5	<p>Foundation and erection of 132kV transmission towers, laying of ACSR conductors, laying of 132kV underground electrical cables, all necessary electrical interconnections, all necessary earthing connections using all necessary accessories such as insulators, supports, clamps, connectors, earth strips, fasteners, other hardware etc.</p>
6	<p>Topography survey after completion of laying of towers / lines / underground cables and submission of as built route map showing actual locations of transmission towers, stretches of overhead lines and underground cables between SPV power plant end and SSTPS end.</p>

(b) Design, drawings, guaranteed technical particulars, quality plan, manuals

Vendor shall submit the following documents for BHEL/NTPC approval within 10 days after receipt of purchase order or at every stage of project implementation as applicable and as mutually agreed with BHEL/NTPC.


1	<p>Design calculations, as per relevant standards, results, together with GA / cross section drawings and bill of materials shall be submitted for the foundations of towers for BHEL/NTPC approval.</p>
2	<p>Design calculations, as per relevant standards, results, together with GA drawings and bill of materials shall be submitted for the transmission towers and overhead lines for BHEL/NTPC approval. BoM shall include all the structural items, ACSR conductors and all other accessories such as insulators, supports, clamps, connectors, hardware etc with item-wise particulars such as item description, quantity, rating, type, make etc.</p>
3	<p>Cross section drawings with bill of materials for the underground cable trenches shall be submitted for BHEL/NTPC approval.</p>
4	<p>As built route map showing actual locations of transmission towers, stretches of overhead lines and underground cables between SPV power plant end and SSTPS end shall be submitted for BHEL/NTPC approval.</p>
5	<p>Soil test reports shall be submitted for BHEL/NTPC approval.</p>

	<p>Specification for design, supply, installation and commissioning, operations and maintenance of 132kV switchyards, transmission lines / towers, underground cables for 15 MWp solar power plant at NTPC-Singrauli (MP/UP)</p>	<p>PS-439-856 Rev 00 Page 21 of 171</p>
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6	<p>Manufacturing quality plan with routine / type / acceptance tests, sampling plan, applicable test standards shall be submitted for BHEL/NTPC approval for all the vendor-supplied items such as tower structure items, insulators, supports, clamps, connectors, ACSR conductors, 132kV cable, 132kV cable termination kits etc.</p>
7	<p>Test reports of all the supply items – type / routine / acceptance test reports as per manufacturing quality plan approved by BHEL/NTPC.</p>
8	<p>Guaranteed technical particulars, datasheets, GA drawings, O&M manuals of transmission towers, 132kV cables and other accessories such as insulators, supports, clamps, connectors etc.</p>

5.4 Pre-commissioning / commissioning / State, CEIG clearances / Liaison etc


#	Scope description
1	<p>Pre-commissioning inspections / checks / tests, MRT tests and coordination / liaison activities with state / central departments / CEIG etc for necessary approvals / clearances for commissioning, synchronization with grid and post-commissioning operation of the plant. (Clearances shall include obtaining prior approvals for all applicable drawings / documents etc from concerned state / central departments / CEIG etc.)</p> <p>(A) Vendor shall carry out following minimum pre-commissioning mechanical / earthing / functional / operational checks:</p> <ol style="list-style-type: none"> (1) Verification of firmness of terminations in all electrical equipments of both the 132kV switchyards (at SPV and SSTPS substation ends) and transmission line towers / underground cable connections. (2) Verification of earthing for all these electrical equipment. (3) Electrical continuity checks. (4) IR tests (HV Meggar). (5) Functional checks to verify the healthy operation (local as well as remote operation from C&R panels) of all the 132kV equipments such as SF6 breakers, motor operated isolators / earth switches, CTs, CVTs, surge arrestors, lightning protection system, etc. (6) Functional checks for AC / DC power supplies as available at various electrical equipments. (7) Functional checks to simulate and verify all the applicable relay operations related to both the power line protection and transformer protection. <p>(B) Pre-commissioning electrical tests on transformer, Neutral CTs on 33kV side, 132kV CTs, CVTs, surge arrestors, SF6 breaker, relays etc:</p> <ol style="list-style-type: none"> (1) Tests that are performed usually are listed below. However, the exact tests

	<p>Specification for design, supply, installation and commissioning, operations and maintenance of 132kV switchyards, transmission lines / towers, underground cables for 15 MWp solar power plant at NTPC-Singrauli (MP/UP)</p>	<p>PS-439-856 Rev 00 Page 22 of 171</p>
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	<p>required to be conducted at site prior to commissioning shall be in line with concerned state electricity board / CEIG requirements / norms.</p> <p>(a) Transformers: IR tests, ratio tests, excitation current measurement, magnetic balance test on HV, short circuit test, excitation test LV side, vector group test.</p> <p>(b) SF6 breaker: IR tests and continuity tests, IR values for CTs/PTs, excitation test on CTs, primary injection tests for CTs, ratio test for PTs</p> <p>(c) Relays in C&R panels: open/close, tripping, primary injection tests.</p> <p>(d) CTs/CVTs: IR tests, Polarity tests, Ratio tests, Burden tests, Winding resistance tests, Primary injection tests, excitation tests.</p> <p>(e) Surge arrestors: IR tests</p> <p>(2) Appropriate testing agency shall be arranged for the tests.</p> <p>(3) Vendor shall coordinate / liaison with concerned state / central electricity board departments / CEIG etc, as the case may be, to fix up test schedules and witness by their representatives.</p> <p>(4) Vendor shall prepare and submit the reports to concerned state MRT departments and obtain their approval through necessary liaison activities.</p> <p>(C) Vendor shall coordinate and liaison with concerned state / central electricity departments / CEIG etc, as the case may be, prepare and submit the applications with necessary enclosures on behalf of BHEL / NTPC and obtain their approval:</p> <p>(a) Approval for drawings / documents</p> <p>(b) Approval for synchronization of plant with grid.</p> <p>(c) Inspection of power plant of CEIG etc.</p> <p>(d) Provisional clearance from CEIG etc to proceed with commissioning (charging the grid)</p> <p>(D) Vendor shall implement corrective steps on the observations of CEIG, follow-up with them and obtain final clearance for licensed operation of the plant on a continuous basis.</p> <p>Note: Scope of coordinating with concerned state / central electricity departments, CEIG to get the clearances / approvals for licensed / statutory operation of the power plant on a continuous basis includes all transactions required for successful liaison and clearances. Application fees and renewal fees (say, in the form of DD) to be enclosed with application / renewal documents shall be in the scope of BHEL / NTPC. All other expenses in the above process shall be in the scope of vendor.</p>
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5.5 General conditions applicable during supply, installation and commissioning phase


1	Vendor shall arrange for safe storage of all the vendor supplied materials. For this purpose, vendor shall construct appropriate storage shed with gates, locks and keys. Security watch and ward shall be deployed round the clock. Insurance of the vendor supplied items shall
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	<p>Specification for design, supply, installation and commissioning, operations and maintenance of 132kV switchyards, transmission lines / towers, underground cables for 15 MWp solar power plant at NTPC-Singrauli (MP/UP)</p>	<p>PS-439-856 Rev 00 Page 23 of 171</p>
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	<p>be in vendor scope until the end of trial run following the commissioning of the power plant.</p>
2	<p>Vendor shall organize power supply on their own. Accordingly, DG sets of suitable capacity shall be deployed by the vendor for construction works.</p>
3	<p>Similarly, water required for construction works shall be organized by vendor.</p>
4	<p>All machinery such as cranes, hydra, JCBs, forklifts, transport trucks, trolleys etc necessary for movement and installation of materials / panels / equipment etc shall be organized by the vendor.</p>
5	<p>All necessary tools and tackles such as crimping tool, screw driver set, power screw drivers, cutting pliers, nose pliers, spanner sets, adjustable spanners, hole saw cutter set, bending tools, torque wrenches, hack saw blades, pipe wrenches, flat / round files, HV termination tools, drilling machines, welding machines, concrete mixers, steel bar bending tools / templates for RCC works, spade, shovel, hammer etc shall be organized by the vendor.</p>
6	<p>All necessary measuring instruments such as digital multimeters, electrical testers, meggers (1kV, 2.5kV, 5kV), lamp load testers for solar array string measurements, earth resistance meters, weighing machines, water level indicators etc shall be organized by the vendor.</p>
7	<p>Vendor shall make their own arrangements for necessary food, drinking water and accommodation for their labour and employees posted at the site. Similarly, food and drinking water required at the site, during the construction operations, shall also be in scope of vendor.</p>
8	<p>Vendor shall organize all necessary steps to meet statutory requirements such as labour license, PF, ESI etc and also ensure compliance with relevant acts such as minimum wages act, income tax act, employee insurance act etc for their labour deployed at site.</p>
9	<p>Vendor shall maintain updated labour register, with name, age, qualification, salary, attendance details etc at the site.</p>
10	<p>Vendor shall use danger boards, wherever required, to ensure safety of the persons during the work at site.</p>
11	<p>Vendor shall adhere to all necessary safety norms such as use of helmet, goggles, hand gloves, gumboots, aprons etc. It is the ultimate responsibility of the vendor in all respect to prevent accidents at the site and safeguard their labour from accidents.</p>
12	<p>Vendor shall, at the completion of every work, clear off the debris, which resulted out of the</p>

	<p>Specification for design, supply, installation and commissioning, operations and maintenance of 132kV switchyards, transmission lines / towers, underground cables for 15 MWp solar power plant at NTPC-Singrauli (MP/UP)</p>	<p>PS-439-856 Rev 00 Page 24 of 171</p>
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	<p>work. In case of excavation work such as cable trench etc, vendor shall finish the land neatly with necessary leveling, rolling etc.</p>
12	<p>Vendor shall carry out the work without causing inconvenience to other contract groups at the site. In case of conflicts with other groups, vendor shall ensure that the matter is resolved at once amicably so that the progress of work is not affected.</p>
13	<p>Any damages on the building, structures etc attributable to the acts of labour / employees of vendor shall be rectified and made good by the vendor at their own cost.</p>
14	<p>No child labour shall be employed for execution of the present contract.</p>
15	<p>Any miscellaneous materials, which are found essential for technical completion of the contract but not mentioned explicitly in this specification, shall be deemed to be included in the specification. Accordingly, such materials shall be included by the vendor as part of the offer.</p>
16	<p>BHEL / NTPC shall witness routine / acceptance / type tests performed at manufacturer works for the items supplied by vendor. Vendor shall accordingly provide inspection call to BHEL with submission of quality assurance plan in advance.</p> <p>For the items bought out from dealers, test certificates, as per relevant IS / IEC standards, as issued by manufacturer shall be submitted to BHEL. However, prior approval shall be obtained from BHEL/NTPC for procurement of the item from dealers.</p>
17	<p>Field Quality Plan / Quality control system</p> <p>Vendor shall set up a field quality control laboratory with full set up to facilitate testing of all construction materials in accordance with FQP (Field quality control plan) as approved by BHEL/NTPC. Vendor shall deploy a well experienced quality control engineer to monitor all QC activities at site as per approved FQP.</p> <p>Specifically with reference to civil works, vendor shall submit all concrete mix designs and bituminous mix designs for BHEL/NTPC approval before starting of the work. All the third party testings should be conducted in NTPC approved laboratories only. Vendor shall submit the FQP for the civil construction works before starting of the works for approval of BHEL/NTPC.</p>
18	<p>Any deviations shall be discussed with BHEL / NTPC site engineers and implementation shall be taken up only after approval from BHEL / NTPC.</p>

	<p>Specification for design, supply, installation and commissioning, operations and maintenance of 132kV switchyards, transmission lines / towers, underground cables for 15 MWp solar power plant at NTPC-Singrauli (MP/UP)</p>	<p>PS-439-856 Rev 00 Page 25 of 171</p>
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19	Vendor shall submit periodic status report, on daily as well as weekly consolidated basis, to BHEL on the progress of the contract.
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5.6 Operations and Maintenance of 132kV switchyards and transmission towers / lines and underground cables


1	<p>Date of commencement of operations and maintenance</p> <p>Zero date for O&M shall be the actual date on which the successful trial run on the power plant is completed after commissioning of the 15MWp solar photovoltaic power plant with synchronization / export of power to the 132kV grid. (Note: Trial run is considered as an event with trouble-free operation for a cumulative period of 72 hours).</p>
2	<p>Period for O&M</p> <p>Vendor shall operate and maintain those portions of the overall 15MWp solar photovoltaic power plant project implemented by them for a period of one year commencing immediately after successful trial run.</p> <p>O&M shall be for the two 132kV switchyards (SPV plant end, SSTPS substation end) and the intermediate transmission towers / lines, underground cables.</p>
3	<p>O&M personnel</p> <ol style="list-style-type: none"> 1. Vendor shall deploy following minimum personnel: <ol style="list-style-type: none"> (a) One technical-cum-administrative in-charge having graduation in electrical / electronics engineering and experience with overall responsibility for complete plant operations. The in-charge shall have competence to deftly handle technical and operational / crisis problems. (b) Three working level staff with ITI / diploma level qualifications in engineering with competence for operating electrical / electronics / mechanical equipment, taking measurements, data logging / maintaining registers, preparation of reports in computer. (c) Three unskilled persons for regular house-keeping (cleaning / mopping etc) and water cleaning of SPV modules. (d) Note: At least one among the technical personnel shall essentially be a certified / licensed person for HT operations (132kV minimum). This is a mandatory requirement. 2. Vendor shall provide separately identifiable uniforms for the respective office staff. 3. Similarly, O&M personnel shall be provided with raincoats, toolsets, earthing rods, safety gloves, safety goggles, gumboots, helmets and all other personal protective equipment (PPE) that will be relevant to ensure human safety.

	<p>Specification for design, supply, installation and commissioning, operations and maintenance of 132kV switchyards, transmission lines / towers, underground cables for 15 MWp solar power plant at NTPC-Singrauli (MP/UP)</p>	<p>PS-439-856 Rev 00 Page 26 of 171</p>
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	<ol style="list-style-type: none"> 4. Names, qualification, work responsibility of personnel shall be listed on a display board within control room. 5. Attendance register shall be maintained for both the teams. 6. Vendor shall ensure statutory requirements such as ESI, PF and labour license for their O&M personnel posted at site. 7. BHEL/NTPC shall have right to disallow any O&M employee, if found unfit to perform. BHEL/NTPC instructions issued in writing shall be binding on vendor who shall replace the person. 8. O&M personnel at site shall be deemed to be aware of damages and risks incidental to conditions of NTPC land and works from time to time and BHEL/NTPC shall not be responsible for any injury to personnel arising there from. 9. Training to O&M personnel It is the absolute responsibility of vendor to ensure imparting of necessary training to their O&M personnel to get them acquainted with the operations of various electrical and mechanical equipment of the power plant. For this purpose, vendor shall identify the O&M personnel well in advance and involve them during installation and commissioning stages so that they become well versed with various functional aspects of the power plant. 10. Availability of O&M personnel at power plant <ol style="list-style-type: none"> (a) Vendor shall ensure that operating staff are present in the power plant round the clock (24 hours) on all days. (b) Vendor shall ensure that certain minimum operating staffs are present at the power plant even on festivals, public holidays and any other unique occasions so that the plant is run under competent supervision on all days. 11. O&M personnel shall, strictly, not use any part of the power plant for their personal / residential purposes. Their presence at the plant shall, strictly, be meant only for the purpose of operation and maintenance of plant.
4	<p>O&M operations – daily basis</p> <ol style="list-style-type: none"> (1) Upkeeping of 132kV switchyard with removal of garbage / litter, removal of weeds / grass / bush. (2) Monitoring the switchyard and the associated C&R panel at the CMCS room (main control room) for line faults, transformer faults or any other technical problems and attending to them with the needed response / corrective action. (3) Manual logging in a register with signature and date: (a) Daily exported energy as recorded at the 33kV and 132kV TEM meters, (b) events of any equipment tripping/ breakdown, (c) Grid outage duration, (d) damages / accidents / injuries / theft etc as

	<p>Specification for design, supply, installation and commissioning, operations and maintenance of 132kV switchyards, transmission lines / towers, underground cables for 15 MWp solar power plant at NTPC-Singrauli (MP/UP)</p>	<p>PS-439-856 Rev 00 Page 27 of 171</p>
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	<p>per BHEL formats. (4) Drinking water and food to be arranged for the deployed O&M personnel at site. (5) Operation of appropriate fire extinguishers in the 132kV switchyard upon fire incident.</p>
5	<p>O&M activities – monthly basis (1) Monitoring and logging of 132kV switchyard fire extinguisher levels / pressures as per BHEL formats: Applicable for both the 132kV switchyards (SPV plant end, SSTPS end). (2) Earthing resistance measurements for all the switchyard equipment: measured values shall be recorded in registers and reported to BHEL as per BHEL approved recording formats. (3) Submission of values / status of plant parameters and events for the corresponding month, as below, as per BHEL approved formats: a. Daily energy generation: at both the 33kV and 132kV meters (on SPV and SSTPS ends) b. Events (with date, time) of faults / tripping / breakdown of equipment c. Events (with date, time) of grid outage d. Events (with date, time) of equipment damages, accidents and thefts (4) Monthly reports shall be submitted to BHEL for all the above data. (5) Energy generation / meter reading report to be prepared and submitted to the concerned state electricity department. Signatures from NTPC and substation representatives shall be obtained as applicable.</p>
7	<p>O&M activities - quarterly basis (1) Cleaning of AC/DC DB panels, marshalling boxes, bay marshalling kiosks, C&R panels etc to remove accumulated dust. (2) Monitoring and status review, followed by rectification / calibration / replenishment / replacement actions as necessary and applicable for following: (a) Spare items of all electrical equipment (b) First aid box items - medicines and accessories (c) Safety gadgets (d) Tool kits and measuring instruments (3) Submission of quarterly report on above activities to BHEL.</p>
8	<p>O&M activities – yearly basis (once during the one year O&M period) (1) BDV measurements for oil samples from 16MVA, 33/132kV transformer as per relevant standards and submission of report to BHEL. (2) Filtration of oil to be arranged, if required, based on BDV measurement report as per relevant standards. (3) Lubrication of moving contacts (GOS isolator switches, Earth switches etc) with appropriate grease etc as per relevant standards. (4) Painting of switchyard gate / fencing, earthing chambers, other steel structures within the two 132kV switchyards, if required, based on conditions of rusting etc. (5) Checking tightness of hardware and cable terminations in 132kV switchyards wherever required.</p>

	<p>Specification for design, supply, installation and commissioning, operations and maintenance of 132kV switchyards, transmission lines / towers, underground cables for 15 MWp solar power plant at NTPC-Singrauli (MP/UP)</p>	<p>PS-439-856 Rev 00 Page 28 of 171</p>
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9	<p>O&M activities - as and when required (contextual basis)</p> <ol style="list-style-type: none"> (1) Monitoring and operation of plant electrical equipment as and when required: <ol style="list-style-type: none"> (a) GOS Air break isolator switches (with / without earth switch) (b) SF6 breaker on/off: local operations from C&R panel and remote operations from SCADA. (c) Settings of numerical relays: review and revision in consultation with BHEL. (d) AC/DC DB operations on LT side (e) Battery and battery charger operations (2) Coordinating, on behalf of BHEL, and obtaining renewal of statutory licenses, clearances and approvals from state electricity departments / CEIG etc. (3) Repair and replacement of vendor supplied items, by vendor, with urgent action plans and implementation, when the items are found non-working / damaged. The same shall be reported to BHEL within 12 hours from time of observation. (4) Reporting, on an immediate basis (within max 2 hours) of functional problems / damages in BHEL supplied items to facilitate repair / replacement by BHEL. Further, vendor shall correspond / coordinate with respective equipment vendors / service centers, on behalf of BHEL, for getting the service engineers to the site. Later, coordinating with the service engineers during their visit to site, and assisting them in the trouble shooting process until the problem is resolved. Vendor shall report to BHEL (within max 2 hours) immediately after the problem is resolved. (5) Vendor shall keep updating the spares inventory at the site every time there is consumption of spare items towards replacement. In case of shortage of spares, the same shall be reported on an urgent basis (with max 2 hours) to BHEL. (6) Coordinating with SSTPS sub-station upon grid failures, line problems etc and implementing the needful steps to restore the plant to normal operation. (7) Theft incidents: immediate reporting to BHEL, filing FIRs with police stations on behalf of BHEL, coordination for site inspection by insurance companies and clearance of insurance claims, logging of events (date, time) and maintaining records. (8) Accidents: immediate reporting to BHEL, coordinating with hospitals, logging of events (data, time) and maintaining records.

	<p>Specification for design, supply, installation and commissioning, operations and maintenance of 132kV switchyards, transmission lines / towers, underground cables for 15 MWp solar power plant at NTPC-Singrauli (MP/UP)</p>	<p>PS-439-856 Rev 00 Page 29 of 171</p>
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6 SWITCHYARD ELECTRICAL

6.3 SCOPE AND GENERAL INFORMATION

- 6.3.2 The intent of this specification for various electrical equipments shall cover the following scope:
- 6.3.3 Contractor shall be responsible for design and engineering of overall system/station, and all elements, systems, sub-systems, facilities, equipments, material, etc. The Contractor shall submit design calculations, drawings, codes, codes of practices, construction drawings, etc. for BHEL approval.
- 6.3.4 The basic design shall include, but not limited to, the following:
- a) Development of general arrangement.
 - b) Development of detailed layout (plan & section/elevation) drawings.
 - c) Development of single line diagram with parameters of equipment and details of protection.
 - d) Protection and control philosophy and selection of protection, control and annunciation schemes.
 - e) Development of interlocking schemes.
 - f) Development of switchyard structure loading details.
 - g) Development of earthing system.
 - h) Development of direct stroke lightning protection system.
 - i) Insulation coordination of the EHV equipment.
 - j) Calculation of static and dynamic force load, and selection of spacer spans and equipment terminal loading.
 - k) Development of clearance diagrams.
 - l) Lighting design, Lux level calculation and conduit wiring diagram.
 - m) Development of power & control cable laying and termination schedules.
 - n) Relay setting calculations.
 - o) Development of erection key diagram with bill of material.
 - p) Foundation design and construction drawings.
 - q) Development of cable trench layout and sections and construction drawings.
- 6.3.5 Contractor shall furnish detailed drawings for the various equipments covered in their scope for BHEL approval. The equipment shall conform to type tests as per specification and applicable standards, and reports of the same shall be furnished for approval.
- 6.3.6 Contractor shall furnish the schematics, general arrangement drawings, cable schedules, interconnection schedules, panel wiring diagrams, etc. for various control and relay panels for BHEL approval. Contractor shall also furnish the recommended relay settings to be adopted.

	<p>Specification for design, supply, installation and commissioning, operations and maintenance of 132kV switchyards, transmission lines / towers, underground cables for 15 MWp solar power plant at NTPC-Singrauli (MP/UP)</p>	<p>PS-439-856 Rev 00 Page 30 of 171</p>
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- 6.3.7 The Contractor shall note that the list of standards specified elsewhere in this specification is not complete. Whenever necessary the list of standards shall be considered in conjunction with specification, IS & IEC. In case governing standards for the equipment is different from IS or IEC, the salient points shall be clearly brought out along with English language version of the same.
- 6.3.8 Exposed live parts shall be placed high enough above ground to meet the requirements of Indian Electricity Rules and other statutory codes. All responsibilities regarding co-ordination with Electrical Inspection Agencies and obtaining clearance certificate from them rests with the Contractor. The necessary fees for such clearances shall be borne by BHEL.
- 6.3.9 All equipment shall be supplied with suitable terminal connectors. The terminal connector shall be well coordinated with the rating/type/size of equipment to be connected. The conductor terminations for equipment shall be either rigid or expansion type suitable for 3" IPS tube or horizontal or vertical take-off suitable for single phase. The type of terminal clamps would be finalised by the Contractor in consultation with BHEL based on layout requirement. The terminal pads shall preferably be capable of taking the required conductor span under normal, short circuit and meteorological conditions, without effecting the performance of the equipment.
- 6.3.10 The rigid busbars of 3" IPS tube for equipment inter connections shall have rigid connections at one end and expansion /flexible at other end. The tubular connections shall have not more than one joint per span. Corona Bell shall be provided at the end of the rigid busbars.
- 6.3.11 The minimum vertical distance from the bottom of the lowest porcelain part of the bushing, porcelain enclosures or supporting insulators to the bottom of the equipment base, where it rests on the foundation pad shall be 2.55 meters.
- 6.3.12 All the cables used for the switchyard shall be armored type.
- 6.3.13 All equipment shall be suitable for hot line washing.
- 6.3.14 The Contractor shall cooperate in all respects and exchange the necessary technical data/ drawings with other agencies and BHEL's other Contractors under intimation to BHEL to ensure proper coordination and completion of work in time.
- 6.3.15 The sag tension, conductor spacing, short circuit forces, spacers location, conductor swing and clearances shall be carried out in accordance with IEC 60865 to achieve the specified clearances.
- 6.3.16 Post insulators shall be provided at line entry so as to avoid mechanical forces on the LA's etc.

	<p>Specification for design, supply, installation and commissioning, operations and maintenance of 132kV switchyards, transmission lines / towers, underground cables for 15 MWp solar power plant at NTPC-Singrauli (MP/UP)</p>	<p>PS-439-856 Rev 00 Page 31 of 171</p>
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6.3.17 The towers and gantries shall be suitable for a normal conductor tension of minimum 2T/conductor. The foundations and structures etc shall be designed accordingly. The minimum height of 132kV gantry and equipment shall be 12500mm (with 5200mm peak for earthwire as required) or as required to match with existing levels and 4900 mm from ground respectively. The gantry width for 132 kV system shall be 12000 mm.

6.3.18 Voltage drop for sizing of power cables shall not be more than 6%.

6.3.19 The illumination level shall be 20 lux in general and 50 lux on equipment boxes. No lighting fixture shall be mounted on gantries, they shall be mounted on lighting masts only. Existing Lighting mast can also be used for the purpose.

6.3.20 The connectors and clamps shall be rated same as the connected equipments.

6.4 CLEARANCES

The minimum clearances for 132kV switchyard shall be as given below:

Phase to earth clearance	1300 mm
Phase to phase clearance	1300 mm
Section clearance	4000 mm


The Contractor shall supply the structures suitable to meet the above clearances.

6.5 SERVICES TO BE PERFORMED BY THE EQUIPMENT BEING SUPPLIED

All the equipment/materials covered in this specification shall perform all its function satisfactorily without undue strain, restrike etc. under normal operating voltage conditions.

6.6 SITE SUPERVISION OF EQUIPMENTS

The contractor shall ensure that, erection, testing and commissioning of Circuit Breaker, Isolator, Instrument Transformer, Surge Arrestor, Substation Automation System & Protective relays is carried out under the supervision of manufacturer of respective equipment.


	<p>Specification for design, supply, installation and commissioning, operations and maintenance of 132kV switchyards, transmission lines / towers, underground cables for 15 MWp solar power plant at NTPC-Singrauli (MP/UP)</p>	<p>PS-439-856 Rev 00 Page 32 of 171</p>
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6.7 SYSTEM PARAMETERS

The system parameters shall be as under:

132kV

- | | | |
|------------------------------|---|--|
| a) Highest system voltage | : | 145 kV rms |
| b) Lightning Impulse voltage | : | ± 650 kVp |
| c) Power frequency withstand | : | 275kV(rms) |
| for 1 min. (rms) | : | |
| d) Max. fault level (1 sec.) | : | 31.5 kA |
| e) Minimum creepagedistance | : | 3625 mm |
| f) Rated ambient temperature | : | 50 deg. C |
| g) System earthing | : | Effectively |
| h) Seismic acceleration | : | earthed 0.3 g |
| i) Rated frequency | : | 50Hz |
| j) Max. Radio interference | : | 1000 micro volts |
| for freq. between 0.5 MHz | : | |
| and 2.0 MHz at 92 kV rms. | : | |
| k) Phase to phase spacing | : | 3000 mm |
| l) Support structure height | : | Adequate so that lowest part of support insulator of equipment is minimum 2550 mm from ground or plinth level. |

	<p>Specification for design, supply, installation and commissioning, operations and maintenance of 132kV switchyards, transmission lines / towers, underground cables for 15 MWp solar power plant at NTPC-Singrauli (MP/UP)</p>	<p>PS-439-856 Rev 00 Page 33 of 171</p>
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6.8 TYPE TEST REQUIREMENTS FOR EQUIPMENTS AND TOWERS

- a) All equipments to be supplied shall be of type tested design. During detail engineering, the contractor shall submit for BHEL approval the reports of all the type tests as listed in this specification and carried out within last ten years (other than that of transmission line towers for which the type test reports conducted prior to ten years shall also be accepted) from the date of bid opening. These reports should be for the test conducted on the equipment similar to those proposed to be supplied under this contract and the test(s) should have been either conducted at an independent laboratory or should have been witnessed by a Client.
- c) However if contractor is not able to submit report of the type test(s) conducted within last ten years from the date of bid opening, or in the case of type test report(s) are not found to be meeting the specification requirements, the contractor shall conduct all such tests under this contract at no additional cost to the BHEL either at third party lab or in presence of client/ BHEL representative and submit the reports for approval.
- d) All acceptance and routine tests as per the specification and relevant standards shall be carried out. Charges for these shall be deemed to be included in the equipment price.

6.9 RIV TESTS

The RIV tests shall confirm to the requirements as per detailed below.

RADIO INTERFERENCE VOLTAGE (RIV) TEST

6.9.2 General

Unless otherwise stipulated, all equipment together with its associated connectors where applicable shall be tested for external corona both by and measurement of radio interference voltage (RIV).


6.9.3 Test Levels

The test voltage levels for measurement of external RIV are listed under the relevant clauses of the specification.

6.9.4 Test Methods for RIV:

6.7.3.1 RIV tests shall be made according to measuring circuit as per International Special – committee on Radio Interference (CISPR) Publication 16 -1 (1993) Part – I. The measuring circuit shall preferably be tuned to frequency with 10% of 0.5 MHz but other frequencies in the range of 0.5 MHz to 2 MHz may be used, the measuring frequency being recorded. The result shall be in microvolts.

6.7.3.2 Alternatively, RIV tests shall be in accordance with NEMA standard Publication

	<p>Specification for design, supply, installation and commissioning, operations and maintenance of 132kV switchyards, transmission lines / towers, underground cables for 15 MWp solar power plant at NTPC-Singrauli (MP/UP)</p>	<p>PS-439-856 Rev 00 Page 34 of 171</p>
---	--	---

No. 107 – 1964 except otherwise noted herein.

6.7.3.3 In measurement of RIV temporary additional external corona shielding may be provided. In measurement of RIV only standard fittings of identical type supplied with the equipment and a simulation of the connections as used in the actual installation will be permitted in the vicinity within 3.5 meters of terminals.

6.7.3.4 Ambient noise shall be measured before and after each series of tests to ensure that there is no variation in ambient noise level. If variation is present, the lowest ambient noise level will form basis for the measurements. RIV levels shall be measured at increasing and decreasing voltages of 85%, 100%, 115% and 130% for the specified RIV test voltage for all equipment unless otherwise specified. The specified RIV test voltage for 145 KV is listed in the detailed specification together with maximum permissible RIV level in microvolts.

6.7.3.5 The metering instruments shall be as per CISPR recommendations or equivalent device so long as it has been used by other testing authorities.

6.7.3.6 The RIV measurement may be made with a noise meter. A calibration procedure of the frequency to which noise meter shall be tuned shall establish the ratio of voltage at the high voltage terminal to the voltage read by the noise meter.

6.10 CIRCUIT BREAKER

6.10.2 GENERAL

Circuit Breakers shall be outdoor type, comprising three identical single pole units, complete in all respects with all fittings and wiring. The circuit breakers and accessories shall conform to IEC- 62271-100 or equivalent Indian Standard.


6.10.3 DUTY REQUIREMENTS

6.8.2.1 Circuit breaker shall be C2/M1 class under all duty conditions and shall be capable of performing their duties without opening resistor. The circuit breaker shall meet the duty requirement of any type of fault or fault location and shall be suitable for line charging and dropping when used on 132 kV effectively grounded or ungrounded systems and perform make and break operations as per the stipulated duty cycles satisfactorily.

6.8.2.2 The Bidder may note that total break time of the breaker shall not be exceeded under any duty conditions specified such as with the combined variation of the trip coil voltage, pneumatic/hydraulic pressure and arc extinguishing medium pressure, etc. While furnishing the proof of the total break time of complete circuit breaker, the Bidder may specifically bring out the effect of non-simultaneity between same pole and poles and show how it is covered in the guaranteed total break time.

6.10.4 CONSTRUCTIONAL FEATURES

6.8.3.1 All the three poles of the breaker shall be linked together either electrically/pneumatically or electro hydraulically.

	<p>Specification for design, supply, installation and commissioning, operations and maintenance of 132kV switchyards, transmission lines / towers, underground cables for 15 MWp solar power plant at NTPC-Singrauli (MP/UP)</p>	<p>PS-439-856 Rev 00 Page 35 of 171</p>
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6.8.3.2 Circuit breakers shall be provided with two (2) independent trip coils, suitable for trip circuit supervision. The trip circuit supervision relay shall also be provided. Necessary terminals shall be provided in the central control cabinet of the circuit breaker.

6.10.5 SULPHUR HEXAFLUORIDE (SF₆) GAS CIRCUIT BREAKER

6.8.4.1 Circuit breakers shall be single pressure type.

6.8.4.2 Each pole shall form an enclosure filled with SF₆ gas independent of two other poles. Common monitoring of SF₆ gas can be provided for the three poles of circuit breaker having a common drive. The interconnecting pipes in this case shall be such that the SF₆ gas from one pole could be removed for maintenance purposes.

6.8.4.3 Sufficient SF₆ gas shall be supplied to fill all the circuit breakers installed plus an additional 20% of the quantity as spare.

6.10.6 OPERATING MECHANISM

6.8.5.1 Circuit breaker shall be operated by pneumatic mechanism or electrically spring charged mechanism or electro-hydraulic mechanism or a combination of these. It shall be gang operated for 3-phase reclosing operation.


6.8.5.2 The pneumatically operated mechanism shall offer unit compressor with each circuit breaker with the breaker local air receivers having a capacity for two 'CO' operations of the breaker at the lowest pressure for reclose duty without refilling.

6.8.5.3 The spring operated mechanism shall be complete with motor, opening spring & closing spring with limit switch for automatic charging and other necessary accessories to make the mechanism a complete operating unit. As long as power is available to the motor, a continuous sequence of closing and opening operations shall be possible. The motor shall have adequate thermal rating for this duty. After failure of power supply to the motor, one close-open operation shall be possible with the energy contained in the operating mechanism. Motor ratings shall be such that it requires not more than 30 seconds for fully charging the closing spring.

6.8.5.4 The hydraulic mechanism shall be suitable for at least two close open operations after failure of ac supply to the motor starting at pressure equal to lowest pressure of auto-reclose duty. All hydraulic joints shall have no oil leakage under the site conditions and joints shall be tested at factory against oil leakage at a minimum of 1.5 times maximum working pressure.

6.10.7 FITTINGS AND ACCESSORIES

6.8.6.1 The insulators and terminal connectors shall conform to requirements stipulated elsewhere. All routine tests shall be conducted on the insulators as per relevant IEC.

	<p>Specification for design, supply, installation and commissioning, operations and maintenance of 132kV switchyards, transmission lines / towers, underground cables for 15 MWp solar power plant at NTPC-Singrauli (MP/UP)</p>	<p>PS-439-856 Rev 00 Page 36 of 171</p>
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6.10.8 UNIT COMPRESSED AIR SYSTEM

6.8.7.1 The unit compressed air system for each breaker shall be provided with compressed air piping, piping accessories, control and non-return valves, filters, coolers of adequate capacity, pressure reducing valves(if any), isolating valves, drain ports, etc. The air compressor shall be driven by automatically controlled motor. It shall be of air cooled type complete with preferably oil-less cylinder lubrication. The compressors or pumps shall be mounted within the operating mechanism housing or a separate weather-proof and dust-proof housing. Each compressor shall be equipped with a time totaliser.

6.8.7.2 (i) The compressor size shall be such that it is capable of performing following operations satisfactorily:

(ii) Total running time of compressor not exceeding 45 minutes per day, considering 2% leakage and 2 CO-operations.

(iii) Air charging time not exceeding 20 minutes after one CO operation of the breaker.

6.8.7.3 Air Receivers:

i) The capacity of receivers shall be sufficient for two (2) CO operations of the breaker.

ii) Air receiver shall be designed in accordance with the latest edition of the ASME Code for Pressure Vessel - Section VIII of BS:5179. A corrosion allowance of 3.0 mm shall be provided for shell and dished ends. Receivers shall be hot dip galvanized.

6.8.7.4 Controls and Control Equipment:

i. The compressor control shall be of automatic start stop type initiated by pressure switches on the receiver. Supplementary manual control shall also be provided.


ii. All control equipment shall be housed in a totally enclosed cabinet. Pressure gauges and other indicating devices, control switches shall be mounted on the control cabinet.

iii. Facility to annunciate failure of power supply to the compressor control shall also be provided.

6.8.7.5 Compressed Air Piping, Valves and Fittings:

i. The flow capacity of all valves shall be at least 20% greater than the compressor capacity.

ii. The high pressure system shall be such that after one 0 - 0.3 Sec - CO operation, the breaker shall be capable of performing one CO operation within 3 minutes.

	<p>Specification for design, supply, installation and commissioning, operations and maintenance of 132kV switchyards, transmission lines / towers, underground cables for 15 MWp solar power plant at NTPC-Singrauli (MP/UP)</p>	<p>PS-439-856 Rev 00 Page 37 of 171</p>
--	--	---

- iii. All compressed air piping shall be bright annealed, seamless phosphorous Deoxidized Non-Arsenical Copper alloy or stainless steel pipe (C-106 of BS:2871).

6.10.9 TESTS

6.8.8.1 TYPE TESTS

Circuit breaker shall confirm to type tests as per IEC in accordance with the requirement stipulated under clause no. 1.05.00.

6.8.8.2 Routine Tests

Routine tests as per IEC-62271-100 on the complete breaker/ pole along with its own operating mechanism and pole column shall be performed on all circuit breakers.

6.8.8.3 SITE TESTS

All routine tests except power frequency voltage dry withstand test on breaker shall be repeated on the completely assembled breaker at site.

6.10.10 PARAMETERS

6.8.9.1 General

- | | |
|--|---|
| a) Type of circuit breaker | Outdoor SF6, single pressure, Live tank |
| b) Number of poles | type Three (3) |
| c) Rated operating duty cycle | O - 0.3 sec. - CO - 3min. – CO |
| d) Reclosing | Three phase high speed auto reclosing |
| e) Total closing time | Not more than 150 ms. |
| f) Maximum difference in the instants of closing/opening of contacts | As per IEC |
| g) Trip and closing coil voltage | 220V DC |



Specification for design, supply, installation and commissioning, operations and maintenance of 132kV switchyards, transmission lines / towers, underground cables for 15 MWp solar power plant at NTPC-Singrauli (MP/UP)

PS-439-856
Rev 00
Page 38 of 171

- h) Auxiliary contacts As required plus 10 NO and 10 NC contacts per pole as spare. The contacts shall have continuous rating of 10A and breaking capacity of 2A with circuit time constant of minimum 20 millisecond at 220V DC.
- i) Noise level Maximum 140dB at 50m distance from base of circuit breaker
- j) Rated terminal load Adequate to withstand 100kg static load as well as wind, seismic and short circuit forces without impairing reliability or current carrying capacity.
- k) Type of operating mechanism Pneumatic/spring/hydraulic/or a combination of these

6.8.9.2 132kV Class Circuit Breakers


- a) Rated voltage 145 kVrms
- b) Rated continuous current 1250 A at rated ambient temperature
- c) Rated short circuit breaking current at rated voltage 31.5kA with percentage of DC component as per IEC corresponding to minimum opening time under operating conditions specified.
- d) Symmetrical interrupting Capability 31.5 kA rms
- e) Short time current carrying Capability 31.5 kA rms for One (1) second
- f) Short circuit making current Capability 80 kAp
- g) Rated out-of-phase breaking 7.8 kA rms
- h) Rated line charging breaking Current (voltage factor of 1.4) As per IEC
- i) Rated small inductive current Switching capability with over voltage less than 2.3 pu 0.5 to 10 A



Specification for design, supply, installation and commissioning, operations and maintenance of 132kV switchyards, transmission lines / towers, underground cables for 15 MWp solar power plant at NTPC-Singrauli (MP/UP)

PS-439-856
Rev 00
Page 39 of 171

- | | |
|---|---|
| j) First pole to clear factor | 1.5 |
| k) Rated break time | 60 ms |
| Total break time | 65 ms |
| l) Rated one minute power frequency withstand voltage (Dry & Wet) | 275 kV rms
. |
| m) Rated lightning impulse withstand voltage (1.2/50 micro sec.) | i) ± 650 kVp between live terminals and earth.
ii) ± 650 kV impulse on one terminal and other terminal earthed with circuit breaker open.
minimum 1750mm or as type tested. |
| n) Pole to pole spacing | |

	<p>Specification for design, supply, installation and commissioning, operations and maintenance of 132kV switchyards, transmission lines / towers, underground cables for 15 MWp solar power plant at NTPC-Singrauli (MP/UP)</p>	<p>PS-439-856 Rev 00 Page 40 of 171</p>
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6.11 DISCONNECTOR

6.9.1 GENERAL


- a) The isolators and accessories shall conform in general to IEC 62271-102 (or equivalent Indian standard) except to the extent explicitly modified in specification.
- b) Earth switches shall be provided on isolators wherever called for.
- c) The isolators and earth switches shall be AC motor operated.
- d) Isolators shall be Horizontal Centre Break type as required.

6.9.2 DUTY REQUIREMENTS

- a) Isolators and earth switches shall be capable of withstanding the dynamic and thermal effects of the maximum possible short circuit current of the system in their closed position. They shall be constructed such that they do not open under influence of short circuit current and wind pressure together. The earth switches wherever provided shall be constructional interlocked so that the earth switches can be operated only when the isolator is open and vice-versa.
- b) In addition to the constructional interlock, isolator and earthswitches 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 fail safe 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 in relevant section. The interlock coil shall be provided with adequate contacts for facilitating permissive logic for 'DC' control scheme of the isolator as well as for AC circuit of the motor to prevent opening or closing of isolators when the interlocking coil is not energised.
- c) The earthing switches shall be capable of discharging trapped charges of the associated lines. Isolator and earth switches shall be able to bear on the terminals the total forces including wind loading and electrodynamic forces on the attached conductor without impairing reliability or current carrying capacity.

6.9.3 CONSTRUCTIONAL FEATURES

- a) The isolators shall be provided with high pressure current carrying contacts on the hinge/ jaw ends and all contact surfaces shall be silver plated. The thickness of silver plating wherever provided should not be less than 25 microns.
- b) The isolator shall be provided with a galvanised steel base provided with holes and designed for mounting on a lattice/pipe support structure. The base shall be rigid and self supporting. The position of movable contact system (main blades) of each of the isolator and earthing switch shall be indicated by a mechanical indicator at the lower end of the vertical rod of shaft for the isolator and earthing switch. The indicator shall be of metal and shall be visible from operating level.

	<p>Specification for design, supply, installation and commissioning, operations and maintenance of 132kV switchyards, transmission lines / towers, underground cables for 15 MWp solar power plant at NTPC-Singrauli (MP/UP)</p>	<p>PS-439-856 Rev 00 Page 41 of 171</p>
---	--	---

- c) All metal parts shall be of non-rusting and non-corroding metal. Current carrying parts shall be 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 equivalent. The live parts shall be designed to eliminate sharp joints, edges and other corona producing surfaces.
- d) The isolators shall be so constructed that the switch blade will not fall to the closed position if the operating shaft gets disconnected. Isolators and earthing switches including their operating parts shall be such that they cannot be dislodged from their open or closed positions by gravity, wind pressure, vibrations shocks or accidental touching of the connecting rods of the operating mechanism. The switch shall be designed such that no lubrication of any part is required except at very infrequent intervals.
- e) The insulator of the isolator shall conform to the requirements stipulated elsewhere and shall have a min. cantilever strength of 600 kg.

6.9.4 EARTHING SWITCHES


Where earthing switches are specified, these shall include the complete operating mechanism and auxiliary contacts. The earthing switches shall form an integral part of the isolator and shall be mounted on the base frame of the isolator. Earthing switches shall be suitable for local operation only. The earthing switches shall be constructionally interlocked with the isolator so that the earthing switches can be operated only when isolator is open and vice versa.

6.9.5 OPERATING MECHANISM AND CONTROL

- a) The Contractor shall offer motor operated switches having padlock arrangement for both 'ON' and 'OFF' positions.
- b) Limit switches for control shall be fitted on the isolator/ earth switch shaft, within the cabinet to sense the open and close positions of the isolators and earth switches.
- c) It shall not be possible, after final adjustment has been made for any part of the mechanism to be displaced at any point in the travel sufficient enough to allow improper functioning of the isolator when the isolator is opened or closed at any speed.
- d) Control cabinet/operating mech. box shall conform to requirements stipulated under auxiliary part and IS:5039/IS 8623/IEC 60439 as applicable.

6.9.6 OPERATION

- a) Isolator shall be electrically/mechanically gang operated for main blades and earth switches. The operation of the three poles shall be well synchronised and interlocked.
- b) 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.

	<p>Specification for design, supply, installation and commissioning, operations and maintenance of 132kV switchyards, transmission lines / towers, underground cables for 15 MWp solar power plant at NTPC-Singrauli (MP/UP)</p>	<p>PS-439-856 Rev 00 Page 42 of 171</p>
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- c) The design of linkages and gears be such so as to allow one man to operate the handle with ease for isolator and earth switch.

6.9.7 TESTS

- a) In continuation to the requirements stipulated elsewhere, the isolator alongwith operating mechanism shall conform to the type tests and shall be subjected to routine tests and acceptance tests in accordance with IEC 62271-102. During final testing of isolator sequential closing/ opening of earth switch shall also be checked only after isolator is fully open/close.
- b) The insulator shall conform to all the type tests as per IEC 60168. In addition to all type, routine and acceptance tests, as per IEC-60168, the following additional routine/ acceptance tests shall also be carried out:
- i) Bending load test in four directions at 50% min. bending load guaranteed in all insulators.
 - ii) Bending load test in four directions at 100% min. bending load guaranteed on sample insulators in a lot.
 - iii) Torsional test on sample insulator of a lot.

6.9.8 PARAMETERS

6.9.8.1 General

- | | |
|---------------------------------------|---|
| a) Type of isolator | Outdoor type |
| b) Number of poles | Three (3) |
| d) Operating time | Not more than 12 sec. |
| e) Control voltage | 220V DC |
| f) Auxiliary contacts on Isolator | As required plus 8NO and 8NC contacts per pole/isolator as spare. The contacts shall have continuous rating of 10A and breaking capacity of 2A with circuit time constant of minimum 20 millisecond at 220V dc. Additionally MBB contacts as required shall also be provided. |
| g) Auxiliary contacts on earth switch | Total 6NO and 6NC |
| h) Rated mechanical terminal load | As per table III of IEC 62271-102 |
| i) Temperature rise over ambient | As per IEC:62271-102 |
| j) Rated mechanical terminal Load | As per table III of IEC 62271-102 |



Specification for design, supply, installation and commissioning, operations and maintenance of 132kV switchyards, transmission lines / towers, underground cables for 15 MWp solar power plant at NTPC-Singrauli (MP/UP)


PS-439-856
Rev 00
Page 43 of 171

k) Operating mechanism of Isolator and Earth Switch

A. C. /Universal Motor operated

6.9.8.2 132kV Class Isolators :

- a) Rated voltage 145 kV rms
- b) Rated current at 50°C ambient temperature 1250A
- c) Rated short time withstand current for 31.5 kA rms One (1) second of isolator and earthswitch
- d) Rated dynamic short circuit withstand current of isolator and earthswitch 80 kAp
- e) Rated Insulation levels
 - i) Rated one minute power withstand voltage ii) 275 kV rms between live terminals and earth. 315 kV rms across isolating distance.
 - ii. Rated lightning impulse Withstand voltage (1.2/50 micro sec)
 - i) 650 kVp between live terminals and earth.
 - ii) 750 kVp impulse on one terminal and other terminal earthed.(across isolating distance).

	<p>Specification for design, supply, installation and commissioning, operations and maintenance of 132kV switchyards, transmission lines / towers, underground cables for 15 MWp solar power plant at NTPC-Singrauli (MP/UP)</p>	<p>PS-439-856 Rev 00 Page 44 of 171</p>
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6.12 INSTRUMENT TRANSFORMER

6.12.2 CODES AND STANDARDS

Current transformers IEC 60044, BS:3938, IS: 2705

Voltage transformers IEC 60044 IEC 60358, IS:3156

Insulating oil IS: 335

6.12.3 GENERAL REQUIREMENTS


- a) The instrument transformers i.e. current and voltage transformers shall be single phase transformer units and shall be supplied with a common marshaling box for a set of three single phase units.
- b) The tank as well as top metallics shall be hot dip galvanised or painted with Grey color of shade RAL 9002.
- c) The instrument transformers shall be hermetically sealed units. The instrument transformers shall be provided with filling and drain plugs.
- d) Polarity marks shall indelibly be marked on each instrument transformer and at the lead terminals at the associated terminal block.
- e) The insulators shall have a cantilever strength of more than 350 kg.

6.12.4 CURRENT TRANSFORMERS (CTs)

- a) The CTs shall have single primary of either ring type or hair pin type or bar type. The Wound Primary type is not acceptable.

In case of "Bar Primary" inverted type CTs, the following requirements shall be met:

- i. The secondaries shall be totally encased in metallic shielding providing a uniform equipotential surface for even electric field distribution.
 - ii. The lowest part of insulation assembly shall be properly secured to avoid any risk of damage due to transportation stresses.
 - iii. The upper part of insulation assembly sealing on primary bar shall be properly secured to avoid any damage during transportation due to relative movement between insulation assembly and top dome.
 - iv. The insulator shall be one piece without any metallic flange joint.
- b) The CT shall be provided with oil sight glass which should be clearly visible to maintenance personnel standing on ground.
 - c) The core lamination shall be of cold rolled grain oriented silicon steel or other equivalent


	<p>Specification for design, supply, installation and commissioning, operations and maintenance of 132kV switchyards, transmission lines / towers, underground cables for 15 MWp solar power plant at NTPC-Singrauli (MP/UP)</p>	<p>PS-439-856 Rev 00 Page 45 of 171</p>
--	--	---

alloys. The cores shall produce undistorted secondary current under transient conditions at all ratios with specified parameters.

- d) Different ratios shall be achieved by secondary taps only, and primary reconnections shall not be accepted.
- e) The guaranteed burdens and accuracy class are to be intended as simultaneous for all cores.
- f) The instrument security factor at all ratios shall be less than five (5) for metering core. If any auxiliary CT/reactor is used, then all parameters specified shall be met treating auxiliary CTs/reactors as integral part of CT. The auxiliary CT/reactor shall preferably be in-built construction of the CT. In case it is separate, it shall be mounted in secondary terminal box.
- g) The physical disposition of protection secondary cores shall be in the same order as given under CT requirement table(s) given below.
- h) The secondary terminals shall be terminated on stud type suitable no's of non-disconnecting and disconnecting terminal blocks as required inside the terminal box of degree of protection IP:55 at the bottom of CT.
- i) The CTs shall have provision for taking oil samples from bottom of CT without exposure to atmosphere to carry out dissolved gas analysis periodically. Contractor shall give his recommendations for such analysis, i.e. frequency of test, norms of acceptance, quantity of oil to be withdrawn, and treatment of CT.
- j) The CT shall have provision for measurement of capacitance and tan delta as erected at site.

6.12.5 VOLTAGE TRANSFORMERS (CVTs)

- a) Voltage transformers shall be of capacitor voltage divider type with electromagnetic unit.
- b) The CVTs shall be thermally and dielectrically safe when the secondary terminals are loaded with guaranteed thermal burdens.
- c) The electro-magnetic unit (EMU) shall comprise of compensating reactor, intermediate transformer, and protective and damping devices. The oil level indicator of EMU with danger level marking shall be clearly visible to maintenance personnel standing on ground.
- d) The secondaries shall be protected by HRC cartridge type fuses for all windings. In addition fuses shall also be provided for protection and metering windings for connection to fuse monitoring scheme. The secondary terminals shall be terminated on stud type non-disconnecting terminal blocks via the fuse inside the terminal box of degree of protection IP: 55. The access to secondary terminals shall be without the danger of access to high voltage circuit.
- e) The protection cores shall not saturate at about 1.5 times the rated voltage for a min. duration of 30 secs.

	<p>Specification for design, supply, installation and commissioning, operations and maintenance of 132kV switchyards, transmission lines / towers, underground cables for 15 MWp solar power plant at NTPC-Singrauli (MP/UP)</p>	<p>PS-439-856 Rev 00 Page 46 of 171</p>
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- f) The accuracy of metering core shall be maintained through the entire burden range upto 75VA on all three windings without any adjustments during operations.

6.12.6 MARSHALLING BOX

Marshaling box shall conform to all requirements as given elsewhere. The wiring diagram for the interconnection of three phase instrument transformer shall be pasted inside the box. Terminal blocks in the marshaling box shall have facility for star/delta formation, short circuiting and grounding of secondary terminals. The box shall have enough terminals to wire all control circuits plus 20 spare terminals.

6.12.7 PARAMETERS FOR CURRENT TRANSFORMERS

6.12.7.1 General Parameters

- | | |
|--|---|
| a) One minute power frequency withstand voltage between secondary terminal and earth | 5 kV |
| b) Partial discharge level | 10 pico Coulombs max. |
| c) Temperature rise | As per IEC 60044 |
| d) Type of insulation | Class A |
| e) Number of cores | Five (5): Details are given in table below. |
| f) Installation | Outdoor (up right) |
| g) Number of terminals in marshalling box | All terminals of control circuits wired upto marshalling box plus 20 terminals spare. |
| h) System Neutral earthing | Effectively |
| i) Seismic acceleration | earthed 0.3g
Horizontal |



Specification for design, supply, installation and commissioning, operations and maintenance of 132kV switchyards, transmission lines / towers, underground cables for 15 MWp solar power plant at NTPC-Singrauli (MP/UP)

PS-439-856
Rev 00
Page 47 of 171

6.12.7.2 132 kV Current Transformers

- a) Rated short time thermal current 31.5 kA for 1 sec.
- b) Rated dynamic current 80 kA (peak)
- c) Rated system voltage (Um) 145 kV (rms)
- d) Rated extended primary current 120% of rated primary current.
- e) Rated insulation level :
 - i) 1.2/50 micro seconds 650 kV (Peak)
 (impulse voltage)
 - ii) 1 minute (dry and wet) 275 kV (rms)
 power frequency withstand voltage
- f) Radio interference voltage at 1000 micro volts
 92kV (rms)
- g) Rated Extended primary Current - 120% of rated primary current



Specification for design, supply, installation and commissioning, operations and maintenance of 132kV switchyards, transmission lines / towers, underground cables for 15 MWp solar power plant at NTPC-Singrauli (MP/UP)


PS-439-856
Rev 00
Page 48 of 171

6.12.8 PARAMETERS FOR VOLTAGE TRANSFORMERS

6.12.8.1 General Parameters

TECHNICAL SPECIFICATIONS

- | | |
|---|---|
| a) Installation | Outdoor |
| b) Standard reference range of frequencies for which the accuracies are valid | 96% to 102% for protection and 99% to 101% for measurement. |
| c) High frequency capacitance for carrier frequency range | Within 80% to 150% of rated entire capacitance |
| d) Equivalent resistance over entire carrier frequency range | Less than 40 ohms |
| e) Stray capacitance and stray conductance of LV terminal over entire carrier frequency range | As per IEC:60358 |
| f) One minute power frequency withstand voltage | |
| a) between LV (HF) terminal and earth | 10kV rms for exposed terminals or 4 kV rms for terminals enclosed in a weather proof box. |
| b) For secondary winding | 2 kV rms |
| g) Temp. rise over an ambient temp. of 50 deg. C | As per IEC 60044 |
| h) Number of terminals in control Cabinet | All terminals of control circuits wired upto marshalling box plus 10 terminals spare. |

	<p>Specification for design, supply, installation and commissioning, operations and maintenance of 132kV switchyards, transmission lines / towers, underground cables for 15 MWp solar power plant at NTPC-Singrauli (MP/UP)</p>	<p>PS-439-856 Rev 00 Page 49 of 171</p>
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- | | |
|-------------------------------|---------------------------------------|
| i) Rated total thermal burden | 750 VA |
| j) Partial discharge level | 10 pico Coulombs max. |
| k) Number of cores | As per details given in Tables below. |
| l) Rated Voltage factor | 1.2 continuous , 1.5 – 30sec |

6.12.8.2 132kV Voltage Transformer

- | | |
|---|-------------------------|
| a) Rated system voltage | 145 kV (rms) |
| b) HF Capacitance | 4400 pf (nominal) |
| c) Rated insulation levels | |
| i) 1.2 micro sec. impulse | 650 kV (peak) |
| ii) 1 min (dry & wet) power frequency withstand voltage | 1050 kV (peak) |
| d) Radio Interference voltage at 92 kV(rms) | 1000 micro volts (max.) |

6.12.9 TESTS

The current and voltage transformers shall confirm to type tests and shall be subjected to routine tests in accordance with the relevant IS/IEC and shall also conform to the following additional type tests as applicable :

- i) Radio Interference test- As per IS:8263
- ii) Thermal withstand test i.e. application of rated voltage and rated current simultaneously by synthetic test circuit.(For CT only)
- iii) Thermal co-efficient test i.e. measurement of Tan-Delta as function of temperature (at ambient and between 80 deg. C and 90 deg. C) and voltage (at 0.3, 0.7, 1.0 and 1.1 Um). (For CT only)
- iv) Multiple chopped impulse test on Primary winding.



Specification for design, supply, installation and commissioning, operations and maintenance of 132kV switchyards, transmission lines / towers, underground cables for 15 MWp solar power plant at NTPC-Singrauli (MP/UP)

PS-439-856
Rev 00
Page 50 of 171

CORE DETAILS OF 132 KV CT

Core No.	Application	Current Ratio(A)	Output Burden (VA)	Accuracy Class as per IEC 185	Min. knee point voltage (V)	Max. CT Sec. wdg. Resistance (ohms)	Max. exciting current in mA at knee voltage
1	Bus Diff. Check	1200/ 600/ 300/1	-	PS	1200/ 600/ 300	10/ 5 /2.5	40/80/160
2	Bus Diff. Main	1200/ 600/ 300/1	-	PS	1200/ 600/ 300	10/ 5 /2.5	40/80/160
3	Metering and synchronizing	1200/ 600/ 300//150/ 1	20	0.2s	-	-	
4	Trans. back up/ Line protn	1200/ 600/ 300/1	-	PS	1200/ 600/ 300	10/ 5 /2.5	40/80/ 160
5	Trans. Backup/ Line protn	1200/ 600/ 300/1	-	PS	1200/ 600/ 300	10/ 5 /2.5	40/80/160

1. The rated extended primary current of all CTs shall be 120 % continuous of 1200A.


2. All relaying CTs shall be of accuracy class PS as per IS:2705

Note: Core 1 & 2 details of switchyard end (Singrauli) CT shall be identical to existing 132kV CTs.

CORE DETAILS OF 132 KV CVTs

Particulars	Secondary I	Secondary II	Secondary III
Rated secondary voltage	110 / $\sqrt{3}$	110 / $\sqrt{3}$	110 / $\sqrt{3}$
Application	Protection	Protection	Metering
Accuracy	3P	3P	0.2
Output Burden (minimum)	75 VA	75 VA	75 VA

- The accuracy of 0.2 on secondary III should be maintained through the entire burden range upto 75 VA on all the three windings without any adjustments during operation.

	<p>Specification for design, supply, installation and commissioning, operations and maintenance of 132kV switchyards, transmission lines / towers, underground cables for 15 MWp solar power plant at NTPC-Singrauli (MP/UP)</p>	<p>PS-439-856 Rev 00 Page 51 of 171</p>
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6.13 SURGE ARRESTOR

6.13.2 GENERAL

- a) The surge arrestors shall conform in general to IEC-60099-4 and IS:3070 except to the extent modified in the specification.
- b) Arrestors shall be hermetically sealed units, self supporting construction, suitable for mounting on lattice/tubular type support structures.

6.13.3 DUTY REQUIREMENTS

- a) The Surge Arresters (SAs) shall be capable of discharging over-voltages occurring due to switching of unloaded transformers, reactors and long lines.
- b) The reference current of SAs shall be high enough to eliminate the influence of grading and stray capacitance on the measured reference voltage.
- c) The SAs shall be capable of withstanding meteorological and short circuit forces under site conditions.

6.13.4 CONSTRUCTIONAL FEATURES

- a) Each Surge Arrester (SA) shall be hermetically sealed single phase unit.
- b) The non linear blocks shall be sintered metal oxide material. The SA construction shall be robust with excellent mechanical and electrical properties.
- c) SAs shall have pressure relief devices and arc diverting ports suitable for preventing shattering of porcelain housing and to provide path for flow of rated fault currents in the event of SA failure.
- d) The SA shall not fail due to porcelain contamination.
- e) Seals shall be effectively maintained even when SA discharges rated lightning current.
- f) Porcelain shall be so coordinated that external flashover will not occur due to application of any impulse or switching surge voltage up to maximum design value for SA. The cantilever strength of the insulator shall be minimum 350kg.
- g) The end fittings shall be non-magnetic and of corrosion proof material. The metal flanges shall be fixed with the porcelain by cement or other materials so as to withstand the forces experienced in normal operation and provide continuous sealing for entry of moisture for a period of minimum 20 years.
- h) The Contractor shall furnish the following:
 - a. The heat treatment cycle details with necessary quality checks used for individual



Specification for design, supply, installation and commissioning, operations and maintenance of 132kV switchyards, transmission lines / towers, underground cables for 15 MWp solar power plant at NTPC-Singrauli (MP/UP)

PS-439-856
Rev 00
Page 52 of 171

blocks along with insulation layer formed across each block.

- b. Metalizing coating thickness for reduced resistance between adjacent discs along with procedure for checking the same.
- c. Details of thermal stability test for uniform distribution of current on individual discs.
- d. Detailed energy calculations to prove thermal capability of discs.

6.13.5 FITTINGS AND ACCESSORIES

- a) Each SA shall be complete with insulating base for mounting on structure.
- b) SAs shall be provided with grading and/or corona rings as required.
- c) Self contained discharge counters, suitably enclosed for outdoor use (IP:55 degree of protection) and requiring no auxiliary or battery supply shall be fitted with each SA along with necessary connections to SA and earth. Suitable leakage current meters shall also be supplied in the same enclosure. The reading of milli-ammeter and counter shall be visible through an inspection glass panel to a man standing on ground. A pressure relief vent/suitable provision shall be made to prevent pressure build up.

6.13.6 PARAMETERS

6.13.6.1 General

- | | |
|--|--|
| a) System neutral earthing | Effectively earthed |
| b) Installation | Outdoor |
| c) i) Nominal discharge current | 10 kA of 8/20 microsec. wave |
| ii) Discharge current at which insulation coord. is done | 20 kA of 8/20 microsec. wave |
| d) Rated frequency | 50 Hz |
| e) Long duration discharge class | 3 |
| f) Current for pressure relief test | 31.5kA rms |
| g) Prospective symmetrical fault current | 31.5 kA rms for 1 second |
| h) Low current long duration test value (2000 micro sec.) | 800 A |
| i) Pressure relief class | Class A of Table VII of IS:3070 or equivalent IEC. |
| j) Partial discharge at 1.05 MCOV (Continuous operating voltage) | Not more than 50 pC |



Specification for design, supply, installation and commissioning, operations and maintenance of 132kV switchyards, transmission lines / towers, underground cables for 15 MWp solar power plant at NTPC-Singrauli (MP/UP)

PS-439-856
Rev 00
Page 53 of 171

- k) Siesmic acceleration 0.3 g horizontal
l) Reference ambient temp. 50 deg. C

6.13.6.2 132 kV class Surge Arrestors

- a) Rated system voltage 145 kV
b) Rated arrestor voltage Not less than 120 kV
c) Minimum discharge capability 5 kJ/kV (referred to rated arrestor voltage corresponding to minimum discharge characteristics).
d) Continuous operating voltage (COV) at 50 deg. C 102 kV rms
e) Maximum Switching surge residual voltage (1 kA) 280 kVp
f) Maximum residual voltage at
i) 5kA nominal discharge current 310 kVp
ii) 10kA nominal discharge current 330 kVp
g) Steep fronted wave residual voltage at 10kA 370 kVp
h) High current short duration test value (4/10 microsec. wave) 100 kAp
i) One minute dry/wet power frequency withstand voltage of arrestor housing 275 kV (rms)
j) Impulse withstand voltage of arrestor Housing with 1.2/50 micro sec. wave. 650 kVp
k) RIV at 92 kV (rms) Less than 1000 micro volts
l) The surge arrestors are provided to protect the following equipment whose insulation levels are indicated in the table I given below. The contractor shall carry out the insulation coordination studies for deciding the location of the surge arrestors.


	<p>Specification for design, supply, installation and commissioning, operations and maintenance of 132kV switchyards, transmission lines / towers, underground cables for 15 MWp solar power plant at NTPC-Singrauli (MP/UP)</p>	<p>PS-439-856 Rev 00 Page 54 of 171</p>
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TABLE – I

S.NO.	EQUIPMENT TO BE PROTECTED	INSULATION LEVEL	
		LIGHTNING FOR 132 KV	IMPULSE (kVp) SYSTEM
1.	Power Transformer		550
2.	Instrument Transformer		650
	CB/Isolator		
	- Phase to ground		650
	- Across open contacts		650

6.13.7 Surge Arrestors shall conform to all type tests as per IEC and shall be subjected to routine and acceptance tests in accordance with IEC-60099-4.

6.13.8 The resistive current drawn by the arrestor at rated voltage shall be indicated in the routine test report.

6.14 POST INSULATOR

6.14.2 GENERAL


The post insulators shall conform in general to latest IS:2544 and IEC – 60815, 60168.

6.14.3 CONSTRUCTIONAL FEATURES

- a) Post type insulators shall consist of a porcelain part permanently secured in a metal base to be mounted on the supporting structures. They shall be capable of being mounted upright. They shall be designed to withstand any shocks to which they may be subjected to by the operation of the associated equipment. Only solid core insulators shall be accepted. Height of post insulator shall be preferably as given under parameters of this part.
- b) Other requirements of insulator as given under auxiliary requirements shall also be applicable.

6.14.4 TESTS

- 6.14.4.1 In accordance with the stipulations elsewhere the post insulators shall conform to type tests and acceptance, sample and routine tests as per IS:2544, IEC-60168 shall be carried out.

	<p>Specification for design, supply, installation and commissioning, operations and maintenance of 132kV switchyards, transmission lines / towers, underground cables for 15 MWp solar power plant at NTPC-Singrauli (MP/UP)</p>	<p>PS-439-856 Rev 00 Page 55 of 171</p>
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6.14.4.2 In addition to acceptance/sample/routine tests as per IS:2544, IEC-60168, the following tests shall also be carried out.

- a) Ultrasonic tests on all cutshells as routine check.
- b) Visual examination and magnaflux test on all flanges prior to fixing.
- c) Check for uniformity of thickness and weight of zinc coating as a sample test from each lot of flanges prior to fixing.
- d) Bending load test shall be carried out at 50% minimum failing load in four directions as a routine test.
- e) Bending load in four directions at 100% minimum bending load guaranteed on samples as per clause-2.3 of IEC. Subsequently this post insulator shall not be used.
- f) Tests for deflection measurement at 20, 50, 70% of specified minimum failing load on sample.


6.14.4.3 The post insulator shall conform to following type tests :

- a) Lightning Impulse withstand test (dry)
- b) Power frequency withstand test (dry & wet)
- c) Measurement of RIV
- d) Test for deflection under load.
- e) Test for mechanical strength,

6.14.4.4 PARAMETERS

132 kV class Bus Post Insulators

a) Type	Solid core
b) Voltage class (kV)	145
c) Dry and wet one minute power frequency withstand voltage (kV)	275
d) Dry impulse withstand positive and negative (kVp)	650
e) Total min. cantilever strength (Kg)	600
f) Min. torsional moment (Kg m)	500
g) Total height of insulator (mm)	1500
i) Top p.c.d. (mm)	127
ii) Bottom p.c.d. (mm)	225

	<p>Specification for design, supply, installation and commissioning, operations and maintenance of 132kV switchyards, transmission lines / towers, underground cables for 15 MWp solar power plant at NTPC-Singrauli (MP/UP)</p>	<p>PS-439-856 Rev 00 Page 56 of 171</p>
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- | | | |
|----|-----------------------------|--------|
| h) | No. of bolts : Top | 4 |
| | : Bottom | 4 |
| i) | Diameter of bolt holes (mm) | |
| | : Top | M16 |
| | : Bottom | dia 18 |

6.15 REQUIREMENT OF AUXILIARY ITEMS

6.15.2 ALUMINIUM TUBULAR CONDUCTOR


- 1) The aluminium tube shall be grade 63401 WP(range2) as per IS 5082.
- 2) There shall be no negative tolerance on OD and thickness of the tube. Other tolerances shall be as per IS:2678 and 2673.
- 3) Tests: In accordance with stipulations of specification routine tests shall be conducted on tubular conductor as per IS:5082. Also the wall thickness and ovality shall be measured by ultrasonic method. In addition 0.2% proof tests on both parent material and aluminium tube after welding shall be conducted.
 - a) Size 3" IPS (EH type),
 - b) Outer diameter 88.9 mm with no negative tolerance
 - c) Thickness of tube 7.62 mm with no negative tolerance
 - d) Cross-sectional area 1947 sq. mm.
 - e) Aluminum grade 63401 WP(range 2) conforming to IS:5082.

6.15.3 ACSR CONDUCTOR

- | | | |
|----|------------------------------|------------------|
| a) | Code and standard | IS 398 |
| b) | Name | MOOSE ACSR |
| c) | Overall diameter | 31.77 mm |
| d) | Weight | 2.004 kg/m |
| e) | Ultimate tensile strength | 161.2 kN minimum |
| f) | Strands and wire diameter of | |
| | - Aluminium | 54 / 3.53 mm |
| | - Steel | 7 / 3.53 mm |

6.15.4 CLAMPS AND CONNECTORS

- a) The material of clamps and connectors shall be Aluminium alloy casting conforming to designation A6 of IS:617 for connecting to equipment terminals and conductors of aluminium. In case equipment terminals are of copper, the same clamps/connectors shall be used with 2mm thick bimetal.
- b) The material of clamps and connectors shall be Galvanised mild steel for connecting to G.S.shield wire.
- c) Bolts, nuts and plain washers shall be hot dip galvanised mild steel for sizes M12 and above. For sizes below M12, they shall be electro-galvanised mild steel. The spring washers shall be electro-galvanised mild steel.

	<p>Specification for design, supply, installation and commissioning, operations and maintenance of 132kV switchyards, transmission lines / towers, underground cables for 15 MWp solar power plant at NTPC-Singrauli (MP/UP)</p>	<p>PS-439-856 Rev 00 Page 57 of 171</p>
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- d) All castings shall be free from blow holes, surface blisters, cracks and cavities. All sharp edges and corners shall be rounded off to meet specified corona and radio interference requirements.
- e) They shall have same current rating as that of the connected equipment. All current carrying parts shall be at least 10 mm thick. The connectors shall be manufactured to have minimum contact resistance.
- f) Flexible connectors, braids or laminated strips shall be made up of copper/aluminium.
- g) Current rating and size of terminal/conductor for which connector is suitable shall be put on a suitable sticker on each component which should last atleast till erection time.

6.15.5 INSULATOR STRING HARDWARE

- 1) The insulator hardware shall be of bolted type and shall be of forged steel except for insulator cap, which can be of malleable cast iron. It shall also generally meet the requirements of clamps and connectors as specified above.
- 2) In one span, Tension string assembly at one end shall be supplied with suitable turn buckle.
- 3) Disc Insulator for porcelain type insulator
The disc insulator shall meet the following parameters:
 - a. Type : Antifog type insulator
 - b. Size of insulator : 255x145
 - c. Electro mechanical strength : 120kN
 - d. Leakage distance (mm) : 430mm minimum or as required to meet the total creepage.
 - e. Power frequency withstand voltage : 85 kV (dry), 50kV (wet)

4) Insulator string


The insulator string shall meet the following parameters

132 KV

- | | | |
|----|-----------------------------|---|
| | Type | Porecelain type/composite type |
| a) | Creepage distance | 3625 mm |
| b) | PF withstand voltage | 275 KV 1 min(rms)
(dry and wet) |
| c) | L / I withstand voltage | +/- 650 KV |
| d) | No. of disc insulator | 10 nos. for porcelain type |
| e) | Electro mechanical strength | 120 KN / string-porcelain
160kN for composite type |

6.15.6 EARTHING CONDUCTOR

- a) The main conductor buried in earth shall be 40mm dia rod for main and auxiliary mat. The earthing conductors over the ground shall be of 75x12 mm GS flat. The earthing leads for columns and auxiliary structures, cable trenches shall be of 75x12 mm GS flat. The earthing of the lighting fixtures shall be carried out by 16 SWG wire.

	<p>Specification for design, supply, installation and commissioning, operations and maintenance of 132kV switchyards, transmission lines / towers, underground cables for 15 MWp solar power plant at NTPC-Singrauli (MP/UP)</p>	<p>PS-439-856 Rev 00 Page 58 of 171</p>
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- b) All earthing conductors above the ground level shall be galvanised steel only.

6.15.7 Earthwire for Lightning Protection

- | | |
|------------------------------------|--|
| a) Number of strands | 7 of steel |
| b) Strand diameter | 3.66 mm |
| c) Overall diameter | 10.98 mm |
| d) Weight | 583 kg/km approx. |
| e) Ultimate tensile strength | 68.4 kN minimum |
| f) Total cross-sectional area | 73.65 sq.mm. |
| g) Calculated d.c. resistance | 2.5 ohms/km at 20 deg.C. |
| h) Direction of lay of outer layer | Right hand |
| i) Protective coating for storage | Boiled linseed oil to avoid wet storage stains
(white rust) |


The earth wire shall be preformed and post formed quality.

6.15.8 BUSHINGS, HOLLOW COLUMN INSULATORS, SUPPORT INSULATORS, AND DISC INSULATORS

- a) Bushings shall be manufactured and tested in accordance with IS:2099& IEC:60137 while hollow column insulators shall be manufactured and tested in accordance with IEC 62155/IS 5284. The support insulators shall be manufactured and tested as per IS:2544 / IEC 60168/IEC 60273. The insulators shall also conform to IEC 60815 as applicable having alternate long and short sheds.

Support insulators/ bushings/ hollow column insulators shall be designed to have ample insulation, mechanical strength and rigidity for the conditions under which they will be used.

- b) Porcelain used shall be homogenous, free from laminations, cavities and other flaws or imperfections that might affect the mechanical or dielectric quality and shall be thoroughly vitrified, tough and impervious to moisture.
- c) Glazing of the porcelain shall be uniform brown in colour, free from blisters, burns and other similar defects.
- d) The design of the insulator shall be such that stresses due to expansion and contraction in any part of the insulator shall not lead to deterioration. All ferrous parts shall be hot dip galvanised.
- e) Post type insulators shall consist of a porcelain part permanently secured in metal base to be mounted on supporting structures. They shall be capable of being mounted upright. They shall be designed to withstand all shocks to which they may be subjected to during operation of the associated equipment.
- f) Bushing porcelain shall be robust and capable of withstanding the internal pressures likely to occur in service. The design and location of clamps, the shape and the strength of the porcelain flange securing the bushing to the tank shall be such that there is no risk of fracture. All portions of the assembled porcelain enclosures and supports other than gaskets, which may in any way be exposed to the atmosphere shall be composed of completely non hygroscopic material such as metal or glazed porcelain.
- g) All iron parts shall be hot dip galvanised and all joints shall be air tight. Surface of joints shall be trued, porcelain parts by grinding and metal parts by machining. Insulator/

	<p>Specification for design, supply, installation and commissioning, operations and maintenance of 132kV switchyards, transmission lines / towers, underground cables for 15 MWp solar power plant at NTPC-Singrauli (MP/UP)</p>	<p>PS-439-856 Rev 00 Page 59 of 171</p>
--	--	---

bushing design shall be such as to ensure a uniform compressive pressure on the joints.

- h) In accordance with the requirements stipulated elsewhere, bushings, hollow column insulators and support insulators shall conform to type tests and shall be subjected to routine tests and acceptance test/ sample test in accordance with relevant standards.

6.15.9 CABINETS, BOXES, KIOSKS, PANELS, ETC.

All types of control cabinets, junction boxes, marshaling boxes, lighting panels, terminal boxes, operating mechanism boxes, Kiosks etc. shall generally conform to IS:5039, IS:8623 and IEC: 60439 as applicable. They shall meet all other requirements specified elsewhere in the specification.

6.15.10 BAY MARSHALLING BOX

- a) Bay Marshaling Box located at a convenient location to receive and distribute cables shall be provided as required. It shall meet all the requirements as specified for cabinets/boxes.
- b) It shall have three separate distinct compartments for following purposes:
- i. To receive two incoming 415V, three phase, AC supplies controlled by 100A four pole MCBs with auto changeover provision, and to distribute five (5) three phase ac supplies controlled by 32A four pole MCBs. It shall also be provided with 63A, 3 phase 4 pin industrial grade receptacle with rotary switch.
 - ii. To receive three phase incoming from first compartment and to distribute ten (10) single phase ac supplies controlled by 16A two pole MCBs.
 - iii. 150 nos. terminal blocks in vertical formation for interlocking facility.

6.15.11 AUXILIARY SWITCH FOR CIRCUIT BREAKERS


The auxiliary switch shall conform of following type tests:

- a) Electrical endurance test - A minimum of 1000 operations for 2A. D.C. with a time constant greater than or equal to 20 milliseconds with a subsequent examination of mV drop/ visual defects/ temperature rise test.
- b) Mechanical endurance test - A minimum of 5000 operations with a subsequent checking of contact pressure test/ visual examination
- c) Heat run test on contacts
- d) IR/HV test, etc.

6.15.12 Type tests

All equipment with their terminal connectors, control cabinets, main protective relays, etc. as well as insulators, insulator strings with hardwares, clamps and connectors, marshalling boxes, etc., shall conform to type tests and shall be subjected to routine and acceptance tests in accordance with the requirements stipulated under respective equipment sections.

6.16 INSTALLATION

	<p>Specification for design, supply, installation and commissioning, operations and maintenance of 132kV switchyards, transmission lines / towers, underground cables for 15 MWp solar power plant at NTPC-Singrauli (MP/UP)</p>	<p>PS-439-856 Rev 00 Page 60 of 171</p>
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6.16.2 EARTHING

The earthing shall be done in accordance with requirements given in Annexure-I of this section and drawing enclosed with the specifications. Earthing of panels shall be done in line with the requirements given in respective equipment section of this specification.

6.16.3 CIVIL WORKS

The civil works shall be done in accordance with requirements stipulated elsewhere in the specification.

6.16.4 STRUCTURAL STEEL WORKS

The structural steel works shall be done in accordance with requirements stipulated elsewhere in the specification.

6.16.5 BAY EQUIPMENT


- a) The disposition of equipment to be supplied is shown in enclosed tender drawings.
- b) The Contractor shall prepare layout drawings and submit the same for approval of the Employer. The approval of drg. shall not absolve Contractor from his responsibility regarding designing & engineering of switchyard and Contractor shall be fully responsible for all works covered in the scope of this specification.

6.16.6 LIGHTNING PROTECTION

- a) Direct stroke lightning protection (DSLPP) shall be provided in the switchyard by lightning masts (at least 50 m high) and shield wires.
- b) Lightning protection System down conductors shall not be connected to other conductors above ground level. Also no intermediate earthing connection shall be made to Surge arrester, Voltage Transformer, earthing leads for which shall be directly connected to rod electrode.
- c) Every down conductor shall be provided with a test joint at about 150mm above ground level. The test joint shall be directly connected to the earthing system.
- d) The lightning protection system shall not be in direct contact with underground metallic service ducts and cables.

6.16.7 EQUIPMENT ERECTION NOTES

- a) All support insulators, circuit breaker interrupters and other fragile equipment shall be handled with cranes with suitable booms and handling capacity.
- b) 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

	<p>Specification for design, supply, installation and commissioning, operations and maintenance of 132kV switchyards, transmission lines / towers, underground cables for 15 MWp solar power plant at NTPC-Singrauli (MP/UP)</p>	<p>PS-439-856 Rev 00 Page 61 of 171</p>
--	--	---


and commissioning. Any equipment damaged due to negligence or carelessness or otherwise shall be replaced by the Contractor at his own expense. The contractor shall strictly follow manufacturer's recommendations for handling and erection of equipment.

- c) The slings shall be of sufficient length to avoid any damage to insulator due to excessive swing, scratching by sling ropes etc. Handling equipment, sling ropes etc. should be tested before erection and periodically thereafter for strength.
- d) Bending of piping should be done by a bending machine and through cold bending only. Bending shall be such that inner diameter of pipe is not reduced. The pipes shall be thoroughly cleaned before installation.
- e) Cutting of the pipes wherever required shall be such as to avoid flaring of the ends. Hence only a proper pipe cutting tool shall be used. Hack saw shall not be used.
- f) For cleaning the inside and outside of hollow insulators only Muslin or leather cloth shall be used.
- g) The rigid busbars for equipment interconnections shall have rigid connections at one end and expansion / flexible at the other end. The tubular aluminium connections shall have not more than one joint per span. Since no wastages are permissible, the bidder shall work out the cut lengths of aluminum tube based on finalized layout and dispatch the same to site without requiring BHEL approval. Corona bells shall be provided at the end of the rigid busbars.

6.16.8 CABLING

- a) Cabling shall be on cable racks, in trenches, vertical shafts, excavated trenches for direct burial, pulled through pipes and conduits run clamped on steel structures etc. in accordance with the requirements specified elsewhere in the specification.
- b) Cables inside the switchyard shall be laid on GI angle supports at 600mm spacing with separate tiers for control and power cables. The GI angles shall be bolted / welded to galvanized insert plates inside RCC trenches.
- c) Cables shall be generally located adjoining the electrical equipment through the pipe insert embedded in the ground. In the case of equipment located away from cable trench either pipe inserts shall be embedded in the ground connecting the cable trench and the equipment or in case the distance is small, notch/opening shall be provided. In all these cases necessary bending radii as recommended by the cable supplier shall be maintained.
- d) Cabling in the control room shall be done on ladder type cable trays with supports at an interval of 2000mm.
- e) All interpole cables (both power & control circuit) for equipments shall be laid in cable trenches/G.I. Conduit Pipe of NB 50/100mm which shall be buried in the ground at a depth of 300mm.

6.16.9 EARTHING FOR SWITCHYARD

	<p>Specification for design, supply, installation and commissioning, operations and maintenance of 132kV switchyards, transmission lines / towers, underground cables for 15 MWp solar power plant at NTPC-Singrauli (MP/UP)</p>	<p>PS-439-856 Rev 00 Page 62 of 171</p>
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a) GENERAL

- i. Earthing of operating boxes, cubicles shall be done by 50 X 6 mm GS flat while cable trenches and structure by 75 X 12 mm GS flat.
- ii. Neutral points of systems of different voltages, metallic enclosures and frame works associated with all current carrying equipments and extraneous metal works associated with electric system shall be connected to a single earthing system unless stipulated otherwise.
- iii. Earthing system installation shall be in strict accordance with the latest editions of Indian Electricity Rules, relevant Indian Standards and Codes of practice and Regulations existing in the locality where the system is installed.

b) DETAILS OF EARTHING SYSTEM


Item	Size	Material
Main Earthing conductor	40mm dia rod	Mild steel Galvanize
Conductor above ground & earthing leads (for equipment)	75 x 12/ G.S. Flat 50 x 6	d steel
Rod Electrode	40mm dia, 3000mm	Mild steel
G.I. Earthwire	7/8 SWG	GI

c) For Step and Touch Potential the following parameters shall be considered

- i) Current distribution factor – 1 (one)
 - ii) Duration of fault current – 0.5 sec
 - iii) Human body weight – 50kg
- d) Grid resistance shall be less than 1(one) ohm.

e) EARTHING CONDUCTOR LAYOUT

- i. Earthing conductors in outdoor areas shall be buried at least 600mm below finished grade level unless stated otherwise.
- ii. Minimum 6000mm or higher spacing between rod electrodes shall be provided based on the earthmat design calculations.
- iii. Wherever earthing conductors cross cable trenches, underground service ducts, pipes, tunnels, railway tracks etc., it shall be laid at least 300mm below them and shall be re-routed in case it fouls with equipment/structure foundations.
- iv. Tap connections from the earthing grid to the equipment/structure to be earthed, shall be terminated on the earthing terminals of the equipment/structure, if the equipment is available at the time of laying the grid. Otherwise, “earth insert”


	<p>Specification for design, supply, installation and commissioning, operations and maintenance of 132kV switchyards, transmission lines / towers, underground cables for 15 MWp solar power plant at NTPC-Singrauli (MP/UP)</p>	<p>PS-439-856 Rev 00 Page 63 of 171</p>
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with temporary wooden cover or “earth riser” shall be provided near the equipment foundation/pedestal for future connections to the equipment earthing terminals.

- v. Earthing conductor along their run on cable trench ladder columns, beams, walls, etc. shall be supported by suitable welding/cleating at intervals of 750mm. Earthing conductors along cable trenches shall be on the wall nearer to the equipment. Wherever it passes through walls, floors etc. galvanized iron sleeves shall be provided for the passage of the conductor. Both ends of the sleeves shall be sealed to prevent the passage of water through the sleeves.
- vi. Earthing conductor around the building shall be buried in earth at a minimum distance of 1500mm from the outer boundary of the building. In case high temperature is encountered at some location, the earthing conductor shall be laid minimum 1500mm away from such location.
- vii. In outdoor areas, tap connections shall be brought 300mm above ground level for making connections in future, in case equipment is not available at the time of grid installations.
- viii. Earthing conductors crossing the road shall be either installed in hume pipes or laid at greater depth to suit the site conditions.
- ix. Earthing conductors embedded in the concrete fibre shall have approximately 50mm concrete cover.

f) EQUIPMENT AND STRUCTURE EARTHING

- i. The connection between earthing pads and the earthing grid shall be made by short and direct earthing leads free from kinks and splices. In case earthing pads are not provided on the item to be earthed, same shall be provided in consultation with engineer.
- ii. Metallic pipes, conduits and cable tray sections for cable installation shall be bonded to ensure electrical continuity and connected to earthing conductors at regular interval. Apart from intermediate connections, beginning points shall also be connected to earthing system.
- iii. Metallic conduits shall not be used as earth continuity conductor.
- iv. A separate earthing conductor shall be provided for earthing lighting fixtures, lighting poles, receptacles, switches, junction boxes, lighting conduits, etc.
- v. Wherever earthing conductor crosses or runs along metallic structures such as gas, water, steam, conduits, etc. and steel reinforcement in concrete it shall be bonded to the same.
- vi. Cable and cable boxes/glands, lockout switches etc. shall be connected to the earthing conductor running alongwith the supply cable which, in turn, shall be connected to earthing grid conductor at minimum two points, whether specifically shown or not.
- vii. Railway tracks within switchyard area shall be bonded across fish plates and

	<p>Specification for design, supply, installation and commissioning, operations and maintenance of 132kV switchyards, transmission lines / towers, underground cables for 15 MWp solar power plant at NTPC-Singrauli (MP/UP)</p>	<p>PS-439-856 Rev 00 Page 64 of 171</p>
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connected to earthing grid at several locations.

- viii. Earthing conductor shall be buried 2000mm outside the switchyard fence. Every post of the fence and gates shall be connected to earthing loop by one lead.
- ix. Flexible earthing connectors shall be provided where flexible conduits are connected to rigid conduits to ensure continuity.
- x. Equipment earthing (Riser & welding of two conductors) shall be done as per standard drawing enclosed in this part.

g) JOINTING


- i. Earthing connections with equipment earthing pads shall be of bolted type. Contact surfaces shall be free from scales, paint, enamel, grease, rust or dirt. Two bolts shall be provided for making each connection. Equipment bolted connections, after being checked and tested, shall be painted with anti-corrosive paint/compound.
- ii. Connection between equipment earthing lead and between main earthing conductors shall be welded/brazed type. For rust protections, the welds should be treated with red lead and afterwards thickly coated with bitumen compound to prevent corrosion.
- iii. Steel to copper connections shall be brazed type and shall be treated to prevent moisture ingress.
- iv. Resistance of the joint shall not be more than the resistance of the equivalent length of the conductor.
- v. All ground connections shall be made by electric arc welding. All welded joints shall be allowed to cool down gradually to atmospheric temperature before putting any load on it. Artificial cooling shall not be allowed.
- vi. Bending of large diameter rod/thick conductor shall be done preferably by gas heating.
- vii. All arc welding with large diameter conductors shall be done with low hydrogen content electrodes.

h) POWER CABLE EARTHING

Metallic sheaths and armour of all multi core power cables shall be earthed at both equipment and switchgear end. Sheath and armour of single core power cables shall be earthed at switchgear end only.

i) SPECIFIC REQUIREMENT FOR EARTHING SYSTEMS

- i. Earthing terminal of each surge arrester, capacitor voltage transformer and lightning down conductors shall be directly connected to rod electrode which in turn, shall be connected to station earthing grid.

	<p>Specification for design, supply, installation and commissioning, operations and maintenance of 132kV switchyards, transmission lines / towers, underground cables for 15 MWp solar power plant at NTPC-Singrauli (MP/UP)</p>	<p>PS-439-856 Rev 00 Page 65 of 171</p>
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- ii. Earthing mat comprising of closely spaced (300mm x 300mm) conductors shall be provided below the operating handles of the isolators.

j) SPECIFIC REQUIREMENTS FOR LIGHTNING PROTECTION SYSTEM

- i. Conductors of the lightning protection system shall not be connected with the conductors of the safety earthing system above ground level.
- ii. Down conductors shall be cleated on the structures at 2000mm interval.
- iii. Connection between each down conductor and rod electrodes shall be made via test joint located approximately 150mm above ground level.
- iv. Lightning conductors shall not pass through or run inside G.I. conduits.
- v. Lightning protection system installation shall be in strict accordance with the latest editions of Indian Electricity Rules, Indian Standards and Codes of practice and Regulations existing in the locality where the system is installed.

6.17 SITE TESTING AND COMMISSIONING

6.17.2 INTRODUCTION


An indicative list of tests is given below. Contractor shall perform any additional test based on specialties of the items as per the field QP/ instructions of the equipment supplier or BHEL without any extra cost to the BHEL. The Contractor shall arrange all instruments required for conducting these tests alongwith calibration certificates and shall get the list of instruments approved from the BHEL.

6.17.3 GENERAL CHECKS

- a) Check for physical damage.
- b) Visual examination of zinc coating/ plating
- c) Check from name plate that all items are as per older/ specification.
- d) Check tightness of all bolts, clamps and connecting terminals using torque wrenches.
- e) For oil filled equipment check for oil leakage, if any. Also check oil level and top up.
- f) Check ground connections for quality of weld and application of zinc rich paint over weld joint of galvanized surfaces.
- g) Check cleanliness of insulator and bushings.
- h) All checks and tests specified by the manufactures in their drawings and manuals as well as all tests specified in the relevant code of erection.
- j) Pressure test on all pneumatic lines at 1.5 times the rated pressure shall be conducted.

6.17.4 CIRCUIT BREAKERS

- a) Insulation resistance of each pole.
- b) Check adjustments, if any, suggested by manufacturer.
- c) Breaker closing and tripping time.
- d) Slow and power closing operation and opening
- e) Trip free and anti pumping operation.
- f) Minimum pick up volts of coils
- g) Contact resistance
- h) Functional checking of compressed air plant and all accessories
- i) Functional checking of control circuits, interlocks, tripping through protective relays
- j) Insulation resistance of control circuits, motor etc.
- k) Resistance of closing and tripping coils.

	<p>Specification for design, supply, installation and commissioning, operations and maintenance of 132kV switchyards, transmission lines / towers, underground cables for 15 MWp solar power plant at NTPC-Singrauli (MP/UP)</p>	<p>PS-439-856 Rev 00 Page 66 of 171</p>
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6.17.5 ISOLATORS

- a) Insulation resistance of each pole
- b) Manual and electrical operation on interlocks
- c) Insulation resistance of control circuits and motors.
- d) Ground connections
- e) Contact resistance
- f) Proper alignment to minimise the vibration to the extreme possible during operation.
- g) Measurement of operating torque for isolator and Earth switch
- h) Resistance of operating and interlocking coils.

6.17.6 CURRENT TRANSFORMERS

- a) Insulation Resistance Test
- b) Polarity test.
- c) Ratio identification test-checking of all ratios on all cores by primary injection of current.
- d) Dielectric test of oil (wherever applicable).
- e) Magnetizing characteristics test.
- f) Capacitance and tan delta measurement at minimum 10kV.

6.17.7 VOLTAGE TRANSFORMERS/CAPACITOR VOLTAGE TRANSFORMER

- a) Insulation resistance test.
- b) Polarity test.
- c) Ratio test.
- d) Dielectric test of oil (if applicable).
- e) Capacitance and tan delta measurement at minimum 10kV.

6.17.8 SURGE ARRESTER

- a) Grading leakage current.
- b) Resistance of ground connection.
- c) Resistive current drawn at rated voltage after energisation.

6.17.9 PHASING OUT

The phasing out of all supplies in the station system shall be carried out.

6.17.10 STATION EARTHING


- a) Check soil resistivity
- b) Check continuity of grid wires
- c) Check earth resistance of the entire grid as well as various sections of the same.
- d) Check for weld joint and application of zinc rich paint on galvanised surface.
- e) Dip test on earth conductor prior to use.

6.17.11 CONDUCTOR STRINGING AND POWER CONNECTORS

- a) Physical check for finish
- b) Electrical clearance check
- c) Testing of torque by torque wrenches on all bus power connectors and other accessories.
- d) Sag and tension check on conductors.

6.17.12 INSULATORS

Visual examination for finish damage, creepage distance, etc.

	<p>Specification for design, supply, installation and commissioning, operations and maintenance of 132kV switchyards, transmission lines / towers, underground cables for 15 MWp solar power plant at NTPC-Singrauli (MP/UP)</p>	<p>PS-439-856 Rev 00 Page 67 of 171</p>
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7.0 TRANSMISSION LINE GENERAL

7.1 SCOPE

Following is the scope of work for overhead Transmission line work:

- a) This specification covers detailed survey, tower spotting, optimization of tower/ pole location, soil resistivity measurements and geo-technical investigation, tower design, fabrication and supply of all type of 132 kV single circuit transmission line towers which are already designed and tested for equal or higher loads specified in this specification including bolts, nuts and washers, hanger, D-shackle and all type of tower accessories like phase plate, number plate, danger plate, anti-climbing device, etc.; foundation design, selecting type of foundation for different towers and casting of foundation for towers and erection of towers, tack welding of bolts and nuts along with subsequent application of zinc coating on the welded portion, supply and application of zinc rich paint, tower earthing, fixing of insulator string, stringing of conductors and earth wires along with all necessary line accessories and testing and commissioning of the erected transmission lines.
- b) Further for type tested towers bidder shall furnish design calculation for transmission line tower structures along with foundation design and drawing meeting the requirements of this technical specification.
- c) This specification includes the design and supply of insulator and their hardware conductor and earthwire, earthwire suspension and tension clamps and all the other line accessories to be incorporated in the towers during erection and stringing.
- d) All the raw materials such as steel, zinc for galvanising, reinforcement steel and cement for foundation, coke and salt for earthing, bird guards, anticlimbing devices, bolts, nuts, washers, D-shackles, hangers, links, danger plates, phase plate, number plate etc. required for tower manufacture and erection shall be included in the scope of supply.
- e) The entire stringing work of conductor and earthwire shall be carried out as per standard stringing practice.
- f) The Contractor shall carry out the detailed survey and shall submit report/results within one (1) month of date of mobilization at site. No other details except those included in tender documents shall be furnished by the Owner. Also no topographical maps shall be furnished by Owner. However, Owner's assistance may be given in obtaining these maps from Survey of India.



- g) The tree-cutting shall be responsibility of the Contractor. The Contractor shall count, mark and put proper numbers with suitable quality of paint at his own cost on all the trees that are to be cut. Contractor may note that Owner shall not pay any compensation for any loss or damage to the properties or for tree cutting due to Contractor's work.

7.2 ROUTE AND TERRAIN


- a) The line survey of the corridor with the route, crossing, ground profile and levels has to be done by the bidder during detailed engineering.
- b) Right of way and way leave clearance shall be arranged by the Owner.
- c) To evaluate and tabulate the trees and bushes coming within 13.5 meters on either side of the central line alignment, the trees will be numbered and marked with quality paint serially from angle point 1 onwards and the corresponding number will be painted on the stem of trees at a height of one meter from ground level. The trees list should contain the following:
- d) Girth (circumference) measured at a height of 1 meter from ground level.
- i) Approximate height of the tree with an accuracy of + 2 meters.
 - ii) Name of the type of the species/tree.
 - iii) The bushy and under growth encountered in the 1.5 meters belt should also be evaluated with its type, height, girth and area in square meters, clearly indicating the growth in the tree/bush statement.
- e) Payment of compensation towards the clearances, etc. will be the responsibility of the Owner.

7.3 DETAILED SURVEY

- a) The detailed survey shall be carried out along the Transmission Line alignment.

b) Route Marking

At the starting point of the commencement of route survey, an angle iron spike of 65 x 65 x 6 mm section and 1000 mm long shall be driven firmly into the ground to project only 150 mm above the ground level. A punch mark on the top section of the angle iron shall be made to indicate location of the survey instrument. Teak wood peg 50 x 50 x 650 mm size shall be driven at prominent position at intervals of not more than 750 meter along the transmission line to be surveyed upto the next angle point. Nails of 100 mm length should be fixed on the top of these pegs to show the location of instrument. The pegs shall be driven firmly into the ground to project 100 mm only above ground level. At angle position stone/concrete pillar with "NTPC" marked on them shall be put firmly on the ground for easy identification.

	<p>Specification for design, supply, installation and commissioning, operations and maintenance of 132kV switchyards, transmission lines / towers, underground cables for 15 MWp solar power plant at NTPC-Singrauli (MP/UP)</p>	<p>PS-439-856 Rev 00 Page 69 of 171</p>
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c) Profile Plotting & Tower Spotting

From the field book entries the route plan with route details and level profile shall be plotted and prepared as per approved procedure. Reference levels at every 20 meters along the profile are also to be indicated on the profile besides R/Ls at undulations. Areas along the profile, which in the view of the Contractor are not suitable for tower spotting, shall also be clearly marked on the profile plots. If the difference in levels is too high, the chart may be broken up according to requirement. A 10mm overlap shall be shown on each following sheet. The chart shall progress from left to right. Sheet shall be in accordance with the IS Standard. For 'as built' profile these shall be A1 size

d) Sag Template

Necessary data in respect of conductor, earth wire and insulator have been given in the specifications. On the basis of these, the Contractor shall prepare the sag template drawing and tower spotting data and submit the same alongwith sag tension calculations for the approval of the Owner. Sag template prepared based on the approved sag-template curve drawing shall only be used for tower spotting on the profiles. Two numbers of the approved template, prepared on rigid transparent plastic sheets, shall be provided by the Contractor to the Owner for the purpose of checking the tower spotting. The templates shall be on the same scale as that of the profile.

e) Tower Spotting

With the help of approved sag template and tower spotting data, tower locations shall be marked on the profiles. While locating the towers on the profile sheet, the following shall be borne in mind:

f) Span


The number of consecutive spans between the section points shall not exceed 15 spans Section point shall comprise of tension point with B type, C type or D Type towers as applicable. For all crossing spans such as major road crossings, railway crossings, power line crossings etc. the span shall not exceed 80% of design span.

g) Extension

An individual span shall be as near to the normal design span as far as possible. In case an individual span becomes too short with normal supports on account of undulations in ground profile, one or both the supports of the span may be extended by inserting standard body extension designed for the purpose according to technical specification.

h) Road Crossing

At all important road crossings, the towers shall be fitted with double tension insulator strings depending on the type of towers but the ground clearance at the

	<p>Specification for design, supply, installation and commissioning, operations and maintenance of 132kV switchyards, transmission lines / towers, underground cables for 15 MWp solar power plant at NTPC-Singrauli (MP/UP)</p>	<p>PS-439-856 Rev 00 Page 70 of 171</p>
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roads under maximum temperature and in still air shall be such that even with conductor broken in adjacent span, ground clearance of the conductor from the road surfaces shall be in line with IE rules. At all national highway crossings, tensions towers shall be used.

i) Railways Crossings

At the time of detail survey all the railway crossings coming enroute the transmission line shall be finalized as per the regulation laid down by the Railway Authorities. The following are the important features of the prevailing regulations (revised in 1987):

- a) The crossing shall be supported on D type tower on either side of railway line with double tension insulator strings.
- b) The crossing shall normally be at right angle to the railway track.
- c) The crossing span shall be limited to 80% of design span.
- d) The minimum distance of the crossing tower shall be at least equal to the height of the tower plus 6 meters away measured from the centre of the nearest railway track..
- e) No crossing shall be located over a booster transformer, traction switching station, traction sub-station or a track cabin location in an electrified area.
- f) Minimum ground clearance above rail level of the lowest portion of any conductor under condition of maximum sag shall be maintained as per IE rules.

The approval for crossing railway track shall be obtained by the Owner from the Railway Authority. However, six copies of profile and plan, tower and foundation design and drawings, required for the approval from the Railway Authority shall supplied by the Contractor to the Owner.


j) River Crossings

In case of major river crossing, towers shall be of suspension type and the anchor towers on either side of the main river crossing shall be C type tower. Clearance required by navigation authority shall be provided. For non navigable river, clearance shall be reckoned with respect to highest flood level (HFL).

k) Power Line Crossing

Where this line is to cross over another line of the same voltage or lower voltage, towers with suitable extension shall be used. Provisions to prevent the possibility of its coming into contact with other overhead lines shall be made in accordance with the Indian Electricity Rules, 1956. The Contractor may be required to under-cross higher voltage lines by erecting gantries/suitable Rail Pole structures.

l) Telecommunication Line Crossing

	<p>Specification for design, supply, installation and commissioning, operations and maintenance of 132kV switchyards, transmission lines / towers, underground cables for 15 MWp solar power plant at NTPC-Singrauli (MP/UP)</p>	<p>PS-439-856 Rev 00 Page 71 of 171</p>
--	--	---

The angle of crossing shall be as near 90 degree as possible. However, deviation to the extent of 30 degree may be permitted under exceptionally difficult situations. When the angle of crossing has to be below 60 degree, the matter will be referred to the authority incharge of the telecommunication

system. On a request from the Contractor, the permission of the telecommunication authority may be obtained by the Owner. Also, in the crossing span power line support will be as near the telecommunication line as possible, to obtain increased vertical clearance between the wires.

m) Details enroute

All topographical details, permanent features, such as trees, building etc. 13.5m on either side of the alignment shall be detailed on the profile plan.

n) Ash Pipe Line (If applicable)

Adequate clearances shall be maintained from ash pipe line and adjacent road.

o) Clearance from Ground, Building, Trees, etc.


Clearance from ground, buildings, trees and telephone lines shall be provided in conformity with the Indian Electricity Rules, 1956 as amended upto date.

7.4 PRELIMINARY LINE SCHEDULE

The profile sheets, duly spotted, alongwith preliminary schedules indicating type of towers, wind span, weight span, angle of deviation, river, power line, railway or road crossing and other details shall be submitted for the approval of the Owner. After approval, the Contractor shall submit six more sets of the approved reports along with two sets in soft copy of final profile drawings to the Owner for record purpose.

7.5 CHECK SURVEY OF TOWER LOCATIONS

- a) The detailed survey shall be conducted to locate and peg mark the tower positions on ground conforming to the approved profile and tower schedule. In the process, it is necessary to have the pit centers marked according to the excavation marking charts. The levels, up or down of each pit center with respect to the center of the tower locations shall be noted and recorded for determining the amount of earthwork required to meet the approved design parameters.
- b) Changes, if required, after detailed survey in the preliminary tower schedule shall be carried out by the Contractor and he shall thereafter submit a final tower schedule for the approval of Owner. The tower schedule shall show position of all towers, type of towers, span length, type of foundation for each tower and the deviation at all angles as set out with other details.

	<p>Specification for design, supply, installation and commissioning, operations and maintenance of 132kV switchyards, transmission lines / towers, underground cables for 15 MWp solar power plant at NTPC-Singrauli (MP/UP)</p>	<p>PS-439-856 Rev 00 Page 72 of 171</p>
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7.6 ELECTRICAL SYSTEM DATA

- | | |
|--|--------------|
| a) Nominal voltage | 132 kV |
| b) Maximum system voltage | 145 kV |
| c) BIL (Impulse) | 650 kVp |
| d) Power frequency withstand voltage (wet) | 275 kV (rms) |

7.7 LIST OF STANDARDS

<u>Indian Standards</u>	<u>Title</u>	<u>International & Internationally recognised standards</u>
1 IS:209	Specification for Zinc Ingot	
2 IS:269	Specification for 33 grade Ordinary Portland Cement.	
3 IS:278	Specification for barbed wire	
4 IS:383	Coarse and fine aggregates from natural sources for concrete.	
5 IS:398 - Part-II	Alum. Condr. Galvanised steel reinforced	
6 IS:406-1964	Methods of Chemical Analysis of Slab Zinc	
7 IS:432 (Part 1 & 2)	Mild steel and medium tensile bars and hard drawn steel wire for concrete reinforcement	
8 IS:456	Code of practice for plan and reinforced concrete.	
9 IS:731-1971	Porcelain Insulators for Overhead Power Lines with a Nominal Voltage greater than 1000 volts	BS:137-1973 (I&II) IEC:274-1968 IEC:383-1976
10 IS:800	Code of practice for use of structural steel in general Building construction.	CSA STEAM 16.1
11 IS:802	Code of practice for use of structural steel in overhead transmission Line. (Load, Permissible stresses. Fabrication, Galvanising, Inspection, and Packing and Testing)	




Specification for design, supply, installation and commissioning, operations and maintenance of 132kV switchyards, transmission lines / towers, underground cables for 15 MWp solar power plant at NTPC-Singrauli (MP/UP)

PS-439-856
Rev 00
Page 73 of 171


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|----|---------|--|
| 12 | IS:1363 | Hexagonal Head bolts |
| 13 | IS:1367 | Technical supply conditions for threaded Fasteners |
| 14 | IS:1489 | Portland Pozzolana Cement |
| 15 | IS:1573 | Electroplated Coating of Zinc on Iron & Steel |

16	IS:1778-1980	Reels and Drums of Barewire
17	IS:1786	High strength deformed steel bars and wires for concrete reinforcement
18	IS:1893	Criteria of Earthquake resistant design of structures.
19	IS:2016	Plain Washers
20	IS:2070-1962	Method of impulse voltage testing
21	IS:2071 Part-I:1993 Part -2 : 1974 Part -3 : 1976	Method of high voltage testing
22	IS:2121-1981 Part-I Part-II	Specification for conductors and earthwire Accessories for Overhead Power Lines Armour Rods Mid-span joints & repair sleeves for Conductors
23	IS:2131	Method of Standard penetration test for soils.
24	IS:2551-1982	Danger Notice Plates
25	IS:2486 Part- I:1993 Part-II:1989 Part-III:1974	Specification for Insulator Fittings for overhead Power Lines with a nominal voltage greater than 1000 volts General Requirements and Tests Dimensional Requirements Locking Devices
		BS:3288-1972 IEC:120-1960 IEC:372-1976
26	IS:2629	Recommended practice for hot dip galvanising of iron & steel.
27	IS:2633	Method of testing uniformity of coating

	<p>Specification for design, supply, installation and commissioning, operations and maintenance of 132kV switchyards, transmission lines / towers, underground cables for 15 MWp solar power plant at NTPC-Singrauli (MP/UP)</p>	<p>PS-439-856 Rev 00 Page 74 of 171</p>
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		of zinc coated articles.
28	IS:3043-1987	Code of Practice for earthing (with amendment No. 1 & 2).
29	IS:3063-1994	Single Coil Rectangular Section spring washers for bolts, nuts, screws.
30	IS:3188-1980	Characteristics of string insulator units

31	IS:4091	Code of practice for design and transmission line tower and poles.	
32	IS:4218	Metric Screw Threads.	
33	IS:4759	Hot-dip zinc coatings on structural steel and other allied products	
34	IS:4826	Galvanised coatings on round steel wire	
	35IS:5300-1980	Porcelain Guy strain insulators	
	36IS:5613 (Part-II)	Code of practice for Design, installation & maintenance of overhead power lines	
37	IS:6610	Specification for heavy washers for steel structures.	
38	IS:6639	Hexagonal bolts for structure	
39	IS:6745	Methods for determination of weight	
40	Pub. No. 19 (N)/ 700-1963	Regulation for Electrical Crossing of Railway Tracks.	
41	IS:7814	Phosphor bronze sheet, strip and foil	
42	IS:8263-1976	Method of Radio Interference tests On high voltage insulators	NEEMA:107 – 1964 CISPR/IEC:437-1937
43	IS:8269-1976	Method of switching impulse test On high voltage insulators	IEC:506-1975
44	IS:8500	Structural steel – Microalloyed (Medium and High	

	<p>Specification for design, supply, installation and commissioning, operations and maintenance of 132kV switchyards, transmission lines / towers, underground cables for 15 MWp solar power plant at NTPC-Singrauli (MP/UP)</p>	<p>PS-439-856 Rev 00 Page 75 of 171</p>
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Strenght qualities) – Specification

- | | |
|-----------------|--|
| 45 IS:9708-1993 | Specifications for Stockbridge Vibration Dampers for overhead power lines |
| 46 | Thermal mechanical performance test IEC:575-1971 and mechanical performance test on String insulator units |
| 47 IS:12427 | Fasteners - Threaded Steel Fasteners - Hexagon Head Transmission Tower Bolts – Specification |

	<p>Specification for design, supply, installation and commissioning, operations and maintenance of 132kV switchyards, transmission lines / towers, underground cables for 15 MWp solar power plant at NTPC-Singrauli (MP/UP)</p>	<p>PS-439-856 Rev 00 Page 76 of 171</p>
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8.0 TOWER LINE ERECTION AND STRINGING

8.1 GENERAL REQUIREMENTS

- a) The details of the scope of erection work shall include the cost of labour, all tools and plants like tension stringing equipment and all other incidental expenses in connection with erection and stringing work.
- b) The Contractor shall be responsible for transportation of all the materials to be provided by the Contractor as per the scope of work to site, proper storage and preservation at their own cost till such time the erected line is taken over by the Owner.
- c) The quantities of conductor, earthwire, insulators hardware, accessories of conductor & earthwire, etc. are estimated by the Owner include excess material towards wastages and damages during erection.

8.2 TREATMENT OF MINOR GALVANISING DAMAGE

In case any minor damage to galvanizing is noticed, the same shall be treated with zinc rich paint (having at least 90% zinc content) before erection.

8.3 ASSEMBLY

8.3.1 The method followed for the erection of towers, shall ensure the points mentioned below:

Straining of the members shall not be permitted for bringing them into position. It may, however, be necessary to match hole positions at joints and to facilitate this, tommy bars not more than 450 mm long may be used.

Before starting erection of an upper section, the lower section shall be completely braced and all bolts provided and tightened adequately in accordance with approved drawings to prevent any mishap during tower erection.

All plan diagonals relevant to a section of tower shall be placed in position before assembly of upper section is taken up.


The bolt position in assembled towers shall be as per IS:5613 (Part-II/Section2)-1976.

Tower shall be fitted with number plate, danger plate, phase plate and anti-climbing device as described.

All bank holes, if any left, after complete erection of the tower, are to be filled up by bolts and nuts of correct size.

8.3.2 Tightening and Punching of Bolts and Nuts

- a) All nuts shall be tightened properly using correct size spanner/torque wrench. Before tightening, it shall be ensured that filler washers and plates are placed in gaps between members wherever applicable, bolts of proper size and length are inserted, and one spring washer is inserted under each nut. In case of step bolts, spring washers shall be placed under the outer nut. The tightening shall progressively be

	<p>Specification for design, supply, installation and commissioning, operations and maintenance of 132kV switchyards, transmission lines / towers, underground cables for 15 MWp solar power plant at NTPC-Singrauli (MP/UP)</p>	<p>PS-439-856 Rev 00 Page 77 of 171</p>
--	--	---

carried out from the top downwards, care being taken that all bolts at every level are tightened simultaneously. The threads of bolts projecting outside the nuts shall be punched at their position on the diameter to ensure that the nuts are not loosened in course of time. If during tightening a nut is found to be slipping or running over the bolt threads, the bolt together with the nut shall be replaced.


- b) The threads of all the bolts projected outside the nuts shall be welded at two diametrically opposite places. The welding shall be provided from ground level to waist level for single circuit towers and to bottom cross arm level for double circuit towers. After welding, cold galvanised paint having at least 90% Zinc content shall be applied to the welded portion. At least two coats of the paint shall be applied. The cost of welding and paint including application of paint shall be deemed to be included in the erection price.
- c) In addition to the tack welding of nuts with bolts, as described above, the Contractor can also propose some alternative arrangements, like use of epoxy resin adhesive which can serve the purpose of locking the nut permanently with the bolt and thus preventing pilferage of the tower members.

8.4 INSULATOR HOISTING

I-Suspension insulator strings shall be used on suspension towers and tension insulator strings on angle and dead end towers. These shall be fixed on all the towers just prior to the stringing. Damaged insulators and fittings, if any, shall not be employed in the assemblies. Before hoisting, all insulators shall be cleaned in a manner that will not spoil, injure or scratch the surface of the insulator, but in no case shall any oil be used for the purpose. Corona control rings/arching horn shall be fitted in an approved manner. The yoke arrangements be horizontal for tensions strings. Torque wrench shall be used for fixing different line materials and their components, like suspension clamp for conductor and earthwire, etc., whenever recommended by the manufacturer of the same of river crossing towers.

8.5 HANDLING OF CONDUCTOR AND EARTHWIRE

- a) The Contractor shall be entirely responsible for any damage to the towers or conductors during stringing. While running out the conductors, care shall be taken that the conductors do not touch or rub against the ground or objects which could cause scratches or damages to the strands. The conductors shall be run out of the drums from the top in order to avoid damage due to chafing. Immediately after running out, the conductor shall be raised at the supports to the levels of the clamps and placed into the running blocks. The groove of the running blocks shall be of such a design that the seat is semi-circular and larger than the diameter of the conductor earthwire and it does not slip over or rub against the sides. The grooves shall be lined with hard rubber or neoprene to avoid damage to conductor and shall be mounted on properly lubricated bearings.
- b) The running blocks shall be suspended in a manner to suit the design of the crossarm. All running blocks, especially those at the tension end, will be fitted on the cross-arm with jute cloth wrapped over the steel work and under the slings to avoid damage to the slings as well as to the protective surface finish of the steel work. In case suspension, or section towers are used even for temporary terminations, if this


	<p>Specification for design, supply, installation and commissioning, operations and maintenance of 132kV switchyards, transmission lines / towers, underground cables for 15 MWp solar power plant at NTPC-Singrauli (MP/UP)</p>	<p>PS-439-856 Rev 00 Page 78 of 171</p>
--	--	---

be unavoidable, they shall be well guyed and steps shall be taken by the Contractor to avoid damage. Guying proposal alongwith necessary calculations shall be submitted by the Contractor to Owner by the Contractor for checking the tensions in the guy made available to the Owner by the Contractor for checking the tensions in the guy wires. The drums shall be provided with a suitable braking device to avoid damages, loose running out and kinking of the conductor. The conductor shall be continuously observed for loose or broken strands or any other damage. When approaching end of a drum length, at least three coils shall be left when the stringing operations are to be stopped. These coils are to be removed carefully, and if another length is required to be run out, a joint shall be made as per the recommendations of the manufacturers.

- c) Repairs to conductors, if necessary, shall be carried out during the running out operations, with repair sleeves. Repairing of conductor surface shall be done only in case of minor damage, scuff marks etc. keeping in view both electrical and mechanical safe requirements. The final conductor surface shall be clean smooth and without any projections, sharp points, cuts, abrasions etc.
- d) Conductor splices shall be so made that they do not crack or get damaged in the stringing operation. The contractor shall use only such equipment/methods during conductor stringing which ensures complete compliance in this regard.
- e) Derricks shall be used where roads, rivers, channels, telecommunication or overhead power lines, railway lines, fences or walls have to be crossed during stringing operations. It shall be seen that normal services are not interrupted or damage caused to property. Shut down shall be obtained when working at crossing of overhead power lines. The Contractor shall be entirely responsible for the proper handling of the conductor, earth-wire and accessories in the field.
- f) The sequence of running out shall be from top to downwards i.e. the earthwire shall be run out first, followed by the conductors in succession. Unbalances of loads on towers shall be avoided as far as possible.
- g) The proposed 132 kV transmission line may run parallel for certain distance with the existing Transmission lines which may remain energised during the stringing period. As a result there is a possibility of dangerous voltage build up due to electromagnetic and electrostatic coupling in the pulling wire, conductors and earthwires, which although comparatively small during normal operations can be severe during switching. It shall be the Contractor's responsibility to take adequate safety precautions to protect his employees and others from this potential danger.
- h) B and C type of towers are not designed for one side stringing. Therefore proper guying arrangement shall be made for B and C type of towers during stringing on one section while the other section is not strung. The Contractor has to submit the detailed proposal alongwith the calculation for guying which shall be approved by the Owner. Proper T&P shall be made available to the Owner by the Contractor for checking the tensions in the guy wires. All the expenditure on account of the above work is deemed to be included in the bid price and no extra payment shall be made for the same.

8.6 STRINGING OF CONDUCTOR AND EARTHWIRE

8.6.1 The stringing of the conductor shall be done by standard stringing method.

	<p>Specification for design, supply, installation and commissioning, operations and maintenance of 132kV switchyards, transmission lines / towers, underground cables for 15 MWp solar power plant at NTPC-Singrauli (MP/UP)</p>	<p>PS-439-856 Rev 00 Page 79 of 171</p>
--	--	---


- 8.6.2 After being pulled the conductor/earthwire shall not be allowed to hang in the stringing blocks for more than 96 hours before being pulled to the specified sag.
- 8.6.3 Conductor creep are to be compensated by over tensioning the conductor at appropriate temperature for which calculations are to be submitted by the contractor for Owner's approval.
- 8.6.4 The Bidder shall give complete details of the stringing methods which be proposes to follow. Before the commencement of stringing the Contractor shall submit the stringing charts for the conductor and earthwire for various temperatures and span alongwith equivalent spans for the approval of the Owner.

8.6.5 Jointing

- a) All the joints on the conductor and earthwire shall be of compression type, in accordance with the recommendations of the manufacturer for which all necessary tools and equipment like compressors, dies, processes etc. shall have to be arranged by the Contractor. Each part of the joint shall be cleaned by wire brush to make it free of rust or dirt etc. and properly greased with anti-corrosive compound if required, and as recommended by the contractor before the final compression is done with the compressors.
- b) All joints or splices shall be made at least 30 meters away from the structures . No joints or splices shall be made in spans crossing over main road, railways, small rivers with tension spans. During compression or splicing operation the conductor shall be handled in such a manner as to prevent lateral or vertical bearing against the dies. After pressing the joint the aluminium sleeve shall have all corners rounded, burrs and sharp edges removed and smoothed.
- c) During stringing of conductor to avoid any damage to the joint, the Contractor shall use a suitable protector with mid span compression joints in case joints are to be passed over pulley blocks/aerial rollers. The size of the groove of the pulley shall be such that the joint along with protection can be passed over it smoothly.

8.6.6 Sagging-in-Operation

- a) The conductor shall be pulled upto the desired sag and left in running blocks for atleast one hour after which the sag shall be re-checked and adjusted, if necessary before transferring the conductor from the running blocks to the suspension clamps. The conductors shall be clamped within 36 hours of sagging in.
- b) The sag will be checked in the first and the last span of the section in case of sections upto eight spans and in one intermediate span also for sections with more than eight spans. The sag shall also be checked when the conductors have been drawn up and transferred from running blocks to the insulator clamps.
- c) The running blocks, when suspended from the transmission structure for sagging

	<p>Specification for design, supply, installation and commissioning, operations and maintenance of 132kV switchyards, transmission lines / towers, underground cables for 15 MWp solar power plant at NTPC-Singrauli (MP/UP)</p>	<p>PS-439-856 Rev 00 Page 80 of 171</p>
--	--	---

shall be so adjusted that the conductors on running blocks will be at the same height as the suspension clamp to which it is to be secured,

- d) At sharp vertical angles, the sags and tensions shall be checked on both sides of the angle, the conductor and earthwire shall be checked on the running blocks for equality of tension on both sides. The suspension insulator assemblies will normally assume vertical positions when the conductor is clamped.
- e) Tensioning and sagging operations shall be carried out in clam weather when rapid changes in temperatures are not likely to occur.

Tensioning and Sagging of Conductors and Earthwire

The tensioning and sagging shall be done in accordance with the approved stringing charts before the conductors and earthwire are finally attached to the tower through the earthwire clamps for the earthwire and insulator strings for the conductor. The 'Initial' stringing chart shall be used for the conductor and 'final' stringing chart for earth-wire should be employed for this purpose. Dynamometers shall be employed for measuring tension in the conductor and earthwire. The dynamometers employed shall be periodically checked and calibrated with the standard dynamometer.

8.6.7 Clipping In


- a) Clipping of the conductors in positions shall be done in accordance with the recommendations of the manufacturer. Conductor shall be fitted with armour rods where it is made to pass through suspension clamps.
- b) The jumpers at the section and angle towers shall be formed to parabolic shape to ensure maximum clearance requirements and shall match the jumper drops shown in the tower drawings.
- c) Fasteners in all fittings and accessories shall be secured in position. The security clip shall be properly opened and sprung into position.

8.6.8 Fixing of Conductor and Earthwire Accessories

Vibration dampers for conductor and earthwire and other conductor and earthwire accessories shall be installed by the Contractor as per the design requirement and respective manufacturer's instructions within 24 hours of the conductor/earthwire clamping. While installing the conductor and earthwire accessories, proper care shall be taken to ensure that the surfaces are clean and smooth and no damage shall occur to any part of the accessories.

8.7 REPLACEMENT

- a) If any replacements are to be effected after stringing and tensioning or during maintenance, leg members and bracings shall not be removed without reducing the tension on the tower with proper guying or releasing the conductor. If the replacement of cross arms becomes necessary after stringing, the conductor shall be suitably tied to the tower at tension points or transferred to suitable roller pulleys as suspension points.


	<p>Specification for design, supply, installation and commissioning, operations and maintenance of 132kV switchyards, transmission lines / towers, underground cables for 15 MWp solar power plant at NTPC-Singrauli (MP/UP)</p>	<p>PS-439-856 Rev 00 Page 81 of 171</p>
--	--	---

- b) The Contractor shall not be required to return to the Owner, empty conductor and earthwire drums and shall dispose off the same at his cost except for steel drums which shall be returned to Owner.
- c) Any conductor and earthwire drum which has been opened by the Contractor shall not be taken back by Owner and the unused conductor or earthwire in such drum shall be treated as wastage permissible within the overall limits.

8.8 FINAL CHECKING TESTING AND COMMISSIONING

After completion of the works, final checking of the line shall be done by the Contractor to ensure that all the foundation works, tower erection, and stringing have been done strictly according to the specifications and as approved by the Owner. All the works shall be thoroughly inspected keeping in view of the following main points:

- a) Sufficient backfilled earth is lying over each foundation pit and it is adequately compacted.
- b) Concrete chimneys and their copings are in good finally shaped conditions.
- c) All the tower members are correctly used, strictly according to final approved drawing and are free of any defect or damage, whatsoever.
- d) All bolts are properly tightened and punched/tack welded.
- e) The stringing of the conductors and earthwire has been done as per the approved sag and tension charts and desired clearances are clearly available.
- f) All conductor and earthwire accessories are properly installed.
- g) All other requirements to complete the work like fixing of danger plate, phase plate, number plate, anti climbing device etc., are properly installed.
- h) Wherever required it should be ensured that revetment is provided.
- i) The original tracings of profile route alignment and tower, design, structural drawings, bill of material, shop drawings of all towers are submitted to the Owner for reference and record.
- j) The insulation of line as a whole is tested by the Contractor by providing his own equipment, labour etc. to the satisfaction of the Owner.
- k) All towers are properly grounded.
- l) The line is tested satisfactorily for commissioning purpose.

	<p>Specification for design, supply, installation and commissioning, operations and maintenance of 132kV switchyards, transmission lines / towers, underground cables for 15 MWp solar power plant at NTPC-Singrauli (MP/UP)</p>	<p>PS-439-856 Rev 00 Page 82 of 171</p>
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9.0 TRANSMISSION LINE TOWERS

9.1 GENERAL DESCRIPTION OF TOWERS


9.1.1 Types of Towers

- a) The towers shall be of self supporting lattice steel type, designed to carry the line conductors with necessary insulators, earth wires and all fittings under all loading conditions.
- b) The tower shall be of a fully galvanised structure, using structural mild steel sections for members. Bolts and nuts with spring washers shall be used for connections.
- c) Bidders can also use high tensile steel and cold formed steel for fabrication of towers provided they furnish the justification for use of such steel with reference to national or international standards. However, the factors of safety, limitation on member length, requirement of fasteners and galvanisation shall be as specified in this specification.

The towers shall be classified as given in Table 1-1

Table T1-1

Type of Tower	Deviation limit	Typical use
A	0 to 2	To be used as tangent/suspension tower
B	0 to 15	<ol style="list-style-type: none"> a) Angle towers with tension insulator string b) Tension tower for uplift forces resulting from an uplift span upto half of ruling span under broken wire conditon. c) Also to be designed for unbalanced tension resulting from unequal ruling span as specified in table T1-2.
B	0	d) to be used as section tower

	<p>Specification for design, supply, installation and commissioning, operations and maintenance of 132kV switchyards, transmission lines / towers, underground cables for 15 MWp solar power plant at NTPC-Singrauli (MP/UP)</p>	<p>PS-439-856 Rev 00 Page 83 of 171</p>
---	--	---


C	15 to 30 degree.	<ul style="list-style-type: none"> a) Angle tower with tension insulator string b) Tension tower for uplift forces resulting from an uplift span upto half of ruling span under broken wire condition. c) Also to be designed for unbalanced tension resulting from unequal ruling span as specified in table T1-2.
D	30 deg. To 60 deg.	<ul style="list-style-type: none"> a) Angle tower with tension insulator string. b) Tension tower for uplift forces resulting from an uplift span upto half of ruling span under broken wire condition. c) Also to be designed for the unbalanced tension resulting from unequal ruling span as specified in Table T1-2. d) Dead end with 0 deg. to 15 deg deviation both on line and sub-station side (slack span).
D	0 deg.	e) Complete dead end.
D	90 deg.	f) To be used near switchyard with Reduced design and span

NOTE:

- 1) Special type of tower/ higher voltage class towers, wherever required shall also be provided by the bidder under the contract at no extra cost.

9.1.2 Extension

The single circuit tower shall be designed so as to be suitable for adding 3M, 6M and 9M body extension for maintaining adequate ground clearance without reducing the specified factor of safety in any manner.

	<p>Specification for design, supply, installation and commissioning, operations and maintenance of 132kV switchyards, transmission lines / towers, underground cables for 15 MWp solar power plant at NTPC-Singrauli (MP/UP)</p>	<p>PS-439-856 Rev 00 Page 84 of 171</p>
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For power line crossing 25 meter extensions with D type towers are required. The 25 meter extension should be designed in such a manner the same can also be used as 18 meter extension to normal tower after removal of bottom panels.

For under line crossing of EHV transmission lines the bidder shall have to design minus-three meters and minus six meter extensions to D type tower.

D type towers shall be designed to cater for 90deg. deviation with auxiliary cross arm and reduced tension/span.

9.1.3 Stub Setting templates

Stub templates shall be designed and arranged by the contractor at his own cost for all types of tower with or without extension and also for leg extension. Stub templates for standard towers and tower with extension shall be of adjustable type. The stub templates shall be painted. One set of each type of stub setting template for single circuit tower shall be supplied to the Owner, on completion of the project, at no extra cost.

9.2 SPANS AND CLEARANCES

9.2.1 Ruling Span

The normal ruling span of the line shall be 305 meters for 132 kV towers.


9.2.2 Wind Span

The wind span is the sum of the two half spans adjacent to the support under consideration. For normal horizontal spans this equals to normal ruling span.

9.2.3 Weight Span

The weight span is the horizontal distance between lowest point of the conductors on the two spans adjacent to the tower. For design of structures, the span limits given below shall prevail.

Tower type	Normal Condition		Broken Wire Condition	
	Max. (m)	Min. (m)	Max. (m)	Min. (m)
A, B, C & D (132 KV)	450	-200	270	-200

	<p>Specification for design, supply, installation and commissioning, operations and maintenance of 132kV switchyards, transmission lines / towers, underground cables for 15 MWp solar power plant at NTPC-Singrauli (MP/UP)</p>	<p>PS-439-856 Rev 00 Page 85 of 171</p>
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9.2.4 Electrical Clearance

a) Ground clearance

The minimum ground clearance from the bottom conductor shall be as per IE rules at the maximum sag conditions i.e. at maximum temperature and still air. However, to achieve the above clearance the height of tower shall be increased in the following manner:

- 1) Allowance of 150 mm shall be provided to account for errors in stringing.
- 2) Conductor creep shall be compensated by over tensioning the conductor at a temperature lower than the ambient temperature. The creep correction temperature along with calculations shall be furnished by the Contractor.
- 3) Minimum spacing
The minimum electrical clearance between conductors shall be as per relevant standards.

b) Rail Crossing

In case of rail crossing the min. height above rail level of the lowest portion of any conductor under condition of max.sag, in accordance with the regulations for Electrical Crossing of Railway tracks as prevailing at the time of construction of line shall be applicable.

c) Power Line Crossing

Minimum clearance between power line to power line crossing shall be as per IE rules.

d) Live Metal Clearance


The minimum live metal clearance to the provided between the live parts and steel work of super-structure shall be as per relevant standards.

NOTE:

- i) Bidder shall adopt same cross arm design where jumper is projecting outside of cross-arm for 'D' type tower to be used as dead end and angle tower.
- ii) The design of the tower shall be such that it will satisfy all the conditions when clearances are measured from any live point of the strings.

e) Angle of Shielding

The angle of shielding is defined as the angle formed by the line joining the center lines of the earthwire and outer power conductor, in still air, at tower supports, to the vertical line through the center line of the earthwire. Bidders shall design the tower in such a way that the angle of shielding does not exceed 30 deg for 132 KV towers. The drop of the earthwire clamp, which is in the scope of contractor supplied items, should be considered while calculating the minimum angle of protection. For estimating the minimum angle of protection the drop of earth wire suspension clamp alongwith shackle

	<p>Specification for design, supply, installation and commissioning, operations and maintenance of 132kV switchyards, transmission lines / towers, underground cables for 15 MWp solar power plant at NTPC-Singrauli (MP/UP)</p>	<p>PS-439-856 Rev 00 Page 86 of 171</p>
---	--	---

shall be taken as 150mm.

f) Mid Span Clearance

The minimum vertical mid span clearance between the earthwire and the nearest power conductor as per IE rules, which shall mean the vertical clearance between earthwire and the nearest conductor under all temperatures and still air condition in the normal ruling span. Further, the tensions of the earthwires and power conductors, shall be so co-ordinated that the sag of earthwires shall be at least 10% less than that of power conductors under all temperature loading conditions.

9.3 LOADING CONDITIONS

9.3.1 Loads at Conductor And Earthwire Points

Contractor shall consider the ultimate external loadings at conductor and earthwire points base on IS 802-1, 1995. The Contractor shall develop the tower designs considering these loadings. The towers are to be designed to cater for the following loads:

- a) Reliability Loads (Normal condition)
- b) Security Loads (Broken wire condition)
- c) Safety Loads (Construction & Maintenance loads)

Suspension towers shall be designed for full wind load under security condition

9.3.2 Wind Loads on Tower Body

The wind load on tower body shall be calculated by the Contractor as per IS:802, Part-I, 1995.

9.3.3 Maximum Tension

Maximum tension shall be based on either of the following (whichever is more stringent):


- a) at 0 deg C with 36% full wind pressure., or
- b) at 32 deg C with full wind pressure

The value of drag co-efficient (Cd) shall be 1.2 for conductor/earthwire if the diameter of the conductor/earth is 15mm or less.

9.3.4 Sag tension calculation for design purpose shall be calculated considering normal span of 305 meter.

9.3.5 The initial conductor and earthwire tension at 32 degree C and without wind shall be 22% of the ultimate tensile strength of the conductor and 20% of the ultimate tensile strength of the Earthwire.

9.3.6 Limiting Tensions of conductor & Earthwire

	<p>Specification for design, supply, installation and commissioning, operations and maintenance of 132kV switchyards, transmission lines / towers, underground cables for 15 MWp solar power plant at NTPC-Singrauli (MP/UP)</p>	<p>PS-439-856 Rev 00 Page 87 of 171</p>
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The ultimate tension of conductor and ground wire shall not exceed 70 per cent of the ultimate tensile strengths.

9.3.7 Broken Wire Condition

The loads for broken wire conditions shall be considered as per clause 16 of IS 802 (Part I/ Sec 1): 1995. The tower type B & C shall be considered as small and medium angle towers whereas tower type D shall be considered as large angle tension tower/ dead end tower.

9.3.8 Design Loads

Owner's requirement for most stringent design longitudinal and transverse loads is summarized in Table T1-2.

9.4 DESIGN OF TOWERS


9.4.1 Design Criteria

Towers shall be designed based on spans and clearances, and loading conditions as detailed above.

9.4.2 Design Temperatures

The following temperature range for the conductors and ground wires shall be adopted for line design:

- | | | |
|---|---|----------|
| a) Minimum temperature | : | 0 deg.C |
| b) Everyday temperature of conductor | : | 32 deg.C |
| c) Max. temperature of Conductor | : | 75 deg.C |
| d) Max. temperature of Earthwire exposed to sun | : | 53 deg.C |

	<p>Specification for design, supply, installation and commissioning, operations and maintenance of 132kV switchyards, transmission lines / towers, underground cables for 15 MWp solar power plant at NTPC-Singrauli (MP/UP)</p>	<p>PS-439-856 Rev 00 Page 88 of 171</p>
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9.4.3 Redundant Design

All redundants in the towers are to be triangulated. Redundants, having an angle of 15 deg or less with horizontal are to be designed for a concentric vertical ultimate load of 1.5 KN acting at center of the unsupported length. The Contractor has to furnish the calculation for the same. The redundants shall also be designed for 2.5% of max. axial load of connecting members (i.e. leg members, bracing members etc.).

9.4.4 Steel Sections

For designing of towers, preferably rationalised steel sections shall be used. During execution of the project, if any particular section is not available same shall be substituted by higher section at no extra cost to Owner and the same shall be borne by the Contractor. However, design approval for such substitution shall be obtained from the Owner before any substitution.

9.4.5 Thickness of Members


The minimum thickness of angle sections used in the design of tower, unless otherwise specified elsewhere in this Specification, shall be kept not less than the following values:

- a) Main corner leg members including the groundwire peak and main cross arm : 5 mm
- b) For all other members : 4 mm

9.4.6 Bolts & Nuts

- a) The minimum bolt spacing and rolled edge distance and sheared edge distance from the centers of the bolt holes to be maintained are given below:

1) Diameter of bolts	16 mm
2) Hole diameter	17.5 mm
3) Min. bolt spacing	40 mm
4) Min. rolled distance	20 mm
5) Min. sheared edge distance	23 mm
- b) Bolts sizes mentioned above shall only be used. The minimum width of the flanges without bolt holes shall be 30mm.
- c) For the purpose of calculating shearing stress and bearing stress for bolts, IS:802-Part-II-1993 may be referred.

	<p>Specification for design, supply, installation and commissioning, operations and maintenance of 132kV switchyards, transmission lines / towers, underground cables for 15 MWp solar power plant at NTPC-Singrauli (MP/UP)</p>	<p>PS-439-856 Rev 00 Page 89 of 171</p>
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9.4.7 Slenderness Ratio

- a) Slenderness ratio for members shall be computed in accordance with IS:802, Part-II, 1993. Slenderness ratio for compression and tension members shall not exceed the values specified therein.
- b) The following maximum limit of the slenderness ratio i.e. the ratio of unsupported length of the section in any plane to the appropriate radius of gyration will be adopted:
- | | |
|--|-----|
| 1) For main corner leg members including the corner members of earthwire peak and the lower corner members of the cross-arms | 120 |
| 2) For other members having calculated stresses | 200 |
| 3) For redundant members | 250 |
| 4) For members having tensile stress only | 400 |
- c) The bracing pattern, including that of secondary bracings (redundants) shall be identical on transverse and longitudinal faces of the tower, i.e. staggering of primary and secondary bracings are not permitted. Primary bracings and redundants shall be properly triangulated, i.e. the overall pattern of bracing on tower body and cross arms shall be triangular only.


9.4.8 Erection Stress

Where erection stress combined with other permissible co-existent stresses could produce a working stress in any member appreciably above the specified working stress, such other provisions are to be made as may be necessary to bring the working stress within the specified limit.

9.5 TOWER MATERIALS

9.5.1 Tower Steel Sections

IS steel sections of tested quality in conformity with IS: 2062 or IS: 8500 are to be used in towers, extensions and stub setting templates. No individual member shall be longer than 6000mm. The Bidder can also use most efficient grades of structural steel angle sections and plates conforming to latest international standards. However, the Bidders are permitted to opt for not more than two (2) grades of steel for any particular package.


	<p>Specification for design, supply, installation and commissioning, operations and maintenance of 132kV switchyards, transmission lines / towers, underground cables for 15 MWp solar power plant at NTPC-Singrauli (MP/UP)</p>	<p>PS-439-856 Rev 00 Page 90 of 171</p>
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9.5.2 Fasteners: Bolts, Nuts and Washers

- a) All bolts and nuts shall conform to IS: 6639. All bolts and nuts shall be galvanised and shall have hexagonal head and nuts, the heads being forged out of the solid, truly concentric, and square with the shank, which must be perfectly straight.
- b) The bolt shall be of 16 mm dia and of property class 5.6 as specified in IS:1367 (Part-III) 1979 and matching nut of property class as specified in IS:1367 (Part-VI).
- c) Bolts upto M16 and having length upto 10 times the diameter of the bolt should be manufactured by cold forging and thread rolling process to obtain good and reliable mechanical properties and effective dimensional control. The shear strength of bolts for 5.6 grade should be 310 MP a minimum as per IS:12427. Bolts should be provided with washer face in accordance with IS:1363 Part-I to ensure proper bearing.
- d) To ensure uniformity of galvanizing, bolts and nuts should be galvanised by high temperature hot-dip galvanizing.
- e) Nuts should be double chamfered as per the requirement of IS:1363 Part-III. It should be ensured by the manufacturer that nuts should not be overtapped beyond 0.4 MM oversize on effective diameter for size upto M16.
- f) Fully threaded bolts shall not be used. The length of bolts shall be such that the threaded portion will not extend into the place of contact of the members.
- g) All bolts shall be threaded to take the full depth of the nuts and threaded enough to permit firm gripping of the members, but not further. It shall be ensured that the threaded portion of each bolt protrudes not less than 3 mm and not more than 8mm when fully tightened. All nuts shall fit and tight to the point where the shank of the bolt connects to the head.
- h) Flat and tapered washers shall be provided wherever necessary. Spring washers shall be provided for insertion under all nuts. These washers shall be of steel electro-galvanised, positive lock type and 3.5mm in thickness for 16mm dia.
- i) The Bidder shall furnish bolt schedules giving thickness of members connected, the nut and the washer and the length of shank and the threaded portion bolts and sizes of holes and any other special details of this nature.
- j) To obviate bending stress in bolts or to reduce to minimum, no bolt shall connect aggregate thickness of more than three (3) times its diameter.
- k) The bolt positions in assembled towers shall be as per IS:5613 (Part-II/Section-2).
- l) Bolts at the joints shall be so staggered that nuts may be tightened with spanners without fouling.

9.5.3 Tower Accessories

- a) **Step Bolts & ladders**

	<p>Specification for design, supply, installation and commissioning, operations and maintenance of 132kV switchyards, transmission lines / towers, underground cables for 15 MWp solar power plant at NTPC-Singrauli (MP/UP)</p>	<p>PS-439-856 Rev 00 Page 91 of 171</p>
---	--	---

Each tower shall be provided with step bolts of not less than 16mm diameter and 175 mm long, spaced not more than 450mm apart and extending from about 3.5 meters above the ground level to the top of the tower. 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. For special structures, where the height of the super structure exceeds 50 meters, ladders along with protection rings shall be provided in continuation of the step bolts on one face of the tower from 30 meters above ground level to the top of the special structure. From 3.5 m to 30 m height of super structure step bolts shall be provided. Suitable railing for access from step bolts to the ladder and from the ladder to each cross arm tip and the groundwire support shall be fixed on tower by using countersunk bolts.


b) Insulator Strings and Earthwire Clamps Attachments

- 1) For the attachment of suspension insulator string a suitable dimensioned swinging hanger on the tower shall be provided so as to obtain requisite clearance under extreme swinging conditions and free from swinging of the string. The hanger shall be designed to withstand an UTS equivalent to that of insulators. The supply of design & supply of hanger is in the scope of the Contractor.
- 2) At tension towers strain plates of suitable dimensions on the underside of each cross-arm tip and at the top of earthwire peak, suitable plate should be provided for taking the hooks or D-Shackle of the tension insulator strings or earthwire tension clamps, as the case may be. Full details of the attachments shall be submitted by the bidder for Owner's approval before starting the mass fabrication.

c) Earthwire peaks/crossarms are to be suitably designed to accommodate the shackle of the suspension clamp/tension clamps.

d) Anti-climbing Device

Barbed wire type anti-climbing device shall be provided and installed by the Contractor for all towers. The height of the anti-climbing device should be provided approximately 3m above ground level. The barbed wire shall conform to IS-278-1978. The barbed wires shall be given chromating dip as per procedure laid down in IS:1340-1959.

	<p>Specification for design, supply, installation and commissioning, operations and maintenance of 132kV switchyards, transmission lines / towers, underground cables for 15 MWp solar power plant at NTPC-Singrauli (MP/UP)</p>	<p>PS-439-856 Rev 00 Page 92 of 171</p>
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e) Danger plate, Number plates, Circuit Plate, Phase plate & Bird Guards.

Danger, Number Plates, Phase Plates & Bird Guards shall be provided and installed by the Contractor:

- 1) Each tower shall be fitted with a number plate, and danger plate. Each tension tower shall be provided with a set of phase plates also. The arrangement for fixing these accessories shall not be more than 4.5m above the ground level.
- 2) The letters, figures and the conventional skull and bones of data plates shall conform to IS:2551-1963 and shall be in a single red on the front of the plate.
- 3) The corners of the number and danger plate shall be rounded off to remove sharp edges.
- 4) To prevent birds from perching immediately above the suspension insulator strings and thus fouling it with droppings suitable birdguards shall be provided at cross arm tips of all suspension towers. The arrangement shall conform to IS:5613 part-2/Sec.I.

9.6 TOWER FABRICATION

- 9.6.1 Except where hereinafter modified, details of fabrication shall conform to IS:802 (Part-II) or the relevant international standards.
- 9.6.2 Butt splices shall be used and the inside Angle and outside plate shall be designed to transmit the load and inside cleat angle, shall not be less than half the thickness of the heavier member connected plus 2mm. Lap splice may be used for connecting members of unequal size and the inside angle of lap splice shall be rounded at the heel to fit the fillet of the outside angle. All splices shall develop full stress in the member connected through bolts. Butt as well as lap splice shall be made as above and as close to the main panel point as possible.
- 9.6.3 Joints shall be so designed as to avoid eccentricity as far as possible. The use of gusset plates for joining tower members shall be avoided as far as possible. However, where the connections are such that the elimination of the gusset plates would result in eccentric joints, gussets plates and spacer plates may be used in conformity with modern practices. The thickness of the gusset plates required to transmit stress shall not be less than that of members connected.
- 9.6.4 The use of filler in connection shall be avoided as far as possible. The diagonal web members in tension may be connected entirely to the gusset plate wherever necessary to avoid the use of filler and it shall be connected at the point of intersection by one or more bolts.
- 9.6.5 The tower structures shall be accurately fabricated to connect together easily at


	<p>Specification for design, supply, installation and commissioning, operations and maintenance of 132kV switchyards, transmission lines / towers, underground cables for 15 MWp solar power plant at NTPC-Singrauli (MP/UP)</p>	<p>PS-439-856 Rev 00 Page 93 of 171</p>
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site without any undue strain on the bolts.

- 9.6.6 No angle member shall have the two leg flanges brought together by closing angle.
- 9.6.7 The diameter of the hole shall be equal to the diameter of bolt plus 1.5mm.
- 9.6.8 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 depression are likely to hold water.
- 9.6.9 All similar parts shall be made strictly inter-changeable. All steel sections before any work is done on them, shall be carefully leveled, 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 through out. No rough edges shall be permitted in the entire structure.

9.6.10 Drilling and Punching

- a) Before any cutting work is started all steel sections shall be carefully straightened and trued by pressure and not by hammering. They shall again be trued after being punched and drilled.
- b) Holes for bolts shall be drilled on punched with a jig but drilled holes shall be preferred. The following maximum tolerance of accuracy of punched holes is permissible.
- 1) Holes must be perfectly circular and no tolerance in this respect permissible.
 - 2) The max. allowable difference in diameter of the holes on the two sides of plates or angle is 0.8mm. i.e. the allowable taper in a punched holes should not exceed 0.8mm on diameter.
 - 3) Holes must be square with the plates or angles and have their walls parallel.
- c) 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.

	<p>Specification for design, supply, installation and commissioning, operations and maintenance of 132kV switchyards, transmission lines / towers, underground cables for 15 MWp solar power plant at NTPC-Singrauli (MP/UP)</p>	<p>PS-439-856 Rev 00 Page 94 of 171</p>
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9.6.11 Erection mark

- a) Each individual member shall have erection mark conforming to the component number given to it in the fabrication drawings. This mark shall be marked with marking dies of 16mm size before galvanising and shall be legible after galvanising.
- b) Erection Mark shall be “A - BB- CC – DDD”, where

A = Owner's code assigned to the Contractor Alphabet.
BB = Contractor's Mark-Numerical
CC = Tower Type-Alphabet
DDD = Number mark to be assigned by Contractor.

9.6.12 Quantities and Weights

The unit weight of each type of tower, stubs and extensions shall be furnished by the bidder. The weight of tower shall mean the weight of tower calculated by using the black sectional (i.e. un-galvanised) weight of steel members of the size indicated in the approved fabrication drawings and bills of materials, without taking into consideration the reduction in weights, holes, notches and bevel cuts etc, but taking into consideration the weight of the fasteners, anti-climbing devices etc.

9.6.13 Galvanising


Fully galvanised towers and stub shall be used for the line. Galvanisation of the member of the towers shall conform to IS:2629 and IS:4759. The minimum weight of galvanisation shall be 610 gms/sqm. The galvanisation shall be done after all fabrication work is completed, except that the nuts may be tapped or re-run after galvanising. Threads of bolts and nuts shall have a neat fit and shall be such that they can be turned with finger throughout the length of the threads of bolts and they shall be capable of developing full strength of the bolts. Spring washers shall be electro-galvanised as per Grade 4 of IS:1573.

9.7 TOWER EARTHING

The footing resistance of all towers shall be measured by the Contractor in dry weather after tower erection but before the stringing of earthwire. All the tower are to be earthed. In no case tower footing resistance shall exceed 10 ohms. Pipe type earthing and counterpoise type earthing wherever required shall be provided in accordance with the stipulations made in IS:3043-1987 and IS:5613 (part-II/Section-2) 1985. The details for pipe and counterpoise type earthing are given in drawing enclosed with the specification.

9.8 INSPECTION AND TESTS

- 9.8.1 All standard tests, including quality control tests, in accordance with appropriate Indian/International standard, shall be carried out unless otherwise specified herein.

	<p>Specification for design, supply, installation and commissioning, operations and maintenance of 132kV switchyards, transmission lines / towers, underground cables for 15 MWp solar power plant at NTPC-Singrauli (MP/UP)</p>	<p>PS-439-856 Rev 00 Page 95 of 171</p>
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9.8.2 Inspection

In addition to the provisions as specified elsewhere in this specification, the following shall also apply:

- a) The Contractor shall keep the Owner informed in advance about the time of starting and the progress of manufacture and fabrication of various tower parts at various stages, so that arrangements could be made for inspection.
- b) The acceptance of any part of items shall in no way relieve the Contractor of any part of his responsibility for meeting all the requirements of the Specification.
- c) The Owner or his representative shall have free access at all reasonable times to those parts of the Contractor's works which are concerned with the fabrication of the Owner's material for satisfying himself that the fabrication is being done in accordance with the provisions of the specifications.
- d) Unless specified otherwise inspection shall be made at the place of manufacture prior to dispatch and shall be conducted so as not to interfere unnecessarily with the operation of the work.
- e) Should any member of the structure be found not to comply with the approved design, it shall be liable to rejection. No member once rejected shall be resubmitted for inspection, except in cases where the Owner or his authorised representative considers that the defects can be rectified.
- f) Defect which may appear during fabrication shall be made good with the consent of, and according to the procedure proposed by the Contractor and approved by the Owner.
- g) All gauges and templates necessary to satisfy the Owner shall be supplied by the manufacturer.
- h) The correct grade and quality of steel shall be used by the Contractor. To ascertain the quality of steel used the inspector may at his discretion get the material tested at an approved laboratory.

9.8.3 Tower Load Tests

- a) The Contractor shall submit one set of shop drawings alongwith the bill of materials. Further, Contractor shall submit one copy of test reports and final tracings of shop drawings and Bill of materials for Owner's reference and record.
- b) The Contractor shall ensure that the specification of materials and workmanship of all towers actually supplied conform strictly to the towers which have successfully under gone the tests. In case any deviation is detected, the Contractor shall replace such defective towers free of cost to the Owner. All expenditure incurred in erection, to and fro transportation and any other expenditure or losses incurred by the Owner on this account shall be fully borne by the Contractor. No extension in delivery time shall be allowed on this account.

	<p>Specification for design, supply, installation and commissioning, operations and maintenance of 132kV switchyards, transmission lines / towers, underground cables for 15 MWp solar power plant at NTPC-Singrauli (MP/UP)</p>	<p>PS-439-856 Rev 00 Page 96 of 171</p>
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9.8.4 Tower Testing Procedure

The testing of towers shall be as per the procedure described below:

a) Bolt Slip Test

In the bolt slip test, the test loads shall be gradually applied up to the 50% of design loads under normal condition and held for two (2) minutes at that loads and then released gradually.

The initial and final readings on the scales (for measurement of deflection) before application and after the release of Loads respectively shall be taken with the help of theodolite. The difference between these readings gives the values of the bolt slip.

b) Normal/Broken Wire Load Tests


All the loads, for a particular load-combination test shall be applied gradually upto the full design loads in the following steps and shall also be released in the similar manner:

- 50 percent
- 75 percent
- 90 percent
- 95 percent
- 100 percent

c) Observation Periods

- 1) Under normal and broken wire load tests, the tower shall be kept under observation for sign of any failure for two minutes (excluding the time for adjustment of loads) for all intermediate steps of loading upto and including 95 per cent of full design loads.
- 2) For normal, as well as broken wire tests, the tower shall be kept under observation for five (5) minutes (excluding the time for adjustment of loads) after it is loaded upto 100 percent of full design loads.
- 3) While the loading operation are in progress, the tower shall be constantly watched, and if it shows any tendency of failure anywhere, the loading shall be immediately stopped, released and then entire tower shall be inspected. The reloading shall be started only after the corrective measures are taken.
- 4) The structure shall be considered to be satisfactory, if it is able to support the specified full design loads for five (5) minutes, with no visible local deformation after unloading (such as bowing, buckling etc.) and no breakage of elements or constituent parts.
- 5) Ovalization of holes and permanent deformation of bolts shall not be considered as failure.

d) Recording

	<p>Specification for design, supply, installation and commissioning, operations and maintenance of 132kV switchyards, transmission lines / towers, underground cables for 15 MWp solar power plant at NTPC-Singrauli (MP/UP)</p>	<p>PS-439-856 Rev 00 Page 97 of 171</p>
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The deflection of the tower shall be recorded at each intermediate and final stage of normal load and broken wire load tests by means of a theodolite and graduated scale. The scale shall be of about one meter long with marking upto 5 mm accuracy.

e) Destruction Test

1. The destruction test shall be carried out under normal condition or broken wire condition. The Owner at the time of approval of rigging chart/test data sheet shall intimate the contractor. Under which load condition the destruction test is to be carried out.
2. The procedure for application of load for normal/broken wire test shall also be applicable for destruction test. However, the load shall be increased in steps of five (5) percent after the full design loads have been reached.

9.9 PACKING

The packings shall be properly done to avoid losses/damages during transit. Each bundle or package shall be appropriately marked.


9.10 DESIGN CALCULATION AND DRAWINGS

9.10.1 The following design calculation and drawings are required to be furnished during detailed engineering.

- a) Computation of wind load
- b) Sag-tension calculation
- c) Tower loading
- d) Single line diagram of towers showing electrical clearances and steel sections.

9.10.2 The Contractor shall also furnish following to the owner:


- a) Detailed design calculation and drawing for towers and foundations.
- b) Detailed structural drawings indicating section size, length of members sizes of plate along with hole to hole distance, joint details etc.
- c) Bill of materials, indicating cutting and bending details against each member.
- d) Shop drawings showing all details relevant to fabrication.
- e) All the drawings for the tower accessories.

	<p>Specification for design, supply, installation and commissioning, operations and maintenance of 132kV switchyards, transmission lines / towers, underground cables for 15 MWp solar power plant at NTPC-Singrauli (MP/UP)</p>	<p>PS-439-856 Rev 00 Page 98 of 171</p>
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**TABLE-T1-2
DESIGN LOADS**

S.No	Tower Type	Longitudinal Loads		Transverse Loads	
		Reliability Condition	Security Condition	Reliability Condition	Security Condition
1	2	3	4	5	6
a.	A	0.0	0.5 x MT For Conductor). 1.0 x MT (For Earth Wire)	WC + WI + DY	0.6 WC + WI +0.25 DY (For Conductor) 0.6 WC + 0.5 DY (For Earth Wire)
b.	B (Section Tower- 0° Deviation)	MT1	1.0 x MT	WC + WI + DY	0.6 WC + WI +0.5 DY
c.	B (15° Deviation)	MT1	1.0 x MT x Cos $\phi/2$	WC + WI + DY	0.6 WC + WI +0.5 DY
d.	C (Section Tower- 0° Deviation)	MT1	1.0 x MT	WC + WI + DY	0.6 WC + WI +0.5 DY
e.	C (30° Deviation)	MT1	1.0 x MT x Cos $\phi/2$	WC + WI + DY	0.6 WC + WI +0.5 DY
f.	D (60° Deviation)	MT1	1.0 x MT x Cos $\phi/2$	WC + WI + DY	0.6 WC + WI +0.5 DY
g.	D (Dead End with slack span of 100 Mtrs. Max.)	0.7 MT	1.0 x MT	WC + WI + (0.3 MT x Sin 15°)	0.6 WC + WI
h.	D Complete Dead End	MT	1.0 x MT	WC + WI	0.1 WC + WI


DESCRIPTION	SYMBOL	REMARKS
Maximum Tension Of Conductor/ Earth Wire under everyday temperature & full wind condition or minimum temperature & 36% Of max. wind which ever is more stringent	MT	
Wind On Conductor	WC	Wind Span shall be the normal ruling span.

	<p>Specification for design, supply, installation and commissioning, operations and maintenance of 132kV switchyards, transmission lines / towers, underground cables for 15 MWp solar power plant at NTPC-Singrauli (MP/UP)</p>	<p>PS-439-856 Rev 00 Page 99 of 171</p>
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Wind On Insulator	WI	In case of Double String Insulators, both their strings shall be considered
Angle Of Deviation (Degrees)	Φ	
Load Due To Deviation Of Tower	$DY = 2 \times MT \times \sin \frac{\Phi}{2}$	
Difference In Tension For Equivalent Spans of 305 M & 150 M (For 132 KV Towers)	MT1	

Note:

1. Vertical loads shall conform to IS 802 – Part I, 1995. Weight spans as furnished under Clause 2.03.00 shall be considered for computation of vertical loads.
2. Safety loads and Anti-cascade loads as specified in IS 802- Part I, 1995 shall also be considered for design of Towers.
3. Wind loads on the towers shall be considered in transverse loads as per clause 11, 12 and 13 of IS: 802 (Part-I/ Sec. I)- 1995.
4. Any additional loads apart from the loads mentioned above, as required as per IS: 802- 1995 shall be considered for design purpose.

	<p>Specification for design, supply, installation and commissioning, operations and maintenance of 132kV switchyards, transmission lines / towers, underground cables for 15 MWp solar power plant at NTPC-Singrauli (MP/UP)</p>	<p>PS-439-856 Rev 00 Page 100 of 171</p>
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10.0 TOWER FOUNDATIONS

10.1 TYPES OF FOUNDATION I

10.1.1 GENERAL

- 1) Reinforced concrete footing shall be used for all type of tower in conformity with the IS Codes and the specifications. All the four footings of the tower and their extension shall be similar, irrespective of down thrust and uplift.
- 2) Foundation includes supply of materials such as cement, sand, coarse aggregates, reinforcement steel etc., and all work related to construction of foundations including excavation and backfilling, form work, stub setting, placing of reinforcement, concreting etc.

10.1.2 Design criteria for Foundations

The foundation shall be designed for the actual soil parameters based on the soil investigation carried out by the bidder and approved by the owner. For design purposes:

- (a) The angle of repose shall be considered as two-third (2/3) of the value as obtained from the soil investigation
- (b) Water table shall be considered up to the ground level.
- (c) The weight of soil shall be considered as 1440 Kg/m³ under dry condition and 940 Kg/m³ under wet condition.


Well foundation or pile foundation shall be provided by the bidder wherever necessitated.

10.2 SOIL INVESTIGATION

- 10.2.1) The Contractor is required to carry out detailed soil investigation at various tower locations along the corridor, one borehole at centre of the tower, angle points, crossings, etc. and also where soil strata is different from the other locations investigated. In addition the soil investigation may be required to be carried at other locations at the discretion of the Engineer.

The investigation comprises of field and laboratory testing. Field investigation includes boreholes, Standard Penetration Test (SPT), Static Cone Penetration Test (SCPT), Dynamic Cone Penetration Test (DCPT), collection of disturbed samples (DS) and undisturbed soil samples (UDS), Trial Pits (TP), Plate Load Tests (PLT), Electrical Resistivity Test (ERT), collection of water samples, etc. Laboratory tests shall include, Physical, chemical and engineering properties of soil/rock.

- 10.2.2) This specification covers technical requirements for geotechnical investigation and preparation of a detailed geotechnical report. It shall include mobilization of necessary equipment, providing necessary engineering supervision and technical personnel, carrying out field investigation and tests, laboratory tests, analysis and interpretation of data and results, collecting data regarding change of course of rivers from local sources, velocity, scour, etc., giving flood details of the area (past history), safe bearing capacity for different sizes of foundations,

	<p>Specification for design, supply, installation and commissioning, operations and maintenance of 132kV switchyards, transmission lines / towers, underground cables for 15 MWp solar power plant at NTPC-Singrauli (MP/UP)</p>	<p>PS-439-856 Rev 00 Page 101 of 171</p>
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different founding strata for the various locations along the transmission lines and preparation of geotechnical report.

- 10.2.3) The diameter of borehole shall be minimum 150 mm in soil and 76 mm in rock. Depth of bore holes at river/bridge crossings shall be 40m, at angle points depth shall be 15.0m and at the centre of tower along the corridor depth of BH shall be 10.0m. Boring shall be terminated at the above specified depth or 3.0m continuous in rock with RQD>25% for river crossings and for balance areas 3.0m in refusal whichever is earlier. Refusal means SPT 'N' value greater than 100.

SPT shall be carried out in all types of soil deposits and in all rock formations with core recovery up to 20%, met within a borehole. This test shall be conducted at every 3.0 m interval or at change of strata, up to the final depth. At refusal penetration shall be measured and the same shall be reported in Borelog. UDS shall be collected at every 3.0 m interval or at change of strata up to depth of borehole. UDS may be replaced by additional SPT, if SPT'N' value in the strata is above 50. The diameter of UDS sampler shall be 100 mm minimum.

- 10.2.4) Laboratory tests shall be done as per relevant IS codes. The laboratory tests, not be limited to the following shall be conducted on disturbed and undisturbed soil samples, rock samples & water samples collected during field investigations in sufficient numbers.


a) Laboratory Tests on Soil Samples

Laboratory tests shall be carried out on disturbed and undisturbed soil samples for Grain Size Analysis, Hydrometer Analysis, Atterberg Limits, Triaxial Shear Tests (UU), Natural Moisture Content, Specific Gravity and Bulk Unit Weight, Consolidation Tests, Unconfined Compression Test, Free swell Index, Shrinkage Limit, Swell Pressure Test, Chemical Analysis test on soil and water samples to determine the carbonates, sulphates, chlorides, nitrates, pH, organic matter and any other chemicals harmful to concrete and reinforcement/ steel.

b) Laboratory Tests on Rock Samples

Moisture content, porosity & density, Specific Gravity, Hardness, Soundness, Slake durability index, Unconfined compression test (Both at saturated and in-situ water content), Point load strength index and deformability test (Both at saturated and in-situ water content) shall be carried out on rock samples.


- 10.2.5) The laboratory tests shall be carried out progressively during the field work after sufficient numbers of samples have reached the laboratory in order that the test results of the initial boreholes can be made use of in planning the later stages of the field investigation and quantum of laboratory tests. All samples brought from field, whether disturbed or undisturbed shall be extracted/prepared and examined by competent technical personnel and the tests shall be carried out as per the procedures laid out in the latest editions of the relevant IS codes. Soil shall be classified as per the provisions of Indian standards.

	<p>Specification for design, supply, installation and commissioning, operations and maintenance of 132kV switchyards, transmission lines / towers, underground cables for 15 MWp solar power plant at NTPC-Singrauli (MP/UP)</p>	<p>PS-439-856 Rev 00 Page 102 of 171</p>
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10.2.6) On completion of all field & laboratory work, geotechnical investigation report shall be submitted for Owner's review/approval. The Geotechnical investigation report shall contain geological information of the region, procedure adopted for investigation, field & laboratory observations/ data/ records, analysis of results & recommendations on type of foundation envisaged for all areas of work with supporting calculations. Recommendations on treatment for soil, foundation, based on subsoil characteristics, soft soils, aggressive chemicals, expansive soils, etc.

10.2.7) The Geotechnical report shall include, but not limited to the following:

- a) Borelogs: A true cross section of all individual boreholes with reduced levels and coordinates, showing the classification and thickness of individual stratum, position of ground water table, details of various in-situ tests conducted and samples collected at different depths and the rock stratum, wherever met with.
- b) Results of all laboratory tests summarized for each Borehole along with a consolidated table giving the layer wise soil and rock properties. All the relevant charts, tables, graphs, figures, supporting calculations, conditions and photographs of representative rock cores shall be furnished.
- c) Recommendations : The report should contain specific recommendations on type of foundations to be adopted for various structures, duly considering the sub soil characteristics, water table, total/ differential settlement permissible for structures and equipments, minimum depth and width of foundation. The observation/recommendations shall include but not limited to the following:
 - i) Geological information of the area, past observations or historical data, if available, for the area and for the structures in the nearby area, fluctuations of water table etc.
 - ii) Net safe allowable bearing pressure on the soil at various depths for different sizes of the foundations based on shear strength and settlements characteristics of soil with supporting calculations for the recommendations.
 - iii) Based on the chemical nature of soil and ground water and exposure condition, recommendations for protective measures on concrete and steel shall be mentioned.
 - iv) If expansive soil is met with, recommendation and removal or retainment of the same under structures/ roads etc. shall be given. In the later case detailed specification of any special treatment required including specifications for materials to be used, construction method, equipments to be deployed, etc. shall be furnished.
 - iv) Additional investigation other then specified above, if any, the same shall be carried out by the bidder at no extra cost to owner.

	<p>Specification for design, supply, installation and commissioning, operations and maintenance of 132kV switchyards, transmission lines / towers, underground cables for 15 MWp solar power plant at NTPC-Singrauli (MP/UP)</p>	<p>PS-439-856 Rev 00 Page 103 of 171</p>
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10.2.8) Indian Standard References

IS:1498 Classification and Identification of Soils for general Engineering Purposes.

IS:1892 Code of practice for Subsurface Investigation for Foundation.

IS:1904 Code of practice for design and construction of foundations in Soils: General Requirements.

IS:2131 Method of Standard Penetration Test for Soils.

IS:2132 Code of practice for Thin walled Tube Sampling of soils.

IS:2470 Code of practice for design and construction of Septic (Part-I) Tanks.

IS:2720 Method of Test for Soils (Relevant Parts).

IS:5313 Guide for Core Drilling Observations.

IS:4968 Method for subsurface Sounding for Soils - Dynamic (Part-II) method using Cone and Bentonite slurry.

IS:4968 Method for subsurface Sounding for Soils- Static Cone (Part-III) Penetration Test.

10.3 LOADS ON FOUNDATIONS

10.3.1) The foundations shall be designed to withstand the specific loads of the superstructure and for the full footings reactions obtained from the structural stress analysis in conformity with the relevant over load factors. The over load factor for foundation design shall be 1.10 for all loads except dead loads.

10.3.2) The reactions on the footings shall be composed of the following type of loads for which these shall be required to be checked:

- a) Max. tension or uplift along the leg slope.
- b) Max. compression or down-thrust along the leg slope.
- c) Max. horizontal shear or side thrust.


10.3.3) The base slab of the foundation shall be designed for additional moments developing due to eccentricity of the loads.

10.3.4) The additional weight of concrete in the footing below ground level over the earth weight and the full weight of concrete above the ground level in the footing and embedded steel parts will also be taken into account adding to the down thrust.

10.4 STABILITY ANALYSIS

10.4.1) In addition to the strength design, stability analysis of the foundation shall be done to check the possibility of failure by over-turning, uprooting, sliding and tilting of the foundation.

10.4.2) The following primary type of soil resistance shall be assumed to act in resisting the loads imposed on the footing in earth:

	<p>Specification for design, supply, installation and commissioning, operations and maintenance of 132kV switchyards, transmission lines / towers, underground cables for 15 MWp solar power plant at NTPC-Singrauli (MP/UP)</p>	<p>PS-439-856 Rev 00 Page 104 of 171</p>
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a) Resistance against uplift

The uplift loads will be assumed to be resisted by the weight of earth in an inverted frustum of a conical pyramid of earth on the footing pad whose sides make an angle equal to the angle of repose of the earth with the vertical. However, the angle of repose for uplift resistance shall be considered two-third (2/3) of the value as obtained from the soil investigation report. The weight of concrete embedded in earth and that above the ground will also be considered for resisting the uplift. In case where the frustum of earth pyramids of two adjoining legs super-impose each other, the earth frustum will be assumed truncated by a vertical plane passing through the center line of the tower base.

b) Resistance against down thrust

The down-thrust load combined with the additional weight of concrete above earth will be resisted by bearing strength of the soil assumed to be acting on the total area of the bottom of the footings.

c) Resistance against side-thrust


The chimney portion of the foundation shall be designed as per limit state method of IS-456, considering the chimney as a column subjected to axial loads (down thrust loads) and biaxial bending moments resulting from side thrust forces. The passive earth pressure (as per Rankine's formula) shall be considered for the design of chimney against side thrust. If uplift and down thrust are computed in vertical direction for the foundation design, full resultant horizontal shear shall be taken at footing tip for design of the footing to resist side thrust.

10.5 PROPERTIES OF CONCRETE

- 10.5.1) The cement concrete used for the foundations shall be of grade M20 (nominal mix) with 20mm coarse aggregate.
- 10.5.2) All the properties of concrete regarding its strength under compression tension, shear, punching and bending etc. as well as workmanship will conform to IS:456.
- 10.5.3) The water used for mixing concrete shall be fresh, clean and free from oil, acids and alkalies, organic materials or other deleterious substances. Potable water is generally preferred.

10.6 DESIGN OF FOUNDATIONS

- 10.6.1) Structural design of the foundations shall be done by limit State method conforming to IS 456.
- 10.6.2) The chimney should have all around clearance of 150mm from any part of stub angle limiting to 450mm sq. minimum.

	<p>Specification for design, supply, installation and commissioning, operations and maintenance of 132kV switchyards, transmission lines / towers, underground cables for 15 MWp solar power plant at NTPC-Singrauli (MP/UP)</p>	<p>PS-439-856 Rev 00 Page 105 of 171</p>
---	--	--

- 10.6.3) The chimney top or muffing must be at least 225 mm above ground level and also the coping shall be extended upto lower most joint level between the bottom lattices and the main corner legs of the tower.
- 10.6.4) Minimum thickness of foundation shall be 300 mm.
- 10.6.5) The distance between the lowest edge of the stub angle and the bottom surface of concrete footing shall not be less than 150 mm or more than 200mm.
- 10.6.6) The total depth of foundations below the ground level shall not be less than 1.5 meters. To maintain the interchangeability of stubs for all types of foundations, for each type of tower, the same depths of foundations shall be used for different types of foundations.
- 10.6.7) The portion of the stub in the chimney and foundation slab shall be designed to take full down-thrust or uplift loads by the cleats combined with the bond between stub angles and concrete. The Contractor shall furnish the calculation for uprooting of stub along with the foundation design.
- 10.6.8) Minimum 50mm thick pad of lean concrete corresponding to 1:3:6 nominal mix shall be provided to avoid the possibility of reinforcement rod being exposed due to unevenness of the bottom of the excavated pit.
- 10.6.9) Over Load Factor

The overload factor for foundations shall be considered as 1.1 i.e. the reaction except due to dead loads on foundations shall be increased by 10 per cent.

10.7 CONSTRUCTION OF TOWER FOUNDATION


10.7.1 Excavation

- a) Excavation work must not be started until the tower schedule & profile and foundation drawing are approved by the Owner.
- b) Except specified otherwise, all excavation for footing shall be made to the lines and grades of the foundation. All excavation shall be protected so as to maintain a clean subgrade, until the footing is placed, using timbering/shuttering, shoring etc., if necessary. Any sand, mud, silt or other undesirable materials which may accumulate in the excavated pit shall be removed by the Contractor before placing concrete.

10.7.2 Rock excavation requiring Blasting

Wherever blasting is required for excavation in rock, the same shall be done after obtaining license from the competent authority. Following shall be adhered to:


- a) All provisions of explosive acts shall be adhered to.

	<p>Specification for design, supply, installation and commissioning, operations and maintenance of 132kV switchyards, transmission lines / towers, underground cables for 15 MWp solar power plant at NTPC-Singrauli (MP/UP)</p>	<p>PS-439-856 Rev 00 Page 106 of 171</p>
---	--	--

- b) The magazine for the storage of explosive shall be to suit as per the requirements of explosive department.
- c) Where blasting is required, same shall be controlled blasting.
- d) Contractor shall prepare the detailed blasting scheme and get the same approved from Engineer-in-charge before carrying out the blasting operation. All blasting shall be done as per the approved blasting scheme.
- e) The Contractor shall obtain Licenses from Competent Authorities for undertaking blasting work as well as for procuring, transporting to site and storing the explosives as per explosives act. The Contractor shall be responsible for the safe transport, use, custody and proper accounting of the explosive Materials.
- f) The Contractor shall also observe any specific instructions given by the Engineer-in-charge. The Contractor shall be responsible and liable for any accident and injury / damage which may occur to any person or property of the project or public on account of any operations connected with the storage, transportation, handling or use of explosives and the blasting operations. The Engineer-in-charge or his authorised representative shall frequently check the Contractor's compliance with these precautions and the manner of storing and accounting of explosives. The Contractor shall provide necessary facilities for this the above.
- g) Controlled blasting shall be done by a specialised agency duly approved by Engineer-in-charge. All controlled blasting shall be done by using time delay detonators (i.e. excel type).
- h) All rules under the Explosives Act and other local rules in force shall be fully observed. All blasting works shall be done in accordance with the stipulations contained in IS: 4081.

10.7.3 Setting of Stubs

- a) The stubs shall be set correctly in accordance with approved method at the exact location and alignment and precisely at correct levels with the help of stub setting templates and leveling instrument. Stubs shall be set in the presence of Owner's representative available at site where required and for which adequate advance intimation shall be given to the Owner by the Contractor.
- b) Setting of stub at each location shall be approved by the Owner's representative.
- c) Stub setting templates shall be designed and arranged by the Contractor at his own cost for all types of towers with or without extension and also for leg extension. Stub templates for standard towers and towers with extension upto 6M shall be of adjustable type. The stub templates shall be painted. Generally for each transmission line tower package, following numbers of stub setting templates shall be deployed by the Contractor:

	<p>Specification for design, supply, installation and commissioning, operations and maintenance of 132kV switchyards, transmission lines / towers, underground cables for 15 MWp solar power plant at NTPC-Singrauli (MP/UP)</p>	<p>PS-439-856 Rev 00 Page 107 of 171</p>
---	--	--

- For each A type tower : 3 Nos.
For each of B, C and D type : 2 Nos.

However, if Owner feels that more number of templates are required for timely completion of a particular line the Contractor shall have to deploy the same without any extra cost to Owner.


- d) One set of each type of stub setting template as applicable, shall be supplied to the Owner, on completion of the project at no extra cost to Owner.

10.7.4 Mixing, Placing and Compacting of Concrete

- a) The concrete shall be mixed in a mechanical mixer. However, in case of difficult terrain hand mixing may be permitted at the discretion of Owner. The water for mixing concrete shall be fresh, clean and free from oil, acids and alkalies. Saltish or blackish water shall not be used.
- b) Mixing shall be continued until there is uniform distribution of material and the mix is uniform in colour and consistency, but in no case the mixing be done for less than two minutes. Normally mixing shall be done close to the foundation, but in case it is not possible the concrete may be mixed at the nearest convenient place. The concrete shall be transported from the place of mixing to the place of final deposit as rapidly as practicable by methods which shall prevent the segregation or loss of any ingredient. The concrete shall be placed and compacted before setting commences.
- c) Form boxes shall be used for casting all type of foundations. The concrete shall be well compacted such that no honey-combing is left in the concrete. The mechanical vibrator shall be employed for compaction of the concrete. However, in case of difficult terrain, manual compaction may be permitted at the discretion of Owner. After concreting the chimney portion to the required height, the top surface should be finished smooth with a slight slope towards the outer edge, to drain off any rain water falling on the coping.
- d) In wet locations, the site must be kept complete de-watered, both during the placing of the concrete and for 24 hours thereafter. There should be no disturbance of concrete by water during this period.
- e) After the form-work has been removed if the concrete surface is found to be defective, the damage shall be repaired with rich cement and sand mortar to the satisfaction of the Owner's representative before the foundation pits are backfilled.

10.7.5 Back-Filling and Removal of Stub Template

- a) After opening of form-work and removal of shoring and timbering, if any, backfilling shall be started, after repairs, if any, to the foundation concrete. Backfilling shall normally be done with excavated soil, unless it consists of large boulders/stones, in which case the boulders shall be broken to a maximum size of 80 mm. At such locations where borrowed earth is required for backfilling, shall be done by the Contractor at his own cost, irrespective of lead.

	<p>Specification for design, supply, installation and commissioning, operations and maintenance of 132kV switchyards, transmission lines / towers, underground cables for 15 MWp solar power plant at NTPC-Singrauli (MP/UP)</p>	<p>PS-439-856 Rev 00 Page 108 of 171</p>
---	--	--

- b) The backfilling materials should be clean and free from organic or other foreign materials. The earth shall be deposited in maximum 200 mm layers, leveled and wetted and tempered properly before another layer is deposited. Care shall be taken that the backfilling is started from the foundation ends of the pits, towards the outer ends. After the pits have been backfilled to full depth, the stub template may be removed.
- c) The backfilling and grading shall be carried to an elevation of about 75 mm above the finished ground level to drain out water. After backfilling 50 mm high earthen embankment (bandh) will be made along the sides of excavation pits and sufficient water will be poured in the backfilled earth for atleast 24 hours.

10.7.6 Curing


The concrete after setting for 24 hours shall be cured by keeping the concrete wet continuously for a period of 10 days after laying. The pit may be back filled with selected earth sprinkled with necessary amount of water and well consolidated in layers not exceeding 200 mm of consolidated thickness after a minimum period of 24 hours and thereafter both the backfilled earth and exposed chimney top shall be kept wet for the remainder of the prescribed time of 10 days. The uncovered concrete chimney above the backfilled earth shall be kept wet by providing empty cement bags dipped in water fully wrapped around the concrete chimney for curing and ensuring that the bags are kept wet by the frequent pouring of water on them.

10.7.7 Benching

When the line passes through hilly/undulated terrain, for a few tower locations it may be required to level the ground for casting of tower footings on same elevation. All the activities related to make the required area of ground in same elevation for casting of foundation, shall be termed as benching work. Benching work shall include cutting of excess earth and removing the same to a suitable point of disposal as required by the Owner. Benching shall be resorted to only after getting specific approval from the Owner.

10.7.8 Protection of Tower Footing

- a) The work shall include all necessary stone revetments, concreting and earth filling above ground level in hilly/undulated terrain and special measures like RCC retaining walls for protection of foundation close to or in nallah, river bed etc. The top seal cover of the stone revetments shall be done with M20 concrete (nominal mix). The Contractor shall furnish recommendations for providing protection at these locations wherever required.
- b) The quantity of excavated earth obtained from a particular location shall generally be utilised in back-filling work in protection of tower footing of same locations, unless it is unsuitable for such purpose. In the latter case, the back-filling shall be done with borrowed earth of suitable quality. The consolidation of earth shall however be done after backfilling.

	<p>Specification for design, supply, installation and commissioning, operations and maintenance of 132kV switchyards, transmission lines / towers, underground cables for 15 MWp solar power plant at NTPC-Singrauli (MP/UP)</p>	<p>PS-439-856 Rev 00 Page 109 of 171</p>
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11.0 LINE MATERIAL

11.1 GENERAL

11.1.1) All the equipment shall be of the latest design and conform to the best modern practice adopted in the extra high voltage field. The Bidder shall offer only such equipment as guaranteed by him to be satisfactory and suitable for 132 kV AC transmission with single conductor and will give continued good performance.

11.1.2) The design, manufacturing process and quality control of all the materials shall be such as to give maximum factor of safety, maximum possible working load, highest mobility, elimination of sharp edges and a good finish.

11.1.3) All ferrous parts shall be hot dip galvanised, after all machining has been completed, nuts may, however, be tapped (threaded) after galvanising and the threads oiled. Spring washers shall be electrogalvanised. The bolt threads shall be undercut to take care of increase in diameter due to galvanising. Galvanising shall be done in accordance with IS:2629-1972. Fasteners shall withstand four dips while spring washers shall withstand three dips. Other galvanised materials shall be guaranteed to withstand at least six dips each lasting one minute under the standard prece tests for galvanising.

11.1.4) The zinc coating shall be perfectly adherent, of uniform thickness, smooth, reasonably bright, continues and free from imperfection such as flux, ash, rust stains, bulky white deposits and blisters. The zinc used for galvanising shall be of grade Zn. 99.95 as per IS:209-1966.

11.1.5) Electrical System Data for 132 kV Lines

Nominal voltage 132 kV

Maximum voltage 145 kV

BIL(Impulse) 650 kV(peak)

Power Frequency 275 kV(rms)


Withstand Voltage

11.1.6) Line Data Conductor

Name "Panther" ACSR

Strand and wire diameter Al 30/3.00 Steel 7/3.00

Conductor per phase One

	<p>Specification for design, supply, installation and commissioning, operations and maintenance of 132kV switchyards, transmission lines / towers, underground cables for 15 MWp solar power plant at NTPC-Singrauli (MP/UP)</p>	<p>PS-439-856 Rev 00 Page 110 of 171</p>
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Inter Phase Spacing Vertical : 4390
Horizontal : 7650
Earthwire Size: 7/3.15 Dia : 9.45

Location of earthwire: one continuous earthwire to run horizontally on top of the towers and conductors.

11.2 EARTHWIRE

11.2.1) The galvanised steel earthwire shall generally conform to the specification of ACSR core wire as mentioned in IS 398 (Part-II)-1976 except where otherwise specified herein.

Parameters of the earthwire

a) Stranding and wire diameter	:	7/3.15 mm steel
b) Total sectional area	:	54.55 sq.mm
c) Overall diameter	:	9.45 mm
d) Approximate weight	:	428 kg/km
e) Calculated D.C resistance at 20 ^o C.	:	3.375 ohms/km
f) Minimum ultimate tensile strength	:	56 KN
g) Direction of lay of outer layer	:	Right Hand

11.2.2) The earthwire shall be performed and post-formed to avoid opening of strands at the time of cutting or joining. The finished material shall have minimum brittleness, as it will be subject to appreciable vibration while in use. It shall withstand 3 and ½ number of one minute dips in the standard preece test.

11.2.3) There shall be no joint of any kind in the finished steel wire strand entering into the manufacture of the earthwire. There shall be no strand joints or strand splicer in any length of the completed stranded earthwire.


11.2.4) Standard length and random length shall be as per clause 3.05.00 below. Bidder may offer two lengths in one drum.

11.3 CONDUCTOR

11.3.1) The conductor shall be Aluminium Core Steel Reinforced (ACSR) type. The conductor shall confirm to IS:398 (Part-II) except where otherwise specified herein.

Parameters of the conductor

a) Type Designation	Panther `ACSR`
b) Number and dia of steel strands	7/3.00 mm
c) Number and diameter of Aluminium strands	30/3.00 mm
d) Total sectiona area of ACSR	261.5 sq.mm
e) Total sectional area of aluminum	212.10 sq.mm
f) Overall diameter	21.00 mm
g) Approximate weight	974 kg/km

	<p>Specification for design, supply, installation and commissioning, operations and maintenance of 132kV switchyards, transmission lines / towers, underground cables for 15 MWp solar power plant at NTPC-Singrauli (MP/UP)</p>	<p>PS-439-856 Rev 00 Page 111 of 171</p>
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h) Calculated d.c. resistance at 20 deg.C	0.1391 Ohm/km
i) Minimum UTS	89.67 kN

11.3.2) The steel strands shall generally comply with the requirements stipulated for earthwire at clause 2.00.00 above.

11.3.3) Joints shall be permitted in the individual Aluminium wires in all layers except the outer most layer of the finished conductor. These joints shall be made by cold pressure butt-welding and shall be such that no two such joints are within 15 metres of each other in the complete stranded conductor.

11.3.4) The standard length of the conductor shall be 2000 metres. A tolerance of $\pm 5\%$ on the standard length offered by the bidder shall be permitted. All lengths outside this limit of tolerance shall be treated as random lengths. Random lengths will be accepted provided no length is less than 70% of the standard length and the total quantity of random lengths shall not be more than 10% of the total quantity ordered.

11.4 CONDUCTOR ACCESSORIES


11.4.1 Mid Span Compression Joint For Conductor

As per details given in IS:2121 Part-2..

11.4.2 Repair Sleeve

Repair Sleeve of compression type shall be used to repair conductor with not more than two strands broken in the outer layer. The sleeve shall be manufactured from 99.5% pure aluminium and shall have a smooth surface. The repair sleeve shall comprise of two pieces with a provision of seat for sliding of the keeper piece. The edges of the seat as well as the keeper piece shall be of rounded that the conductor strands are not damaged during installation.


11.4.3 The Bidder shall clearly specify the before and after compression dimensions of the mid span compression joint and repair sleeve. The compression pressure shall also be indicated by the Bidder. The dimensions and dimensionl tolerances for Mid Span Compression Joint and Repair Sleevs for ACSR `PANTHER` conductor shall be as follows:

	<p>Specification for design, supply, installation and commissioning, operations and maintenance of 132kV switchyards, transmission lines / towers, underground cables for 15 MWp solar power plant at NTPC-Singrauli (MP/UP)</p>	<p>PS-439-856 Rev 00 Page 112 of 171</p>
---	--	--

Item	Dimensions before compression			Dimensions after compression	
	Inner dia	Outer dia	Length	Corner to corner width	Face to face width
	(mm)				
Al sleeve Mid span compression joint	23 +/-1	38 +/-1	610 +/- 5	37+/- 0.5	32 +/- 0.5
Repair sleeve	23 +/-1	38 +/-1	250 +/- 5	37+/- 0.5	32 +/- 0.5
Steel sleeve Mid span compression joint	9.3 +/- 0.5	18 +/- 0.5	203 +/- 5	17.1 +/- 0.5	15.1 +/- 0.5

11.4.4 Vibration damper for conductor and earthwire

- a) Vibration dampers of 4 R -Stock bridge type with four (4) different resonance spread within the specified aeolian frequency bandwidth shall be used at all suspension and tension points on each span to damp out the Aeolian vibrations of the conductors to the specified level as mentioned hereinafter. Two dampers minimum on each side per conductor/earthwire shall be used at tension points and one damper minimum on each side per conductor at suspension points for ruling design span.
- b) The clamp of the vibration damper shall be made of high strength aluminium alloy of type LM-6 or equivalent.
- c) The messenger cable shall be made of high strength galvanised steel/stainless steel with a minimum strength of 135 kg/mm². It shall be of pre-formed and post-formed quality in order to prevent subsequent droop of weight and to maintain consistent flexural stiffness of the cable in service. The number of strands in messenger cable shall be 19. The messenger cable other than stainless steel shall be hot dip galvanised in accordance with the recommendations of IS:4826-1979 for heavily coated wires.
- d) The manufacturer must indicate the clamp bolt tightening torque to ensure that the slip strength of the clamp is maintained between 2.5 KN and 5KN. The clamp when installed on the conductor shall not cause excessive stress concentration on the conductor leading to permanent deformation of the conductor strands and premature fatigue failure in operation.
- e) The vibration damper for conductor shall not have magnetic power loss more than 0.5 watt at 350 amp at 50 Hz alternating current.
- f) The vibration analysis of the system, with and without damper and dynamic characteristics of the damper as detailed under Annexure-A shall have to be submitted by the Bidder along with his bid. The technical particulars for vibration

	<p>Specification for design, supply, installation and commissioning, operations and maintenance of 132kV switchyards, transmission lines / towers, underground cables for 15 MWp solar power plant at NTPC-Singrauli (MP/UP)</p>	<p>PS-439-856 Rev 00 Page 113 of 171</p>
---	--	--

analysis and damping design of the systems area follows:

Configuration	Single conductor per phase and all the phases in horizontal configuration
Span length	
(a) Ruling design span	300 meters
(b) Maximum span	600 meters
(c) Minimum span	50 meters
Tensile load in conductor / earthwire	As per sag tension calculations
Armour rods used	Standard performed armour rods / AGS
Max velocity of wind	30 kms per hour
Max permissible dynamic strains	150 micro strains


- g) The damper placement chart for spans ranging from 50 m to 600 m shall be submitted by the Bidder. All the placement charts should be duly supported by relevant technical documents and sample calculations.
- h) The damper placement charts shall include the following:
- 1) Location of the dampers for various combinations of spans and line tensions clearly indicating the number of dampers to be installed per conductor/earthwire per span.
 - 2) Placement distances clearly identifying the extremities between which the distances are to be measured.
 - 3) Placement recommendation depending upon type of suspension clamp (viz Freecentre type, Armour grip type, etc.)
 - 4) The influence of mid span compression joints, repair sleeves and armour rods (standard and AGS) in the placement of dampers.

11.5 EARTHWIRE ACCESSORIES

11.5.1 Mid Span Compression Joint For Earthwire

It shall be used for joining two lengths of earthwire. The joint shall be made of mild steel. The steel sleeve should not crack or fail during compression in it or service period. The Brinell Hardness of steel should not exceed 200. The steel sleeve shall be hot dip galvanised. The joints shall not permit slipping off, damage to, or failure of the complete earthwire or any part thereof at a load not less than 95% of the ultimate tensile strength of the earthwire. The joint shall have resistivity less than 75% of resistivity of equivalent length of earthwire. The dimensions and the dimensional tolerance of the joint shall be as given below:

Item	Dimensions before compression			Dimensions after compression	
	Inner dia	Outer dia	Length	Corner to corner width	Face to face width
	(mm)				
Repair sleeve	10 +/- 0.2	18 +/- 0.5	230 +/- 0.5	20.2 +/- 0.5	17.5 +/- 0.5

	<p>Specification for design, supply, installation and commissioning, operations and maintenance of 132kV switchyards, transmission lines / towers, underground cables for 15 MWp solar power plant at NTPC-Singrauli (MP/UP)</p>	<p>PS-439-856 Rev 00 Page 114 of 171</p>
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11.5.2 Vibration Damper For Earthwire

Refer Clause 4.04.00 detailed above.

11.5.3 Flexible Copper Bond

As detailed in IS:2121 Part3.

11.5.4 Suspension Clamp For Earthwire

As detailed in IS:2121 Part3

- a. At all suspension towers, suitable suspension clamp shall be used to support the earthwire of 7/3.15 mm size, the clamp shall be of either free-centre type or trunion type and shall provide adequate area of support to the earthwire.
- b. The total drop of the suspension assembly from the center point of the attachment to the centre point of the Earthwire shall not exceed 150 mm. The complete assembly shall be guaranteed for slip strength of not less than 9 kN and not more than 14 kN. The breaking strength of the assembly shall not be less than 25 kN.

11.5.5 Tension Clamp For Earthwire

The details shall be as per IS:2121 part-3. Only Compression type tension clamp shall be used to hold 7/3.15 mm galvanised steel earthwire. Anchor shackle shall be supplied which shall be suitable for attaching the tension clamp to strain plates. The strain plates supplied with the towers will have a minimum thickness of 8 mm with a hole of 17.5 mm diameter. Suitable lugs for jumper connection shall also be supplied alongwith necessary bolts and nuts.


11.6 HARDWARE FITTINGS

11.6.1 The hardware fittings shall be as per the specification for hardware fittings along with its component for the following insulator strings:

- (a) Single – 'I' suspension insulator string.
- (b) Single Suspension –I string with Pilot Clamp
- (c) Double suspension insulator string.
- (d) Single tension insulator string.
- (e) Double tension insulator string.

11.6.2 Each hardware fittings shall be supplied complete in all respects and include the following hardware parts:

- a) Ball hook for suspension hardware fittings suitable for attaching to V-hanger of the tower. Anchor shackle shall be supplied which shall be suitable for attaching the tension hardware fittings to 12mm thick strain plate having 17.5 mm dia hole, of the tower.

	<p>Specification for design, supply, installation and commissioning, operations and maintenance of 132kV switchyards, transmission lines / towers, underground cables for 15 MWp solar power plant at NTPC-Singrauli (MP/UP)</p>	<p>PS-439-856 Rev 00 Page 115 of 171</p>
---	--	--

- b) Suitable yoke plates for double suspension and double tension hardware fittings for the single conductor arrangement complying with the specifications given hereinafter.
- c) Suspension and deadend assembly to suit conductor size.
- d) Other necessary fittings such as eye links, ball clevis, socket clevis, clevis eye, U-clevis, ball link, arcing horn etc. to make the hardware fittings complete.
- e) 2.5% extra fasteners shall be supplied along with the hardware fittings.
- f) Socket fittings shall be provided with only R-shaped security clip in accordance with IS-2486 (part-II).

11.6.3 Suspension Assembly

- a) The suspension assembly shall include one AGS type suspension clamp alongwith standard performed armour rods set suitable for ACSR PANTHER conductor. The elastomer used for AGS clamp shall be neoprene rubber with insert. This shall be suitable to withstand upto 75deg. Cetrigrade temperature and atmospheric ozone.
- b) The suspension clamp assembly alongwith standard armour rods shall have a slip strength between 11to 16 KN.
- c) The length and diameter of each rod shall be 1550+/-16 mm minimum and 6.35+/-10 mm respectively. The tolerance in length of the rods in completed set should be within 13 mm between the longest and shortest rod. The ends of armour rod shall be parrot billed or ball ended.
- d) The number of armour rods in each set shall be eleven. Each rod shall be marked in the middle with paint for easy applications on the line.
- e) The armour rod shall not loose, their resilience even after five applications. The conductivity of each rod of the set shall not be less than 40% of the conductivity of the International Annealed Copper Standard (IACS).
- f) The armour rods shall be made of aluminium alloy of type 6061 or equivalent. The alloy shall have a minimum tensile strength of 35 kg / mm².

11.6.4 Dead And Assembly

The bidder shall clearly specify the before and after compression dimensions of the deadend clamp. The compression pressure shall also be indicated by the bidder. The dimensions and dimensional tolerances of the cross section of aluminium dead-end for conductor shall be as given below:



Specification for design, supply, installation and commissioning, operations and maintenance of 132kV switchyards, transmission lines / towers, underground cables for 15 MWp solar power plant at NTPC-Singrauli (MP/UP)

PS-439-856
Rev 00
Page 116 of 171

Item	Dimensions before compression		Dimensions after compression	
	Inner dia	Outer dia	Corner to corner width	Face to face width
	(mm)			
Al sleeve	23 +/- 1	38 +/- 1	37 +/- 0.5	32 +/- 0.5
Steel sleeve	9.3 +/- 0.5	18 +/- 0.5	17.4 +/- 0.5	15.1 +/- 0.5

11.6.5 Yoke Plates

The strength of yoke plates shall be adequate to withstand the minimum ultimate tensile strength, as specified in clause 7.01.00


The Plates shall be either triangular or rectangular in shape as may be necessary. The design of yoke plate shall take into account the most unfavourable loading conditions likely to be experienced as a result of dimensional tolerances for disc insulators as well as components of hardware fittings within the specified range. The plates shall have suitable holes for fixing arcing horn. All the corners and edges should be rounded off with a radius of atleast 3 mm. Design calculations, i.e. for bearing & tensile strength, for deciding the dimensions of yoke plate shall be furnished by the bidder. The holes provided for bolts in the yoke plate should satisfy shear edge condition as per Clause No. 8.10 of IS:800-1984.

11.7 INSULATOR

11.7.1 The size of disc insulator, the number to be used in different type of strings, their electromechanical strength and minimum creepage distance shall be as follows:

Type of string	Size of disc insulator (mm)	Min creepage distance of each disc (mm)	Number of standard discs	Electromechanical strength of insulator string (kN)
Single suspension	255/280 x 145	292	1 x 9	70
Double suspension	- do -	- do -	2 x 9	2 x 70 (140)
Single tension	- do -	- do -	1 x 10	90
Double tension	- do -	- do -	2 x 10	2 x 90 (180)

Note: Single suspension (pilot) string will be used for jumpers of tension type towers. It will be similar to single suspension type except the clamp of the conductor.

	<p>Specification for design, supply, installation and commissioning, operations and maintenance of 132kV switchyards, transmission lines / towers, underground cables for 15 MWp solar power plant at NTPC-Singrauli (MP/UP)</p>	<p>PS-439-856 Rev 00 Page 117 of 171</p>
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11.7.2 Disc Insulator: The insulator shall be pin and cap ; ball and socket type. The disc insulator shall conform to IS:731.

11.7.3 Ball and Socket Designation


The dimensions of the balls and sockets shall be of 16mm designation , for 70 KN/90KN disc insulator in accordance with the standard dimensions stated in IS:2486-(Part-II)/IEC:120.

11.7.4 Materials

- a) Porcelain: The porcelain used in the manufacture of shells shall be sound, free from defects thoroughly vitrified and smoothly glazed.
- b) Glaze: The finished porcelain shall be glazed in brown colour. The glaze shall cover all exposed parts of he insulator and shall have a good lustre, smooth, surface and good performance under the extreme weather conditions of a tropical climate. It shall not be cracked or chipped by ageing under the normal service conditions. The glaze shall have the same co-efficient of expansion as of the porcelain body throughout the working temperature range.
- c) Toughened Glass : In case of glass insulator, the glass used for the shells shall be sound, free from defects such as flows, bubbles, inclusions etc. and be of uniform toughness over its entire surface. All exposed glass surfaces shall be smooth.
- d) Cement: Cement used in the manufacture of the insulator shall not cause fracture by expansion or loosening by contraction. The cement shall not give rise to chemical reaction with metal fittings and its thickness shall be as small and uniform as possible. Proper care shall be taken to correctly centre and locate individual parts during cementing.
- e) Pins and Caps: Pins and Caps shall be made of drop forged steel and malleable cast iron/spheroidal graphite iron/drop forged steel respectively, duly hot dip galvanised and shall not be made by jointing, welding, shrink fitting or any other process from more than one piece of material.
- f) Security Clips: Security clips shall be made of good quality stainless steel or phosphor bronze as per IS:1385-1968 2.5% extra Security clip shall be provided.

11.7.5 Hot Line Maintenance

- a) The insulators offered shall be suitable for employment of hot line maintenance technique so that the usual hot line operations can be carried out with ease, speed and safety.
- b) Bidders shall indicate the methods generally used in the routine hot and dead

	<p>Specification for design, supply, installation and commissioning, operations and maintenance of 132kV switchyards, transmission lines / towers, underground cables for 15 MWp solar power plant at NTPC-Singrauli (MP/UP)</p>	<p>PS-439-856 Rev 00 Page 118 of 171</p>
---	--	--

line maintenance of HV lines for which similar insulator have been supplied by them. Bidders shall also indicate the recommended periodicity of such maintenance.

11.8 TEST REQUIREMENT


GENERAL

The materials shall conform to all the type tests as per relevant standards. The acceptance, routine tests and tests during manufacturer shall be carried out as per the specification and relevant standards on the line material.

12.0 CONTROL & PROTECTION OF 132 kV of line bay at NTPC Singrauli

The Bidder's scope of work shall include the supply, delivery, installation, testing and commissioning of the following including full protection, control, metering, monitoring, mimic diagram and all other equipment required as detailed in this specification:

1. Conventional hardwired Control Panel including control, metering, monitoring, annunciation windows, mimic diagram, and all other equipment required.
2. Numerical Protection Panels including (Main I as distance and Main II as over current and EF) .Augmentation of existing 132kV bus bar protection (CAG) including supply required hardware e.g WPRP, CT switching relays and trip relays etc.
3. Scope also covers other items like Event logger, time synchronizing equipment, dynamic relay test kit, furniture etc also as mentioned at relevant portions of the specification.
4. All associated power and control cabling as detailed in the specification shall be in the scope.
5. The testing of all control & protection functions for the 132 kV bays shall be the responsibility of the bidder.
6. It shall be possible to monitor and control all the Switchyard bay equipment from the control panel in Switchyard Control Room.
7. Interlocking to prevent unsafe operation of Switchyard equipment such as circuit breakers, isolators, earth switches etc. shall be implemented. Proper interfacing with the existing scheme shall be ensured.
8. The Employer shall approve the list of alarms and plant status (Analog and Digital) to be wired for Sequence of Events log, existing RTU and annunciation system during detailed engineering stage.
9. The historical data logs received from Bay Protection Relays shall include Digital Fault Records and Sequence of Events.
10. All Protection Relays shall be provided with self-diagnosis and supervision functions to ensure maximum availability. An alarm contact shall be provided for hardware failures, failures of internal and external auxiliary supplies etc.

	<p>Specification for design, supply, installation and commissioning, operations and maintenance of 132kV switchyards, transmission lines / towers, underground cables for 15 MWp solar power plant at NTPC-Singrauli (MP/UP)</p>	<p>PS-439-856 Rev 00 Page 119 of 171</p>
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12.1 Control Panels for HV Switchyard

Conventional Control Panels shall be provided for following bays:

1. 132 kV line - Bay 01 Control Panel.

Control Panels for various feeders shall comprise minimum of the equipment as listed below:

12.2 Annunciation System

The annunciation system shall be either relay based or based on state of the art static system of proven design. The annunciation facia shall be at least of 35mm x 50mm size for each point. The system shall have accept, reset and test facilities for alarms in each control panel. Annunciation alarm shall be provided for failure of annunciation dc supply by means of separate AC supply. No of annunciation windows per control panel shall be decided during detailed engineering.


Any contact multiplication relays required to multiply the contacts of existing isolators, CBs, trip relays etc to be used in the scheme logics related to bays under present scope shall be provided by the bidder. Any cabling between the bidder's panels and existing control & relay panels for this purpose shall also be in bidder's scope. Any modification and associated cabling in existing scheme logics required due to addition of new bays in the existing switchyards shall also be in the bidder's scope. All such existing schemes shall be revised to show the modifications and submitted to NTPC for reference.

12.3 General Requirements of protection system

- i) The manufacturer of the offered numerical protection system shall carry out complete engineering, testing & commissioning at site of the offered protections including the associated relay & protection panels.
- ii) The protection system shall be arranged to provide two independent, high performance and reliable systems with separate monitored DC supplies, separate CT/VT cores, separate cables and trip relays to obtain 100% redundancy. Associated trip relays of the two systems shall be separate, having sufficient number of contacts for all the functions. Each protection shall energize both trip coils of the circuit breakers to be tripped.
- iii) All numerical relays shall be supplied with all protection functions / features in disabled condition. Relevant features / protection functions shall be enabled at the time of commissioning at site as per approved logic and relay settings.
- iv) The total critical fault clearance time from fault initiation in any part of the system shall be 80 m sec for phase to phase fault in the generator-transformer unit and for phase to phase and phase to earth faults in the EHV system inter-connection.
- v) Modification and interfacing with the existing protection scheme, including supply of any hardware/ software, such as bus bar protection shall be in bidder's scope.

12.4 Operational Requirements for Numerical Relays and Auxiliary Relays

- i) All protection relays to be supplied under this package shall be Numerical type and IEC 61850 compliant.
- ii) All numerical relays, auxiliary relays and devices shall be of latest version, reputed make and types proven for the application, satisfying requirement covered elsewhere and shall be subject to Owner's approval. Relays and timers shall have appropriate setting ranges, accuracy, resetting ratio, transient overreach and other characteristics to provide required sensitivity to the satisfaction of the Owner.
- iii) Numerical relays shall be suitable for efficient and reliable operation of the protection

	<p>Specification for design, supply, installation and commissioning, operations and maintenance of 132kV switchyards, transmission lines / towers, underground cables for 15 MWp solar power plant at NTPC-Singrauli (MP/UP)</p>	<p>PS-439-856 Rev 00 Page 120 of 171</p>
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- scheme. Necessary auxiliary relays, timers, trip relays, etc. required for complete scheme, interlocking, alarm, logging, etc. shall be provided. No control relay, which shall trip the circuit breaker when relay is de-energized, shall be employed in the circuits.
- iv) Relays shall be provided with self-reset contacts except for the trip lockout relays, which shall have manual reset facility. Suitable measures shall be provided to ensure that transients present in CT & VT connections due to extraneous sources in EHV system do not cause damage to the numerical and other relays. CT saturation shall not cause mal-operation of numerical relays.
 - v) Except for event logging, alarm and annunciation type of non-trip functions, protective relay contact multiplier relay shall be high speed trip relay only.
 - vi) Only DC/DC converters shall be provided in the solid state devices / numerical relays wherever necessary to provide a stable auxiliary supply for relay operation. DC batteries in protective relays and timers necessary for relay operation shall not be acceptable. Equipment shall be protected against voltage spikes in auxiliary DC supply.
 - vii) Pick up range of the Binary inputs shall be minimum 70 V DC /AC.”
 - viii) The numerical relays offered shall have self-diagnostic features to reduce the down time of the relay and provide useful diagnostic information on detection of an internal fault to speed up the maintenance. Necessary support documentation explaining the self-diagnostic features of the numerical relays in detail shall be furnished for owner’s use.
 - ix) The numerical protection shall have continuous self-monitoring & cyclical test facilities. The internal clock of all the numerical relays being supplied under this package shall be synchronized through the GPS Time Synchronizing System, under present scope. A timing accuracy of 1ms shall be achieved for all the numerical relays.
 - x) The sampling rate of analog inputs, the processing speed and processing cycle of digital values shall be selected so as to achieve the operating times of various protection functions specified.
 - xi) Display of various measured parameters during normal as well as fault condition on segregated phase basis shall be provided. In addition to a local HMI, Numerical relays shall also have LEDs and back lit LCD screen shall be provided for visual indication and display of messages related to major trips / alarms generated in the relays.
 - xii) All the numerical relays shall have adequate processor capability to carry out programmable scheme logics (PSL) required for implementing approved protection and control schemes over and above its inbuilt protection functions algorithm.
 - xiii) The numerical relays shall be provided with built-in disturbance recorder. The data from DR function shall be available in IEEE/COMTRADE format and compatible with the dynamic relay test system being supplied in this contract.


12.5 Interface with Existing Bus Bar protection

The bidder shall provide all interfacing requirements with the existing 132 kV bus bar protection scheme at switchyard of NTPC Singrauli. All trip relays, multiplication relays, CT switching relays (if required), Weather Proof Relay Panels (if provided in existing scheme), cable and associated cabling required to achieve this interfacing shall be provided under this package.

Bidder to take note of existing B/B protection (CAG) relay at NTPC Singrauli. Details of existing system shall be given to the successful bidder during detail engineering.

12.6 Panels

- The dimensions of control / relay panel shall be matching with the existing panels at site, details of which shall be furnished during the detailed engineering.
- Each panel shall be provided with a 240V AC fluorescent lighting fixture controlled by door switch as well as a 5A, 240V AC switch-socket unit.
- Synchronizing socket matching with the existing trolley shall be provided else separate


	<p>Specification for design, supply, installation and commissioning, operations and maintenance of 132kV switchyards, transmission lines / towers, underground cables for 15 MWp solar power plant at NTPC-Singrauli (MP/UP)</p>	<p>PS-439-856 Rev 00 Page 121 of 171</p>
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synchronizing trolley shall be provided.

- Shall be provided with necessary arrangements for receiving, distributing, isolating and fusing of AC & DC supplies for various circuits for control, signaling, lighting, interlocking, etc. Selection of main and sub-circuit fuse rating shall ensure selective clearance of the sub-circuit faults.
- Voltage circuits for protection and metering shall be protected by fuses. Suitable fuse failure relays shall be provided to give an alarm for voltage circuits of protection/metering. Voltage selection scheme based on relays shall be provided for meters wherever possible.
- The DC supplies at the individual relay and protection panels shall be monitored by suitable relays and failure of DC supplies shall be annunciated.
- All equipments mounted on front and rear side of the panels should have individual name-plates with equipment designation engraved.
- Each panel shall also have circuit/feeder designation name plate
 - (a) All panels shall be free standing, floor mounting type and completely metal enclosed. Cable entries shall be from the bottom. Panels shall be of IP 31 class or better.
 - (b) Panels shall have removable gland plates with glands made of brass and shall be suitable for armoured cables.
 - (c) Panels shall be painted. The colour of paint for exterior of the panels shall be matching with other panels in the station & shall be decided during detail engineering
 - (d) Panels shall have a lockable front Plexiglas door and a swing frame. Panels shall facilitate direct access to any component mounted inside and shall have at least 20% free space for future expansion.
 - (e) All equipment mounted on the panels shall have individual name-plates with equipment designation engraved.
 - (f) Internal wiring to be connected to external equipment shall terminate on terminal blocks. Shall have 20% terminals as spare terminals in each panel.
 - (g) The terminal blocks for CTs and VTs shall be provided with test links and isolating facilities. The CT terminal blocks shall be provided with short circuiting and earthing facilities.
 - (h) Contractor shall be solely responsible for completeness and correctness of all the wiring, and for proper functioning of the connected equipment.

12.7 Earthing

- (a) The panels shall be equipped with an earth bus of at least 50x6mm² galvanized steel flat bar or equivalent copper.
- (b) Earth buses of adjoining panels shall be connected for continuity. The continuous earth bus so formed shall be connected to the main earth grid at one end only.
- (c) All metallic cases of the mounted equipment shall be separately connected to the earth bus by 2.5mm² copper wires. No loops in the earth wiring shall be permitted.
- (d) CT/VT neutral secondary shall only be earthed at the terminal block of the panel through links, such that the earthing of one group may be removed without disturbing others.
- (e) An independent Electronic Earth System shall be provided as per bidder's standard. The electronic earth shall be connected to the substation earth mat through a dedicated riser.

	<p>Specification for design, supply, installation and commissioning, operations and maintenance of 132kV switchyards, transmission lines / towers, underground cables for 15 MWp solar power plant at NTPC-Singrauli (MP/UP)</p>	<p>PS-439-856 Rev 00 Page 122 of 171</p>
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12.8 Control Cabling Philosophy

- (a) Each three phase secondary core of each CT/VT shall be brought to the associated relay panel through independent cables.
- (b) Duplicated cores with at least 2 x 2.5 sq.mm² CU/equivalent core cross-sectional area per connection shall be used for connection of all CT/VT circuits.
- (c) VT leads used for tariff metering shall have an equivalent core cross-sectional area of at least 10 mm² CU/equivalent per phase/neutral connection.
- (d) Duplicate channels of protection shall have independent cables for tripping, DC supply, etc. Duplicated cores shall be used for ALL closing/tripping commands and interlocking signals involving long (more than 500 m) cable lengths.
- (e) For the following applications multiple cores with at least 2 x 2.5 mm² CU / equivalent core cross - sectional area per connection shall be used:
 - DC supply to Bay Marshalling box
 - DC supply to circuit-breaker cubicle
 - DC looping for closing and tripping circuits of circuit-breaker
- (f) All the interconnections (both AC/DC) within the switchyard and between switchyard and other systems required for the successful implementation of the control, interlocks and protection schemes under present package, as shown in the tender drawings for control & protection SLD, shall be in the scope of the bidder. Such interconnections between switchyard and other system shall include but not limited to the following:
 - Extension of switchyard bus voltages to Control & Protection Panels.
 - Necessary interconnections for the Inter tripping / closing interlocking between upstream and down stream systems of transformer.
 - Necessary interfacing between Transformer MBs & Control Panel for various Transformer monitoring systems and fire protection system shall also be in bidder's scope
 - Any screened cable required for connecting 4-20 mA analog signals.
 - Cables for interfacing different protections & control schemes of the new bay to the existing 132 kV SWYD protections & schemes.
- (g) Spare cores shall be provided as per following norms:
 - Up to 3-core cable - Nil
 - 5 Core Cable - Min. 1 core
 - 7 to 14 core cables - Min. 2 cores
 - More than 14 core - Min. 3 cores


12.9 Mimic Diagram

Colour mimic diagram showing the exact representation of the system shall be provided in front of the control panel.

Mimic colour shall be matching with that of the existing control panels and the details shall be furnished by the Owner during detailed engineering.

12.10 Auxiliary Equipment

All control and instrumentation switches shall be rotary operated type with escutcheon plate showing the operating position and circuit designation. All switches shall be flush mounted. Handles of different shapes shall be provided as approved by Owner.

	<p>Specification for design, supply, installation and commissioning, operations and maintenance of 132kV switchyards, transmission lines / towers, underground cables for 15 MWp solar power plant at NTPC-Singrauli (MP/UP)</p>	<p>PS-439-856 Rev 00 Page 123 of 171</p>
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Control switches for breaker or disconnecting switch shall be of spring return to neutral type, while all other shall be stay-put type all the synchronizing switches shall have a removable common handle, removable only in off-position.

Lockable type switches shall be provided for same application as specified by the Owner. The contact combination and their operation shall ensure completeness of the scheme function and interlock requirements. Contact ratings of the switches shall be as per relevant standards. Contacts shall be spring assisted and contact faces shall be made pure silver.

Cluster type LED indicating lamps shall be provided.

Position indicators for the earth switches of semaphore type shall be provided as specified in the mimic diagram.

It shall be suitable for DC operation.

12.11 Indicating Instruments

- Shall conform to IS: 1248
- Shall be suitable for the instrument transformers as indicated in the drawings enclosed and shall be calibrated to read directly the primary quantities.
- Shall be calibrated and adjusted at works and shall also be tested and calibrated at site before commissioning. All these instruments shall be flush mounted.
- Shall be transducer operated, having 240 deg. scale and a dial of 96x96 mm², have an accuracy of 1.5 class and resolution of at least 50% of accuracy class
- Current coils shall be 120% of rated current and 10 times for 0.5 sec. without losing accuracy.


12.12 Recording Instruments (if applicable)

The recorders shall

- Shall be draw out type and suitable for back connection.
- Provision for automatic shorting of CT leads shall be provided when recorder is drawn out.
- Shall be dual pen employing potentiometric servo principle.
- Shall record continuously on a calibrated 100mm (min) wide plain paper chart.
- The accuracy of the recording shall be 0.5 % span. Full span response time shall not be less than 2 sec.
- Shall include an inverter for operating on AC supply in case of DC supply failure. Switching shall be automatic.

12.13 Transducers

- Shall conform to IEC: 688-1.
- The output of the transducers shall be 4-20mA/0-10mA/10-0-10mA dc as necessary for the instruments.
- Accuracy class shall be 0.5 or better except for frequency transducer, which shall have an accuracy of 0.2.
- Summation transducer shall be suitable for taking multiple inputs from individual MW/MVAR transducers.
- Shall have dual output. One output shall be used for the indicating instrument/recorder provided and other shall be wired up to terminal block of the panel for Owner's use in future.
- Energy transducers shall be suitable for 3 phase, 4 wire connection.

	<p>Specification for design, supply, installation and commissioning, operations and maintenance of 132kV switchyards, transmission lines / towers, underground cables for 15 MWp solar power plant at NTPC-Singrauli (MP/UP)</p>	<p>PS-439-856 Rev 00 Page 124 of 171</p>
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12.14 Site / Commissioning Tests

TYPE TEST REQUIREMENTS

Test reports for following type tests shall be submitted for all BCUs / BPU's / Energy Meter. Test reports / certificates of tests conducted in accredited laboratories (accredited by the national accreditation body of the country where the lab is located) are also acceptable.


BPU /BCU

A. Insulation Tests:

Sl. No.	Description	Standard
1.	Dielectric Withstand Tests	IEC 60255-5 2kV rms for 1 minute between all case terminals connected together and the case earth. 2kV rms for 1 minute between all terminals of independent circuits with terminals on each independent circuit connected together. ANSI/ IEEE C37.90-1989 1kV rms for 1 minute across the open contacts of the watchdog relays. 1kV rms for 1 minute across open contacts of changeover output relays. 1.5kV rms for 1 minute across open contacts of normally open output relays.
2.	High Voltage Impulse Test, class III	IEC 60255-5 5 kV peak; 1.2/50 sec; 0.5 J; 3 positive and 3 negative shots at intervals of 5 sec

B. Electrical Environment Tests:

Sl. No.	Description	Standard
1.	DC Supply Interruption	IEC 60255-11
2.	AC Ripple on DC supply	IEC 60255-11
3.	AC voltage dips and short Interruptions	IEC 61000-4-11
4.	High Frequency Disturbance	IEC 60255-22-1, class III At 1MHz, for 2s with 200 source impedance: 2.5 kV peak; 1 MHz; T = 15 sec; 400 shots/sec; duration 2 sec between independent circuits and independent circuits and case earth. 1.0kV peak across terminals of the same circuit.
5.	Fast Transient Disturbance	IEC 60255-22-4, class IV 4kV, 2.5kHz applied directly to auxiliary Supply


	<p>Specification for design, supply, installation and commissioning, operations and maintenance of 132kV switchyards, transmission lines / towers, underground cables for 15 MWp solar power plant at NTPC-Singrauli (MP/UP)</p>	<p>PS-439-856 Rev 00 Page 125 of 171</p>
---	--	--

4kV, 2.5kHz applied to all inputs.

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|----|----------------------------|---|
| 6. | Surge Withstand Capability | IEEE/ANSI C37.90.1 (1989)
4kV fast transient and 2.5kV oscillatory applied directly across each output contact, optically isolated input and power supply circuit. |
| 7. | Electrostatic Discharge | IEC 60255-22-2 Class 4
15kV discharge in air to user interface, display and exposed metal work. |
| 8. | Surge Immunity | IEC 61000-4-5: 1995 Level 4
4kV peak, 1.2/50ms between all groups and case earth.
2kV peak, 1.2/50ms between terminals of each group. |

C. EMC Tests:

Sl. No.	Description	Standard
1.	Radiated Immunity	C37.90.2: 1995 25MHz to 1000MHz,
2.	Radiated Electromagnetic Field Disturbance Test	IEC 60255-22-3 80-1000 MHz, Amplitude Modulated
3.	Disturbances Induced by Radio Frequency fields, Amplitude Modulated (Conducted Immunity)	IEC 60255-22-6 150kHz– 80 MHz;
4.	Power Frequency Magnetic Field	IEC 61000-4-8, class IV
5.	Interference Voltage, Aux. Voltage (Conducted Emission)	EN 50081-2, 1994 or equivalent 150 kHz to 30 MHz
6.	Interference Field Strength (Radiated Emission)	EN 50081-2, 1994 or equivalent 30 MHz to 1000 MHz

	<p>Specification for design, supply, installation and commissioning, operations and maintenance of 132kV switchyards, transmission lines / towers, underground cables for 15 MWp solar power plant at NTPC-Singrauli (MP/UP)</p>	<p>PS-439-856 Rev 00 Page 126 of 171</p>
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D. Atmospheric Environment Tests:

Sl. No.	Description	Standard
1.	Humidity	IEC 60068-2-3
2.	Temperature	IEC 60255-6 IEC 60068-2-1 for Cold IEC 60068-2-2 for Dry heat

E. Mechanical Stress Tests:


Sl. No.	Description	Standard
1.	Vibration (during Operation and Transportation)	IEC 255-21-1; IEC 68-2-6
2.	Shock (during Operation and Transportation)	IEC 255-21-2, IEC 68-2-27
3.	Seismic Vibration (during Operation)	IEC 60255-21-3

12.15 Settings

The bidder shall provide the Employer with a philosophy document clearly setting out the philosophy the bidder will use in determining setting levels. Each setting will have a brief description of the specific function or element. The setting calculation and formula will also be shown on the document. All relevant system parameters, line data, transformer data additionally used for calculating the setting will appear in the setting document. The bidder will conduct system studies in determining fault levels on different locations. These study results will also form part of the setting document. Any additional information required to complete this exercise shall be timely requested by the bidder.

The setting document will be presented and discussed with the Employer prior to final issue of the document. The final accepted setting document should be made available to the Employer in PDF format.

It is the bidder's responsibility to configure each protection relay to provide the protection and control facilities required. A full set of relay configuration and setting files shall be included in the design and documentation submissions. The bidder will issue three sets of setting documents once accepted by the client and consultant

	<p>Specification for design, supply, installation and commissioning, operations and maintenance of 132kV switchyards, transmission lines / towers, underground cables for 15 MWp solar power plant at NTPC-Singrauli (MP/UP)</p>	<p>PS-439-856 Rev 00 Page 127 of 171</p>
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13.0 EHV CABLES

13.1 CODES AND STANDARDS

The design, manufacture, testing and performance of the cables supplied under this specification shall comply with the latest edition of the following Standards, Rules and Acts.

IEC Standards

IEC 60840	Power cables with extruded insulation and their accessories for rated voltages above 30kv (Um=36kv) upto 150 kV (Um=170kv) Test methods and requirements
IEC 60060	H.V.Test Techniques
IEC 885	Electrical test methods for Electric cables.
IEC 60228	Conductors of Insulated cables
IEC 60229	Tests on cable oversheath which have a special protective function and are applied by extrusion.
IEC 61462	Composite Insulators- Hollow insulators for use in outdoor and indoor electrical equipment - Definitions, test methods, acceptance criteria and design recommendations
IEC 60183	Guide to the selection of high voltage cables
IEC 60230	Impulse tests on cables and their accessories.
IEC 60270	High Voltage Test Techniques - Partial discharge measurements
IEC 60287	Electric cables - Calculations of the current ratings
IEC 60811	Common test methods for insulating and sheathing materials of electric cables
Part-1 to 4	
IEC 60885 Part-3	Electrical test methods for electric cables -Test methods for partial discharge measurements on lengths of extruded power cables.
ANSI/ IEEE Std	Guide Electrical safety and Sub- station grounding 80-1986
IS 5216	Indian Standards & Rules Guide for safety procedures and practice in electrical works. Indian Electricity Act 1910. Indian Electricity Rules 1956.

	<p>Specification for design, supply, installation and commissioning, operations and maintenance of 132kV switchyards, transmission lines / towers, underground cables for 15 MWp solar power plant at NTPC-Singrauli (MP/UP)</p>	<p>PS-439-856 Rev 00 Page 128 of 171</p>
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13.2 GENERAL FEATURES

Unless otherwise specified 132 KV cable shall conform to the standards specified above.

The design ambient air temperature for cable shall be 50 deg C, when laid in air. The design ambient ground temperature for cables shall be 40 deg C. Cables shall be installed in air, in built up concrete trenches and/or directly buried in soil.

13.2.1 The cable shall conform to IEC-60840. The cable shall be stranded copper compacted circular conductor, extruded semi conducting compound conductor screen, cross linked polyethylene (XLPE) dry cured insulation, extruded semi conducting compound insulation screen, bedding of swellable type water blocking semi conducting tape, copper wire screen with copper binder tape(as per requirement), aluminium or lead or lead alloy sheath and extruded PVC outersheath with overall graphite coating or overall extruded semiconducting layer

13.2.2 The conductor screen, insulation and semiconducting insulation screen shall be extruded in one operation, so as to obtain continuously smooth interfaces. The conductor screen and insulation screen shall be of semiconducting compound. The copper wire/tape screen together with aluminium or lead or lead alloy sheath shall be capable of withstanding the short circuit current of 31.5KA for one second. The Bidder shall furnish the supporting calculation for screen sizing.

13.2.3 The cable shall be suitable for use in solidly earthed system.

13.2.4 The cable shall be suitable for installation in air, in built up concrete trench and/or directly buried in soil with chances of flooding by water. The cable shall withstand all mechanical and thermal stresses under steady state and transient operating conditions.

13.2.5 Repair to the cables shall not be accepted. Pimples, fish eye, blow holes etc. are also not acceptable.

13.2.6 Cable ends shall be kept sealed by heat shrinkable PVC caps to prevent damage and ingress of moisture.

13.2.7 Each cable length shall be provided with a pulling socket eye which shall be fitted to the pulling end. Pulling socket eye shall be able to take the pulling force.

13.2.8 The Eccentricity of the core shall not exceed 10% and Ovality of the core shall not exceed 5%.


The Eccentricity shall be calculated as $(t_{max} - t_{min})/t_{max} \leq 0.15$

The Ovality shall be calculated as $(d_{max} - d_{min})/d_{max} \leq 0.05$

where t_{max}/t_{min} are the maximum/minimum thickness of insulation and d_{max}/d_{min} are the maximum/minimum diameter of the core.

13.3 CONDUCTOR

Conductor shall consist of plain annealed copper wires in accordance with IEC-60228 or equivalent and the shape shall be circular and very well compacted to facilitate a smooth interface between

	<p>Specification for design, supply, installation and commissioning, operations and maintenance of 132kV switchyards, transmission lines / towers, underground cables for 15 MWp solar power plant at NTPC-Singrauli (MP/UP)</p>	<p>PS-439-856 Rev 00 Page 129 of 171</p>
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conductor screen(shield) and the insulation. The conductor shall have smooth surface with no intermediate joint.

13.4 CONDUCTOR SCREEN (SHIELD)

Conductor screen shall consist of extruded semi-conducting compound applied over the conductor, which shall be firmly bonded to the inner surface of the insulation layer. The semi-conducting compound shall be free from any void and protrusion.

13.5 INSULATION

Insulation shall be of extruded Cross Linked Polyethylene (XLPE). The insulation shall be free from any void and contaminant.

13.6 INSULATION SCREEN(SHIELD)

Insulation screen shall consist of extruded semi-conducting compound and shall firmly be bonded to the insulation. The semi-conducting compound shall be free from any void and protrusion.

13.7 BEDDING

Bedding shall consist of layer(s) of swellable semi conducting tape(s) to be applied over the extruded semi-conducting insulation screen with suitable overlap. Semiconducting swelling tape(s) shall also be provided over copper wire screen(if applicable).

13.8 METALLIC SHEATH

The metallic innersheath shall consist of aluminium or lead or lead alloy. The calculations for sizing and short circuit withstand capability of the metallic sheath, alongwith copper wire screen & copper binder tape(if applicable) shall be submitted during detailed design stage.


13.9 OUTER SHEATH

Outer sheath shall consist of extruded black PVC compound, in accordance with IEC-60840.

13.10 CABLE IDENTIFICATION/ MARKING

Atleast the following clear markings shall be provided over outer sheath of the cable at an interval of five metres throughout the length of the cable by embossing:

- Rated voltage
- Conductor size
- Type of insulation
- Manufacturer's name
- Year of manufacture

	<p>Specification for design, supply, installation and commissioning, operations and maintenance of 132kV switchyards, transmission lines / towers, underground cables for 15 MWp solar power plant at NTPC-Singrauli (MP/UP)</p>	<p>PS-439-856 Rev 00 Page 130 of 171</p>
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Purchaser's name

Sequential marking of length of cable in metres by embossing/printing at every meter.

The embossing/printing shall be progressive, automatic, in line and marking shall be legible and indelible and incase of printing it should be done with the help a contact less printer.

13.11 CABLE DRUMS

Cables shall be supplied in steel drums of heavy construction.

13.12 CABLE ACCESSORIES

The termination and jointing kits shall be suitable for the cable and shall be complete with all accessories including crimping type cable lugs, jointing materials and consumables. Accessories offered shall be of proven design.

13.12.1 OUT DOOR SEALING ENDS

The termination shall be suitable for outdoor installation in heavily polluted atmosphere and shall be made completely weather proof through cable sealing ends. Accessories shall consist of stress relief system comprising of premoulded material. The termination for open connection shall be housed in porcelain insulator/composite insulator to give high creepage resistance. The minimum nominal specific creepage distance shall be 25mm/kV. Each outdoor type sealing ends shall be supplied complete with mounting plate insulators to insulate the sealing end from supporting structures. Each sealing end shall be provided with two terminals, diametrically opposite each, suitable for bolting of the copper screen and/or metallic sheath of cable.

13.12.2 LINK BOXES


Link boxes shall be suitable for outdoor installation in heavily polluted atmosphere and shall be made completely weather proof. There shall be one link box for each phase. The cable screen/sheath connections shall be bolted type. The connecting bar and disconnecting link shall be of copper. The arrangement shall be installed in a water tight box of min. 2mm thick CRCA steel having degree of protection as IP 55.

The cost of link boxes shall be deemed to be included in the supply price of 132KV cable outdoor sealing ends.

13.12.3 FRP TRENCH COVER

The FRP Trench cover shall be made of non biodegradable & non corrosive material/fillers, suitable designed for required strength. FRP trench cover shall be of medium duty type as per IS1726. Suitable locking & lifting features shall be provided for the FRP trench Cover. Further FRP trench cover shall be UV resistant type. Surface profile of the FRP trench cover shall be anti-skid type.

Erection of FRP trench covers shall be in the scope of contractor.

	<p>Specification for design, supply, installation and commissioning, operations and maintenance of 132kV switchyards, transmission lines / towers, underground cables for 15 MWp solar power plant at NTPC-Singrauli (MP/UP)</p>	<p>PS-439-856 Rev 00 Page 131 of 171</p>
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All accessories shall be suitable for the technical parameters as specified and shall be suitably derated to the site conditions.

13.12.4 CABLE /ACCESSORIES PARAMETERS


1	Type of Cables	Cross-linked polyethylene insulated
2	No. of Cores	Single.
3	Conductor size	--
4	Conductor material	Copper
5	Normal system voltage	132KV
6	Maximum system voltage	145kV
7	Fault current	Symmetrical short circuit 31.5kA r.m.s for 1 second
8	System frequency	50hz
9	Frequency variation	+/- 5%
10	Rated continuous Current	350 Amp.
11	Overload capacity	Nil



Specification for design, supply, installation and commissioning, operations and maintenance of 132kV switchyards, transmission lines / towers, underground cables for 15 MWp solar power plant at NTPC-Singrauli (MP/UP)


PS-439-856
Rev 00
Page 132 of 17

- | | | |
|-----|---|-----------------------------------|
| 12 | Maximum allowable temperature for cable and accessories. | |
| a) | At rated full load and at site conditions. | 90 deg C |
| b) | The conductor temperature after a short circuit for 1 second shall not exceed (with conductor temp. at inception of short circuit as 90 deg. C) | 250 deg C |
| 13 | Basic impulse insulation level (1.2/50 micro second wave) | 650 kV (peak) |
| 14 | Laying conditions | |
| (a) | Directly Buried in soil in flat formation with spacing between cables center. | 500 mm centre to centre (typical) |
| (b) | Earthing of screen | Bonded to earth at both ends. |
| (c) | Ambient air temp. | 50 deg. C |
| (d) | Type of atmosphere | Heavily polluted |
| (e) | Ground temperature | |
| (f) | Thermal resistivity of soil | 40 deg C |
| (g) | Depth of buried cable | 150 degC.cm/watt
1 metre |

	<p>Specification for design, supply, installation and commissioning, operations and maintenance of 132kV switchyards, transmission lines / towers, underground cables for 15 MWp solar power plant at NTPC-Singrauli (MP/UP)</p>	<p>PS-439-856 Rev 00 Page 133 of 171</p>
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13.13 INSTALLATION WORK AT SITE

- 13.13.1 Cable installation shall be carried out generally as per applicable standard/ manufacturer guidelines. Cable shall be laid buried/in trench/on trestle. All necessary work like cable tagging, marking, dressing etc. as required shall be in contractor's scope.
- 13.13.2 Cable drums shall be unloaded, handled and stored in an approved manner on hard and well drained surface so that they may not sink. In no case shall the drum be stored flat i.e. with flange horizontal. Rolling of drums shall be avoided as far as possible. For unreeling the cable, the drum shall be mounted on suitable jacks or on cable wheels and shall be rolled slowly so that cable comes out from over the drum and not from below. All possible care shall be taken during unreeling and laying to avoid damage due to twist, kink or sharp bends. Cable ends shall be kept sealed by heat shrinkable PVC caps to prevent damage and ingress of moisture.
- 13.13.3 While laying cable, ground rollers shall be used at every 2 meter interval to avoid cable touching ground. The cables shall be pushed over the rollers by a gang of people positioned in between the rollers. Cables shall not be pulled from the end without having intermediate pushing arrangement. Pulling tension shall not exceed the values recommended by cable Manufacturer. Cable ends shall be kept sealed by heat shrinkable PVC caps to prevent damage and ingress of moisture. Selection of cable drums for each run shall be so planned so as to avoid straight through joints. Cable splices will not be allowed except where called for by the drawings or is unavoidable and permitted by the Project Manager. Care should be taken while laying the cables so as to avoid damage to cables.
- 13.13.4 Bending radii for cables shall be as per manufacturer's recommendations. Manufacturer's instructions shall be strictly adhered to and necessary conducting medium for checking healthiness of outersheath shall be applied.
- 13.13.5 Where cables cross roads/rail tracks underground, the cables shall be laid in HDPE pipes embedded in PCC in ground with a minimum cover of 1 metre. HDPE pipe shall also be provided where cables cross existing HT/LT cable trenches. The HDPE pipes and accessories shall be supplied, laid and encased in PCC by the employer. Ends of HDPE pipes shall be sealed properly after laying of cable.

	<p>Specification for design, supply, installation and commissioning, operations and maintenance of 132kV switchyards, transmission lines / towers, underground cables for 15 MWp solar power plant at NTPC-Singrauli (MP/UP)</p>	<p>PS-439-856 Rev 00 Page 134 of 171</p>
---	--	--

13.13.6 In each cable run, extra length shall be kept at suitable point to enable two straight joints to be made, should the cable develop fault at a later stage.

13.13.7 Construction of buried cable trench shall include excavation, preparation of sieved sand bedding, riddled soil cover, supply and installation of concrete protective covers, back filling and compacting, supply and installation of route markers. Bidder shall furnish the details for burying the cable in ground.

13.13.8 RCC cable route markers and RCC joint markers shall be provided as required for buried cable trench. The voltage grade of cables shall be engraved on the marker. Location of underground cable joint shall be indicated with cable marker with an additional inscription "Cable Joint". The marker shall project 150 mm above ground and shall be provided at every change in direction. Top of cable marker/ joint marker shall be sloped to avoid accumulation of water/dust on marker.

Bidder shall ensure that the drawings, instructions and recommendations are correctly followed to avoid damage to the equipment.

13.13.9 Bidder shall carry out the bonding of screen at the both ends of terminal using the insulated conductor of required size with earth mat.


13.13.10 The bidder shall ensure that the cables and accessories supplied by him are installed in a neat workman-like manner such that it is levelled, properly aligned and well oriented. The tolerance shall be as established in the bidder's drawing and/or as stipulated by the Employer.

13.13.11 The cable termination work shall be carried out by an experienced cable jointer who shall have adequate experience in jointing and termination of 132kV or higher grade XLPE cables. The successful bidder shall submit, sufficiently in advance, the bio-data of the cable jointer giving the details of his qualification and experience for employer's approval.

13.14 TYPE, ROUTINE AND ACCEPTANCE TESTS

FOR 132 KV CABLES & ACCESSORIES:

(a) Reports for type tests on 132kV cables shall be furnished in

	<p>Specification for design, supply, installation and commissioning, operations and maintenance of 132kV switchyards, transmission lines / towers, underground cables for 15 MWp solar power plant at NTPC-Singrauli (MP/UP)</p>	<p>PS-439-856 Rev 00 Page 135 of 171</p>
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line with IEC 60840 and accessories as per IEC 60840/ IEC 61462.

- (b) All equipments to be supplied shall be of type tested design. During detailed engineering, the contractor shall submit for Owner's approval the reports of all the type tests as listed in this specification and carried out within last ten years from the date of bid opening. These reports should be for the test conducted on the equipment similar to those proposed to be supplied under this contract and the test(s) should have been either conducted at an independent laboratory or should have been witnessed by a client.

However if the contractor is not able to submit report of the type test(s) conducted within last ten years from the date of bid opening, or in the case of type test report(s) are not found to be meeting the specification requirements, the contractor shall conduct all such tests under this contract at no additional cost to the owner either at third party lab or in presence of client /owners representative and submit the reports for approval.

All acceptance and routine tests as per the specification and relevant standards shall be carried out. Charges for these shall be deemed to be included in the equipment price

The type test reports once approved for any projects shall be treated as reference . For subsequent projects of NTPC, an endorsement sheet will be furnished by the manufacturer confirming similarity and "No design Change". Minor changes if any shall be highlighted on the endorsement sheet.


- (c) All acceptance and routine tests as per the specification and relevant standards shall be carried out. Charges for these shall be deemed to be included in the equipment price.

Routine tests and Acceptance tests shall be conducted on cables as per IEC 60840, QA table and other relevant standards.

13.15 SITE TESTS:

Following site tests shall be carried out by the bidder and all the equipment required for the site tests shall be arranged by the bidder.

- a) HV test as per clause 15.2 IEC 60840.
- b) After completion of installation non metallic outer sheath shall be tested in accordance with clause- 5 IEC 60229.
- c) The insulation resistance of the cable shall be checked before & after the HV test on cable.
- d) The core resistance shall be measured and the value corrected in accordance with clause 5 of IEC 60228.

	<p>Specification for design, supply, installation and commissioning, operations and maintenance of 132kV switchyards, transmission lines / towers, underground cables for 15 MWp solar power plant at NTPC-Singrauli (MP/UP)</p>	<p>PS-439-856 Rev 00 Page 136 of 171</p>
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14.0 LT POWER AND CONTROL CABLES

LT Power & control cables shall be of minimum 1100 volts grade XLPE / PVC insulated conforming to IS 1554 for utilization voltages less than equal to 415 V. Instrumentation / signal cable shall be of 225 V grade. MV / HV cables shall be manufactured using dry curing method.

14.1 Codes and standards

All standards, specifications and codes of practice referred to herein shall be the latest editions including all applicable official amendments and revisions as on date of opening of bid. In case of conflict between this specification and those (IS codes, standards, etc.) referred to herein, the former shall prevail. All the cables shall conform to the requirements of the following standards and codes:


TUV specification 2 Pfg 1169/08.2007	DC cable for photovoltaic system
IS :1554 - I	PVC insulated (heavy duty) electric cables for working voltages upto and including 1100V.
IS : 3961	Recommended current ratings for cables
IS : 3975	Low carbon galvanised steel wires, formed wires and tapes for armouring of cables.
IS : 5831	PVC insulation and sheath of electrical cables.
IS:7098 (Part -I)	Cross linked polyethylene insulated PVC sheathed cables for working voltages upto and including 1100V.
IS : 8130	Conductors for insulated electrical cables and flexible cords.
IS : 10418	Specification for drums for electric cables.
IS : 10810	Methods of tests for cables.
ASTM-D -2843	Standard test method for density of smoke from the burning or decomposition of plastics.
IEC-754 (Part-I)	Tests on gases evolved during combustion of electric cables.
IEC-332	Tests on electric cables under fire conditions. Part-3: Tests on bunched wires or cables (Category-B).

14.2 General technical requirements

The cables shall be suitable for laying on racks, in ducts, trenches, conduits and under ground buried installation with chances of flooding by water.

All cables including EPR cables shall be flame retardant, low smoke (FRLS) type designed to withstand all mechanical, electrical and thermal stresses developed under steady state and transient operating conditions as specified elsewhere in this specification.

All cables of module area if laid on cable trays should be covered. If cables

	<p>Specification for design, supply, installation and commissioning, operations and maintenance of 132kV switchyards, transmission lines / towers, underground cables for 15 MWp solar power plant at NTPC-Singrauli (MP/UP)</p>	<p>PS-439-856 Rev 00 Page 137 of 171</p>
---	--	--

are to be laid underground, laying shall be as per latest relevant IS code.

Copper/aluminium conductor used in power cables shall have tensile as per relevant standards. Conductors shall be stranded. Conductor of control cables shall be made of stranded, plain annealed copper.

XLPE insulation shall be suitable for a continuous conductor temperature of 120 deg. C and short circuit conductor temperature of 200 deg C for 5 secs.

XLPE insulation shall be suitable for a continuous conductor temperature of 90 deg. C and short circuit conductor temperature of 250 deg C.

PVC insulation shall be suitable for continuous conductor temperature of 70 deg C and short circuit conductor temperature of 160 deg. C.

The cable cores shall be laid up with fillers between the cores wherever necessary. It shall not stick to insulation and inner sheath. All the cables, other than single core unarmoured cables, shall have distinct extruded PVC inner sheath of black colour as per IS : 5831.

For single core armoured cables, armouring shall be of copper/aluminium wires/ formed wires. For multicore armoured cables, armouring shall be of galvanised steel as follows :

Calculated nominal dia. Size and Type of armour of cable under armour

Upto 13 mm 1.4mm dia GS wire

Above 13 & upto 25mm 0.8 mm thick GS formed wire / 1.6 mm dia GS wire

Above 25 & upto 40 mm 0.8mm thick GS formed wire / 2.0mm dia GS wire

Above 40 & upto 55mm 1.4 mm thick GS formed wire /2.5mm dia GS wire


Above 55 & upto 70 mm 1.4mm thick GS formed wire / 3.15mm dia GS wire

Above 70mm 1.4 mm thick GS formed wire / 4.0 mm dia GS wire

The aluminium used for armouring shall be of H4 grade as per IS: 8130 with maximum resistivity of 0.028264 ohm mm² per meter at 20 deg C. The sizes of aluminiumarmouring shall be same as indicated above for galvanized steel.

The gap between armour wires / formed wires shall not exceed one armour wire / formed wire space and there shall be no cross over / over-riding of armour wire / formed wire. The minimum area of coverage of armouring shall be 90%. The breaking load of armour joint shall not be less than 95% of that of armour wire / formed wire. Zinc rich paint shall be applied on armour joint surface of GS wire / formed wire.

Outer sheath of module inter-connecting DC cable as per TUV specification 2

	<p>Specification for design, supply, installation and commissioning, operations and maintenance of 132kV switchyards, transmission lines / towers, underground cables for 15 MWp solar power plant at NTPC-Singrauli (MP/UP)</p>	<p>PS-439-856 Rev 00 Page 138 of 171</p>
---	--	--

Pfg 1169/08.2007.

Outer sheath shall be of PVC as per IS: 5831 & black in colour for power cables & grey in colour for control cables.. In addition to meeting all the requirements of Indian standards referred to, outer sheath of all the cables shall have the following FRLS properties.

- (a.) Oxygen index of min. 29 (as per IS 10810 Part-58).
- (b.) Acid gas emission of max. 20% (as per IEC-754-I).
- (c.) Smoke density rating shall not be more than 60 % (as per ASTM-D-2843).

Cores of the cables shall be identified by colouring of insulation.

Following colour scheme shall be adopted:

- | | |
|----------|-----------------------------|
| 1 core - | Red, Black, Yellow or Blue |
| 2 core - | Red & Black |
| 3 core - | Red, Yellow & Blue |
| 4 core - | Red, Yellow, Blue and Black |

For control cables having more than 5 cores, core identification shall be done by numbering the insulation of cores sequentially, starting by number 1 in the inner layer (e.g. say for 10 core cable, core numbering shall be from 1 to 10). The number shall be printed in Hindu-Arabic numerals on the outer surfaces of the cores. All the numbers shall be of the same colour, which shall contrast with the colour of insulation. The colour of insulation for all the cores shall be grey only. The numerals shall be legible and indelible. The numbers shall be repeated at regular intervals along the core, consecutive numbers being inverted in relation to each other. When the number is a single numeral, a dash shall be placed underneath it. If the number consists of two numerals, these shall be disposed one below the other and a dash placed below the lower numeral. The spacing between consecutive numbers shall not exceed 50 mm.


For reduced neutral conductors (in case of power cable), the core shall be black.

In addition to manufacturer's identification on cables as per IS, following marking shall also be provided over outer sheath.

- (a) Cable size and voltage grade - To be embossed
- (b) Word 'FRLS' at every 5 metre - To be embossed
- (c) Sequential marking of length of the cable in metres at every one metre -To be embossed / printed

The embossing shall be progressive, automatic, in line and marking shall be legible and indelible. For EPR cables identification shall be printed on outer sheath.

All cables except module inter-connecting DC cable shall meet the fire resistance requirement as per Category-B of IEC 332 Part-3.

	<p>Specification for design, supply, installation and commissioning, operations and maintenance of 132kV switchyards, transmission lines / towers, underground cables for 15 MWp solar power plant at NTPC-Singrauli (MP/UP)</p>	<p>PS-439-856 Rev 00 Page 139 of 171</p>
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Module inter-connecting DC cable shall meet the fire resistance requirement as per TUV specification 2 Pfg 1169/08.2007.

Allowable tolerances on the overall diameter of the cables shall be ± 2 mm maximum, over the declared value in the technical data sheets.

Repaired cables shall not be accepted. Pimples, fish eye, blow holes etc. are not acceptable.

14.3 Cable selection & sizing

Cables shall be sized based on the following considerations:

- (a) Rated current of the equipment
- (b) The voltage drop in the cable, during motor starting condition, shall be limited to 10% and during full load running condition, shall be limited to 3% of the rated voltage
- (c) Short circuit withstand capability

This will depend on the feeder type. For a fuse protected circuit, cable should be sized to withstand the letout energy of the fuse. For breaker controlled feeder, cable shall be capable of withstanding the system fault current level for total breaker tripping time inclusive of relay pickup time.

Control cables shall be sized based on the following considerations:

- (a) The minimum conductor cross-section shall be 1.5 sq.mm.
- (b) The minimum number of spare cores in control cables shall be as follows:


No. of cores in cable	Min. No. of spare cores
2C, 3C	NIL
5C	1
7C-12C	2
14C & above	3

14.4 De rating Factors

De rating factors for various conditions of installations including the following shall be considered while selecting the cable sizes:

- a) Variation in ambient temperature for cables laid in air
- b) Grouping of cables
- c) Variation in ground temperature and soil resistivity for buried cables.

Cable lengths shall be considered in such a way that straight through cable

	<p>Specification for design, supply, installation and commissioning, operations and maintenance of 132kV switchyards, transmission lines / towers, underground cables for 15 MWp solar power plant at NTPC-Singrauli (MP/UP)</p>	<p>PS-439-856 Rev 00 Page 140 of 171</p>
---	--	--

joints are avoided.

Cables shall be armoured type if laid in switchyard area or directly buried.

All LT power cables of sizes more than 120 sq.mm. shall be XLPE insulated.

14.5 Constructional features of LT Power Cables

1.1 KV Grade Power Cables

1.1 KV grade XLPE power cables shall have compacted aluminium/ copper conductor, XLPE insulated, PVC inner-sheathed (as applicable), armoured/ unarmoured, PVC outer-sheathed conforming to IS:7098. (Part-I).

1.1KV grade PVC power cables shall have aluminium/copper conductor(compact type for sizes above 10 sq.mm), PVC Insulated, PVC inner sheathed (as applicable) armoured/ unarmoured, PVC outer-sheathed conforming to IS:1554 (Part-I).

1.1 KV grade Trailing cables shall have tinned copper (class 5) conductor, insulated with heat resistant elastomeric compound based on Ethylene Propylene Rubber(EPR) suitable for withstanding 90 deg.C continuous conductor temperature and 250deg C during short circuit, inner-sheathed with heat resistant elastomeric compound, nylon cord reinforced, outer-sheathed with heat resistant, oil resistant and flame retardant heavy duty elastomeric compound conforming to IS 9968.


14.6 Constructional features of LT control cables

1.1 KV Grade Control Cables shall have stranded copper conductor and shall be multicore PVC insulated, PVC inner sheathed, armoured / unarmoured, FRLS PVC outer sheathed conforming to IS: 1554. (Part-I).

1.1 KV grade Trailing cables shall have tinned copper (class 5) conductor, insulated with heat resistant elastomeric compound based on Ethylene Propylene Rubber(EPR) suitable for withstanding 90 deg.C continuous conductor temperature and 250deg C during short circuit, inner-sheathed with heat resistant elastomeric compound, nylon cord reinforced, outer-sheathed with heat resistant, oil resistant and flame retardant heavy duty elastomeric compound conforming to IS 9968. Minimum conductor size shall be 2.5 sqmm.

14.7 Cable Drums

Cables shall be supplied in non returnable wooden or steel drums of heavy construction. The surface of the drum and the outer most cable layer shall be covered with water proof cover. Both the ends of the cables shall be properly sealed with heat shrinkable PVC/ rubber caps secured by 'U' nails so as to eliminate ingress of water during transportation, storage and erection. Wood preservative anti-termite treatment shall be applied to the entire drum. Wooden

	<p>Specification for design, supply, installation and commissioning, operations and maintenance of 132kV switchyards, transmission lines / towers, underground cables for 15 MWp solar power plant at NTPC-Singrauli (MP/UP)</p>	<p>PS-439-856 Rev 00 Page 141 of 171</p>
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drums shall comply with IS: 10418.

Each drum shall carry manufacturer's name, purchaser's name, address and contract number, item number and type, size and length of cable and net gross weight stenciled on both sides of the drum. A tag containing same information shall be attached to the leading end of the cable. An arrow and suitable accompanying wording shall be marked on one end of the reel indicating the direction in which it should be rolled.

14.8 Tests on LT power and control cables

Indicative list of tests/checks, Routine and Acceptance tests shall be as per Quality Assurance & Inspection table of LT power and control cables enclosed at relevant section.

Type test, routine, acceptance tests requirements for module inter-connecting DC cable shall be as per TUV specification 2 Pfg 1169/08.2007.

	<p>Specification for design, supply, installation and commissioning, operations and maintenance of 132kV switchyards, transmission lines / towers, underground cables for 15 MWp solar power plant at NTPC-Singrauli (MP/UP)</p>	<p>PS-439-856 Rev 00 Page 142 of 171</p>
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15.0 Cabling

15.1 Codes and standards

All standards, specifications and codes of practice referred to herein shall be the latest editions including all applicable official amendments and revisions as on date of opening of bid. In case of conflict between this specification and those (IS codes, standards, etc.) referred to herein, the former shall prevail. All work shall be carried out as per the following standards/ codes as applicable .

IS:513	Cold rolled low carbon steel sheets and strips.
IS:802	Code of practice for the use of Structural Steel in Overhead Transmission Line Towers.
IS:1079	Hot Rolled carbon steel sheet & strips
IS:1239	Mild steel tubes, tubulars and other wrought steel fittings
IS:1255	Code of practice for installation and maintenance of power cables upto and including 33 KV rating
IS:1367 Part-13	Technical supply conditions for threaded Steel fasteners. (Hot dip galvanized coatings on threaded fasteners).
IS:2147	Degree of protection provided by enclosures for low voltage switchgear and control gear
IS:2309	Code of Practice for the protection of building and allied structures against lightning.
IS:2629	Recommended practice for hot dip galvanising of iron & steel
IS:2633	Method for testing uniformity of coating on zinc coated articles.
IS:3043	Code of practice for Earthing
IS:3063	Fasteners single coil rectangular section spring washers.

IS:6745	Methods for determination of mass of zinc coating
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	<p style="text-align: center;">Specification for design, supply, installation and commissioning, operations and maintenance of 132kV switchyards, transmission lines / towers, underground cables for 15 MWp solar power plant at NTPC-Singrauli (MP/UP)</p>	<p style="text-align: right;">PS-439-856 Rev 00 Page 143 of 171</p>
---	--	---

on zinc coated iron & steel articles.


IS:8308	Compression type tubular in- line connectors for aluminium conductors of insulated cables
IS:8309	Compression type tubular terminal ends for aluminium conductors of insulated cables.
IS:9537	Conduits for electrical installation.
IS:9595	Metal - arc welding of carbon and carbon manganese steels - recommendations.
IS:13573	Joints and terminations for polymeric cables for working voltages from 6.6kv upto and including 33kv performance requirements and type tests.
BS:476	Fire tests on building materials and structures
IEEE:80	IEEE guide for safety in AC substation grounding
IEEE:142	Grounding of Industrial & commercial power systems
DIN 46267 (Part-II)	Non tension proof compression joints for Aluminium conductors.
DIN 46329	Cable lugs for compression connections, ring type ,for Aluminium conductors
VDE 0278	Tests on cable terminations and straight through joints
BS:6121	Specification for mechanical Cable glands for elastomers and plastic insulated cables. Indian Electricity Act. Indian Electricity Rules.

Equipment complying with other internationally accepted standards such as IEC, BS, DIN, USA, VDE, NEMA etc. will also be considered if they ensure performance and constructional features equivalent or superior to standards listed above. In such a case, the Bidder shall clearly indicate the standard(s) adopted, furnish a copy in English of the latest revision of the standards alongwith copies of all official amendments and revisions in force as on date of opening of bid and shall clearly bring out the salient features for comparison.

15.2 Design and constructional features

15.2.1 Inter Plant Cabling

Interplant cabling for main routes shall be laid in Cable trenches/duct banks. Cables from main plant to control room shall be laid in Cable trenches/duct banks. In case of Duct banks, pull-pits shall be filled with sand and provided with

	<p>Specification for design, supply, installation and commissioning, operations and maintenance of 132kV switchyards, transmission lines / towers, underground cables for 15 MWp solar power plant at NTPC-Singrauli (MP/UP)</p>	<p>PS-439-856 Rev 00 Page 144 of 171</p>
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a PCC covering. Directly buried cables, if essential, shall not have concentration of more than 4 cables in one route. All buried cables shall be armoured.

15.2.2 Trenches

PCC flooring of built up trenches shall be sloped for effective drainage with sump pits and sump pumps.

No sub zero level cable vault/trenches shall be provided below control building/switchgear rooms in plant.


15.2.3 General

- a) The cable slits to be used for motor/equipment power/control supply shall be sand filled & covered with PCC after cabling.
- b) Sizing criteria, derating factors for the cables shall be met as per respective chapters. However for the power cables, the minimum conductor size shall be 6 sq.mm. for aluminium conductor and 2.5 sq.mm. for copper conductor cable.
- c) Conscious exceptions to the above guidelines may be accepted under special conditions but suitable measures should be taken at such location to:
 1. Meet all safety requirements
 2. Safeguard against fire hazards, mechanical damage, flooding of water, oil accumulation, electrical faults/interferences, etc

15.3 Cabling support system – cable trays, pipes, glands etc

15.3.1 Cable trays, Fittings & Accessories

- a) Cable trays shall be ladder/perforated type as specified complete with matching fittings (like brackets, elbows, bends, reducers, tees, crosses, etc.) accessories (like side coupler plates, etc. and hardware (like bolts, nuts, washers, G.I. strap, hook etc.) as required. Cable tray shall be ladder type for power & control cables and perforated for instrumentation cables.
- b) Cable trays, fittings and accessories shall be fabricated out of rolled mild steel sheets free from flaws such as laminations, rolling marks, pitting etc. These (including hardware) shall be hot dip galvanized as per relevant IS.
- c) Cable trays shall have standard width of 150 mm, 300 mm & 600 mm and standard lengths of 2.5 metre. Thickness of mild steel sheets used for fabrication of cable trays and fittings shall be 2 mm. The thickness of side coupler plates shall be 3 mm.
- d) Cable troughs shall be required for branching out few cables from main cable route. These shall be U-shaped, fabricated of mild steel sheets of thickness 2 mm and shall be hot dip galvanised as per relevant IS.

	<p>Specification for design, supply, installation and commissioning, operations and maintenance of 132kV switchyards, transmission lines / towers, underground cables for 15 MWp solar power plant at NTPC-Singrauli (MP/UP)</p>	<p>PS-439-856 Rev 00 Page 145 of 171</p>
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Troughs shall be standard width of 50 mm & 75 mm with depth of 25 mm

15.3.2 Support System for Cable Trays

Cable tray support system shall be pre-fabricated similar or equivalent to "Unistrut make".


Support system for cable trays shall essentially comprise of the two components i.e. main support channel and cantilever arms. The main support channel shall be of two types : (i) C1:- having provision of supporting cable trays on one side and (ii) C2:-having provision of supporting cable trays on both sides. The support system shall be the type described hereunder:

- a. Cable supporting steel work for cable racks/cables shall comprise of various channel sections, cantilever arms, various brackets, clamps, floor plates, all hardwares such as lock washers, hexagon nuts, hexagon head bolt, support hooks, stud nuts, hexagon head screw, channel nut, channel nut with springs, fixing studs, etc.
- b. The system shall be designed such that it allows easy assembly at site by using bolting. All cable supporting steel work, hardwares/fittings and accessories shall be prefabricated factory galvanised.
- c. The main support and cantilever arms shall be fixed at site using necessary brackets, clamps, fittings, bolts, nuts and other hardware etc. to form various arrangements required to support the cable trays. Welding of the components shall not be allowed. However, welding of the bracket (to which the main support channel is bolted) to the overhead beams, structural steel, insert plates or reinforcement bars will be permitted. Any cutting or welding of the galvanised surface shall be brushed and red lead primer, oil primer & aluminium paint shall be applied
- d. All steel components, accessories, fittings and hardware shall be hot dip galvanised after completing welding, cutting, drilling and other machining operation.
- e. The typical arrangement of flexible support system is described briefly below:

The main support channel and cantilever arms shall be fabricated out of 2.5 thick rolled steel sheet conforming to IS.

Cantilever arms of 320 mm, 620mm and 750 mm in length are required, and shall be as shown in the enclosed drawing. The arm portion shall be suitable for assembling the complete arm assembly on to component constructed of standard channel section. The back plate shall allow sufficient clearance for fixing bolt to be tightened with tray in position.

Support system shall be able to withstand
weight of the cable trays
weight of the cables (75 Kg/Metre run of each cable tray)
Concentrated load of 75 Kg between every support span.

	<p>Specification for design, supply, installation and commissioning, operations and maintenance of 132kV switchyards, transmission lines / towers, underground cables for 15 MWp solar power plant at NTPC-Singrauli (MP/UP)</p>	<p>PS-439-856 Rev 00 Page 146 of 171</p>
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Factor of safety of minimum 1.5 shall be considered.

The size of structural steel members or thickness of sheet steel of main support channel and cantilever arms and other accessories as indicated above are indicative only. Nevertheless, the support system shall be designed by the bidder to fully meet the requirements of type tests as specified. In case the system fails in the tests, the components design modification shall be done by the Bidder without any additional cost to the Employer. The bidder shall submit the detailed drawings of the system offered by him alongwith the bid.

15.3.3 Pipes, Fittings & Accessories


- a) Pipes offered shall be complete with fittings and accessories (like tees, elbows, bends, check nuts, bushings, reducers, enlargers, coupling caps, nipples etc.) The size of the pipe shall be selected on the basis of maximum 40% fill criteria
- b) GI Pipes shall be of medium duty as per IS:1239
- c) Duct banks shall be High Density PE pipes encased in PCC (10% spare of each size, subject to minimum one) with suitable water-proof manholes.
- d) Hume pipes shall be NP3 type as per IS 458.

15.3.4 Junction Boxes

- a) Junction Boxes with IP:55 degree of protection, shall comprise of a case with hinged door constructed from cold rolled sheet steel of thickness 2mm. Top of the boxes shall be arranged to slope towards rear of the box. Gland plate shall be 3mm thick sheet steel with neoprene/synthetic rubber gaskets. All junction boxes shall be of adequate strength and rigidity, hot dip galvanised as per relevant IS, and suitable for mounting on wall, columns, structures etc. The boxes shall include brackets, bolts, nuts, screws M8 earthing stud etc. required for installation.
- b) Terminal blocks shall be 1100V grade, 10Amps rated, made up of unbreakable polyamide 6.6 grade. The terminals shall be screw type or screw-less (spring loaded) / cage clamp type with lugs. Marking on terminal strips shall correspond to the terminal numbering in wiring diagrams. All metal parts shall be of non-ferrous material. In case of screw type terminals the screw shall be captive, preferably with screw locking design. All terminal blocks shall be suitable for terminating on each side two (2) nos. stranded copper conductors of size upto 2.5 sq mm each. All internal wiring shall be of minimum 1.5 sq. mm cu. Conductor PVC wire.

15.3.5 Terminations & Straight Through Joints

- a) Termination and jointing kits for 33kV, 11kV, 6.6 kV and 3.3 kV grade XLPE insulated cables shall be of proven design and make which have already

	<p>Specification for design, supply, installation and commissioning, operations and maintenance of 132kV switchyards, transmission lines / towers, underground cables for 15 MWp solar power plant at NTPC-Singrauli (MP/UP)</p>	<p>PS-439-856 Rev 00 Page 147 of 171</p>
---	--	--

been extensively used and type tested. Termination kits and jointing kits shall be pre-moulded type, taped type or heat shrinkable type. 33kV, 11kV and 6.6 kV grade joints and terminations shall be type tested as per IS:13573. 3.3kV grade joints and terminations shall be type tested as per VDE0278. Critical components used in cable accessories shall be of tested and proven quality as per relevant product specification/ESI specification. Kit contents shall be supplied from the same source as were used for type testing. The kit shall be complete with the aluminium solderless crimping type cable lugs & ferrule as per DIN standard.

- b) Straight through joint and termination shall be capable of withstanding the fault level for the system.
- c) 1.1KV grade Straight Through Joint shall be of proven design.

15.3.6 Cable glands

Cable shall be terminated using double compression type cable glands. Cable glands shall conform to BS:6121 and be of robust construction capable of clamping cable and cable armour (for armoured cables) firmly without injury to insulation. Cable glands shall be made of heavy duty brass machine finished and nickel chrome plated. Thickness of plating shall not be less than 10 micron. All washers and hardware shall also be made of brass with nickel chrome plating. Rubber components shall be of neoprene or better synthetic material and of tested quality. Cable glands shall be suitable for the sizes of cable supplied/erected.

15.3.7 Cable lugs/ferrules


Cable lugs/ferrules for power cables shall be tinned copper solderless crimping type suitable for aluminium compacted conductor cables. Cable lugs and ferrules for control cables shall be tinned copper type. The cable lugs for control cables shall be provided with insulating sleeve and shall suit the type of terminals provided on the equipments. Cable lugs and ferrule shall conform to relevant standard

15.3.8 Trefoil clamps

Trefoil clamps for single core cables shall be pressure die cast aluminum or fibre glass or nylon and shall include necessary fixing accessories like G.I. nuts, bolts, washers, etc. Trefoil clamps shall have adequate mechanical strength to withstand the forces generated by the peak value of maximum system short circuit current.

15.3.9 Cable Clamps & Straps


The cable clamps required to clamp multicore cables on vertical run shall be made up of Aluminium strip of 25x3 mm size. For clamping the multicore cables, self-locking, de-interlocking type nylon clamps/straps shall be used. The clamps/straps shall have sufficient strength and shall not get affected by direct

	<p>Specification for design, supply, installation and commissioning, operations and maintenance of 132kV switchyards, transmission lines / towers, underground cables for 15 MWp solar power plant at NTPC-Singrauli (MP/UP)</p>	<p>PS-439-856 Rev 00 Page 148 of 171</p>
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exposure to sun rays and outdoor environment

15.3.10 Receptacles

Receptacles boxes shall be fabricated out of MS sheet of 2mm thickness and hot dip galvanized or of die-cast aluminium alloy of thickness not less than 2.5 mm. The boxes shall be provided with two nos. earthing terminals, gasket to achieve IP55 degree of protection, terminal blocks for loop-in loop-out for cable of specified sizes, mounting brackets suitable for surface mounting on wall/column/structure, gland plate etc. The ON-OFF switch shall be rotary type heavy duty, double break, AC23 category, suitable for AC supply. Plug and Socket shall be shrouded Die-cast aluminium. Socket shall be provided with lid safety cover. Robust mechanical interlock shall be provided such that the switch can be put ON only when the plug is fully engaged and plug can be withdrawn only when the switch is in OFF position. Also cover can be opened only when the switch is in OFF position. Wiring shall be carried out with 1100 V grade PVC insulated stranded aluminium/copper wire of adequate size. The Terminal blocks shall be of 1100 V grade. The Terminal blocks shall be of 1100 V grade made up of unbreakable polyimide 6.6 grade with adequate current rating and size. The welding receptacles shall be provided with inbuilt ELCB rated for suitable mA sensitivity.

	<p>Specification for design, supply, installation and commissioning, operations and maintenance of 132kV switchyards, transmission lines / towers, underground cables for 15 MWp solar power plant at NTPC-Singrauli (MP/UP)</p>	<p>PS-439-856 Rev 00 Page 149 of 171</p>
---	--	--

15.3.11 Galvanising

Galvanising of steel components and accessories shall conform to IS:2629 , IS4759 & IS:2633. Additionally galvanising shall be uniform, clean smooth, continuous and free from acid spots.

The amount of zinc deposit over threaded portion of bolts, nuts, screws and washers shall be as per IS:1367 . The removal of extra zinc on threaded portion of components shall be carefully done to ensure that the threads shall have the required zinc coating on them as specified


15.3.12 Welding

The welding shall be carried out in accordance with IS:9595. All welding procedures and welders qualification shall also be followed strictly in line with IS:9595

15.4 INSTALLATION

15.4.1 Cable tray and Support System Installation

- a) Cables shall run in cable trays mounted horizontally or vertically on cable tray support system which in turn shall be supported from floor, ceiling, overhead structures, trestles, pipe racks, trenches or other building structures.
- b) Horizontally running cable trays shall be clamped by bolting to cantilever arms and vertically running cable trays shall be bolted to main support channel by suitable bracket/clamps on both top and bottom side rails at an interval of 2000 mm in general . For vertical cable risers/shafts cable trays shall be supported at an interval of 1000mm in general . Fixing of cable trays to cantilever arms or main support channel by welding shall not be accepted. Cable tray installation shall generally be carried out as per the approved guidelines/ drawings. Vendor shall design the support system along with tray, spacing etc in line with relevant standard .
- c) The cantilever arms shall be positioned on the main support channel with a minimum vertical spacing of 300 mm unless otherwise indicated.
- d) The contractor shall fix the brackets/ clamps/ insert plates using anchor fasteners. Minimum size of anchor fasteners shall be M 8 X 50 and material shall be stainless steel grade 316 or better. Anchor fastener shall be fixed as recommended by manufacturer and as approved by site engineer. For brick wall suitable anchor fasteners shall be used as per the recommendations of manufacturer. Make of anchor fasteners subject to QA approval and the same shall be finalized at pre-award stage.
- e) All cable way sections shall have identification, designations as per cable way layout drawings and painted/stenciled at each end of cable way and where there is a branch connection to another cable way. Minimum height

	<p>Specification for design, supply, installation and commissioning, operations and maintenance of 132kV switchyards, transmission lines / towers, underground cables for 15 MWp solar power plant at NTPC-Singrauli (MP/UP)</p>	<p>PS-439-856 Rev 00 Page 150 of 171</p>
---	--	--

of letter shall be not less than 75 mm. For long lengths of trays, the identification shall be painted at every 10 meter. Risers shall additionally be painted/stenciled with identification numbers at every floor.

- f) In certain cases it may be necessary to site fabricate portions of trays, supports and other non standard bends where the normal prefabricated trays, supports and accessories may not be suitable. Fabricated sections of trays, supports and accessories to make the installation complete at site shall be neat in appearance and shall match with the prefabricated sections in the dimensions. They shall be applied with one coat of red lead primer, one coat of oil primer followed by two finishing coats of aluminium paint.

15.4.2 Conduits/Pipes/Ducts Installation


- a) The Contractor shall ensure for properly embedding conduit pipe sleeves wherever necessary for cabling work. All openings in the floor/roof/wall / cable tunnel/cable trenches made for conduit installation shall be sealed and made water proof by the Contractor.
- b) GI pull wire of adequate size shall be laid in all conduits before installation. Metallic conduit runs at termination shall have two lock nuts wherever required for junction boxes etc.
- c) Conduit runs/sleeves shall be provided with PVC bushings having round edge at each end. All conduits/pipes shall have their ends closed by caps until cables are pulled. After cables are pulled, the ends of conduits/pipes shall be sealed with Glass wool/Cement Mortar/Putty to prevent entrance of moisture and foreign material
- d) Exposed conduit/pipe shall be adequately supported by racks, clamps, straps or by other approved means. Conduits /pipe support shall be installed square and true to line and grade with an average spacing between the supports as given below, unless specified otherwise

Conduit /pipe size (dia).	Spacing
Upto 40 mm	1 M
50 mm	2.0 M
65-85 mm	2.5 M
100 mm and above	3.0 M

- e) For bending of conduits, bending machine shall be arranged at site by the contractor to facilitate cold bending. The bends formed shall be smooth.

15.4.3 Junction Boxes Installation


Junction boxes shall be mounted at a height of 1200mm above floor level or as specified in the drawings and shall be adequately supported/mounted on masonry wall by means of anchor fasteners/ expandable bolts or shall be

	<p>Specification for design, supply, installation and commissioning, operations and maintenance of 132kV switchyards, transmission lines / towers, underground cables for 15 MWp solar power plant at NTPC-Singrauli (MP/UP)</p>	<p>PS-439-856 Rev 00 Page 151 of 171</p>
---	--	--

mounted on an angle, plate or other structural supports fixed to floor, wall, ceiling or equipment foundations.

15.4.4 Cable Installation

- a) Cable installation shall be carried out as per IS:1255 and other applicable standards.
- b) For Cable unloading , pulling etc following guidelines shall be followed in general :
 - i. Cable drums shall be unloaded, handled and stored in an approved manner on hard and well drained surface so that they may not sink. In no case shall be drum be stored flat i.e. with flange horizontal. Rolling of drums shall be avoided as far as possible. For short distances, the drums may be rolled provided they are rolled slowly and in proper direction as marked on the drum. In absence of any indication, the drums may be rolled in the same direction as it was rolled during taking up the cables. For unreeling the cable, the drum shall be mounted on suitable jacks or on cable wheels and shall be rolled slowly so that cable comes out over the drum and not from below. All possible care shall be taken during unreeling and laying to avoid damage due to twist, kink or sharp bends. Cable ends shall be provided with sealed plastic caps to prevent damage and ingress of moisture.
 - ii. While laying cable, ground rollers shall be used at every 2 meter interval to avoid cable touching ground. The cables shall be pushed over the rollers by a gang of people positioned in between the rollers. Cables shall not be pulled from the end without having intermediate pushing arrangements. Pulling tension shall not exceed the values recommended by cable manufacturer. Selection of cable drums for each run shall be so planned so as to avoid using straight through joints. Care should be taken while laying the cables so as to avoid damage to cables. If any particular cable is damaged, the same shall be repaired or changed to the satisfaction of Project Manager.
- c) Cables shall be laid on cable trays strictly in line with cable schedule
- d) Power and control cables shall be laid on separate tiers in line with approved guidelines/drawings. The laying of different voltage grade cables shall be on different tiers according to the voltage grade of the cables. In horizontal tray stacks, H.T. cables shall be laid on topmost tier and cables of subsequent lower voltage grades on lower tiers of trays. Single core cable in trefoil formation shall be laid with a distance of four times the diameter of cable between trefoil center lines and clamped at every two meter. All multi core cables shall be laid in touching formation. Power and control cables shall be secured fixed to trays/support with self locking type nylon cable straps with de-interlocking facilities. For horizontal trays arrangements, multi core power cables and control cables

	<p>Specification for design, supply, installation and commissioning, operations and maintenance of 132kV switchyards, transmission lines / towers, underground cables for 15 MWp solar power plant at NTPC-Singrauli (MP/UP)</p>	<p>PS-439-856 Rev 00 Page 152 of 171</p>
---	--	--


shall be secured at every five meter interval. For vertical tray arrangement, individual multi core power cables and control cables shall be secured at every one meter by nylon cable strap. After completion of cable laying work in the particular vertical tray, all the control cables shall be binded to trays/supports by aluminium strips at every five meter interval and at every bend.

- e) Bending radii for cables shall be as per manufacturer's recommendations and IS:1255.
- f) Where cables cross roads/rail tracks, the cables shall be laid in hume pipe/HDPE pipe.
- g) No joints shall be allowed in trip circuits, protection circuits and CT/PT circuits. Also joints in critical equipment in main plant area shall not be permitted. Vendor shall identify and accordingly procure the cable drum length.
- h) In each cable run some extra length shall be kept at suitable point to enable one LT/two HT straight through joints to made, should the cable develop fault at a later stage. Control cable termination inside equipment enclosure shall have sufficient lengths so that shifting of termination in terminal blocks can be done without requiring any splicing.
- i) Wherever few cables are branching out from main trunk route troughs shall be used.
- j) Wind loading shall be considered for designing support as well Cable trays wherever required.
- k) Where there is a considerable risk of steam, hot oil or mechanical damage cable routes shall be protected by barriers or enclosures.
- l) The installation work shall be carried out in a neat workman like manner & areas of work shall be cleaned of all scraps, water, etc. after the completion of work in each area every day. Contractor shall replace RCC/Steel trench covers after the Installation work in that particular area is completed or when further work is not likely to be taken up for some time.

15.4.5 Separation

At least 300mm clearance shall be provided between

HT power & LT power cables,

	<p>Specification for design, supply, installation and commissioning, operations and maintenance of 132kV switchyards, transmission lines / towers, underground cables for 15 MWp solar power plant at NTPC-Singrauli (MP/UP)</p>	<p>PS-439-856 Rev 00 Page 153 of 171</p>
---	--	--

LT power & LT control/instrumentation cables,

15.4.6 Segregation

- a. Segregation means physical isolation to prevent fire jumping.
- b. All cables associated with the unit shall be segregated from cables of other units.
- c. Interplant cables of station auxiliaries and unit critical drives shall be segregated in such a way that not more than half of the drives are lost in case of single incident of fire. Power and control cables for AC drives and corresponding emergency AC or DC drives shall be laid in segregated routes. Cable routes for one set of auxiliaries of same unit shall be segregated from the other set.
- d. In switchyard, control cables of each bay shall be laid on separate racks/trays.


15.4.7 Minimum number of spare cores required to be left for interconnection in control cables shall be as follows:

Minimum number of spare cores required to be left for interconnection in control cables shall be as follows:

No. of cores in cable	No. of spare cores
2C,3C	NIL
5C	1
7C-10C	2
14C and above	3

15.4.8 Directly Buried Cables

- a) Cable trenches shall be constructed for directly buried cables. Construction of cable trench for cables shall include excavation, preparation of sieved sand bedding, riddled soil cover, supply and installation of brick or concrete protective covers, back filling and compacting, supply and installation of route markers and joint markers. Laying of cables and providing protective covering shall be as per IS:1255.
- b) RCC cable route and RCC joint markers shall be provided wherever required. The voltage grade of the higher voltage cables in route shall be engraved on the marker. Location of underground cable joints shall be indicated with cable marker with an additional inscription "Cable Joint". The marker 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 crossings and drain crossings. Top of cable marker/joint marker shall be sloped to avoid accumulation of water/dust on marker.


	<p>Specification for design, supply, installation and commissioning, operations and maintenance of 132kV switchyards, transmission lines / towers, underground cables for 15 MWp solar power plant at NTPC-Singrauli (MP/UP)</p>	<p>PS-439-856 Rev 00 Page 154 of 171</p>
---	--	--

15.4.9 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 20 meters in cable tray/trench runs. Cable tags shall also be provided inside the switchgear, motor control centers, control and relay panels etc. where a number of cables enter together through a gland plate. Cable tag shall be of rectangular shape for power cables and control cables. Cable tag shall be of 2 mm thick aluminum with number punched on it and securely attached to the cable by not less than two turns of 20 SWG GI wire conforming to IS:280. Alternatively, the Contractor may also provide cable tags made of nylon, cable marking ties with cable number heat stamped on the cable tags

15.4.10 While crossing the floors, unarmoured cables shall be protected in conduits upto a height of 500 mm from floor level if not laid in tray.

15.5 Cable Terminations & Connections

- a) The termination and connection of cables shall be done strictly in accordance with cable termination kit manufacturer" instructions, drawings and/or as directed by Project Manager. Cable jointer shall be qualified to carryout satisfactory cable jointing/termination. Contractor shall furnish for review documentary evidence/experience reports of the jointers to be deployed at site.
- b) Work shall include all clamps, fittings etc. and clamping, fitting, fixing, plumbing, soldering, drilling, cutting, taping, preparation of cable end, crimping of lug, insulated sleeving over control cable lugs, heat shrinking (where applicable), connecting to cable terminal, shorting and grounding as required to complete the job to the satisfaction of the Project Manager.
- c) The equipment will be generally provided with undrilled gland plates for cables/conduit entry. The Contractor shall be responsible for punching of gland plates, painting and touching up. Holes shall not be made by gas cutting . The holes shall be true in shape. All cable entry points shall be sealed and made vermin and dust proof. Unused openings shall be effectively sealed by 2mm thick aluminium sheets.
- d) Control cable cores entering control panel/switchgear/MCC/miscellaneous panels shall be neatly bunched, clamped and tied with self locking type nylon cable ties with de interlocking facility to keep them in position.
- e) All the cores of the control cable to be terminated shall have identification by providing ferrules at either end of the core, each ferrule shall be indelible, printed single tube ferrule and shall include the complete wire number and TB number as per the drawings. The ferrule shall fit tightly on the core. Spare cores shall have similar ferrules with suffix sp1, sp2, ---etc along with cable numbers and coiled up after end sealing.
- f) All cable terminations shall be appropriately tightened to ensure secure

	<p>Specification for design, supply, installation and commissioning, operations and maintenance of 132kV switchyards, transmission lines / towers, underground cables for 15 MWp solar power plant at NTPC-Singrauli (MP/UP)</p>	<p>PS-439-856 Rev 00 Page 155 of 171</p>
---	--	--

and reliable connections.

16.0 Metering System


All the tariff meters (Main, Check & Standby may be installed by Central Transmission Utility and as per practice being followed in thermal units accordingly space for these owners supplied meters shall be provided in respective C&R panels.) Only one set of meters may be included in present scope for 33kV and 132kV side.

- (a) One (1) Main Energy Meter of Class 0.2S accuracy suitable for ABT requirement shall be provided for the 132 kV side of the transformer at Solar Plant.
- (b) One (1) Main Energy Meter of Class 0.2S accuracy suitable for ABT requirement shall be provided for the 132 kV feeder at NTPC Singrauli end / SSTPS substation. (The specification of this energy meter shall be given to successful bidder.)
- (c) 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 the scope of bidder

All type test reports as per IEC 62052-11/IEC 62053-22

16.1 Technical Requirements of ABT Compliant Energy Meters


- i) Shall be microprocessor-based conforming to IEC 60687 /IEC 62052-11/IEC 62053-22 / IEC 62056 /IS15959 for category B.
- ii) 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.
- iii) Shall have an accuracy of energy measurement of at least Class 0.2S for active energy and at least Class 0.5 for reactive energy according to IEC60687, and shall be connected to Class 0.2S CT cores and Class 0.2 VT windings.
- iv) The active and reactive energy shall be directly computed in CT & VT primary ratings.
- v) The reactive energy shall be recorded for each metering interval in four different registers as MVARh (lag) when active export, MVARh (Lag) when active import, MVARh (lead) when active export, MVARh (Lead) when active import.
- vi) Two separate registers shall be provided to record MVARh when system voltage is 103% and when system voltage is < 97%.
- vii) Shall compute the net MWh and MVARh during each successive 15-minute block metering interval along with a plus/minus sign, instantaneous net MWh, instantaneous net MVARh, average frequency of each 15 minutes, net active energy at midnight, net reactive energy for voltage low and high conditions at each midnight.

	<p style="text-align: center;">Specification for design, supply, installation and commissioning, operations and maintenance of 132kV switchyards, transmission lines / towers, underground cables for 15 MWp solar power plant at NTPC-Singrauli (MP/UP)</p>	<p style="text-align: right;">PS-439-856 Rev 00 Page 156 of 171</p>
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- viii) Each energy meter shall have a display unit with a seven digit display unit. It shall display the net MWh and MVARh with a plus/minus sign and average frequency during the previous metering interval; peak MW demand since the last demand reset; accumulated total (instantaneous) MWh and MVARh with a plus/minus sign, date and time; and instantaneous current and voltage on each phases.
- ix) All the registers shall be stored in a non-volatile memory. Meter registers for each metering interval, as well as accumulated totals, shall be downloadable. All the net active/reactive energy values displayed or stored shall be with a plus /minus sign for export/import.
- x) At least the following data shall be stored before being over-written for the following parameters.

Sl	Parameters	Details	Min No of days
1.	Net MWH	15 min block	40 days in meter
2.	Aver Freq	15 min block	40days in meter
3.	Net MVARH for V > 103%	15min block	40days in meter
4.	Net MVARH for V < 97%	15min block	40days in meter
5.	Cumulative Net MWH	At every midnight	10 days in meter / 40 days in PC
6.	Cumulative Net MVARH for V> 103%	At every midnight	10 days in Meter / 40 days in PC
7.	Cumulative Net MVARH for V < 97%	At every midnight	10 days in Meter / 40 days in PC
Date and time blocks of VT failure on any phase			

- xi) Shall have a built in clock and calendar with an accuracy of less than 15 seconds per month drift without assistance of external time synchronizing pulse.
- xii) Date/time shall be displayed on demand. The clock shall be synchronized by GPS time synchronization equipment.
- xiii) The meter shall be suitable to operate with power drawn from the VT supplies. The burden of the meters shall be as per relevant standard.
- xiv) The power supply to the meter shall be healthy even with a single-phase VT supply. An automatic backup, in the event of non-availability of voltage in all the phases, shall be provided by a built in long life battery and shall not need replacement for at least 10 years with a continuous VT interruption of at least 2 years. Date and time of VT interruption and restoration shall be automatically stored in a non-

	<p>Specification for design, supply, installation and commissioning, operations and maintenance of 132kV switchyards, transmission lines / towers, underground cables for 15 MWp solar power plant at NTPC-Singrauli (MP/UP)</p>	<p>PS-439-856 Rev 00 Page 157 of 171</p>
---	--	--

volatile memory.

- xv) Even under the absence of VT input, energy meter display shall be available and it shall be possible to download data from the energy meters.
- xvi) 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.
- xvii) The meter shall have means to test MWh and MVARh accuracy and calibration at site in-situ and test terminal blocks shall be provided for the same.
- xviii) The meter shall have a unique identification code provided by the Employer and shall be permanently marked on the front of the meter and stored in the non volatile memory of the meter.

The owner shall have the right to carry out surprise inspections of the Metering Systems from time to time to check their accuracy.

In addition to above, space for mounting another energy meter shall be provided in the C&R panel.

17.0 EARTHING SYSTEM


17.1 Earthing system shall be in strict accordance with IS: 3043 and Indian Electricity Rules/Acts.

17.2 Earthing system network/earthmat shall be interconnected mesh of mild steel rods buried in ground in the plant. All off-site areas shall be interconnected together by minimum two parallel conductors. The Contractor shall furnish the detailed design and calculations for Employer's approval. Contractor shall obtain all necessary statutory approvals for the system.

17.3 The earth conductors shall be free from pitting, laminations, rust, scale and other electrical, mechanical defects

17.4 The material of the earthing conductors shall be as follows :


- | | |
|--|-------------------|
| 1) Conductors above ground level and in built up trenches. | -Galvanized steel |
| 2) Conductors buried in earth | -Mild steel |
| 3) Earth electrodes | -Mild steel rod |

	<p>Specification for design, supply, installation and commissioning, operations and maintenance of 132kV switchyards, transmission lines / towers, underground cables for 15 MWp solar power plant at NTPC-Singrauli (MP/UP)</p>	<p>PS-439-856 Rev 00 Page 158 of 171</p>
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17.5 The sizes of earthing conductors for various electrical equipments shall be as below:


	Equipment	Earth conductor buried in earth	Earth conductor above ground level & in built-up trenches
a)	Main earth grid	40 mm dia. MS rod	65 x 8mm GS flat
b)	33kV/11kV/6.6kV/3.3 kV/ switchgear equipment and 415V switchgear	---	65 x 8mm GS flat
c)	415 V MCC/ Distribution boards / Transformers	---	50 x 6mm GS flat
d)	LT Motors above 125 KW	---	50 x 6mm GS flat
	25 KW to 125 KW	---	25 x 6mm GS flat
	1KW to 25 KW Fractional House power motor	---	25 x 3mm GS flat
e)	Control panel & control desk	---	8 SWG GS wire
f)	Push button station / Junction Box	---	25 x 3 mm GS flat
g)	Columns, structures, cable trays and bus ducts enclosures	---	8 SWG GI wire
h)	Crane, rails, rail tracks & other non-current carrying metal parts	---	50 x 6mm GS flat
			25 x 6mm GS flat

17.6 Metallic frame of all electrical equipment shall be earthed by two separate and distinct connections to earthing system, each of 100% capacity, Crane rails, tracks, metal pipes and conduits shall also be effectively earthed at two points. Steel RCC columns, metallic stairs, and rails etc. of the building housing electrical equipment shall be connected to the nearby earthing grid conductor by one earthing ensured by bonding the different sections of hand rails and metallic stairs. Metallic sheaths/screens, and armour of multi-core cables shall be earthed at both ends. Metallic Sheaths and armour of single core cables shall be earthed at switchgear end only unless otherwise approved. Every alternate post of the switchyard fence shall be connected to earthing grid by one GS flat and gates by flexible lead to the earthed post. Railway tracks within the plant area shall be bonded across fish plates and connected to earthing grid at several locations. Portable tools,

	<p>Specification for design, supply, installation and commissioning, operations and maintenance of 132kV switchyards, transmission lines / towers, underground cables for 15 MWp solar power plant at NTPC-Singrauli (MP/UP)</p>	<p>PS-439-856 Rev 00 Page 159 of 171</p>
---	--	--


appliances and welding equipment shall be earthed by flexible insulated cable.

- 17.7 Each continuous laid lengths of cable tray shall be earthed at minimum two places by G.S. flats to earthing system, the distance between earthing points shall not exceed 30 meter. Wherever earth mat is not available , necessary connections shall be done by driving an earth electrode in the ground
- 17.8 Neutral points of HT transformer shall be earthed through NG resistors. The Contractor shall connect the NGR earthing point to earth electrodes by suitable earth conductors.
- 17.9 Neutral connections and metallic conduits/pipes shall not be used for the equipment earthing. Lightning protection system down conductors shall not be connected to other earthing conductors above the ground level.
- 17.10 Connections between earth leads and equipment shall normally be of bolted type. Contact surfaces shall be thoroughly cleaned before connections. Equipment bolted connections after being tested and checked shall be painted with anti corrosive paint/compound.
- 17.11 Suitable earth risers as approved shall be provided above finished floor/ground level, if the equipment is not available at the time of laying of main earth conductor.
- 17.12 Connections between equipment earthing leads and between main earthing conductors shall be of welded type. For rust protection the welds should be treated with red lead compound and afterwards thickly coated with bitumen compound. All welded connections shall be made by electric arc welding.
- 17.13 Resistance of the joint shall not be more than the resistance of the equivalent length of conductors.
- 17.14 Earthing conductors buried in ground shall be laid minimum 600 mm below grade level unless otherwise indicated in the drawing. Back filling material to be placed over buried conductors shall be free from stones and harmful mixtures. Back filling shall be placed in layers of 150 mm.
- 17.15 Earthing conductors embedded in the concrete floor of the building shall have approximately 50 mm concrete cover.
- 17.16 A minimum earth coverage of 300 mm shall be provided between earth conductor and the bottom of trench/foundation/underground pipes at

	<p>Specification for design, supply, installation and commissioning, operations and maintenance of 132kV switchyards, transmission lines / towers, underground cables for 15 MWp solar power plant at NTPC-Singrauli (MP/UP)</p>	<p>PS-439-856 Rev 00 Page 160 of 171</p>
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crossings. Earthing conductors crossings the road can be installed in pipes. Wherever earthing conductor crosses or runs at less than 300 mm distance along metallic structures such as gas, water, steam pipe lines, steel reinforcement in concrete, it shall be bonded to the same.

- 17.17 Earthing conductors along their run on columns, walls, etc. shall be supported by suitable welding / cleating at interval of 1000mm and 750mm respectively.
- 17.18 Earth pit shall be constructed as per IS:3043. Electrodes shall be embedded below permanent moisture level. Minimum spacing between electrodes shall be 600mm. Earth pits shall be treated with salt and charcoal if average resistance of soil is more than 20 ohm meter.
- 17.19 On completion of installation continuity of earth conductors and efficiency of all bonds and joints shall be checked. Earth resistance at earth terminations shall be measured and recorded. All equipment required for testing shall be furnished by contractor.
- 17.20 Earthing conductor shall be buried at least 2000mm outside the fence of electrical installations. Every alternate post of the fences and all gates shall be connected to earthing grid by one lead.

	<p>Specification for design, supply, installation and commissioning, operations and maintenance of 132kV switchyards, transmission lines / towers, underground cables for 15 MWp solar power plant at NTPC-Singrauli (MP/UP)</p>	<p>PS-439-856 Rev 00 Page 161 of 171</p>
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17.21 Other Requirements of Earthing System:

Standard/Code	IEEE 80, IS 3043
Earthing System	
Life expectancy	40 Years
System Fault Level	As per system requirement (B0)
Soil resistivity	Actual as per site conditions.
Min. Steel corrosion	0.12mm/year
Depth of burial of main earth conductor	600mm below grade where it crosses trenches, pipes, ducts, tunnels, rail tracks, etc., it shall be at least 300mm below them.
Conductor joints	By electric arc welding, with resistance of joint not more than that of the conductor.
Welds to be treated with red lead for rust protection and then coated with bitumen compound for corrosion protection.	
Surface resistivity - Gravel	3000 ohm-meter
- Concrete	500 ohm-meter

	Specification for design, supply, installation and commissioning, operations and maintenance of 132kV switchyards, transmission lines / towers, underground cables for 15 MWp solar power plant at NTPC-Singrauli (MP/UP)	PS-439-856 Rev 00 Page 162 of 171
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18.0 QUALITY ASSURANCE CHAPTERS

18.1 132 kV Switchyard Equipments

Attributes / Characteristics Items/Components Sub Systems	Make, model, Type & Rating, Test Certificate	Routine & Acceptance Test as per IS / IEC	Functional requirements as per NTPC Specification
Circuit Breaker (IEC:62271-100)	Y	Y	Y
Interruptor & hollow insulator (IEC:233/ IS:5284)	Y	Y	Y
Isolator (IEC:62271-102)	Y	Y	Y
Current Transformer (IEC:60044)	Y	Y	Y
Voltage Transformer (IEC:)	Y	Y	Y
Bus Post Insulator (IEC:168 / 273 / IS:2544)	Y	Y	Y
Disc, Pin & String Insulator (IEC:383 / IS:731)	Y	Y	Y
Surge Arrestor (IEC:99-4)	Y	Y	Y
Hardware fittings for Insulator (IS:2486 / BS:3288)	Y	Y	Y
Spacer Clamps & Connector (IS:10162 / 5561)	Y	Y	Y
Aluminium Tube (IS:5082 / 2673 / 2678)	Y	Y	Y
Conductor (IS:398)	Y	Y	Y
Galvanised Steel Structures (IS:2062/2629/4759/6745)	Y	Y	Y
Vibration Damper (IS:9708)	Y	Y	Y
Sag Compensating Spring DIN:2089/2096 IS:3195 / 7906	Y	Y	Y
Control & Relay Panel	Y	Y	Y
Leakage Current Analyser	Y	Y	Y
Protection Relays	Y	Y	Y
Tariff Metering System as per IEC 62052-11 & 62053-22 & IS 14697)	Y	Y	Y
Synchronising Trolley	Y	Y	Y
Relay Test Kit	Y	Y	Y
Surge Monitor	Y	Y	Y

Notes : 1) This is an indicative list of test/checks. The manufacture is to furnish a detailed Quality Plan indicating the practice and procedure along with relevant supporting documents during QP finalisation for all items.

2) All major Bought Out Items will be subject to NTPC approval.



Specification for design, supply, installation and commissioning, operations and maintenance of 132kV switchyards, transmission lines / towers, underground cables for 15 MWp solar power plant at NTPC-Singrauli (MP/UP)

PS-439-856
Rev 00
Page 163 of 171

18.2 CABLING, EARTHING, LIGHTNING PROTECTION

ATTRIBUTES / CHARACTERISTICS	Dimension	Paint shade, paint thickness, adhesion	Pre-treatment of sheet	IP protection	Proof load*	Surface finish	Deflection test*	HV & IR	Galvanise Test (If Applicable)	Functional	Bought out items/Bill of material	Routine tests as per relevant standard & specification	Acceptance tests as per relevant standard & specification	Constructional feature as per NTPC Specification
ITEMS/COMPONENTS / SUB SYSTEMS														
Wall Mounted-Lighting Panel (IS-513, IS:5, IS:2629, 2633, 6745)	Y	Y	Y	Y		Y		Y	Y	Y	Y	Y	Y	Y
Switch box/junction box/ Receptacles Panel (IS-513, IS:5, IS:2629, 2633, 6745)	Y	Y	Y	Y		Y		Y	Y	Y	Y	Y	Y	Y
Cable glands(BS-6121)	Y											Y		
Cable lug(IS-8309)	Y											Y		
Lighting wire(IS-694)	Y											Y		
Flexible conduits	Y											Y		Y
Conduits(Galvanise& Epoxy) IS-9537 & IS-2629,2633 ,6745	Y		Y								Y	Y		Y
RCC Hume Pipe (IS-458)												Y		
Cable termination & straight through joint (VDE-0278)	Y											Y		Y
Cable Trays, Flexible supports system & accessories IS-513, 2629,2633,6745	Y		Y		Y	Y	Y	Y	Y	Y		Y	Y	Y
Trefoil clamp	Y													Y
GI flats for earthing& lighting protection (IS 2062, 2629, 6745,2633)	Y		Y						Y			Y		Y
GI wire (IS-280)	Y											Y		
Fire Sealing System (BS – 476)												Y	Y	Y

Note: 1.This is an indicative list of tests /checks. The manufacturer is to furnish a detailed Quality Plan indicating the practice and procedure along with relevant supporting documents.

2.* Deflection Test on cable trays and Proof Load test on cable trays support system will be as per details given in the NTPC technical specification & approved MQP. The above acceptance tests shall be done only on one sample from each size of offered lot. (3) Make of all items will be subject to NTPC approval.



Specification for design, supply, installation and commissioning, operations and maintenance of 132kV switchyards, transmission lines / towers, underground cables for 15 MWp solar power plant at NTPC-Singrauli (MP/UP)


PS-439-856
Rev 00
Page 164 of 171

18.3 LT Control Cable

(1.1 KV PVC Cables)

Attributes / Characteristics	Item / Components / Sub System Assembly	Make	Type	Rating	T.C	Dimension/surface finish	Mechanical Properties	Chemical Composition	Electrical Properties	Spark Test	Lay length/Sequence	Armour coverage, cross over, looseness, can between the armour wires	Sequential marking/surface finish/cable length	Tensile strength, elongation before & after ageing of insulation & outer sheath	Thermal stability of insulation and outer sheath	Anti termite treatment on wooden drums	Constructional feature as per NTPC	Routine & Acceptance test as per relevant standard & para 7 & 7.1 of this	FRLS Test
	Copper Conductor (IS-8130)	Y	Y	Y	Y	Y	Y	Y	Y										
	PVC Compound (IS-5831)	Y				Y			Y					Y					
	FRLS PVC Compound IS-5831 ASTM-D-2843/ IS 10810 (Part-58) IEC 60754 Part-1	Y				Y								Y					Y
	Armour wire/strip (IS-3975)	Y	Y	Y															
	Insulated Core		Y							Y	Y				Y				
	Laid up core		Y								Y								
	PVC Inner sheath		Y																
	Armouring		Y									Y							
	Outer sheath		Y										Y	Y	Y				Y
	Finish cable (IS-1554- 1) ASTM-D-2843/ IS 10810 (Part-58) IEC-60754 Part-1 Swedish Chimney: SEN SS 424-1475(F3 category) Flammability test IEC-60332 Part-3 Cat-B	Y	Y									Y	Y	Y	Y		Y	Y	Y
	Wooden drum(IS : 10418) / Steel drum		Y													Y			

- 1.Note : This is an indicative list of test/checks. The manufacturer is to furnish a detailed quality plan indicating the Practice and procedure along with relevant supporting documents.

	<p>Specification for design, supply, installation and commissioning, operations and maintenance of 132kV switchyards, transmission lines / towers, underground cables for 15 MWp solar power plant at NTPC-Singrauli (MP/UP)</p>	<p>PS-439-856 Rev 00 Page 165 of 171</p>
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CONTROL CABLE

ROUTINE TESTS

Routine tests shall be carried out on each drum of finished cables for all types & sizes.


Following shall constitute routine tests:

- 1) Conductor Resistance test
- 2) High voltage test at room temperature

ACCEPTANCE TESTS

Following Acceptance tests shall be carried out for each type and size of the cables on the cable drums selected at random as per sampling plan mentioned in IS: 1554 Part 1

- A) For Conductor**
 - 1) Annealing test For copper conductor only
 - 2) Resistance test
- B) For Armour Wires / Formed Wires (If applicable)**
 - 1) Measurement of Dimensions
 - 2) Tensile Tests
 - 3) Elongation Test
 - 4) Torsion Test For Round wires only
 - 5) Wrapping Test
 - 6) Resistance Test
 - 7) Mass of Zinc coating test For G S wires / Formed wires only
 - 8) Uniformity of Zinc coating For G S wires / Formed wires only
 - 9) Adhesion test For G S wires / Formed wires only
 - 10) Freedom from defects
- C) For PVC insulation & PVC Sheath**
 - 1) Test for thickness
 - 2) Tensile strength & Elongation before ageing
- D) For completed cables**
 - 1) Insulation resistance test (Volume resistivity method)
 - 2) High voltage test **at room temperature**

	<p>Specification for design, supply, installation and commissioning, operations and maintenance of 132kV switchyards, transmission lines / towers, underground cables for 15 MWp solar power plant at NTPC-Singrauli (MP/UP)</p>	<p>PS-439-856 Rev 00 Page 166 of 171</p>
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- E) Following tests shall be carried out and only one sample shall be taken from each offered lot of all sizes for these tests:-**
- 1) Thermal stability test **on PVC insulation and outer sheath**
 - 2) Oxygen index test **on outer sheath**
 - 3) Smoke density rating test **on outer sheath as per ASTM –D 2843**
 - 4) Acid gas generation test **on outer sheath as per IEC –60 754 (Part 1)**

F) Ageing test on PVC insulation and PVC outer sheath as per following:

In case of regular manufacturers:-

Samples as per relevant IS from every size per type of cable in the offered lot shall be tested for tensile strength & elongation (before ageing). The values will be compared with corresponding values mentioned in the type test report accepted by NTPC. In case values of tensile strength & elongation (before ageing) are within + /- 15% of the type test reports then 1 sample per type of cable of offered lot will be put on accelerated ageing test. The accelerated ageing test procedure: sample to be put in air oven at temperature of 130^oc +/- 2^oc for 5 hours, tensile strength & elongation acceptance norms as per relevant IS. However in case the tensile strength and elongation values are not within +/- 15% of type test values then ageing test will be carried out on that particular size of cable of offered lot as per relevant IS.

In case of new manufacturers / suppliers (supplying first time to NTPC through corporate contract):-


Samples as per relevant IS from every size per type of cable in the offered lot shall be tested for tensile strength & elongation (before ageing). The values will be compared with corresponding values mentioned in the type test report accepted by NTPC. In case values of tensile strength & elongation (before ageing) are not within + /- 15% of the type test reports then sample from that particular cable size will be put on ageing test as per relevant IS. However not withstanding above condition, 1 sample per cable type of offered lot will be put on ageing test as per relevant IS.

G) Flammability test as per IEC 60332 - Part- 3 (Category- B) on completed cable as per following sampling plan.

The test shall be carried out on every size & type of control cable offered for inspection as an acceptance test. This test will be carried out using composite sampling i.e. irrespective of sizes of cables of a particular type, may be tested together as per calculations in line with the IEC (all sizes will be covered)

H) Following tests shall be carried on one length of each size of offered lot:

Surface finish, length measurement, sequence of cores, armour coverage, Gap between two consecutive armour wires / formed wires

	<p>Specification for design, supply, installation and commissioning, operations and maintenance of 132kV switchyards, transmission lines / towers, underground cables for 15 MWp solar power plant at NTPC-Singrauli (MP/UP)</p>	<p>PS-439-856 Rev 00 Page 167 of 171</p>
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18.4 LT Power Cables
(1.1 KV & XLPE Cables)

Attributes / Characteristics	Item / Components / Sub System Assembly	Make, Rating, Type & TC	Dimension/surface finish	Mechanical Properties	Chemical Composition	Electrical Properties	Spark Test	Tlot set test (XT,PF)	Lay length / Sequence	Armour coverage, Cross over, looseness, Gap between two armour wire/strip	Sequential marking/surface finish /cable length	Tensile strength, elongation before & after ageing of insulation & outer sheath	Thermal Stability of insulation and outer sheath *	Anti termite treatment on wooden drums	Constructional/ requirement as per NTPC Spec.	Routine and acceptance test as per Relevant Standard and NTPC specification	FRLS Test
	Aluminum (IS-8130)	Y	Y	Y	Y	Y											
	PVC Compound (IS-5831)	Y		Y		Y						Y					
	XLPE Compound(IS-7098 Part-I)	Y		Y		Y		Y				Y					
	FRLS PVC Compound(IS-5831) ASTM-D-2843/ IS 10810 (Part-58) IEC-60754 Part-I	Y		Y								Y					
	Armour wire/strip (IS-3975)	Y	Y	Y													
	Insulated Core		Y				Y	Y					Y				
	Laid up core		Y						Y								
	PVC Inner sheath		Y														
	Armouring		Y							Y							
	Outer sheath		Y								Y	Y	Y				Y
	Finish cable (IS-1554 & 7098 – Part-1) ASTM-D-2843/ IS 10810 (Part- - 58) IEC-60754 Part-I Swedish Chimney SS 4241475 for (F3 category) Flammability test IEC-60332 Part –3 Cat-B	Y	Y							Y	Y	Y	Y		Y	Y	Y
	Wooden drum (IS-10418) / Steel drum		Y											Y			

Note: This is an indicative list of test/checks. The manufacturer is to furnish a detailed quality plan indicating the practice and procedure along with relevant supporting documents.

* 2. Not applicable for XLPE insulation




Specification for design, supply, installation and commissioning, operations and maintenance of 132kV switchyards, transmission lines / towers, underground cables for 15 MWp solar power plant at NTPC-Singrauli (MP/UP)


PS-439-856
Rev 00
Page 168 of 171

	ROUTINE TESTS Routine tests shall be carried out on each drum of finished cables for all types & sizes. Following shall constitute routine tests:
1)	Conductor Resistance test
2)	High voltage test at room temperature

	ACCEPTANCE TESTS
	Following Acceptance tests shall be carried out for each type and size of the cables on the cable drums selected at random as per sampling plan mentioned in IS: 1554 Part 1 & IS 7098 Part-I
A)	For Conductor
1)	Annealing test For copper conductor only
2)	Tensile test For aluminium conductor only
3)	Wrapping test For aluminium conductor only
4)	Resistance test
B)	For Armour Wires / Formed Wires (If applicable)
1)	Measurement of Dimensions
2)	Tensile Tests
3)	Elongation Test
4)	Torsion Test For Round wires only
5)	Wrapping Test
6)	Resistance Test
7)	Mass of Zinc coating test For G S wires / Formed wires only
8)	Uniformity of Zinc coating For G S wires / Formed wires only
9)	Adhesion test For G S wires / Formed wires only
10)	Freedom from defects
C)	For PVC / XLPE insulation & PVC Sheath
1)	Test for thickness
2)	Hot set test For XLPE insulation only
3)	Tensile strength & Elongation before ageing
D)	For completed cables
1)	Insulation resistance test (Volume resistivity method)
2)	High voltage test at room temperature
E)	Following tests shall be carried out and only one sample shall be taken from each offered lot of all sizes for these tests:-
1)	Thermal stability test on PVC insulation and outer sheath
2)	Oxygen index test on outer sheath


	<p>Specification for design, supply, installation and commissioning, operations and maintenance of 132kV switchyards, transmission lines / towers, underground cables for 15 MWp solar power plant at NTPC-Singrauli (MP/UP)</p>	<p>PS-439-856 Rev 00 Page 169 of 171</p>
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- 3) Smoke density rating test **on outer sheath as per ASTM –D 2843**
- 4) Acid gas generation test **on outer sheath as per IEC –60 754 (Part 1)**
- F) Ageing test on PVC / XLPE insulation and PVC outer sheath as per following:**
- In case of regular manufacturers:-**
- Samples as per relevant IS from every size per type of cable in the offered lot shall be tested for tensile strength & elongation (before ageing). The values will be compared with corresponding values mentioned in the type test report accepted by NTPC. In case values of tensile strength & elongation (before ageing) are within +/- 15% of the type test reports then 1 sample per type of cable of offered lot will be put on accelerated ageing test. The accelerated ageing test procedure: sample to be put in air oven at temperature of $130^{\circ}\text{C} \pm 2^{\circ}\text{C}$ for 5 hours, tensile strength & elongation acceptance norms as per relevant IS. However in case the tensile strength and elongation values are not within +/- 15% of type test values then ageing test will be carried out on that particular size of cable of offered lot as per relevant IS.
- In case of new manufacturers / suppliers (supplying first time to NTPC through corporate contract):-**
- Samples as per relevant IS from every size per type of cable in the offered lot shall be tested for tensile strength & elongation (before ageing). The values will be compared with corresponding values mentioned in the type test report accepted by NTPC. In case values of tensile strength & elongation (before ageing) are not within +/- 15% of the type test reports then sample from that particular cable size will be put on ageing test as per relevant IS. However not withstanding above condition, 1 sample per cable type of offered lot will be put on ageing test as per relevant IS.
- G) Flammability test as per IEC 60332 - Part- 3 (Category- B) on completed cable as per following sampling plan.**
- The test shall be carried out on every size & type of control cable offered for inspection as an acceptance test. This test will be carried out using composite sampling i.e. irrespective of sizes of cables of a particular type, may be tested together as per calculations in line with the IEC (all sizes will be covered)
- H) Following tests shall be carried on one length of each size of offered lot:**
- Surface finish, length measurement, sequence of cores, armour coverage, Gap between two consecutive armour wires / formed wires

	<p>Specification for design, supply, installation and commissioning, operations and maintenance of 132kV switchyards, transmission lines / towers, underground cables for 15 MWp solar power plant at NTPC-Singrauli (MP/UP)</p>	<p>PS-439-856 Rev 00 Page 170 of 171</p>
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18.5 132KV CABLES

Attributes / Characteristics Item Components Sub System Assembly	Make, Type, Rating, TC	Dimension/surface finish	Mechanical Properties	Chemical Composition/Purity	Electrical Properties	Triple Extrusion & Curing / Hot Set Test	Eccentricity / ovality	Void & Contamination Test	Metallic (Cu) Screening	Moisture Barrier	Extrusion	Overlapping / Bonding	Spark test on outer Sheath	Thermal stability of Sheath	Constructional feature as per NTPC SPEC.	Routine and acceptance test as per relevant standard and NTPC specification
Copper (IEC 60228)		Y			Y											
Semiconducting compound	Y															
PVC Compound (IEC 60840)	Y		Y		Y											
Swelling Tape(Water blocking tape)	Y	Y	Y													
Copper tape/Foil/Wire	Y	Y	Y		Y											
XLPE Compound (IEC60840)	Y		Y		Y											
Lead Alloy/ AL	Y		Y	Y												
Laminated/ Binder Tape	Y	Y	Y													
Steel drum		Y														
Triple extrusion & Curing of Cores		Y	Y		Y	Y	Y	Y								
Semiconducting swell able tape over insulation screening	Y	Y	Y		Y					Y		Y				
Copper wire screening/copper tape		Y							Y							
Lead sheathing										Y	Y					
Laminated/ Binder Tape		Y										Y				
Inner Sheathing		Y									Y		Y			
Outer Sheathing (Graphite Coated PVC)		Y									Y	Y	Y			

	<p>Specification for design, supply, installation and commissioning, operations and maintenance of 132kV switchyards, transmission lines / towers, underground cables for 15 MWp solar power plant at NTPC-Singrauli (MP/UP)</p>	<p>PS-439-856 Rev 00 Page 171 of 171</p>
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Power Cable Final inspection (IEC – 60840)		Y	Y		Y	Y		Y	Y				Y			Y		Y
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Notes:

1. This is an indicative list of tests / checks. The manufacturer is to furnish a detailed Quality Plan indicating the practice and procedure along with relevant supporting documents.
2. Make of all major Bought Out Items will be subject to NTPC approval.

Following acceptance (sample) tests will be carried out on samples per lot as per IEC.

- a) Conductor examination
- b) Measurement of electrical resistance of conductor and of metallic screen
- c) Measurement of thickness of insulation and over-sheath
- d) Measurement of thickness of metallic sheath
- e) Measurement of diameters,
- f) Hot set test for XLPE
- g) Measurement of capacitance
- i) Water penetration test,
- j) Tests on components of cables with a longitudinally applied metal foil

COMMERCIAL TERMS & CONDITIONS (to be enclosed with TECHNO-COMMERCIAL BID) (For Indigenous Purchase Orders)				
RFQ No.HBSMM20003 RFQ DATE : 25.10.2013 DUE DATE : 18.11.2013 FOR 132kV switchyards, transmission lines / towers, underground cables for 15 MWp solar power plant at NTPC-Singrauli				
Sl No.	Terms	BHEL Term	Confirmation	Deviation / Remarks
1	Bidding	(a) Bid has to be submitted as Two Part - in two sealed covers- Techno Commercial Bid(Part-1) & Price Bid (Part-II)- clearly written on each cover both put in a single sealed envelope super-scribed with RFQ No. and Due date.	Acceptable / Not acceptable	
		(b) Documents as called in Pre-Qualification Criteria (Clause 2.0 of PS 439-856) to be submitted along with technical bid(Part-1).	Acceptable / Not acceptable	
		(c) Enclosures-B & B1 to be submitted along with technical bid (Part-1) & Enclosure-B2 to be submitted along with Price bid (Part-II).	Acceptable / Not acceptable	
		(d) Clause-wise compliance to BHEL Purchase specification along with all documents as called in Technical specification to be submitted along with technical bid(Part-1).	Acceptable / Not acceptable	
2	Price Basis	Firm i.e., from the date of PO to completion of supply if I&C is not applicable. If I&C is in supplier's scope, then the prices shall remain Firm till commissioning & handing-over of the complete system. (PVC clause not acceptable).	Acceptable / Not acceptable	
3	Terms of Delivery	Free On Road Basis to Project site :NTPC-Singrauli-MP.	Acceptable / Not acceptable	
4	Delivery Period	(a) Supply : Completion within 12 weeks from the date of Drawing Approval. Drawing Submission : Within 1 week from PO date.	Acceptable / Not acceptable	
		(b) I&C : Completion within 4 weeks from supply date.	Acceptable / Not acceptable	
5	Payment Term	(a)Supply :80% payment of Supply value + 100% Taxes shall be made with 45 days credit from the date of receipt of material at site. 10% on completion of I&C and certification line item wise on pro-rata basis. Balance 10% on execution of PBG valid for warranty period + 6 months claim period from any of the BHEL Consortium banks.	Acceptable / Not acceptable	
		(b)I&C: 90% on completion of I&C and certification line item wise on pro-rata basis.Balance 10% on execution of PBG valid for warranty period + 6 months claim period from any of the BHEL Consortium banks.	Acceptable / Not acceptable	
		(c)O&M: 100% payment on quarterly basis on completion and certification.	Acceptable / Not acceptable	
		(d)For any other deviation loading will be done as per clause 25(A) of Enquiry - General Terms & Conditions (Ref : SCPV/BOS/01-Rev 00)	Acceptable / Not acceptable	
6	Excise Duty	(a) To confirm whether applicable. If applicable, indicate prevailing rate of Excise duty.	Applicable / Not applicable	Prevailing rate of Excise duty : %
		(b) BHEL is trying to avail Customs Duty & Excise duty exemption.Successful bidder shall support with all relevant documents.	Agree/Not Agree	
7	Sales Tax	(a) To confirm whether applicable. If applicable, indicate prevailing rate of Sales Tax against Form c.	Applicable / Not applicable	Prevailing rate of Sales Tax against Form c: %
		(b) For issue of form "C", vendor has to furnish "E1/E2" form.Please confirm that "E1/E2 Sale form" will be submitted.	Agree/Not Agree	
8	Value Added Tax	Since it is inter-state movement of goods, VAT is not applicable. Only CST against form C is applicable.	Applicable / Not applicable	CST applicable @.....%
		OR Both are in the same State, VAT is applicable please indicate VAT applicable.	Applicable / Not applicable	VAT applicable @.....%
9	Octroi	To confirm whether applicable, if applicable indicate current rate of Octroi.	Applicable / Not applicable	Octroi.....%
10	Service Tax	To confirm whether applicable, if applicable indicate current rate of Service Tax.Furnish Service Tax Regn. No. Confirmation that Service Tax register is maintained.	Applicable / Not applicable	Service Tax.....% Service Tax Regn. No. S.Tax Register maintained : Yes/No

AUTHORISED SIGNATORY WITH SEAL

Sl No.	Terms	BHEL Term	Confirmation	Deviation / Remarks
11	Freight	If Freight is quoted extra, original money receipt from Transporter has to be submitted for payment of freight. Please indicate a lumpsum value for Freight charges in Price bid if quoted extra.	Agree/Not Agree	
12	Insurance	Transit Insurance will be in vendor's scope	Agree/Not Agree	
13	Evaluation of L1 vendor	(a) Over all L1 of Supply + I&C + O&M on "FOR" basis to site will only be considered.	BHEL	
		The percentage of Supply, I&C and O&M values shall be in the range indicated below (approximately, with overall tallying to 100%): (a) Supply : 74-78% (b) I&C : 16-20% (c) O&M : 2-6%	Agree/Not Agree	
14	Warranty	Warranty for 60 months from the date of commissioning or 63 months from the date of supply whichever is earlier.	Agree/Not Agree	
15	Pre Shipment Inspection	Pre Shipment Inspection will be carried out by BHEL/NTPC for which test report shall be sent one week in advance.	Agree/Not Agree	
16	Penalty	Penalty of 0.5% per week at the basic price of the good for undelivered quantity of supply portion, subject to a maximum of 10%. For Supply, Pre Shipment Inspection Call Letter Date (Receipt of test report) will be treated as delivery for purpose of penalty. For other activities the activity completion date as certified by Engg. will be considered for penalty calculation.	Agree/Not Agree	
		For any deviation, loading will be done as per Clause 25.B of Enquiry - General Terms & Conditions (Ref: SCPV/BOS/01-Rev 00)	Agree/Not Agree	
17	Road Permit	Road permit if applicable will be given by BHEL before Dispatch of ordered Items	BHEL	
18	PBG	(a) PBG shall be furnished in the BHEL prescribed format. (b) Deviation if any Please specify	Agree/Not Agree	
19	Despatch Documents	Complete set of despatch documents in 3 sets shall be forwarded to BHEL directly. Despatch documents include Commercial Invoice, Excise Invoice (if ED is applicable), Lorry receipt (L/R), Packing list, Warranty certificate, Insurance intimation letter, & Original Performance Bank Guarantee (Directly from issuing bank to BHEL). One set of Invoice, Packing list and L/R shall be faxed immediately after despatch to BHEL-EDN, Bangalore.	Agree/Not Agree	
20	Reverse Auction	BHEL reserves the right to conduct Reverse auction. Procedure for the same will be informed by BHEL. Please confirm your acceptance for reverse auction.	Agree/Not Agree	
21	Other terms & conditions	For any other Terms and Conditions, kindly refer to the enclosed Enquiry - General Terms & Conditions (Ref: SCPV/BOS/01-Rev 00)	Agree/Not Agree	
22	Integrity Pact	The bidder shall sign an "INTEGRITY PACT" in the format enclosed (total 8 sheets). Only those vendors / bidders who have entered into such an Integrity pact with BHEL would be competent to participate in the bidding. In other words, entering into this pact is a preliminary qualification.	Agree/Not Agree	
		The Name & Address of Independent External Monitor (IEM) is given below: Shri Kanwarjit Singh, IRS (Retd.) D-6/11, Ground Floor, Vasant Vihar, New Delhi - 110 057 e-mail : kanwarfeb@gmail.com		
23	Validity	(a) Quotation should remain valid for a period of 90 days from the due date	Agree/Not Agree	
		(b) Deviation if any Please specify	(b)	
24	Bank Charges	(a) All Bank charges to respective accounts	Agree/Not Agree	
		(b) Deviation if any Please specify	(b)	
25	Billing Schedule	Billing schedule shall be submitted by successful vendor after PO is released.	Agree/Not Agree	
26	Spares	Vendor shall quote for spares as per PS-439-856. Successful vendor shall provide the price breakup of spares.	Agree/Not Agree	

AUTHORISED SIGNATORY WITH SEAL

TECHNICAL BID ENCLOSURE FOR COMPLIANCE OF QUOTE (UNPRICED BID)										
RFQ REF:HBSMM20003 dt.25.10.2013 DUE DATE(TECH BID) : 18.11.2013										
SI No.		DESCRIPTION	QTY	UNIT	QUOTED	TAXES				Remarks
						ED %	CST%	VAT %	SERVICE TAX %	
A. SUPPLY :										
1	PS0679033750	Electrical eqpt. 132 KV s/yard SPV side	1	ST	YES/NO				NA	Taxes Extra
2	PS0679033769	Structure items for 132 KV Switchyard	1	ST	YES/NO				NA	Taxes Extra
3	PS0679033777	Electrical eqpt. 132 KV S/yard Grid side	1	ST	YES/NO				NA	Taxes Extra
4	PS0679033807	Supply of Spares	1	ST	YES/NO				NA	Taxes Extra
5	PS0679033815	Materials for 132 KV Transmission line	10	ST	YES/NO				NA	Taxes Extra
B. I&C :										
1	PS0679033785	I&C: 132 KV Switchyard SPV side	1	AU	YES/NO	NA	NA	NA		Taxes Extra
2	PS0679033793	I&C: 132 KV Switchyard Grid side	1	AU	YES/NO	NA	NA	NA		Taxes Extra
3	PS0679033823	I&C of 132 KV Transmission line	10	AU	YES/NO	NA	NA	NA		Taxes Extra
4	PS0679033831	I&C:Commissioning & State Dept Clearance	1	AU	YES/NO	NA	NA	NA		Taxes Extra
C.O&M										
1	PS0679033840	Operation & Maintenance	12	AU	YES/NO	NA	NA	NA		Taxes Extra
D	**Freight Charge including Service Tax on Freight(12.36% on 25% of Freight Value)		LUMPSUM		YES/NO	NA	NA	NA	NA	Freight : Included/Extra
E	**Transit Insurance		LUMPSUM		YES/NO	NA	NA	NA	NA	Insurance : Included/Extra

- NOTE: 1.YOUR QUOTED PRICES SHALL BE on "FREE ON ROAD" basis to NTPC-SINGRAULI
2.PL INDICATE TAXES : ED,VAT/CST,SERVICE TAX CLEARLY APPLICABLE AS ON DATE.
3.USE THIS FORMAT FOR COMPLIANCE(REPRODUCING ON YOUR LETTER HEAD IS ACCEPTABLE).
4. FOR SL NOS A TO C, TAXES WILL BE CONSIDERED EXTRA.PLEASE QUOTE ONLY THE BASIC RATES.
5.**INDICATE WHETHER FREIGHT CHARGE & INSURANCE CHARGE IS INCLUDED IN QUOTED RATE OR WILL BE CHARGED EXTRA.
IN ABSENCE OF CLARITY, QUOTED RATE WILL BE CONSIDERED AS INCLUSIVE OF FREIGHT & INSURANCE CHARGES.

AUTHORISED SIGNATORY WITH SEAL

PRICE BID FORMAT											
RFQ REF:HBSMM20003 dt25.10.2013 DUE DATE(TECH BID) : 18.11.2013											
Sl No.	Material No.	DESCRIPTION	QTY	UNIT	Unit Rate (Rs.)	TAXES				Remarks	
						ED %	CST%	VAT %	WCT : Option 1/2/3		SERVICE TAX %
A. SUPPLY :											
1	PS0679033750	Electrical eqpt. 132 KV s/yard SPV side	1	ST					NA	NA	Taxes Extra
	Unit Rate in words :										
2	PS0679033769	Structure items for 132 KV Switchyard	1	ST					NA	NA	Taxes Extra
	Unit Rate in words :										
3	PS0679033777	Electrical eqpt. 132 KV S/yard Grid side	1	ST					NA	NA	Taxes Extra
	Unit Rate in words :										
4	PS0679033807	Supply of Spares	1	ST					NA	NA	Taxes Extra
	Unit Rate in words :										
5	PS0679033815	Materials for 132 KV Transmission line	10	ST					NA	NA	Taxes Extra
	Unit Rate in words :										
B. I&C :											
1	PS0679033785	I&C: 132 KV Switchyard SPV side	1	AU		NA	NA	NA	NA		Taxes Extra
	Unit Rate in words :										
2	PS0679033793	I&C: 132 KV Switchyard Grid side	1	AU		NA	NA	NA	NA		Taxes Extra
	Unit Rate in words :										
3	PS0679033823	I&C of 132 KV Transmission line	10	AU		NA	NA	NA	NA		Taxes Extra
	Unit Rate in words :										
4	PS0679033831	I&C:Commissioning & State Dept Clearance	1	AU		NA	NA	NA	NA		Taxes Extra
	Unit Rate in words :										
C.O&M											
1	PS0679033840	Operation & Maintenance	12	AU		NA	NA	NA	NA		Taxes Extra
	Unit Rate in words :										
D	**Freight Charge including Service Tax on Freight(12.36% on 25% of Freight Value)		LUMPSUM			NA	NA	NA	NA	NA	Freight : Included/Extra
	Unit Rate in words :										
E	**Transit Insurance		LUMPSUM			NA	NA	NA	NA	NA	Insurance : Included/Extra
	Unit Rate in words :										

NOTE: 1.YOUR QUOTED PRICES SHALL BE on "FREE ON ROAD" basis to NTPC-SINGRAULI

2.PL INDICATE TAXES : ED,VAT/CST,SERVICE TAX CLEARLY APPLICABLE AS ON DATE.

3.USE THIS FORMAT FOR COMPLIANCE(REPRODUCING ON YOUR LETTER HEAD IS ACCEPTABLE).

4. FOR SL NOS A TO C, TAXES WILL BE CONSIDERED EXTRA.PLEASE QUOTE ONLY THE BASIC RATES.

5.INDICATE WHETHER FREIGHT CHARGE & INSURANCE CHARGE IS INCLUDED IN QUOTED RATE OR WILL BE CHARGED EXTRA.**

IN ABSENCE OF CLARITY, QUOTED RATE WILL BE CONSIDERED AS INCLUSIVE OF FREIGHT & INSURANCE CHARGES.

AUTHORISED SIGNATORY WITH SEAL

Bharat Heavy Electricals Ltd.,
(A Government of India undertaking)
Electronics Division
PB No.2606, Mysore Road, Bangalore-560026, India

Enquiry - General Terms & Conditions (Two part bid)

I. Enquiry / Request for Quotation (RFQ):

- (a) Any Purchase Order resulting from this enquiry shall be governed by **these general terms and conditions listed below and special terms and conditions, if any, along with this enquiry** of Bharat Heavy Electricals Limited, Electronics Division, Bangalore-560026 (**hereinafter referred to as BHEL EDN**).
- (b) Any of the terms and conditions not acceptable to vendor, shall be explicitly mentioned in the quotation. Otherwise, it will be treated as that all terms and conditions of this enquiry are acceptable.
- (c) If counter terms and conditions are offered by vendor, BHEL EDN shall not be governed by such terms and conditions, unless it is agreed and incorporated in the Purchase Order of BHEL EDN.
- (d) Any deviation to the terms and conditions not mentioned in the quotation by vendor in response to this enquiry will not be considered, if put forth subsequently or after issue of order, unless clarification is sought for by BHEL EDN and agreed upon in the Purchase Order of BHEL EDN.
- (e) BHEL EDN reserves the right to adopt Reverse Auction for the enquiry sent, at its discretion.
- (f) BHEL EDN shall be at liberty to cancel the tender at any time, before ordering, without assigning any reason.
- (g) Any specific terms and conditions to be complied will be mentioned in RFQ.

II. General Terms and conditions:

1. **TWO PART BID:** Quotation shall be submitted in two part bid i.e.

(a) Techno-commercial i.e., Un-priced Bid (in one sealed envelope):

Techno-commercial bid shall be submitted with complete description of the equipment, specification compliances to the enquired specification and all the commercial terms & conditions indicated in the **COMMERCIAL TERMS (ANNEXURE-A for Foreign Purchase and ANNEXURE-B for Indigenous Purchase)**. Any other enclosure, which the vendor wishes to submit like product catalogue, technical literature etc., may also be submitted in a sealed envelope super scribed clearly as **"TECHNO-COMMERCIAL BID" with RFQ No. and DUE DATE**. An un-priced copy of price bid (without price) as per **ANNEXURE A-1 for Foreign Purchase and ANNEXURE B-1 for Indigenous Purchase** shall also be enclosed with the techno-commercial bid for evaluation of commercial terms. The vendor shall not give the price in the technical bid.

Confirmation to BHEL specifications shall be indicated by the vendor in the respective columns provided in the purchase specification wherever applicable. Deviations to the specification / item description, if any shall be brought out clearly indicating **"DEVIATION TO BHEL SPECIFICATION"** without fail as a part of technical offer.

Compliance to Pre-qualification criteria (if applicable) shall also be enclosed with the Techno-commercial bid.

Manufacturer's name, their trade mark and brand, part number, alternate material to the one asked in enquiry, if any, should be mentioned in quotation and illustrative leaflets giving technical particulars etc. are to be attached to facilitate consideration and technical evaluation of the quotation. BHEL EDN material code number (as in enquiry) shall be indicated for each item quoted.

(b) Price Bid (in one sealed envelope):

Price bid should contain basic unit prices, discount if any, applicable taxes & duties, packing & forwarding charges (if applicable), Freight & insurances (if applicable), FOB charge (if applicable) etc., in a sealed envelope super scribed clearly as **"PRICE BID" with RFQ No. and DUE DATE**.

It is preferred to indicate the rates in both figures and words. In such case, if there is a difference / discrepancy

Signature of tenderer / with seal
Page 1 of 12

between the rates in figures and words, the **least of the two** rates will be considered. **Price bid shall be quoted as per ANNEXURE A-2 for Foreign Purchase and ANNEXURE B-2 for Indigenous Purchase.**

(c) Tender Offer (above two envelopes inside another sealed envelope):

Both these sealed envelopes [(a) Techno-commercial i.e., un-priced Bid and (b) Price Bid] shall be kept in a single sealed envelope and super scribed clearly with **RFQ No. and DUE DATE.**

2. The above sealed envelope (Tender) shall reach our office on or before the due date by 13:00 hrs. Quotations are to be dropped in the tender box marked for the OPENING ON respective days i.e., MONDAY / WEDNESDAY / FRIDAY kept at BHEL-EDN's Reception area of our works with caption "CE, SC & PV, DEFENCE". **Quotations also can be dispatched by Couriers / Registered post / FAX / e-mail to the Purchase Executive indicated in the RFQ at the risk of vendor / bidder.**

Quotation through courier / register post / fax / email when addressed to the specific fax number and email address given in the enquiry, to be sent well in advance to enable BHEL EDN purchase personnel to drop in the tender box before the scheduled opening date and time. Vendor is fully responsible for lack of secrecy on information of such quotations. Vendor shall confirm with the concerned purchase executive after sending the offer regarding such delivery mode to ensure participation. BHEL EDN is not responsible for any delay in receipt of quotation sent by vendor through post/fax/email.

Late Tenders i.e., Tenders received after due date & time will be rejected.

3. The rate quoted shall be in units stated in the enquiry. Where quotation is in terms of unit other than that in enquiry, relationship between the two units must be furnished in the quotation.
4. As far as possible, the quotations shall be free from corrections / overwriting. Corrections / overwriting, if any should be signed by authorized person with the company seal. Any typographical errors, totaling mistakes, currency mistakes, multiplication mistakes, summary mistakes observed in your priced bids, BHEL may consider whichever is beneficial to BHEL for evaluation. Vendor shall doubly ensure that the quote is correct and complete. The corrections / overwriting if any shall be signed with the seal.
5. Quotations are to be duly signed. Unsigned bids/offers are liable for rejection.
6. Tenders will be opened at **13:30 hrs** & the venue is New Engineering Building, 2nd floor, MM conference hall, BHEL EDN, Bangalore. All the tenderers or their authorized representatives (with authorization letter from their principals) may witness opening of techno-commercial bid on the due date.
7. After evaluation of techno-commercial bids, price bids of only those which are technically & commercially accepted, will be opened on a subsequent date, which will be intimated to the concerned in advance for witnessing of price bid opening.
8. The quantity in each item to be purchased may vary from quantity enquired according to the actual requirement at the time of placing the purchase order.

9. DUN & BRADSTREET REPORT (for Foreign purchase):

In case of foreign vendors, BHEL reserves the right to verify the Dun & Bradstreet report during techno-commercial scrutiny. Please mention DUN Number in **Techno-Commercial bid.**

10. Payment of Agency Commission to Indian Agent (for Foreign purchase):

- a. BHEL shall deal directly with foreign vendors, wherever required, for procurement of goods. However, if the foreign principal desires to avail of the services of an Indian agent, then the foreign principal should ensure compliance to regulatory guidelines - which require mandatory submission of an Agency Agreement.
- b. It shall be incumbent on the Indian agent and the foreign principal to adhere to the relevant guidelines of Government of India, issued from time to time.

Signature of tenderer / with seal
Page 2 of 12

- c. The Agency Agreement should specify the precise relationship between the foreign OEM / foreign principal and their Indian agent and their mutual interest in the business. All services to be rendered by agent/ associate, whether of general nature or in relation to the particular contract, must be clearly stated by the foreign supplier/ Indian agent. Any payment, which the agent or associate receives in India or abroad from the OEM, whether as commission or as a general retainer fee should be brought on record in the Agreement and be made explicit in order to ensure compliance to laws of the country.
 - d. Any agency commission to be paid by BHEL to the Indian agent shall be in Indian currency only.
 - e. Tax deduction at source is applicable to the agency commission paid to the Indian agent as per the prevailing rules.
 - f. In the absence of any agency agreement, BHEL shall not deal with any Indian agent (authorized representatives / associate / consultant, or by whatever name called) and shall deal directly with the foreign principal only for all correspondence and business purposes.
 - g. The "Guidelines for Indian Agents of Foreign Suppliers" shall apply in all such cases.
 - h. The supply and execution of the Purchase Order (including indigenous supplies/ service) shall be in the scope of the OEM/ foreign principal. The OEM/ foreign principal should submit their offer inclusive of all indigenous supplies/ services and evaluation will be based on 'total cost to BHEL'. In case OEM/ foreign principal recommends placement of order(s) towards indigenous portion of supplies/ services on Indian supplier(s)/ agent on their behalf, the credentials/ capacity/ capability of the Indian supplier(s)/ agent to make the supplies/ services shall be checked by BHEL as per the extant guidelines of Supplier Evaluation, Approval & Review Procedure (SEARP), before opening of price bids. It will be the responsibility of the OEM/ foreign principal to get acquainted with the evaluation requirements of Indian supplier/ agent as per SEARP available on www.bhel.com.
- The responsibility for successful execution of the contract (including indigenous supplies/ services) lies with the OEM/ foreign principal. All bank guarantees to this effect shall be in the scope of the OEM/ foreign principal.
- i. **Installation & Commissioning:** Scope will be as per RFQ.E&C value should be quoted separately by bidders.
11. **TOTAL COST TO BHEL:** Purchase order will be placed on the lowest quotation (L1) only among the technically & commercially accepted quotations. Lowest quotation (L1) is determined on the basis of the total cost to BHEL.

For Foreign offers, the Exchange rate(TT selling rate of SBI) shall be taken as under.

Single part bids	Date of Tender opening
Two/Three part bid	Date of Part-1 bid opening
Reverse Auction	Date of Part-1 bid opening

If the relevant day happens to be a bank holiday, then the forex rate as on the previous bank (SBI) working day shall be taken.

- (1) If Freight is quoted extra, original money receipt from Transporter shall be submitted for payment of Freight charges.
- (2) C-form : For issue of form "C", vendor has to furnish "E1/E2" form.

12. FIRM PRICE:

Rates quoted should be firm from the date of offer, till completion of supply. No enhancement in the rates and changes in the techno-commercial terms will be allowed once the quotation is accepted and order is placed.

If Installation & Commissioning is in vendor's scope, then the price shall remain FIRM till commissioning & handing over of the complete system.

13.TERMS OF PAYMENT:

1.SUPPLY

A. : FOR FOREIGN PURCHASE

Payment will be made against "SIGHT DRAFT" on presentation of documents to our bankers . Payment through LC is also made subject to loading factors as per Clause 25 (A). For LC payment bank charges within India will be borne by BHEL and outside India will be to vendor"s account.

The payment terms are as follows:

SIGHT DRAFT PAYMENT (direct payment):

SUPPLY :

(a) **I&C not included in vendor's scope** : 90% payment of Supply value + 100% Taxes shall be made with 45 days credit from the date of receipt of material at site. Balance 10% on execution of PBG valid for warranty period + 6 months claim period from any of the BHEL Consortium banks.

(b) **Supply & I&C in vendor's scope** : 80% payment of Supply value + 100% Taxes shall be made with 45 days credit from the date of receipt of material at site. 10% on completion of I&C and certification line item wise on pro-rata basis. Balance 10% on execution of PBG valid for warranty period + 6 months claim period from any of the BHEL Consortium banks..

(B) FOR INDIGENOUS PURCHASE (DIRECT PAYMENT):

SUPPLY :

(a) **I&C not included in vendor's scope** : 90% payment of Supply value + 100% Taxes shall be made with 45 days credit from the date of receipt of material at site. Balance 10% on execution of PBG valid for warranty period + 6 months claim period from any of the BHEL Consortium banks.

(b) **Supply & I&C in vendor's scope** : 80% payment of Supply value + 100% Taxes shall be made with 45 days credit from the date of receipt of material at site. 10% on completion of I&C and certification line item wise on pro-rata basis. Balance 10% on execution of PBG valid for warranty period + 6 months claim period from any of the BHEL Consortium banks.

2. For I&C: 100% on completion of I&C and certification line item wise on pro-rata basis.

3.Civil Works : 90% on completion of activity milestone and certification line item wise from site-in charge. Balance 10% against PBG for 10% of basic Civil value valid warranty period + 6 months claim period from any of the BHEL Consortium banks.

4.O&M: 100% O&M charges are payable as per RFQ terms against report certified by BHEL.

If PBG cannot not be submitted, vendors can also accept for the final 10% payment, payable after the warranty period + 6 months of claim period against supplementary invoice subject to the completion of commissioning (if applicable).

For any deviation in payment term, the offer will be loaded as per Clause 25.00.

5.ADVANCE PAYMENT: Quotations with "Advance payment" shall be liable for rejection.

14. PENALTY:

Failure to supply within the delivery time as per purchase order will make the vendor liable to an unconditional penalty of 0.5 % (half percent) per week at the basic price of the goods for the undelivered quantity, subject to a maximum of 10%.

Supply : Date of issue of pre-shipment inspection/ call letter with supporting documents like test reports/conformance to test carried by the vendor will be treated as date of dispatch for the purpose of penalty calculation wherever Pre-Inspection Call is carried out.

Signature of tenderer / with seal

For all other activities, the actual date of completion of activity as certified by concerned site-incharge will be considered for the purpose of penalty calculation.

15. PBG:

Performance Bank Guarantee (PBG) to be submitted on non-judicial stamp paper as per the BHEL prescribed format given in **ANNEXURE-E for Foreign Purchase and Annexure-F for Indigenous Purchase** for 10% of the total supply value obtained from any BHEL member (consortium) banks indicated in **ANNEXURE-G**.

The Bank Guarantee shall be submitted directly to the concerned Purchase Executive by the issuing Bank with their forwarding letter. BHEL will verify independently with the bank to establish the authenticity. Alternately, standby LC issued from approved banker can also be considered.

16. TERMS OF DELIVERY:

(a) FOR IMPORTED PURCHASE:

Price offered shall be for goods packed and delivered **FOB** Seaport,/FCA International Airport including packing, forwarding, Handling, Ancillary charges like processing of Sight Draft, negotiation charges of bank, Export declaration, Certificate of origin etc.

Packing shall be Air/Sea worthy, best suitable for trans-shipment and to take care of transit damages. If containerized, no. of containers & size of container shall be mentioned. Packing weight (gross & net) Packing dimensions shall be given prior to shipment to ascertain whether the consignment can be carried on standard cargo in contract or as ODC.

Wooden packing material for all the foreign consignments should be treated as per ISPM-15 & **Fumigation / Phytosanitary certificate** to be submitted to the freight forwarders/ BHEL along with the invoice, B/L, packing list etc.

Vendors shall indicate the name of International Airport/Seaport. Approved Airports are as per **Annexure-C**. The consignment shall be handed over to BHEL approved freight forwarder as mentioned in PO.

17. DELIVERY REQUIREMENT:

Delivery date mentioned in RFQ is tentative. Actual requirement is as per RFQ terms & conditions.

18. VALIDITY:

Quotation should remain valid for a period of **90 days** from the date of technical bid opening.

19. POST-ORDER REQUISITES:

- a. Vendor shall give an Order Acknowledgement indicating the delivery date within one week of receipt of PO.
- b. Pre-shipment inspection at vendor's works, if required, will be carried out by BHEL. Required assistance will have to be provided by the vendor at the time of pre-shipment inspection.
- c. Test certificates, Calibration certificates and warranty certificates as stipulated at the time of ordering shall be furnished.
- d. Items shall be dispatched by Air worthy /Sea worthy/ Road worthy packing. Any damage and later rejection, due to poor / improper packing shall be to vendor's account.
- e. Any damage/rejection should be made good or replaced immediately without any extra cost to BHEL such as freight, duties, taxes etc. The liability is restricted to the value of the order.
- f. Wherever commissioning is involved, it shall be carried out by the vendor's qualified engineers. Scope of work includes installation, commissioning and start-up trials till satisfactory performance level is reached as certified by BHEL.
- g. BHEL will not be responsible for any loss, damage or injuries to vendor's personnel sustained during

Signature of tenderer / with seal

- h. installation / commissioning / start-up trials. Vendor shall ensure compliance with all statutory requisites as laid down by local bodies, state & Central Government. Vendor shall indemnify BHEL for all damages/ losses to various personnel during their presence in BHEL"s premises for whatever purpose.
- i. Suitable markings & damage control indicating devices shall be provided where applicable.
- j. Equipment shall comply with the standard requirements of ISO 14001 & OHSAS 18001.

20. RISK PURCHASE:

The purchaser at his discretion may also make purchase of the materials NOT supplied in time at the RISK & COST of the supplier. In this event, it will be obligatory on the part of the supplier who fails to supply the goods in time to make good to BHEL any loss due to such risk purchase.

21. GENERAL TERMS AND CONDITIONS GOVERNING REVERSE AUCTION (RA):

- (a) In case of RA, BHEL will communicate business rules governing the RA to the bidders through a service provider.
- (b) BHEL EDN reserves the right to adopt Reverse Auction for the enquiry sent, at its discretion.
- (c) Confirm acceptance for RA in ANNEXURE A/B.

22. REGRET LETTER: In case any vendor is unable to quote, vendor shall send a regret letter.

23. Any dispute arising out of this, shall be referred to the sole arbitration of Head of Dept. Materials Management of group concerned, BHEL EDN or any other officer nominated by him and his award shall be final and binding on the parties. The venue of the arbitration in all cases shall be Bangalore, India.

24. Any legal suit in respect of this enquiry lies in the court of Jurisdiction of Bangalore (India) only.

25. LOADING FACTORS:

Loading factors as detailed below will be added to the quoted price (basic) to evaluate the lowest quote for non compliance of BHEL standard commercial term.

A (i). For non compliance of standard Terms of payment (For Foreign Purchase Orders)

Sl. No.	BHEL standard term	If you quote	Loading factor in % for non-compliance
1	80% against "SIGHT DRAFT" + 20% after commissioning and against PBG(where both commissioning & PBG are applicable)	Payment through Letter of Credit (LC)	10%

In general, if the quote is through L/C, it shall be opened 30 days prior to dispatch and valid for 3 months.

A(ii).For non compliance of standard Terms of payment (For Indigenous Purchase Orders)

Sl. No.	BHEL standard term	If you quote	Loading factor in % for non-compliance
1	As per RFQ Terms	Any other Payment term	10%

B.For non compliance of standard Terms of Penalty

Sl. No.	BHEL standard term	If you quote	Loading factor for non-compliance
1	Penalty of 0.5% per week	Other than the above.	Loading Factor 10%-Quoted Max %
	subject to max. of 10% on the		
	basic value of the items not		
	supplied /delayed		

LIST OF INTERNATIONAL AIRPORTS

Sl. No	Country	Air Ports
1	Austria	Vienna, Linz, Graz
2	Australia	Sydney, Melbourne, Perth
3	Belgium	Antwerp, Brussels
4	Canada	Toronto, Montreal
5	China	Shanghai
6	Cyprus	Lamaca
7	Czech Republic	Prague (Via Frankfurt)
8	Denmark	Copenhagen
9	Egypt	Cairo
10	Finland	Helsinki
11	France	Paris (Rosny), Lyon
12	Germany	Darmstadt, Mannheim, Nurnberg, Hamburg, Stuttgart, Munich, Koln, Dusseldorf & Hannover, Frankfurt, Berlin
13	Hong Kong	Hong Kong
14	Italy	Rome, Milan, Turin, Bologna, Florence
15	Ireland	Dublin
16	Israel	Telaviv
17	Japan	Tokyo, Osaka
18	Malaysia	Kuala lumpur, Penang
19	Netherlands	Amsterdam, Rotterdam
20	New Zealand	Auckland
21	Norway	Oslo
22	Oman	Muscat
23	Philippines	Manila
24	Romania	Bucharest
25	Russia	Moscow
26	Saudi Arabia	Riyad
27	Singapore	Singapore
28	Slovakia	Bartslowa
29	South Africa	Johannesburg, Durban
30	South Korea	Kimpo
31	Spain	Barcelona
32	Sweden	Stockholm, Gothenburg, Milano
33	Switzerland	Basle, Zurich, Geneva
34	Taiwan	Taipei
35	U.A.E.	Dubai
36	U.K.	Landon (Heathrow), Newcastle, Oxford, Cheltham, Bristol, Welling borough, Birmingham, East Midland, Manchester, Leeds, Glasgow.
37	U.S.A.	New York, Chicago, San Francisco, Los Angeles, Atlanta
38	Ukraine	Kiev

BHEL EDN APPROVED TRANSPORTERS FOR INLAND ROAD TRANSPORTATION

1. M/s Awagaman Road Carriers ltd., Bangalore. (AWG)
2. M/s BLR India Pvt. Ltd., Bangalore. (BLR)
3. M/s Delhi Assam Roadways corporation ltd., Bangalore. (DRL)
4. M/s Indo Arya Central transport ltd., Bangalore. (IACT)
5. M/s Prakash parcel Services, Bangalore. (PPS)
6. M/s Road Carrier of India, Bangalore. (RCI)
7. M/s Union Roadways ltd., Bangalore. (URL)

Signature of tenderer / with seal
Page 7 of 12

PERFORMANCE BANK GUARANTEE
(FOR FOREIGN PURCHASE ORDERS)
BANK NAME AND ADDRESS

Bharat Heavy Electricals Limited (BHEL),
Electronics Division,
PB No. 2606,
Mysore Road,
BANGALORE- 560 026
INDIA

Dear Sir,
Ref: CONTRACT PERFORMANCE GUARANTEE.

WHEREAS you have entered into a contract reference No PO NO. _____

wit

h M/s

_____ having its registered office _____

at _____ for the supply of _____ as
detailed in your purchase order No. _____ which is hereinafter referred to as "the said contract" and
whereas M/s _____

has undertaken to produce a Bank Guarantee for 10% (Ten Percent) of _____ the contract price
amounting to _____ (_____

_____) to secure its obligations to Electronics Division, BHEL having its registered office at New Delhi
for the performance of the contract including the warranty of the equipment supplied, We _____
Bank , _____ hereby expressly, irrevocably and unreservedly undertake and guarantee as
principal obligors on behalf of M/s _____ that in the event Bharat Heavy Electricals Ltd. (B.H.E.L.)
declares to us in writing that M/s _____ has not fulfilled any obligation according to the
contractual obligation of the said contract, to pay you on demand and without demur to Bharat Heavy Electricals Ltd.,
Electronics Division , Mysore Road, P.B. No. 2606, Bangalore-560 026, India an amount of _____ (in words
_____) subject to as may be determined below:

- 1) Notwithstanding any right M/s. _____ may have directly against you or any disputes raised
by M/s _____, Your written demand shall be conclusive evidence to us that repayment
is due under the terms of the said contract and shall be binding on us.
- 2) We shall not be discharged or released from this undertaking and Guarantee by any arrangements, variations
made between you and M/s. _____
with or without our consent and Knowledge or by any alterations in the obligations of M/s.
_____ by any forbearance whether as to payment, time, performance or otherwise.
- 3) This guarantee shall remain valid until the end of twenty four weeks after the close of the warranty period or until
the same is reported by BHEL to us whichever is earlier.
- 4) We agree and undertake not to revoke this guarantee during its validity unless discharged in writing by you
subject to the provision of clause (7) below.
- 5) This guarantee shall be a continuing guarantee subject to the foregoing and shall not be discharged by any change
in the constitution of the Bank or M/s.
_____.
- 6) This guarantee shall be governed by and constructed in accordance with the Laws of India.
- 7) At any time _____ Bank may render this guarantee null and void by paying to Bharat Heavy
Electricals Ltd. the full amount being
_____ (in words _____)

For and on behalf of Bank
by its Authorized
Signatory

Note:

Signature of tenderer / with seal
Page 8 of 12

- (1) To be executed in Non-Judicial stamp paper by any authorized Indian Bank.
- (2) To be submitted directly by banker to concerned executive in purchase dept., Please give BHEL address to banker.
- (3) Do not enclose with Bank document.
- (4) Any Modification & omissions to this are not permitted

PERFORMANCE BANK GUARANTEE
(FOR INDIGENOUS PURCHASE ORDERS)

THIS DEED OF GUARANTEE made and executed on the _____ day of _____(year), by the _____ (Bank), registered under the Companies Act 1956/Nationalized Bank constituted under the Banking Companies (acquisition and transfer of undertakings) Act constituted under the State Bank of India Act / Subsidiary Banks Act, having its registered / head office at _____ represented herein by its Branch Manager / authorized representative Sri. _____ & Sri. _____(Hereinafter called 'guarantor ' which term shall mean and include its successors and assigns)

IN FAVOUR OF BHARAT HEAVY ELECTRICALS LIMITED

_____ (Buyer's Name), a company registered under the companies Act, 1956 having its registered office at BHEL House at Siri Fort , New Delhi-100 049 and its Electronics Division at Mysore road, Bangalore-26 (hereinafter referred to as the 'Company' Which term shall include its successors and assigns):

Whereas the company has placed an order on _____ (State the name of the company / firm and its address) (hereinafter referred to as the 'Supplier' which term shall mean and include its liquidators, successors and assign) for the supply of system under order / Contract No _____ Dt _____.

AND WHEREAS the supplier has agreed to supply the materials and carryout the works as detailed and in accordance with the terms set out in the said order/contract.

AND WHEREAS the company is not required to pay to the supplier a sum of Rupees _____ being the 10% of the value of the goods supplied / Works performed / Services rendered under the said order / contract between the supplier and the company, till the company is satisfied with the mechanical Warranties and the performance standards stipulated in the said order / contract between the company and the supplier has been duly fulfilled, except against a Bank Guarantee for the said sum of Rs _____ in favour of the company by reputed Bank, in which case the company has agreed to make payment to the supplier of the said sum of Rupees _____ being (...%) of the value of the goods supplied / Works performed / Services rendered under the agreement between the supplier and the company and the Guarantor has at the request of the supplier, agreed to furnish this Guarantee subject to the terms and conditions stated below:

NOW THIS DEED WITNESSES THAT IN pursuance of the above said agreement, the guarantor hereby agrees and covenants With company is as follows :-

- 1) That during the period this contract of Guarantee remains effectual, the guarantor shall be liable in respect of the amount due and owing to the company in respect of the payments to the extent of Rs _____ (in words) _____ against any loss or damage caused to or suffered by the company by reasons of any breach of the terms of the said order / contract / Agreement by the supplier.
- 2) The Guarantor hereby undertakes to pay the amounts due and payable under this guarantee without any demur, merely on demand from the company intimating that the amount claimed is due by way of loss or damage caused to or suffered or would be caused or suffered by the supplier of any terms contained in the said order / contract. Any such demand made on the guarantor shall be conclusive as regards the amount due and payable by the Guarantor irrespective of the fact whether the Contractor / supplier admits or denies.
- 3) The Guarantor further agrees that the agreement herein contained shall remain in force and effect till all the supplies to be made / Works to be performed / Services to be rendered under the said order / contract / agreement are completed to the entire satisfaction of the company or till company certifies that the terms and conditions of the said order / contract / agreement have been fully and properly carried out by the said supplier and accordingly discharges the Guarantee. Unless a demand or claim under this guarantee is made on the guarantor in writing on or before the expiry of claim period indicated in clause 6 below, the guarantor shall be discharged from all the liability under this guarantee thereafter.
- 4) The guarantor further agrees with the company that the company shall have the fullest liberty without the consent of the guarantor and without effecting in any manner the obligations of the guarantor hereunder to vary any of the terms of the said order / contract / agreement or extend the time of performance by the said supplier from time to time or refrain from exercising the power exercisable by the company against the said supplier or to forebear or omit to enforce any of the terms and conditions relating to the said order / contract / agreement, and the guarantor shall not be relieved of its liability in whole or in part , by reason of any act, commission or forbearance on the part of the company or by reason of any such variation, or extension being granted to the said

Signature of tenderer / with seal

supplier or by reason of any such matter or thing whatsoever which under the law relating to sureties would but for this provision have effect of so relieving the guarantor.

- 5) The guarantor undertakes not to revoke this guarantee during its currency except with the previous consent of the company in writing.
- 6) Notwithstanding anything herein above contained, the liability of the guarantor under these presents is restricted to Rs_____. The guarantee shall be in force till its expiry on _____ unless a demand is made on the guarantor within SIX months from the date of expiry, all the liability of the guarantor under this guarantee shall stand fully discharged. The decision of the claimant in regard to breach of contract is final and binding on the Bank.

IN WITNESS whereof, the guarantor, acting through it authorized representative has executed this deed of Guarantee on the day, month and year first above written.

(Seal of the Bank to be affixed)

WITNESS

- 1.
- 2.

Note:

- (1) To be executed in INR 100 Non-Judicial stamp paper by any authorized Indian Bank.
- (2) To be submitted directly by banker to concerned executive in purchase dept., Please give BHEL address to banker.
- (3) Do not enclose with Bank document.
- (4) Any Modification & omissions to this are not permitted.

BHEL MEMBER BANKS (CONSORTIUM BANKS)**PBG SHALL BE ISSUED FROM THE FOLLOWING BANKS OR THEIR BRANCH OFFICES ONLY**

1	STATE BANK OF INDIA
2	PUNJAB NATIONAL BANK
3	HDFC BANK
4	SYNDICATE BANK
5	CANARA BANK
6	INDIAN BANK
7	ST. BANK OF HYDERABAD
8	ICICI BANK
9	STANDARD CHARTERED BANK
10	UCO BANK
11	KOTAK MAHINDRA
12	ORIENTAL BANK OF COMMERCE
13	STATE BANK OF TRAVANCORE
14	CENTRAL BANK
15	IDBI BANK
16	FEDERAL BANK
17	HSBC LTD
18	DEUTSCHE BANK
19	CORPORATION BANK
20	CITI BANK
21	BANK OF BARODA
22	ABN AMRO BANK
23	UNITED BANK OF INDIA
24	VIJAYA BANK
25	UNION BANK OF INDIA
26	PUNJAB & SIND BANK
27	ANDHRA BANK
28	BANK OF INDIA
29	AXIS BANK

The above list is tentative and is subject to change from time to time.
The Purchase Executive shall be contacted for confirmation of the same.

INTEGRITY PACT

Between

Bharat Heavy Electricals Ltd. (BHEL), a company registered under the Companies Act 1956 and having its registered office at “BHEL House”, Siri Fort, New Delhi – 110049 (India) hereinafter referred to as “The Principal”, which expression unless repugnant to the context or meaning hereof shall include its successors or assigns of the ONE PART

and

_____, (description of the party along with address), hereinafter referred to as “The Bidder/ Contractor” which expression unless repugnant to the context or meaning hereof shall include its successors or assigns of the OTHER PART

Preamble

The Principal intends to award, under laid-down organizational procedures, contract/s for

_____. The Principal values full compliance with all relevant laws of the land, rules and regulations, and the principles of economic use of resources, and of fairness and transparency in its relations with its Bidder(s)/ Contractor(s).

In order to achieve these goals, the Principal will appoint Independent External Monitor(s), who will monitor the tender process and the execution of the contract for compliance with the principles mentioned above.

Section 1 – Commitments of the Principal

- 1.1 The Principal commits itself to take all measures necessary to prevent corruption and to observe the following principles:-
 - 1.1.1 No employee of the Principal, personally or through family members, will in connection with the tender for, or the execution of a contract, demand, take a promise for or accept, for self or third person, any material or immaterial benefit which the person is not legally entitled to.
 - 1.1.2 The Principal will, during the tender process treat all Bidder(s) with equity and reason. The Principal will in particular, before and during the tender process, provide to all Bidder(s) the same information and will not provide to any Bidder(s) confidential / additional information through which the Bidder(s) could obtain an advantage in relation to the tender process or the contract execution.
 - 1.1.3 The Principal will exclude from the process all known prejudiced persons.
- 1.2 If the Principal obtains information on the conduct of any of its employees which is a penal offence under the Indian Penal Code 1860 and Prevention of Corruption Act 1988 or any other statutory penal enactment, or if there be a substantive suspicion in this regard, the Principal will inform its Vigilance Office and in addition can initiate disciplinary actions.

Section 2 – Commitments of the Bidder(s)/ Contractor(s)

- 2.1 The Bidder(s)/ Contractor(s) commit himself to take all measures necessary to prevent corruption. He commits himself to observe the following principles during his participation in the tender process and during the contract execution.
 - 2.1.1 The Bidder(s)/ Contractor(s) will not, directly or through any other person or firm, offer, promise or give to the Principal or to any of the Principal's employees involved in the tender process or the execution of the contract or to any third person any material, immaterial or any other benefit which he / she is not legally entitled to, in

order to obtain in exchange any advantage of any kind whatsoever during the tender process or during the execution of the contract.

- 2.1.2 The Bidder(s)/ Contractor(s) will not enter with other Bidder(s) into any illegal or undisclosed agreement or understanding, whether formal or informal. This applies in particular to prices, specifications, certifications, subsidiary contracts, submission or non-submission of bids or any other actions to restrict competitiveness or to introduce cartelization in the bidding process.
- 2.1.3 The Bidder(s)/ Contractor(s) will not commit any penal offence under the relevant IPC/ PC Act; further the Bidder(s)/ Contractor(s) will not use improperly, for purposes of competition or personal gain, or pass on to others, any information or document provided by the Principal as part of the business relationship, regarding plans, technical proposals and business details, including information contained or transmitted electronically.
- 2.1.4 The Bidder(s)/ Contractor(s) will, when presenting his bid, disclose any and all payments he has made, and is committed to or intends to make to agents, brokers or any other intermediaries in connection with the award of the contract.
- 2.2 The Bidder(s)/ Contractor(s) will not instigate third persons to commit offences outlined above or be an accessory to such offences.

Section 3 – Disqualification from tender process and exclusion from future contracts

If the Bidder(s)/ Contractor(s), before award or during execution has committed a transgression through a violation of Section 2 above, or acts in any other manner such as to put his reliability or credibility in question, the Principal is entitled to disqualify the Bidders(s)/ Contractor(s) from the tender process or take action as per the separate “Guidelines for Suspension of Business Dealings with Suppliers/ Contractors” framed by the Principal.

Section 4 – Compensation for Damages

- 4.1 If the Principal has disqualified the Bidder(s) from the tender process prior to the award according to Section 3, the Principal is entitled to demand and recover the damages equivalent to Earnest Money Deposit/ Bid Security.
- 4.2 If the Principal has terminated the contract according to Section 3, or if the Principal is entitled to terminate the contract according to section 3, the Principal shall be entitled to demand and recover from the Contractor liquidated damages equivalent to 5% of the contract value or the amount equivalent to Security Deposit/Performance Bank Guarantee, whichever is higher.

Section 5 – Previous Transgression

- 5.1 The Bidder declares that no previous transgressions occurred in the last 3 years with any other company in any country conforming to the anti-corruption approach or with any other Public Sector Enterprise in India that could justify his exclusion from the tender process.
- 5.2 If the Bidder makes incorrect statement on this subject, he can be disqualified from the tender process or the contract, if already awarded, can be terminated for such reason.

Section 6 – Equal treatment of all Bidders/ Contractors/ Sub-contractors

- 6.1 The Bidder(s)/ Contractor(s) undertake(s) to demand from his sub-contractors a commitment consistent with this Integrity Pact. This commitment shall be taken only from those sub-contractors whose contract value is more than 20% of Bidder's/ Contractor's contract value with the Principal.
- 6.2 The Principal will enter into agreements with identical conditions as this one with all Bidders and Contractors.
- 6.3 The Principal will disqualify from the tender process all bidders who do not sign this pact or violate its provisions.

Section 7 – Criminal Charges against violating Bidders/ Contractors /Sub-contractors

If the Principal obtains knowledge of conduct of a Bidder, Contractor or Subcontractor, or of an employee or a representative or an associate of a Bidder, Contractor or Subcontractor which constitutes corruption, or if the Principal has substantive suspicion in this regard, the Principal will inform the Vigilance Office.

Section 8 –Independent External Monitor(s)

- 8.1 The Principal appoints competent and credible Independent External Monitor for this Pact. The task of the Monitor is to review independently and objectively, whether and to what extent the parties comply with the obligations under this agreement.
- 8.2 The Monitor is not subject to instructions by the representatives of the parties and performs his functions neutrally and independently. He reports to the CMD, BHEL.
- 8.3 The Bidder(s)/ Contractor(s) accepts that the Monitor has the right to access without restriction to all contract documentation of the Principal including that provided by the Bidder(s)/ Contractor(s). The Bidder(s)/ Contractor(s) will grant the monitor, upon his request and demonstration of a valid interest, unrestricted and unconditional access to his contract documentation. The same is applicable to Sub-contractor(s). The Monitor is under contractual obligation to treat the information and documents of the Bidder(s)/ Contractor(s) / Sub-contractor(s) with confidentiality.
- 8.4 The Principal will provide to the Monitor sufficient information about all meetings among the parties related to the contract provided such meetings could have an impact on the contractual relations between the Principal and the Contractor. The parties offer to the Monitor the option to participate in such meetings.
- 8.5 As soon as the Monitor notices, or believes to notice, a violation of this agreement, he will so inform the Management of the Principal and request the Management to discontinue or

take corrective action, or heal the situation, or to take other relevant action. The Monitor can in this regard submit non-binding recommendations. Beyond this, the Monitor has no right to demand from the parties that they act in a specific manner, refrain from action or tolerate action.

8.6 The Monitor will submit a written report to the CMD, BHEL within 8 to 10 weeks from the date of reference or intimation to him by the Principal and, should the occasion arise, submit proposals for correcting problematic situations.

8.7 The CMD, BHEL shall decide the compensation to be paid to the Monitor and its terms and conditions.

8.8 If the Monitor has reported to the CMD, BHEL, a substantiated suspicion of an offence under relevant IPC / PC Act, and the CMD, BHEL has not, within reasonable time, taken visible action to proceed against such offence or reported it to the Vigilance Office, the Monitor may also transmit this information directly to the Central Vigilance Commissioner, Government of India.

8.9 The number of Independent External Monitor(s) shall be decided by the CMD, BHEL.

8.10 The word 'Monitor' would include both singular and plural.

Section 9 – Pact Duration

9.1 This Pact begins when both parties have legally signed it. It expires for the Contractor 12 months after the last payment under the respective contract and for all other Bidders 6 months after the contract has been awarded.

9.2 If any claim is made / lodged during this time, the same shall be binding and continue to be valid despite the lapse of this pact as specified as above, unless it is discharged/ determined by the CMD, BHEL.

Section 10 – Other Provisions

- 10.1 This agreement is subject to Indian Laws and jurisdiction shall be registered office of the Principal, i.e. New Delhi.
- 10.2 Changes and supplements as well as termination notices need to be made in writing. Side agreements have not been made.
- 10.3 If the Contractor is a partnership or a consortium, this agreement must be signed by all partners or consortium members.
- 10.4 Should one or several provisions of this agreement turn out to be invalid, the remainder of this agreement remains valid. In this case, the parties will strive to come to an agreement to their original intentions.
- 10.5 Only those bidders/ contractors who have entered into this agreement with the Principal would be competent to participate in the bidding. In other words, entering into this agreement would be a preliminary qualification.

For & On behalf of the Principal
(Office Seal)

For & On behalf of the Bidder/ Contractor
(Office Seal)

Place-----

Date-----

Witness: _____
(Name & Address) _____

Witness: _____
(Name & Address) _____
