

REQUEST FOR QUOTATION

	BHARAT HEAVY ELECTRICALS LIMITED Electronics Division PB No. 2606, Mysore Road Bangalore - 560026 INDIA	RFQ NUMBER: BKC0000006 RFQ DATE : 21.FEB.2017	Due Date 03.MAR.2017 Time: 13:00 HRS VENUE : NEW ENGG. BLDG
MMI:PU:RF:003			

	(for all correspondence) Purchase Executive : CHANDAN BK Phone : 080 26989608 Fax : 26989217 E-mail: chandanbk@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.**

Sl No.	Description	Qty	Unit	Delivery qty	Delivery Date
1	PS0679069119 Supply of 33kV metering yard -Elec items Supply of 33kV metering yard electrical items, ABT metering panels, trivector meters etc as per clause 3.1 of PS-439-1110. Test Certificate	1	ST	1	01.MAY.2017
2	PS0679069127 Supply of 33kV Tr line- Electrical items Supply of 33kV transmission line electrical items as per clause 3.2 of PS-439-1110. Test Certificate	1	ST	1	01.MAY.2017
3	PS0679069135 Supply 33kV meter yard/ Tr line -struct Supply of structural items for 33kV metering yard, 33kV transmission line as per clause 3.3 of PS-439-1110. Test Certificate	1	ST	1	01.MAY.2017
4	PS0679069143 Supply of 33kV S/yard substn-Elec items Supply of 33kV switchyard electrical items at substation as per clause 3.4 of PS-439-1110. Test Certificate	1	ST	1	01.MAY.2017
5	PS0679069151 Supply of 132kV S/yard substn-Elec items Supply of 132kV switchyard electrical items, neutral CTs of 12.5MVA power transformer, C&R panels, ABT metering panel, AC/DC DB boards etc at substation as per clause 3.5 of PS-439-1110. Test Certificate	1	ST	1	01.MAY.2017
6	PS0679069160 Supply structure items 33&132kV S/yard Supply of structural items for 33kV switchyard and 132kV switchyard at substation as per clause 3.6 of PS-439-1110. Test Certificate	1	ST	1	01.MAY.2017
7	PS0679069178 Supply of spare items Supply of spare items as per clause 3.10 of PS-439-1110. Test Certificate	1	ST	1	01.MAY.2017
8	PS0679069186 I&C of 33kV metering yard: FP structure I&C of 33kV four-pole metering yard, ABT metering panels, trivector meters etc as per clause 3.7 of PS-439-1110.	1	AU	1	15.MAR.2017
	PS0679069194 I&C of 33kV & 132kV S/yards - substation	1	AU	1	15.MAR.2017

For and On behalf of BHEL.

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Sl No.	Description	Qty	Unit	Delivery qty	Delivery Date
9	I&C of 33kV and 132kV switchyards, 12.5MVA power transformer, neutral CTs, C&R panels, ABT metering panel, AC/DC DB boards etc at substation as per clause 3.9 of PS-439-1110.				
10	PS0679069208 I&C of 33kV transmission line 6km I&C of 33kV transmission line as per clause 3.8 of PS-439-1110.	1	AU	1	15.MAR.2017
11	PS0679069216 Commissioning and state dept. clearance Pre-commissioning tests, liaison with state/ central departments for clearances, commissioning etc as per clause 3.11 of PS-439-1110.	1	AU	1	15.MAR.2017
12	PS0679069224 Operation and maintenance Operation and Maintenance for 10 years as per clause 3.12 of PS-439-1110.	120	AU	120	15.MAR.2017

Total Number of Items - 12

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.
- 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 .

For and On behalf of BHEL.

	Specification for design, supply, installation and commissioning, operations and maintenance of 33kV metering yard, 33kV transmission line, 33kV/132kV switchyards for 10MW(AC) solar power plant at Ordnance Factory Bolangir, Odisha	PS-439-1110 Rev 00 Page 1 of 105
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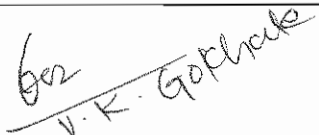
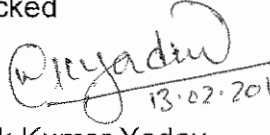
It must not be used directly or indirectly in anyway detrimental to the interest to the company

Technical specification

for

Design, Supply, Installation, Commissioning, Operations and Maintenance of 33kV metering yard, 33kV Transmission line, 33kV/132kV switchyards for 10MW (AC) Solar Photovoltaic Grid-connected Power plant at

Ordnance Factory, Badmal village, Saintala Taluk, Bolangir district, Odisha

Approved by : VK Gokhale 			
Revision details :R 00	Prepared  NV Rajesh	Checked  Vivek Kumar Yadav	Date 13.02.2017 03.02.2017

	Specification for design, supply, installation and commissioning, operations and maintenance of 33kV metering yard, 33kV transmission line, 33kV/132kV switchyards for 10MW(AC) solar power plant at Ordnance Factory Bolangir, Odisha	PS-439-1110 Rev 00 Page 2 of 105
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1.0 Introduction

1.1 Project outline of 10MW (AC) solar photovoltaic power plant

Bharat Heavy Electricals Limited (BHEL), Electronics Division, Bangalore is setting up a 10 MW (AC) solar photovoltaic (SPV) power plant for Bharat Electronics Limited (BEL), Bangalore at Ordnance Factory OFBL, Badmal village, Saintala taluk, Bolangir district, Odisha with the overall project scope comprising of three major portions as follows:

Solar PV modules generate DC electricity that is inverted to 3-phase AC in the range 300-400V. 5MW AC output of each of the two inverter room blocks is stepped up to 33kV. Both the outputs are combined to 10MW AC at the main control room and further hooked up to 33kV transmission line through a CT/PT metering yard placed next to the room. Power generated at the plant is transmitted to the substation that is ~6 Km away from the solar plant. 33kV transmission poles are erected to run the overhead conductor from the solar plant to the substation.

At substation, the 33kV level is stepped up to 132kV. Prior to stepping up, a 33kV switchyard bay is constructed using necessary outdoor equipments viz CT/ CVT/ PT/ LA/ Isolator/ Earth switch/ VCB breaker etc. Similarly, after stepping up, the power is hooked up to main/ transfer buses presently available at substation through an outdoor 132kV switchyard to be constructed using necessary equipments viz CT/ CVT/ PT/ LA/ Isolator/ Earth switch/ SF6 breaker etc.

The solar plant is envisaged to have several other infrastructural support systems such as bore wells, module cleaning system for SPV modules, plant illumination system, fire alarm system, boundary fencing, approach roads, pathways, drainage system etc.

1.2 Brief outline of vendor scope

Vendor scope includes design, supply, installation, testing, commissioning, operations and maintenance for a period of 10 years from the date of successful commissioning of the plant as certified by BHEL/BEL.

This scope includes activities but not limited to design, engineering, drafting of drawings, obtaining approval from BHEL/BEL for the drawings, manufacture/ testing/ inspection at manufacturer's works, packing, supply, transportation, transit insurance, delivery to site, unloading, storage, civil activities (route survey for transmission line, jungle clearance/ soil testing etc at locations of transmission poles and switchyards, land development viz land leveling/grading, foundations for electrical equipment, switchyard structures, towers, power transformer, neutral CTs etc), erection of switchyard structures/ equipment, right of way issues during construction, coordination/ liaison with concerned state/ central authorities such as Transco/ Discom/ CEIG etc for the following four specific portions of the project:

(1) 33kV outdoor metering yard on SPV plant end

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- (2) 33kV transmission line between SPV power plant and substation
- (3) 33kV switchyard bay at substation
- (4) 132kV switchyard bay at substation including the erection and commissioning of power transformer 12.5MVA 33/132kV that is in BHEL scope of supply.

Vendor shall have design capability for substation / switchyard / transmission lines. In case they do not have design/drafting capability, after receiving purchase order from BHEL, the vendor shall tie up with competent design consultants in which case vendor shall submit the credentials of the proposed consultants for BHEL approval. Vendor shall award the work on the consultants only after approval by BHEL. All drawings/ design documents shall be originated by the consultants, endorsed by the vendor clearly stating the name of the project, names of clients (BHEL/BEL), drawing/document number, revision number, number of sheets etc. Details of drawings/ design documents to be submitted are brought out under section 5.0 of this specification.

All civil related works shall be tested as per BHEL/BEL-approved FQP that will be issued during course of project execution. All third party testing shall be carried out only at NABL accredited laboratories (or) Government laboratories.

Note: The above is only a broad outline of vendor scope for the sake of introduction. The detailed vendor scope is listed and elaborated under sections 3.0 and 5.0 supported by the various general specifications and supplementary clauses brought out in the subsequent sections from 6.0 onwards.

1.3 Address of power plant:

10MW (AC) Solar Photovoltaic Power Plant
Ordnance Factory OFBL
Badmal village
Saintala taluk
Bolangir district
Odisha 767 070

2.0 Enclosures and other indicative details:

2.1 Enclosures to this specification

- (a) AC SLD of the overall solar PV plant where “bidder scope” is clearly marked.
- (b) Geo technical soil report for solar plant end
- (c) Overall site map
- (d) Indicative solar array plant layout

2.2 Other indicative details to the bidders for tender purpose

- (a) At solar plant end, distance between ABT metering panel (placed in main control room) and 33kV metering yard: 50m
- (b) Distance between end of 33kV metering yard at solar plant and start of 33kV switchyard at substation: 6Km

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(c) At substation end:

- (i) Distance between the 33kV/ 132kV switchyard and C&R panel/ ABT metering panel in control room: 200m
- (ii) 230V/415V AC and 220V DC aux supplies for C&R panel/ ABT metering panel in the main control room, 33kV & 132kV switchyard equipments and 12.5MVA 33/132kV power transformer and other utilities shall be taken from existing feeders of substation.
- (iii) An exclusive control room at substation for placement of C&R panels, ABT metering panel and AC/DC DB boards will be constructed by BHEL. This control room will be located just adjacent to the existing room at substation.

(d) As the above details are indicative, vendor shall visit project site prior to submission of bids so as to make better assessment of site conditions such as (1) land terrain, (2) nature of soil, (3) transmission line route, (4) bay arrangements of existing substation to which the new 33/132kV switchyard of this specification shall be hooked up, (5) cable trench path at substation

(e) As regards voltage transformers, either PT or CVT shall be adopted as per Discom/ Transco requirements.

(f) Vendor shall engage approved contractor of Discom/ Transco, in case it is insisted by them as part of their conventional practice/ statutory requirement. Vendor shall submit credentials of such contractor for BHEL/BEL approval during detailed engineering.

3.0 List of deliverables to be offered by vendor

#	Deliverables	Qty
3.1	Supply of all electrical equipments and materials for 33kV metering yard (at solar plant end) such as CTs, PTs, surge arrestors, GOS isolators, disc insulators, junction boxes, ABT metering panels, trivector meters, ACSR conductors, clamps & connectors, electrical cables with glands/ lugs/ washers etc, cable trays, earthing electrodes/ flats, earth chamber lids, earth mat rods/ risers, chain link fencing materials, fence gate, stone jelly etc together with complete set of hardware items as per main clauses 5.2.1, 5.2.2, 5.2.3 and other supporting clauses.	1 Set
3.2	Supply of all electrical equipments and materials for 33kV transmission line such as pin insulators, disc insulators, ACSR conductors, earthing wires, clamps & connectors etc together with complete set of hardware items as per main clause 5.2.9 and other supporting clauses.	1 Set
3.3	Supply of all structural items for the 33kV metering yard and 33kV transmission line such as RSJ poles, steel sections for cross-arms/ brackets/ steel plates, stay/guy sets etc together with complete set of insulation and hardware items as per main clauses 5.2.3, 5.2.9 and other supporting clauses.	1 Set

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3.4	Supply of all electrical equipments and materials for 33kV switchyard at substation end such as CTs, PTs, surge arrestors, VCB breaker panel, GOS isolators, earth switches, bus post insulators, disc insulators, pin insulators, junction boxes, marshalling boxes, ACSR conductors, clamps & connectors, electrical cables with glands/ lugs/ washers etc, cable trays, earthing electrodes/ GI flats, earth chamber lids, earth mat rods/ risers, chain link fencing materials, fence gate, stone jelly etc together with complete set of hardware items as per main clause 5.2.6 and other supporting clauses.	1 Set
3.5	Supply of all electrical equipments and materials for 132kV switchyard at substation end such as CTs, PTs, neutral CTs of 33kV & 132kV sides of power transformer, surge arrestors, SF6 breaker, GOS isolators, bus post insulators, disc insulators, junction boxes, marshalling boxes, C&R panels, ABT metering panel, ACDB/DCDB boards for aux AC/DC supplies, ACSR conductors, clamps & connectors, electrical cables with glands/ lugs/ washers etc, cable trays, earthing electrodes/ flats, earth chamber lids, earth mat rods/ risers, fencing materials, fence gate, stone jelly etc together with complete set of hardware items, lighting system for 33kV metering yard & 33kV/132kV switchyards etc as per main clauses 5.2.4, 5.2.5, 5.2.7, 5.2.8, 5.2.10 and other supporting clauses.	1 Set
3.6	Supply of structural items of the 33kV and 132kV switchyards put together (at substation end) for construction of GI gantry towers / beams/ mounting structures etc together with complete set of hardware required to meet the structural support requirements of the switchyards as per main clauses 5.2.6 and 5.2.7 and other supporting clauses.	1 Set
3.7	Installation of 33kV metering yard (at solar plant end) including jungle clearance, soil testing, land leveling/ grading/ drain works, laying of earth mat grid, earth chamber construction, civil foundations for four-pole RSJ structures, RCC cable trenches, erection of RSJ poles/ steel mounting fixtures/ electrical equipments, laying of cable trays/ cables, laying and termination of ACSR conductors, cable terminations, fencing works, gate fixing, painting, stone jelly works, identification marking works, sign/ danger boards fixing, erection of ABT meters, trivector meters etc as per main clauses 5.2.1, 5.2.2, 5.2.3, 5.2.11, 5.2.12 and other supporting clauses.	1 AU
3.8	Installation of 33kV transmission line including jungle clearance wherever applicable, soil testing, civil foundations for RSJ structures, erection of RSJ poles/ mounting fixtures/ pin/disc insulators/ clamps & connectors, erection of stay/guy sets, stringing of ACSR conductors, painting, identification marking works, sign/ danger boards fixing etc as per main clause 5.2.9, 5.2.11, 5.2.12 and other supporting clauses.	1 AU

	Specification for design, supply, installation and commissioning, operations and maintenance of 33kV metering yard, 33kV transmission line, 33kV/132kV switchyards for 10MW(AC) solar power plant at Ordnance Factory Bolangir, Odisha	PS-439-1110 Rev 00 Page 8 of 105
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3.9	Installation of 33kV and 132kV switchyards (at substation end) including jungle clearance, soil testing, land leveling/ grading/ drain works, laying of earth mat grid, earth chamber construction, earthing connections, civil foundations and erection of towers/ gantries/ mounting structures, erection of electrical equipments, civil foundation and erection of 12.5MVA 33/132kV power transformer/ neutral CTs, C&R panels, marshalling boxes, motor boxes, ABT metering panels, trivector meters, ACDB/DCDB boards, RCC cable trenches, laying of cable trays/ cables, stringing of ACSR conductors, cable terminations, chain link fencing works, gate fixing, painting works, stone jelly spreading, identification marking works, sign/ danger boards fixing, lighting system for 33kV metering yard & 33kV/132kV switchyards etc as per main clauses 5.2.3 – 5.2.8, 5.10, 5.2.11, 5.2.12.	1 AU
3.10	Supply of spare items: 1. MCBs: 2 Nos each type 2. Fuses: 3 Nos each type 3. Indication lamps of C&R panels: 10 Nos (all colours to be covered) 4. Tripping coil of SF6 breaker: 2 Nos 5. Closing coil of SF6 breaker: 2 Nos 6. Tripping coil of VCB breaker: 2 Nos 7. Closing coil of VCB breaker: 2 Nos 8. Spring charge motor of SF6 breaker: 2 Nos 9. Spring charge motor of VCB breaker: 2 Nos 10. 33kV CT for metering yard: 1 No 11. 33kV CT for substation: 1 No 12. 33kV PT for metering yard: 1 No 13. 33kV PT for substation: 1 No 14. 132kV metering CT for substation: 1 No 15. 132kV protection CT for substation: 1 No 16. 132kV PT for substation: 1 No 17. Surge arrestors 30kV 10kA: 3 Nos 18. Surge arrestors 120kV 10kA: 2 Nos 19. 33kV Pin insulators: 10 Nos	1 Set
3.11	Pre-commissioning inspections / checks / tests on 33kV metering yard, 33kV & 132kV switchyard equipments at both solar plant and substation ends/ 33kV transmission line/ C&R panel/ ABT metering panel etc. and coordination / liaison activities with related state / central departments / Transco/ Discom/ CEA/ CEIG etc as applicable for necessary approvals/ clearances for drawings/ documents and also for plant commissioning activities viz. line-charging/ grid synchronization as per main clause 5.2.14 and other supporting clauses.	1 AU
3.12	Operations and Maintenance of the portions of 33kV metering yard, 33kV&132kV switchyards and 33kV transmission line installed and commissioned by the vendor for a period of ten years as per clause 5.2.16.	120 mon

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3.13	Note: There shall not be any separate charges for design/ drafting of engineering documents viz drawings/ schemes/ layouts/ calculations etc and consultancy, as these charges shall be deemed to be absorbed in the above line items.
3.14	Warranty All supply items shall be warranted for 18 months from date of supply or 12 months from date of commissioning whichever earlier.

4.0 Instructions to vendor on bid submission

4.1	Offer shall be submitted in two-parts (Two part-bid). Both parts shall be in separate sealed envelopes as per instructions in tender. The individual envelopes shall be enclosed in a common envelope with markings (address etc) on the envelope as per instructions in tender.
4.2	First-part shall be techno-commercial bid with following details: (a) List of installations of substations/ switchyards/ transmission lines in the range 33kV - 132kV or above in the past three years from date of tender opening shall be submitted with details viz client name, project name, rating of installation, scope of supply, scope of installation and year of installation. (b) Technical offer (c) Filled-up enclosures as per BHEL formats provided in the tender. (d) Vendor company profile and brochure (e) Statement expressing compliance to this BHEL specification. Deviations, if any, shall be brought out in separate sheet. (f) List of spares offered (with quantity) and without prices.
4.3	Second part shall be price bid with filled up enclosures as per BHEL format provided in the tender. Spares shall be quoted separately with price.
4.4	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.

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5.0 Detailed BHEL scope and Vendor scope

5.1 BHEL scope

1. Supply, civil foundation and installation of oil-filled, 200kVA 33kV/433V aux transformer together with earth chambers for the same. **Note:** Aux transformer will be located within the 33kV metering yard near main control room of solar plant end. Vendor shall take into account the space requirements of 33kV metering yard accordingly.
2. Supply, laying and termination of HT 33kV cables for the above aux transformer
3. Supply, laying and termination of LT cables for the aux transformer
4. Supply of 12.5MVA 33/132kV, oil-filled, ONAN/ONAF power transformer; **Note:** civil foundation, installation, testing and commissioning in vendor scope.
5. Supply and installation of aux power supply equipments viz battery, battery charger, ACDB, DCDB etc in main control room at SPV plant end to facilitate 230V AC/ 110V DC supply for the 33kV metering yard and also for the ABT metering panels.
6. Construction of main control room at SPV plant
7. Construction of exclusive control room at substation: size ~ 4m x 4m (for C&R panels, ABT metering panel, AC/DC DB boards etc.)

5.2 Vendor scope

All supplies, installation, testing and commissioning shall be as per relevant standards such as IS/IEC etc, Indian electricity rules (1956), CBIP, State electricity boards/ Transco/ DISCOM/ CEIG regulations etc.

This section shall be read in conjunction with the subsequent sections (6.0 onwards) where various general specifications and supplementary clauses are brought out.

5.2.1	Supply and installation of ABT metering panels in 33kV metering yard 1. 33kV metering yard is located close to the main control room at solar plant side 2. ABT metering panels: 2 Nos 3. One panel with two ABT meters: main and check 4. Other panel with one ABT meter: standby 5. Both the panels indoor type, IP20 or better; shall be installed in main control room 6. ABT meters (a) make: L&T or Secure (b) Model: equivalent to R3M024 of Secure (c) with RS485 Modbus RTU compatibility for SCADA (d) Meter reading instrument (MRI) with cables & accessories to be supplied (e) MRI to be configured for downloading the data from ABT meters (f) Software to be loaded/ configured in SCADA PC of BHEL at site (g) Downloading of data from ABT meter to PC to be demonstrated to BHEL (h) Meters to be calibrated/ tested at NABL accredited laboratory (i) Calibration/ testing to be witnessed by BHEL/ BEL/ Transco (j) Calibration/ test certificates/ reports to be submitted to BHEL/BEL for approval (k) Further details as per relevant clause of this specification 7. Bottom side cable entry 8. TTBs with locking provisions
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	9. Internal cable trays for wiring 10. Power socket, MCBs, panel illumination lamp, indication lamps 11. Door switch 12. Space heater, thermostat 13. Structural details (a) Main frame structure: built up thickness more than 2mm with standard profile (b) Front/ back doors, top/side covers: 1.6mm CRCA sheet (c) Doors with toughened glass to view the meter readings (d) Gland plate: 3mm CRCA (e) Base frame: 3mm formed sheet/ 3mm corner block (f) Powder coating: Internal & external colour IS5 – 631 (60-80 microns) (g) Base frame: black painted (h) Brackets/ plates etc to physically support the ABT meters 14. Door locks 15. Panel lifting hooks 16. All metallic parts to be earthed; suitable earth terminals 17. Nomenclature plates, danger plates 18. Internal electrical wiring works 19. CT/PT cables: routing, dressing and termination 20. Aux supply cables: routing, dressing and termination 21. Gland plates to be drilled using hole-saw cutter for cable entry 22. Cable glands, lugs, washers, ferrules, cable ties
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5.2.2	Supply and installation of trivector meters in 33kV VCB panels 1. Supply of trivector meters (3 Nos) of L&T / Secure make. Model shall be equivalent to Premier 300 of type E3M024 (Secure make). 2. Meters shall be calibrated and tested at NABL accredited laboratory in the presence of BHEL/ BEL/ Transco representatives. Calibration and test reports / certificates shall be submitted for BHEL/BEL approval. 3. Installation of these meters in the 2 x 10MW incomer 33kV HT panels and the auxiliary outgoer breaker panel (both of BHEL supply) in the main control room at solar PV plant end. Meters shall be fixed in the cut-outs provided in the panels. 4. Supply of all applicable TTBS, auxiliary power supply cables, control cables, cable ties, ferrules, cable trays, hardware etc for making electrical wiring between the trivector meters and internal metering circuit of HT panel. 5. Wiring works for the above including cable routing, dressing, termination etc. 6. As part of pre-commissioning activities, vendor shall liaison/ co-ordinate with CEIG for arranging their inspection of the trivector as well as the ABT meters at site. Vendor shall provide all assistance/ support to BHEL/BEL/CEIG team in sealing of these meters by CEIG. 7. Vendor shall supply the MRI instruments along with all related hardware accessories and software. 8. Vendor shall demonstrate to BHEL/BEL downloading of the energy data from the trivector meters and loading of the same on laptop/PC as applicable.
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5.2.3	Supply and installation of 33kV metering yard items 33kV metering yard is a RSJ-based four-pole structure on which the instrument transformers CT/PT, GOS isolators, lightning arrestor etc are mounted. 33kV CTs (3 Nos), 1-ph, outdoor, oil filled as per IS: 2705; two cores, 250/1-1; Core1: 0.2s, 10VA for standby ABT meter; Core2: 0.2s, 10VA for main and check ABT meters; short time thermal current rating: 25kA/1sec; 33kV PTs (3 Nos), 1-ph, outdoor, oil filled as per IS: 3156; two cores: 33kV/$\sqrt{3}$, 110V/$\sqrt{3}$, 110V/$\sqrt{3}$; Core1: 0.2, 50VA for standby ABT meter; Core2: 0.2, 50VA for main and check ABT meters; 30kV 10kA station class-3 metal oxide gapless lightning arrestor as per IS: 3070 (part 3): 3 Nos 36kV 1250A GOS air break isolator with single earth switch (1 set), short time current 25kA/3sec, rated short-time withstand current 25kA, as per IS: 9921 part 1 to part 5, and IEC 60129, triple pole, upright mounting type, each pole having three pedestal type porcelain insulator stacks as per IS:2544 and IEC 60168, total creepage distance 900mm minimum, double break with blades centrally rotating in horizontal plane, provisions to ensure proper alignment and simultaneous making/breaking of contacts, terminal connectors of bimetallic clamp and compatible with the type of ACSR conductor as per Discom/ Transco requirements, motor operated (local operation) for both isolator and earth switch complete with all accessories and motor control boxes as per applicable IS/IEC standards; - Moving and fixed contacts of the GOS isolator shall be made of hard drawn electrolytic grade Cu strips, heavy-duty self-aligning, high-pressure type to apply pressure to the contact surfaces while closing and to release pressure while opening. Moving contacts shall close first and open last so as to avoid damages due to arcing. The female contact and its tensioning by spring shall be such that is always positing contact with adequate pressure to provide enough contact surface for passing of current. The springs provided should not go out of alignment or get entangled with the male contact during operation. - Earth switch of GOS isolator shall comprise of three earth links per isolator which will normally rest against the frames when isolator is closed. Earth links of all the three phases shall be suitable for fitting on either side of the isolator. Short time current withstand capacity shall be same for the blades of both the isolator and the earth switch. Each blade shall be provided with flexible copper connections (60 sqmm minimum) of adequate length. - ACSR conductors as per IS: 398; Type/size of conductor shall be selected based on electrical/mechanical design calculations and as per Discom/ Transco requirements. - Conductor and earth wire accessories as per IS: 2121; Part-1: Armour rods, binding wires and tapes for conductors; Part-2: Mid-span joints and repair sleeves for conductors; Part-3: Accessories for earth wire; Part-4: Non-tension joints; - Porcelain insulators such as string insulator unit, suspension/ tension insulator sets, pin insulator/ line post insulator and other items as applicable as per IS: 731; Alternately, usual practice is to adopt (a) 33-36kV polymeric composite pin insulators. Similarly, for DP as well as SP/DP cut-points, usual practice is to adopt 33-36kV polymeric composite disc insulators with FRP rod & silicone rubber housing, with T&C or B&S fitting as applicable, with mechanical load 70/90 kN as per IEC: 61109, IEC: 60815, IEC: 62217.
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	Vendor shall choose the appropriate type in line with Discom/Transco requirements. 11. Metal fittings of insulators such as various types of pins, clamps, shackles, yoke plates, tongues, horns, hooks, eyes etc as per IS: 2486; Part-1: General requirements, materials and tests; Part-2: Dimensional requirements; Part-3: Locking devices; Part-4: Tests for locking devices 12. Connectors as per IS: 5561 13. Junction boxes for CTs, PTs 14. Bay marshalling box 15. LT cables from CTs/ PTs to ABT metering panel 16. Aux supply cables from motor control boxes to DBs in main control room 17. RSJ poles: 4 Nos as per IS: 2062 (MS steel, Grade E250, Quality A), IS: 808 (dimensions), IS: 1608 (mechanical testing of metals) and IS:12777; Tolerances shall be as per IS: 1852, IS: 12778 and IS: 12779. ISHB 150 (DxBxt = 150x150x11.8mm) section shall be adopted. 18. Stay sets with MS stay rods/ anchor plates/ turn buckles/ thimbles/ hardware etc as applicable, stay insulators as per IS: 5300, GI stay wires as per IS: 2141 and all associated accessories as per applicable IS standards to provide positional stability to the four-pole structure. 19. MS sections to support CTs, PTs, LAs, GOS Isolators also for structural reinforcements such as brackets/ cross-arms etc: C-channels/angles as per IS: 808, plates/ sheets/ strips/ flats as per IS: 1730. Tolerances as per IS: 1852; 20. Any other items considered essential to meet the functional / operational requirements of the 33kV metering yard as per relevant standards or Indian Electricity rules (1956), CBIP, state electricity board/ Transco/ DISCOM/ CEIG etc requirements.
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5.2.4	Supply and installation of ABT metering panel and AC/DC DB boards at substation 1. Supply and installation of ABT metering panel (1 No) with two ABT meters (main, check) to be installed in control room at substation end. ABT meters and the panel shall be similar to the one at solar plant side. 2. Supply and installation of wall mounted / ground-mounted AC/DC distribution boards (with incoming/outgoing feeders, MCBs, TBs etc as applicable) of Legrand, Siemens, Schneider or any other reputed equivalent subject to BHEL/BEL approval. 3. Supply, laying and termination of all associated cables (a) from the existing AC/DC main feeders of substation to the AC/DC DB boards in control room, (b) from AC/DC DB boards to ABT meter, C&R panels, panels/equipments of 33kV/132kV switchyards, lighting system etc and (c) from ABT meter to CT/PTs in 132kV switchyards, together with supply and installation of all related cable accessories such as glands, lugs, washers, ferrules, cable trays, cable ties etc shall be in vendor scope. Cable trays shall be of GI ladder type and the size/ dimensions shall be selected suitably for both the outdoor underground RCC trench (from the yard to the control room) and the indoor RCC trench within the control room.
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5.2.5	Supply and installation of C&R panels for 33kV/ 132kV switchyards 1. Control and relay (C&R) panels for the 33kV/ 132kV switchyards at substation end. 2. Either a common panel or two separate ones for the 33kV and 132kV yards. 3. Indoor type, IP20 or better 4. Free standing, simplex type, floor mounting type 5. Main enclosure with 2mm thick CRCA sheet 6. Internals and partitions using 1.6mm thick CRCA sheet 7. Gland plates using 3mm thick HRCA sheet 8. Holes in gland plates to be made using hole-saw cutters at site 9. Main enclosure mounted on base frame ISMC 100x50 MS section 10. Base frame to be painted with black colour 11. Internal surface shall have glossy white finish all over 12. External finish colour as per IS:5 – 631, 8-tank process 13. Numerical relays IEC 61850 compliance, based on open access communication protocol; with RS485 port for SCADA; with operating voltage 220V DC 14. Numerical relays to include all the protection features as shown in SLD such as 50, 51, 50N, 51N, 27, 59, 63, 64R LV, 64R HV, 67N, 67P, 195, 295, 26, 30, 74, 87T, 80DC, 80AC, 94, 50LBB, 86 15. Annunciation facia windows as required 16. Digital ammeter, Digital voltmeter: 1 each 17. Digital ammeter/voltmeter shall have RS485 connectivity provision for SCADA 18. Load manager (MFM) with RS485 connectivity provision for SCADA: current, voltage, W/Varh/VA power, W/Varh/VA energy, power factor, frequency etc 19. LED indication lamps for: RYB supply, Breaker ON, Breaker OFF, Breaker Trip, Spring charged status, Trip circuit healthy, DC failure 20. Push buttons: Accept, Reset, Lamp test, Alarm function test, DC fail test 21. TNC switch with spring return to neutral position for breaker operation 22. Local/ remote selector switch for breaker operation 23. Hooters for fault alarms, fault trips 24. Hooter for DC failure 25. Semaphore indicators (LED) for breaker and isolator 'open' and 'close' operations 26. Mimic diagram for the systems with aluminum strips 27. ON/ OFF indications for isolators 28. TTBs to be located internally 29. Internal cable trays, cable ties, cable dressing 30. Control, instrumentation, auxiliary supply cables as per IS: 1554 31. Cable glands, lugs, washers, ferrules 32. Space heater, thermostat 33. Panel illumination lamp 34. Door limit switch 35. MCBs, fuses wherever necessary 36. Panel earthing provisions 37. Lifting hooks 38. Name plate / rating plate 39. Vendor shall erect the C&R panel inside the control room at substation and carry out laying and termination of related auxiliary power and control cables between the 33kV/ 132kV switchyards and the control room.
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	40. Vendor shall supply and install the MS checkered plates of 8mm minimum thick with suitable lifting hooks in the opened-up areas of cable trench surrounding the C&R panel and ABT metering panels. Checkered plates shall be red-oxide coated and black color painted both sides.
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5.2.6	Supply and installation of 33kV switchyard items 33kV CTs (3 Nos), 1-ph, outdoor, oil filled as per IS: 2705; Two cores, 250/1-1; Core1: 5P20, 5VA; Core2: PS, 10VA; short time thermal current rating: 25kA/1sec; 33kV PTs (3 Nos), 1-ph, outdoor, oil filled as per IS: 3156; 3 Nos; Single core: 33kV/v₃, 110V/v₃; Core1: 3P, 50VA 30kV 10kA station class-3 metal oxide gapless lightning arrestor as per IS: 3070 (part 3): 3 Nos 36kV 630A GOS air break isolator with single earth switch (1 set, 3-phase), short time current 25kA/3sec, rated short-time withstand current 25kA, as per IS: 9921 part 1 to part 5, and IEC 60129, triple pole, upright mounting type, each pole having three pedestal type porcelain insulator stack as per IS:2544 and IEC 60168, double break with blades centrally rotating in horizontal plane, provisions to ensure proper alignment and simultaneous making/breaking of contacts, fixed contact assembly (isolator, ES), moving contact assembly (isolator, ES), rotating shaft with lever arm and clamp, down operating pipes (isolator, ES), mechanical interlocks between isolator and ES, terminal connectors of bimetallic clamp and compatible with the type of ACSR conductor as per Discom/ Transco requirements, motor box (AC motor, local & remote operations) for both isolator and earth switch complete with all accessories as per applicable IS/IEC standards; - Moving and fixed contacts of the GOS isolator shall be made of hard drawn electrolytic grade Cu strips, heavy-duty self-aligning, high-pressure type to apply pressure to the contact surfaces while closing and to release pressure while opening. Moving contacts shall close first and open last so as to avoid damages due to arcing. The female contact and its tensioning by spring shall be such that is always positing contact with adequate pressure to provide enough contact surface for passing of current. The springs provided should not go out of alignment or get entangled with the male contact during operation. - Earth switch of GOS isolator shall comprise of three earth links per isolator which will normally rest against the frames when isolator is closed. Earth links of all the three phases shall be suitable for fitting on either side of the isolator. Short time current withstand capacity shall be same for the blades of both the isolator and the earth switch. Each blade shall be provided with flexible copper connections (60 sqmm minimum) of adequate length. 36kV/630A, 3-pole, 50 Hz, VCB breaker (1 No), as per IS: 13118 / IEC: 62271-100, outdoor, porcelain clad, control boxes IP-55, rated TRV as per the above IS/IEC, rated insulation level 36kV/75kV/170kVp, rated short time withstand current 25kA/3s, rated short circuit breaking current 25kA, rated short circuit making current 62.5kA (peak), vacuum interrupter (3 Nos) with top and bottom insulators (6 Nos) as per IS: 5621, total creepage distance 900mm minimum, rated operating sequence O-0.3s-CO-3min-CO, spring charge motor 220V AC/DC, indicator lamps for ON/OFF/ spring charged, PBs
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	for local trip/close, manual/electrical spring release, push-to-trip provision, plug-in type relay for anti-pumping, manual spring charge handle, Trip/close coils with 220V DC supply, auxiliary contacts as required plus 6 NO + 6 NC as spares, local/remote switch, local/remote control circuits, protection relay circuits, MCBs/ fuses/ links/ TBs as required, TNC BCS switch, heater/ thermostat, panel illumination lamp, door switch, 3-pin power socket with ON/OFF switch, GI lattice structure supports with complete hardware, foundation fasteners, terminal connectors (6 Nos) suitable for ACSR as per DISCOM/ TRANSCO requirements, panel paint shade light grey 631 of IS:5; anodized Al sheet name plate, noise level 140dB max at 50m distance from base of VCB, seismic acceleration 0.4g horizontal; 8. ACSR conductors as per IS: 398; Vendor shall choose cross-section/ size of conductor based on calculations as per applicable standards. 9. Conductor and earth wire accessories as per IS: 2121; Part-1: Armour rods, binding wires and tapes for conductors; Part-2: Mid-span joints and repair sleeves for conductors; Part-3: Accessories for earth wire; Part-4: Non-tension joints 10. Porcelain insulators such as string insulator unit, suspension/ tension insulator sets, pin insulator/ line post insulator and other items as applicable as per IS: 731; Alternately, usual practice is to adopt (a) 33-36kV polymeric composite pin insulators. Similarly, for DP as well as SP/DP cut-points, usual practice is to adopt 33-36kV polymeric composite disc insulators with FRP rod & silicone rubber housing, with T&C or B&S fitting as applicable, with mechanical load 70/90 kN as per IEC: 61109, IEC: 60815, IEC: 62217. Vendor shall choose the appropriate type in line with Transco requirements. 11. Metal fittings of insulators such as various types of pins, clamps, shackles, yoke plates, tongues, horns, hooks, eyes etc as per IS: 2486; Part-1: General requirements, materials and tests; Part-2: Dimensional requirements; Part-3: Locking devices; Part-4: Tests for locking devices 12. Connectors as per IS: 5561; bimetallic wherever applicable; 13. Junction boxes for CTs, PTs 14. Bay marshalling box 15. LT cables from CTs/ PTs/ VCB breaker 16. Aux supply cables for connecting within the yard and also between the yard and the DB in control room 17. GI lattice support structures for CT/PT/LA/VCB/Bus post insulators etc as per IS: 2062 (MS steel, Grade E250, Quality-A), IS: 808 (dimensions), IS: 1608 (mechanical testing of metals) and IS:12777; Tolerances shall be as per IS: 1852, IS: 12778 and IS: 12779; Hot Dip Galvanizing shall be as per IS: 209, IS: 2629, IS: 4759 & IS: 2633. 18. GI lattice structures: gantries / beams as applicable (vendor to assess based on site visit prior to bid submission) 19. GI hardware items: bolts/ nuts/ washers 20. Any other items considered essential to meet the functional / operational requirements of the 33kV switchyard as per relevant standards or Indian Electricity rules (1956), CBIP, state electricity board/ Transco/ DISCOM/ CEIG etc requirements.
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5.2.7	Supply and installation of 132kV switchyard items 132kV CTs (3 Nos), 1-ph, outdoor, upright mounting, oil filled, as per IS: 2705, with two cores, 60/1-1; Core1: 5P20, 10VA; Core2: PS, 10VA; short time thermal current rating: 31.5kA/1sec; rated dynamic current 80kAp; HSV & insulation levels 145kV/275kV/650kVp; partial discharge 10 pC max, RIV at 92kV: 10 microvolts, Class A insulation, all terminals of control circuits wired up to marshalling box plus 20 terminals spare, seismic acceleration 0.3g horizontal. 132kV CTs (3 Nos), 1-ph, outdoor, upright mounting, oil filled, as per IS: 2705, with two cores, 60/1-1; Core1: 0.2s, 10VA for ABT main/check; Core2 (spare): 0.2s, 10VA; short time thermal current rating: 31.5kA/1sec; rated dynamic current 80kAp HSV & insulation levels 145kV/275kV/650kVp; partial discharge 10 pC max, RIV at 92kV: 10 microvolts, Class A insulation, all terminals of control circuits wired up to marshalling box plus 20 terminals spare, seismic acceleration 0.3g horizontal. 132kV PTs (3 Nos), 1-ph, outdoor, oil filled as per IS: 3156, with two cores: 132kV/$\sqrt{3}$, 110V/$\sqrt{3}$, 110V/$\sqrt{3}$; Core1: 0.2, 10VA; Core2: 3P, 75VA; HSV & insulation levels 145kV/275kV/650kVp; rated voltage factor 1.2 (cont)/ 1.5 (30sec), partial discharge 10pC max, RIV at 92kV: 1000 microvolts max, all terminals of control circuits wired up to marshalling box plus 10 terminals spare. 120kV rated surge arrester (3 Nos), as per IEC 60099-4 & IS: 3070 part-3, outdoor, lattice structure mounting type, porcelain type, metal oxide gapless, station class, discharge current 10kA, 50Hz, long duration discharge class-3, rated short circuit current 40kA, MCOV: 102kV, insulation levels 145kV/275kV/650kVp, partial discharge not more than 50pC, RIV at 92kV: 1000 microvolts max, seismic acceleration 0.3g horizontal, with surge monitor having counter operation and current meter and all associated accessories. 145kV 1250A GOS air break isolator with single earth switch (1 set), without earth switch (3 sets), as per IS: 9921 part 1 to part 5, and IEC 60129 and IEC 62271, short time withstand current 31.5kA/1sec, rated dynamic short circuit withstand current of isolator and ES 80kAp, insulation levels 275kV/650kVp between live terminals and earth, 315kV/750kVp across isolating distance, operating time not more than 12sec, triple pole, upright mounting type, each pole having three pedestal type porcelain insulator stack as per IS:2544 and IEC 60168, double break with blades centrally rotating in horizontal plane, provisions to ensure proper alignment and simultaneous making/breaking of contacts, fixed contact assemblies, moving contact assemblies, rotating shaft with lever arm and clamp, down operating pipes, manual operating handle, mechanical interlocks between isolator and ES, terminal connectors of bimetallic clamp, motor box (AC motor, local & remote operations) for both isolator and earth switch complete with all accessories, auxiliary contacts on isolator as required plus 8NO and 8NC per pole/per isolator as spare, auxiliary contacts on earth switch total 6 NO and 6NC, as per applicable IS/IEC standards; - Moving and fixed contacts of GOS isolator shall be made of hard drawn electrolytic grade Cu strips, heavy-duty self-aligning, high-pressure type to apply pressure to the
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	contact surfaces while closing and to release pressure while opening. Moving contacts shall close first and open last so as to avoid damages due to arcing. The female contact and its tensioning by spring shall be such that is always positing contact with adequate pressure to provide enough contact surface for passing of current. The springs provided should not go out of alignment or get entangled with the male contact during operation. 7. Earth switch of GOS isolator shall comprise of three earth links per isolator which will normally rest against the frames when isolator is closed. Earth links of all the three phases shall be suitable for fitting on either side of the isolator. Short time current withstand capacity shall be same for the blades of both the isolator and the earth switch. Each blade shall be provided with flexible copper connections (60 sqmm minimum) of adequate length. 8. 145kV/1250A, 3-pole, 50 Hz, SF6 breaker (1 No), as per IS: 13118 / IEC: 62271-100, outdoor, porcelain clad, control boxes IP-55, rated TRV as per the above IS/IEC, rated insulation level 145kV/275kV/650kVp, rated short time withstand current 31.5kA/3s, rated short circuit breaking current 31.5kA, rated short circuit making current 79kA (peak), vacuum interrupter (3 Nos) with top and bottom hollow porcelain insulators (6 Nos) as per IS: 5621, total creepage distance 900mm minimum, rated operating sequence O-0.3s-CO-3min-CO, spring charge motor 220V AC/DC, indicator lamps for ON/OFF/ spring charged, PBs for local trip/close, manual/electrical spring release, push-to-trip provision, plug-in type relay for anti-pumping, manual spring charge handle, Trip/close coils with 220V DC supply, auxiliary contacts as required plus 6 NO + 6 NC as spares, local/remote switch, local/remote control circuits, protection relay circuits, MCBs/ fuses/ links/ TBs as required, TNC BCS switch, heater/ thermostat, panel illumination lamp, door switch, 3-pin power socket with ON/OFF switch, GI lattice structure supports with complete hardware, foundation fasteners, terminal connectors (6 Nos) suitable for ACSR as per DISCOM/ TRANSCO requirements, panel paint shade light grey 631 of IS:5; anodized Al sheet name plate, noise level 140dB max at 50m distance from base of VCB, seismic acceleration 0.4g horizontal; 9. ACSR conductors as per IS: 398; type and size as per design calculations and as per Discom/ Transco requirements. 10. Conductor and earth wire accessories as per IS: 2121; Part-1: Armour rods, binding wires and tapes for conductors; Part-2: Mid-span joints and repair sleeves for conductors; Part-3: Accessories for earth wire; Part-4: Non-tension joints; 11. Porcelain insulators such as string insulator unit, suspension/ tension insulator sets, pin insulator/ line post insulator and other items as applicable as per IS: 731; 12. Metal fittings of insulators such as various types of pins, clamps, shackles, yoke plates, tongues, horns, hooks, eyes etc. as per IS: 2486; Part-1: General requirements, materials and tests; Part-2: Dimensional requirements; Part-3: Locking devices; Part-4: Tests for locking devices
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	13. Connectors as per IS: 5561 14. Bimetallic connectors wherever applicable 15. Marshalling boxes for CTs, PTs 16. Bay marshalling boxes 17. LT cables from CTs/ PTs/ VCB breaker 18. Aux supply cables for connecting within the yard and also between the yard and the DB in control room 19. GI lattice support structures for CT/PT/LA/SF6/Bus post insulators/ GOS isolators etc as per IS: 2062 (MS steel, Grade E250, Quality-A), IS: 808 (dimensions), IS: 1608 (mechanical testing of metals) and IS: 12777; Tolerances shall be as per IS: 1852, IS: 12778 and IS: 12779; Hot Dip Galvanizing shall be as per IS: 209, IS: 2629, IS: 4759 & IS: 2633. 20. GI lattice structures: tower, gantries/ beams, with lightning masts, with earth wire, as applicable and duly considering the transfer bus and main bus connection requirements at site (vendor to assess based on site visit prior to bid submission) 21. GI hardware items: bolts/ nuts/ washers 22. Any other items considered essential to meet the functional / operational requirements of the 33kV switchyard as per relevant standards or Indian Electricity rules (1956), CBIP, state electricity board/ Transco/ DISCOM/ CEIG etc requirements.
5.2.8	Supply and installation of neutral CTs and installation of power transformer 1. Neutral CT 33kV (1 No) between LV side neutral of 12.5MVA power transformer and earth, 1-ph, outdoor, upright mounting, oil filled, as per IS: 2705, with two protection cores, 250/1-1; Core1 for EF: 5P20, 10VA; Core2 for Restricted EF: PS, 10VA; short time thermal current rating: 25kA/1sec; HSV & insulation levels 36kV/75kV/170kVp; partial discharge 10 pC max, Class A insulation, all terminals of control circuits wired up to marshalling box plus 10 terminals spare, seismic acceleration 0.3g horizontal. 2. Neutral CT 132kV (1 No) between HV side neutral of 12.5MVA power transformer and earth, 1-ph, outdoor, upright mounting, oil filled, as per IS: 2705, with two protection cores, 60/1-1; Core1 for EF: 5P20, 10VA; Core2 for Restricted EF: PS, 10VA; short time thermal current rating: 25kA/1sec; HSV & insulation levels 145kV/275kV/650kVp; partial discharge 10 pC max, RIV at 92kV: 10 microvolts, Class A insulation, all terminals of control circuits wired up to marshalling box plus 10 terminals spare, seismic acceleration 0.3g horizontal. 3. All items such as ACSR conductor, clamp and connectors, cables and cable accessories, fittings and accessories, marshalling box, GI lattice structure for mounting, earthing items, hardware etc as per applicable IS/IEC standards necessary for physical erection and electrical connection of the above neutral CTs to the 12.5MVA transformer and earth mat. 4. Supply of ACSR conductor, terminal clamp & connectors, hardware etc for electrically connecting/jointing to the LV and HV side bushings of the 12.5MVA 33kV/132kV oil-filled transformer supplied by BHEL.

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	5. Erection and testing of the 12.5MVA power transformer: - Lifting the transformers by using heavy duty cranes and placement on the civil pedestal with proper alignment. - Assembly of all fittings such as LV/HV bushings, conservator, radiators, marshalling box, buchholz relay, PRV relay, thermometers, valves, oil pipes etc as per GA/BoM. - Oil filtration using suitable truck-mounted facility of at least 5000 Liters per hour of oil cycling capacity and with appropriate vacuum pumps, degassing units, heaters, pressure/vacuum gauges, temperature indicators, hose pipes, BDV measuring unit etc. - Measurement of BDV at site; Oil collection kit and BDV measuring instrument shall be arranged at site. After attaining the desired BDV level based on site measurement, oil samples shall be tested for BDV and PPM at NABL accredited laboratory. For this, standard sample collection capsules (bottles) shall be organized. Acceptance limits of BDV/PPM shall be as per relevant IS/IEC standards. Test reports/ certificates shall be submitted for BHEL/BEL approval. - Stringing of ACSR conductor using terminal clamp & connectors / hardware etc to the LV and HV side bushings. - Electrical wiring, laying, routing etc from marshalling box to C&R panels, Aux supply panels, SCADA etc. All cables and cable accessories in vendor scope of supply. - Testing as per pre-commissioning test schedule of this specification. - Power supply such as DG set, extension board, cables etc shall be arranged by the vendor.
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5.2.9	Supply and installation of 33kV transmission line items
1	- Installation of poles (choice of route, electrical design, pole structures, choice of span, ruling span, pole structure configurations, conductors & accessories, line configuration & conductor spacing, earth conductors & accessories, earthing, clearances, sag & tension calculations) shall be as per IS: 5613 part 2/sec 1 and IS: 5613 part 1/ sec 1 wherever cross-referred. 33kV line clearances as per IS: 5613: Over open country: 5.20m, over road: 6.10m, along road: 5.80m, over telecommunication lines: 2.44m, Over rivers: 6.10m, over railways: 14.10m, Over 11kV or LV lines: 2.44m, under HV lines: 2.44m, near buildings (vertical): 3.70m, near buildings (horizontal): 2.00m
2	ROUTE SURVEY OF 33KV LINES Preliminary Survey The route alignment shall be plotted on Survey of India topographical maps to the scale of 1 cm = 0.25 Km. (1:25,000) where these are available, or 1 cm = 0.5 km (1:50,000). All topographical details including all Railway lines, rivers, canals, roads upto 2 km on either side of the route of lines shall be drawn to the scale. The name of railway stations shall be written in capital letters only. Alignment shall be plotted on the map with North being

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	clearly indicated on each drawing. Latitude and longitude shall also be properly marked. In large urban areas, maps shall be to the scale of 1:10,000. For convenience in handling, each drawing shall be restricted to the standard 'Survey of India' Toposheet size with 30 mm overlaps between the sheets. The match line shall be clearly shown on each sheet. Some portions of the line may require clearance from various authorities. Vendor shall indicate the portion of the line so affected, the nature of clearance required and the name of concerned organization such as local bodies, municipalities, DoT (name of circle), Inland Navigation, Irrigation Department and Zonal Railways, Divisional Forest Authorities etc. Three copies of the route alignment drawings and all other the information shall be furnished in a report form, for BHEL/BEL approval. After approval, the Contractor shall submit three more sets of the approved survey report along with one set of reproducible of final route alignment drawings to BHEL/BEL. The preliminary shall include details of all obligatory points on the route. These obligatory points shall include all the rivers crossing, railway crossings, power line crossings, telecommunication line crossings, forest areas or any other important crossings encountered in the line route. Final Survey Immediately after BHEL/BEL approves the line routes as determined by the preliminary survey, vendor shall arrange for clearing to commence to allow the ground profile survey to proceed with the minimum of delay. At the starting point of the commencement of route survey, an angle iron spike of 65x65x6mm 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 x650 mm size shall be driven at prominent position at intervals of not more than 750m along the line to be surveyed up to the next angle point. Nails of 100 mm wire 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 BHEL/BEL marked on them shall be put firmly on the ground for easy identification. The ground profiles (longitudinal sections) with strip route plans are to be prepared by the vendor for the complete route length, generally in accordance with the requirements of IS: 5613 and this Specification. The scale shall be 1:2000 horizontal and 1:200 vertical. In addition to showing the line route ground line and tower (centre point) location, the following features, where applicable, shall be shown: • Continuous longitudinal chain-age
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	• Ground line • Indication of side slopes where these affect clearances (account being taken of conductor under wind loaded conditions) • All the numbered pegs identifying the survey points and the towers locations. For each peg, the plan shall show partial and progressive distances and elevation • Buildings, rivers, roads, power and telecommunication lines, railways and other obstacles to be crossed, including where necessary details to confirm the required electrical clearances are obtained • Sections unsuitable for structure locations • Vegetation and nature of ground • Distances from center line of route to forest land/groves/orchards • Land scheduling for forest stretches • Structure locations, type of structure with height (standard, standard plus 1 m etc.) if necessary and structure number • Angles of deviation, spans, ruling spans. • Line of lowest conductor at maximum still air sag (75°C) • Clearance curve Vendor shall be responsible for ensuring that at crossings of public services he has complied with all relevant Regulations and Rules. All topographical details, permanent features, such as trees, building etc. within 7.5m of the lines on either side of the alignment shall be detailed on the profile plan. Clearance from ground, buildings, trees and telephone lines shall be provided in conformity with the Indian Electricity Rules, 1956 as amended up to date. Line schedule As soon as the final tower locations are agreed and approved by BHEL/BEL, vendor shall submit a line schedule. The line schedule shall indicate route designation, voltage, conductor type number and size, structure numbers, structure types, structure heights, angles of deviation, insulator types, insulators string types, spans, equivalent spans, section lengths, accumulated chain-age, and a "remarks" column in which details of crossings, etc. can be entered. After the completion of various parts of the works further data, for instance the foundation types for each structure, locations of conductor mid-span joints and repair sleeves, shall be added to the line schedule. For rehabilitation work, completed detailed inspection sheets showing work to be done on a structure by structure / span-by-span basis. In addition, maps, to a 1: 25000 scale in rural areas and a minimum of 1:10000 in urban areas, showing the location of individual poles / tower, shall be required where inter-poling takes place.
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	A comprehensive detailed plan, on a circuit-by-circuit basis, showing proposed isolation and commissioning detail, to effectively manage the shutdowns to achieve minimum disruption to consumers shall be included with each line schedule.
3	FOUNDATIONS FOR 33KV LINES Ground Types Foundations for structures shall be designed to cater for the following types of ground: • Normal dry soil Cohesive or non-cohesive soils which are present without encountering sub-soil water table within the first 1.50 metres of depth of the foundation. • Wet soil (Ground Type 'A') Wet earth due to sub-soil water table met at less than 1.50 metres below the ground level and in locations where surface water is prevalent for long periods of time, for instance, paddy fields. • Black cotton soil (Ground Type 'B') Soil of a clayey type, not necessarily black in colour, which shrinks when dry and swells when wet, resulting in differential movement. For designing the foundation at such locations, the soils are to be considered as wet soil. • Fissured rock (Ground Type 'C') Decomposed or fissured rock, hard gravel, kankar, lime stone, laterite or any other soil of a similar nature. • Hard rock (Ground Type "D") Rock, which requires chiseling, drilling or blasting for excavation. Rock anchoring techniques are required to prevent uplift forces. Pole structure foundations The foundation design criteria shall be determined from the classification of the ground into which the structure is to be erected and in accordance with IS: 2720 and the Ground Types definitions as above. The allowable bearing pressure of the soil where the poles are to be erected shall be based on adequate subsoil exploration and tests carried out in accordance with IS: 1888 and IS: 1892. The pole foundation holes in normal soil shall not be so large as to affect adversely the bearing strength of the ground in the immediate vicinity. The butt end of the pole structure shall be supported with the installation of a 100 mm thick concrete pad, six mm thick galvanized steel plate or cast iron plate, set in the bottom of the foundation hole.

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	The structure shall be mounted on this pad. Where the bearing area of the support structure is insufficient to resist the overturning moment acting on the foundation, then the bearing area shall be increased by casting a concrete collar around the structure. Vendor shall demonstrate by calculation which option is required. The collar of concrete cover to be provided shall be of not less than 100 mm thick and shall be cast around the pole from the base pad to a point approximately 250 mm below ground level. A further collar of concrete of the same thickness shall be applied from this point to 300 mm above ground level. Each section of the concrete being allowed to dry prior to the application/installation of the next section. The concrete shall be to a minimum nominal mix of 1:3:6 with the size of aggregates for the pad and top collar being 18 mm and for the intermediate section 13 mm. Where a foundation hole has been excavated directly into the ground and the pole erected without any concrete support then the soil shall be thoroughly tamped, as the foundation hole is backfilled, at intervals of not more than 300 mm. When backfilling, the subsoil shall be filled first, and so on progressively until the topsoil is replaced in its proper position in order to achieve maximum strength for the pole foundations and to restore the site to its original condition. In poor ground, precautions shall be taken to increase the bearing area in order to ensure the bearing strength of the foundation is adequate to sustain the overturning moment due to the wind loads on the conductors and structures. Where necessary, side stays or baulks shall be used in addition to assist stability. Baulks, if used shall be buried at least 450 mm below surface level, they shall be securely fastened to the structure with galvanized bolts and hardware. Baulks shall be constructed from reinforced concrete or galvanized steel, and shall be of adequate cross section to withstand the worst design loads to be applied during their life. Baulks shall be designed with the factors of safety specified in the concerned section above. In general, the planting depth of the pole shall not be less than one sixth of the total length of the pole above ground level, and shall not be less than 1.5m. Where soil is of a composite nature, classification of the foundation shall be according to the type of soil predominant in the excavation. The type of foundation to be used at each position shall be subject to BHEL/BEL approval. Guidelines for the design and construction of foundations are detailed in IS: 4091 - 1979. Vendor shall submit detailed foundation design calculations for various types of pole structures such as single pole, double pole, four pole, cut-point structures etc for BHEL/BEL approval during detailed engineering.
4	Supply and installation 1. ACSR conductors as per IS: 398; Vendor shall choose cross-section/ size of conductor based on design calculations as per applicable standards.

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	2. Conductor and earth wire accessories as per IS: 2121; Part-1: Armour rods, binding wires and tapes for conductors; Part-2: Mid-span joints and repair sleeves for conductors; Part-3: Accessories for earth wire; Part-4: Non-tension joints 3. RSJ-based poles with three pin insulators per every configuration as below: (a) Single poles, SP (with pin insulators, without tension/suspension insulators) (b) SP cut-points (with disc insulators and looping of conductors passing over the pin insulators) shall be adopted for every certain number of SP poles. Typically, general practice is to adopt a SP cut-point every sixth SP with 45-55m span length. However, vendor shall appropriately take into account the span length, applicable standards and Transco requirements for choosing the frequency of SP cut-points. (c) DP pole (with disc insulators and looping of conductors passing over the pin insulators) shall be adopted on either side of road crossings and also at sharp turn of the transmission line. The latter case is usually called as DP cut-point. (d) Four pole structures (with disc insulators) shall be adopted where GOS isolators require to be employed. 4. Porcelain insulators such as string insulator unit, suspension/ tension insulator sets, pin insulator/ line post insulator and other items as applicable as per IS: 731; Alternately, usual practice is to adopt (a) 33-36kV polymeric composite pin insulators. Similarly, for DP as well as SP/DP cut-points, usual practice is to adopt 33-36kV polymeric composite disc insulators with FRP rod & silicone rubber housing, with T&C or B&S fitting as applicable, with mechanical load 70/90 kN as per IEC: 61109, IEC: 60815, IEC: 62217. Vendor shall choose the appropriate type in line with Discom/ Transco requirements. 5. Metal fittings of insulators such as various types of pins, clamps, shackles, yoke plates, tongues, horns, hooks, eyes etc. as per IS: 2486; Part-1: General requirements, materials and tests; Part-2: Dimensional requirements; Part-3: Locking devices; Part-4: Tests for locking devices 6. RSJ poles as per IS: 2062 (MS steel, Grade E250, Quality A), IS: 808 (dimensions), IS: 1608 (mechanical testing of metals) and IS: 12777; Tolerances shall be as per IS: 1852, IS: 12778 and IS: 12779. ISHB 150 (DxBxt = 150x150x11.8mm) section shall be adopted for 33kV poles. Length shall be 13m for DP poles at all road crossings and 11m for SP poles, SP cut-points and FP structures. 7. Pole cross arms shall be constructed of MS steel and shall be bolted to the pole: C-channels/angles as per IS: 808, plates/ sheets/ strips/ flats as per IS: 1730. Tolerances as per IS: 1852; 8. Sets of stay/ guy/ strut shall be adopted at all DP poles, SP/DP cut-points, tapping points, dead-end poles and at all road/ nullah crossings. Number of sets shall be based on relevant mechanical stability calculations. Also, refer detailed procedure for 33kV line installation in this specification. Stay sets with MS stay rods/ anchor rod/ anchor plates/ turn buckles/ thimbles/ Guy grip/ stay clamp/ other hardware items as applicable, stay insulators as per IS: 5300, GI stay wires as per IS: 2141 and all associated accessories as per applicable standards shall be provided to achieve positional stability to the pole structure. 9. The angle between the pole and the stay wire should be about 45 deg and in no case should be less than 30 deg. If the site conditions are such that an angle or more than 30 deg between the pole and the stay wire cannot be obtained, special stays such as, foot stay, flying stay or struts shall be used. The tensile strength of these wires shall
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	not be less than 70 kgf/mm². Only standard wires should be used for staying purpose. Mild steel rods should be used for stay rods. The tensile strength of these rods shall not be less than 42 kgf/mm². Stays should be anchored either by providing base plates of suitable dimensions or by providing angle iron or rail anchors of suitable dimensions and lengths. Stay insulator with FI turn buckle shall be at a height of 5m above ground level. 10. Binding-in: Al conductor shall be bound-in on the top groove of pin insulators using two suitable stirrups in each case. The bind shall be formed of a single layer of closely wound wire, extending at least 25 mm beyond the stirrups. The bind shall be wound in opposite directions, on each side of the insulator. With ACSR conductor, the bind shall be formed of two stirrups, with 3.53 mm minimum diameter Al binding wire. In addition, Al armour tape shall be used, wrapped in a direction opposite to that of the conductor lay. The armour tape shall cover the portion of the conductor, which is in contact with the insulator, and extend at least 40 mm beyond the bind, on each side. At 33kV angle, section and end pole positions where disc-type strain insulators are used, the conductor shall be terminated using compression joints of a material suitable for the conductor. Wrapped joints or terminations shall not be permitted. All connections to suspension disc type insulators shall be via an appropriate conductor clamp and armour rods as per relevant standards. 11. Phase Rotation: Lines shall comply with the conventional phase rotation RYB used in the overhead network of the concerned Transco. On "V" and horizontal cross-arms, the convention is that, with one's back to the sending station, the phases are arranged R, Y and B from left to right. This same arrangement is maintained from top to bottom on any pole in which a vertical construction is used. All connections to transformers, and to cable end boxes, must be arranged so that LV networks may be paralleled. 12. Conductor Stringing: Running out blocks or stringing pulleys shall be used to run out the conductors and care shall be taken to ensure that the conductors are run out from the top of the drums and do not touch or rub on the ground or against any object that may cause damage or scratching of the conductors. Pulling of conductors over and against cross-arms is prohibited. The fullest possible use shall be made of the maximum lengths of line conductor to reduce to a minimum the number of mid-span joints. All mid-span joints used shall be of the compression type. Vendor shall submit procedure for stringing for BHEL/BEL approval during detailed engineering. 13. Tensioning and Sagging of Conductors: For each type and size of conductor, suitable sag and tension charts shall be provided by the vendor for both design and erection conditions. Vendor shall also submit detailed procedure for erection, sagging and tensioning of the conductors for BHEL/BEL approval during detailed engineering. 14. Joints: The fullest possible use shall be made of maximum conductor lengths and therefore tension joints shall be minimized but where they are unavoidable they shall preferably be of the compression type and in accordance with the requirements of IEC - 1284, IS - 2121 and IS - 2486. Other tension joints, such as "preformed" and "self-locking", may be proposed, but final approval for use shall be at the discretion of BHEL/BEL. The electrical conductivity and current carrying capacity of each joint shall be such that the resistance of the joint is not greater than 75% of the resistance of an equivalent length of the line conductor. Vendor shall measure the electrical resistance of joints after completion and before erection. The resistance of the joint shall be in accordance with the requirements of this Specification and shall in no case
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	be greater than 75 percent of the resistance of the equivalent length of conductor. Any faulty joint shall be cut out and replaced. Vendor shall supply not less than one suitable resistance measuring machine complete with calibration test certificate. 15. Tension joints shall not permit slipping of, or cause damage to, or failure of, the complete line conductor or any part thereof at a load less than 95% of the ultimate tensile strength of the line conductor. Mid- span joints shall not be less than 15m from the nearest conductor tension / suspension clamp or bind connection, and there shall not be more than one joint per conductor in any one span. Mid-span joints shall not be used in railway crossings, where lines cross other lines of different voltages, cross over communications lines or pass over or in close proximity to buildings. Two mid-span joints shall not be made less than four spans apart in any one conductor. 16. Jumpers shall be formed in smooth curves, without sharp bends. They shall be as short as possible, and where necessary, shall be supported on pilot insulators to which they shall be clamped or bound. 17. Earthing details are brought out in separate sections of this specification. 18. Guards or cradles shall be erected where overhead lines cross over roads, railways, telecommunications lines and other overhead power lines. 19. Anti-climbing device (GI barbed-wire with spikes) shall be provided for each pole at an appropriate height (minimum 3m above GL) as per applicable standards and Transco requirements. Barbed wire shall be as per IS: 278 Grade A1 and provided with chromatin dip finish as per IS: 1340. 20. Danger plates as per IS: 2551 shall be provided for all the RSJ pole configurations. 21. All poles shall be painted with suitable identification numbers using black letters in yellow background. Alternately, number plates as per relevant standards shall be provided. Any other items considered essential to meet the functional / operational requirements of the 33kV switchyard as per relevant standards or Indian Electricity rules (1956), CBIP, state electricity board/ Transco/ DISCOM/ CEIG etc requirements.
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5.2.10	Lighting system for 33kV metering yard and 33kV/132kV switchyards
	Vendor shall supply, install and commission lighting system for 33kV metering yard at solar plant side, 33kV/132kV switchyards at substation. The system shall include all necessary items such as luminaires, LED lamps, GI poles, bend pipes, junction boxes with MCBs/TBs/ glands/ provisions for earthing, conduit pipes for aux supply cables above ground level up to junction box for street light poles, conduit pipes for cables above ground level up to luminaire for wall mounted lighting, casing/capping wherever applicable, GI earth wires, aux supply cables (multicore, 1.1kV, Al/Cu, PVC, armoured, PVC FRLS as per IS:1554, appropriate sizing) up to junction box, cables (1.1kV, Al/Cu, PVC, unarmoured, unsheathed, as per IS: 694, appropriate sizing) from junction box to luminaires, cable glands, cable lugs, termination hardware etc. Scope also includes civil foundation works for street lighting poles. Cables shall be routed through the RCC cable trench as per IS: 1255 with reference the section “cable installation methodology” of this specification. Cables shall be terminated at both the lighting end and Lighting DB boards (LDB) at the control rooms of solar plant and substation.

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Spacing between poles/lamps shall satisfy the lux requirements of the respective areas. AC supply shall be from the LDB distribution boards from the three inverter rooms/ main control room.

Vendor shall submit lux calculations, lighting layout, single line diagram for aux supply from LDB boards, GA drawings of lighting poles/ wall-mounted/ column-mounted/ fence-mounted systems, GA drawings of civil foundation for street light poles, bill of materials with make/ GTPs/ model number/ part number/ rating/ applicable IS standards/ quantity etc for BHEL/BEL/SECI approval during detailed engineering. For all the items, reputed brand shall be procured after approval from BHEL/BEL/SECI. Cable schedule shall also be submitted.

Street lighting poles/ wall mounted/ column-mounted/ fence-mounted systems as applicable (20 lux minimum)

- in front of control room at substation
- for 33kV metering yard at solar plant side
- for 33kV/ 132kV switchyards at substation including coverage for the power transformer and the NCTs.

General technical requirements:

- All LED luminaires shall be supplied with proper diffuser to avoid direct visibility of LED with proposer thermal management for longer life.
- The lighting level shall take into account appropriate light output ratio of luminaires, coefficient of utilization maintenance factor (of 0.7 or less) to take into account deterioration with time and dust deposition.

(3) LED luminaires shall meet the following parameters

1	Input voltage	170-260V
2	Input frequency	50 +/- 1 Hz
3	Power factor	0.95 minimum
4	Power efficiency	>96%
5	LED efficacy	>130 lumens per watt
6	Dispersion angle	Minimum 120 deg
7	Usage hours	Dusk to dawn
8	Total harmonic distortion	<15%
9	Working temperature	-5 deg to +50 deg C
10	Working humidity	10% - 90% RH (preferably hermetically sealed unit)
11	Index of protection level	Minimum IP65
12	Lamp casing	Powder coated metal/ Aluminium
13	Life	> 50,000 Hrs
14	LED type	Power LEDs from reputed make
15	Colour temperature	2800 deg K / 3000 deg K
16	Colour rendering	>75
17	Junction temperature	< 60 deg C
18	Electrical connector	Lead wire with 2m long (or) as required by customer at site
19	Expected life of components	Passive electronic components life greater than > 1,00,000 hrs

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20	Moisture protection in case of casing damage	IP 65 (preferably totally encapsulated)
(4) Control gear specification EN 61347-2-13: Particular requirements for DC/AC supplied electronic control gear for LED module EN 62384: DC/AC supplied electronic control gear for LED modules (5) Luminaire EMC specification EN 61000-3-2: Electromagnetic compatibility (EMC). Limits for harmonic current emissions (Equipment input current < 16 A per phase) EN 61000-3-3: Limitation of voltage fluctuation and flicker in low voltage supply systems for equipment with rated current < = 16 A (6) Additional information for LED luminaire The LED luminaire housing, heat sink, pole mounting bracket, individual LED reflectors and front heat resistant tempered glass should be provided. The LED luminaire housing should be made of non-corrosive high pressure die cast aluminium and the housing should be power coated grey, so as to ensure good weatherability. Each individual LED source should be provided with asymmetrical distribution high reflectance aluminized reflector, which should ensure that the light distribution of the luminaire is suitable for road lighting applications (wide beam distribution) and should ensure high pole to pole spacing. The luminaire should be provided with in built power unit and electronic driver. The luminaire should be so constructed to ensure that the gear and LED modules are replaceable, if required. The luminaire should be suitable for both standard street light poles with a typical pole diameter of 50 mm – 60 mm and should be suitable for both side entry and bottom entry (post top). (7) Junction Boxes, Conduits, Fitting & Accessories Junction boxes for street lighting poles, lighting mast, wall-mounted, fence-mounted as applicable shall be deep drawn or fabricated type made of min 1.6 mm thick CRCA Sheet. The box shall be hot dip galvanized. The degree of protection shall be IP55. All switches and receptacles up to 16A shall be modular type. These shall be provided with pre-galvanized/ galvanized modular switchbox & plate. Conduits, Pipes and Accessories Galvanized heavy duty steel conduits for normal area and 29alvanized heavy duty steel conduits with an additional epoxy coating for corrosive area shall be offered. Alternatively glass reinforced epoxy conduits with comparable compressive and impact strength with that of heavy duty steel conduits may be offered. Rigid steel conduits shall be heavy duty type, hot dip galvanized conforming to IS: 9537 Part-I & II shall be suitable for heavy mechanical stresses, threaded on both sides and threaded length shall be protected by zinc rich paint. Conduits shall be smooth from inside and outside.		

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Flexible conduit shall be water proof and rust proof made of heat resistant lead coated steel.

Pull out boxes shall be provided at suitable interval in a conduit run. Boxes shall be suitable for mounting on Walls, Columns, Structures etc. Pull-out boxes shall have cover with screw and shall be provided with good quality gasket lining. Pull out boxes used outdoor shall be weather proof type suitable for IP55 degree of protection and those used indoor shall be suitable for IP52 degree of protection. Pull out box & its cover shall be hot dip galvanized.

(8) Lighting Poles

Street Light system and peripheral lighting shall be designed generally in line with design guidelines. Height of the poles should be chosen so as not to affect working of Solar panels. The maximum height of pole shall be 8 m. The poles shall be hot-dip galvanized as per relevant IS: 2629/ IS: 2633/ IS: 4759. The average coating thickness of galvanizing shall be min 70 micron. The System shall be capable of withstanding the appropriate wind load etc as per IS: 875 considering prevailing soil/ site condition considering all accessories mounting on pole.

Street light poles shall have loop-in/ loop-out arrangement for cable entry and light fixture / wiring protected with suitably rated MCB.

Lighting fixtures shall generally be controlled from switchboxes of each area and not directly from lighting panel.

(9) Earthing

Lighting poles etc shall be earthed by two separate and distinct connections with earthing system. Distribution boards, junction boxes, lighting fixtures etc shall be earthed by means of separate earth continuity conductor. The earth continuity conductor 14 SWG GI wire shall be run along with each conduit run. Cable armours shall be connected to earthing system at both the ends.

5.2.11	Earthing of 33kV/ 132kV yards and 33kV transmission line
1	Earthing for RSJ poles of 33kV metering yard and 33kV transmission line Each RSJ pole of 33kV transmission line shall be earthed using coil type GI wire of SWG-8 size. The wire shall be closely wound with minimum 115 turns and with coil diameter of 50mm. Accordingly, coil length shall be 460 mm minimum. The coil shall be centrally and vertically seated at the bottom of the bored hole of 600mm minimum diameter and 1500mm minimum depth from GL. The bore shall be filled with charcoal/ coak and salt in alternate layers of 300mm thickness up to a level of 300mm below GL. Apart from the coil length, the balance length of free GI wire shall be 2500mm minimum that will be connected to the pole by way of welding. The central axis line of the bore shall be 1200mm minimum away from pole. For DP and Four-pole structures, GI pipe of 40mm minimum diameter (or) GI rod of 20mm minimum diameter shall be used. Length of the pipe/ rod shall be 2500mm minimum long with 45 deg chamfer on one end to facilitate hammering down the alternate layers of charcoal/ coak and salt each 300mm thick. The pipe shall have holes of 12mm diameter

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	with 150mm pitch. The pipe/ rod shall be buried in a bored hole of diameter 600mm minimum and depth of 2700mm below GL. (a) For pipe earthing, suitable semi-circular split clamps made of MS flat of 40x3mm thick and with matching radius (21R) shall be used. The semi-clamps shall be bolted together and also to GI wire SWG-8 using M12 bolt and spring/plain washers. (b) For rod earthing, connecting end of the rod shall have a flattened width of 40mm with a hole of size suitable for bolting to the SWG-8 GI wire using M12 bolt and spring/plain washers. The connecting (clamp) point to the GI wire shall be at 300mm below GL. Accordingly, 500x500 mm recess shall be made to a depth of 500mm below GL so as to expose the connecting (clamp) point.
2	Earthing for 33kV metering yard equipments and 33kV switchyards i. General 1. Earthing shall be as per IS: 3043 and IEEE 80 2. All structure-mounted junction box, distribution box shall be earthed at one point by 50x6 mm minimum GI flat. 3. All ground-mounted boxes/cubicles such as bay marshalling box etc shall be earthed at two points by 75x12 mm GI flat. 4. On solar plant side, switchyard earth mat shall be connected to plant earth mat at two points. 5. GI support structures, equipments (CT/CVT/PT/LA/SF6 breaker/ GOS isolator/ etc) of switchyard and cable trenches shall be earthed at two points by 75x12 GI flat. For these, direct risers of same size shall be connected to the earth mat. 6. GI pipe earthing electrode of 40mm diameter and 3m long shall be provided for each LA, each CVT/PT, the towers with peak & lightning mast. Length of GI pipe shall be 2500mm minimum with 45 degree chamfer on bottom end to facilitate hammering down the pipe into alternate layers of charcoal/ coak and salt each 300mm thick. Such layers shall surround the GI pipe for 300mm diameter and all along the length of GI pipe. The pipe shall have holes of 12mm diameter with 150mm pitch. The GI pipe shall be buried into a bored hole of diameter 600mm and depth of 2700mm below GL. Suitable semi-circular split clamps made of GI flat of 40x3mm thick and with matching radius (21R) shall be used. The semi-clamps shall be bolted together using M12 bolt and spring/plain washers. 7. GI pipe earthing electrode as above shall be connected to earth mat grid. 8. Inner dimension of earth chamber for the GI pipe electrode without having any test link shall be 400x400 mm minimum; for electrodes with test link, it shall be 700x700 mm minimum. Walls and floor of the pit shall be of RCC (M-15) with 125 mm minimum wall thickness and 100 mm minimum floor thickness. Cover slab with lifting hook shall be of RCC (M-15) of 75 mm minimum thickness. Chamber including cover slab shall be plastered with cement mortar (1:4) on all sides include inner walls. Depth of RCC chamber shall be 400 mm minimum below GL. 9. Auxiliary earth mat of overall size 1500x1500 mm comprising of closely spaced (300x300 mm) MS conductors of 40mm diameter shall be provided below the operating handles of the motor/ junction boxes of GOS isolators/ earth switches.

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	10. 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. 11. 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. ii. Details of underground earth mat system 1. Main earthing conductor: MS rod of 40mm diameter 2. Rod electrode: MS 40mm diameter, 3000mm long iii. Earthwire: GI SWG-7/ SWG-8 iv. For step and touch potential, following parameters shall be considered: 1. Current distribution factor: 1 2. Duration of fault current: 0.5 sec 3. Human body weight: 50 Kg v. Grid resistance shall be less than 1 Ohm. vi. Earthing conductor layout (Earth mat) 1. Earthing conductors in outdoor areas shall be buried at least 600 mm below finished grade level unless stated otherwise. Minimum 6000 mm or higher spacing between rod electrodes shall be provided based on the earth mat design calculations. 2. 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. 3. 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" with temporary wooden cover or "earth riser" shall be provided near the equipment foundation/pedestal for future connections to the equipment earthing terminals. 4. 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, GI sleeves shall be provided for the passage of the conductor. Both ends of sleeves shall be sealed to prevent the passage of water through the sleeves. 5. Earthing conductor around the building shall be buried in earth at a minimum distance of 1500 mm from the outer boundary of the building. In case high temperature is
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	encountered at some location, the earthing conductor shall be laid minimum 1500 mm away from such location. 6. In outdoor areas, tap connections shall be brought 300 mm above ground level for making connections in future, in case equipment is not available at the time of grid installations. 7. Earthing conductors crossing the road shall be either installed in hume pipes or laid at greater depth to suit the site conditions. 8. Earthing conductors embedded in the concrete fiber shall have approximately 50mm concrete cover. vii. Equipment and structure earthing 1. 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. 2. 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. 3. Metallic conduits shall not be used as earth continuity conductor. 4. A separate earthing conductor shall be provided for earthing lighting fixtures, lighting poles, receptacles, switches, junction boxes, lighting conduits, etc. 5. 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. 6. Cable and cable boxes/glands, lockout switches etc. shall be connected to the earthing conductor running along with the supply cable which, in turn, shall be connected to earthing grid conductor at minimum two points, whether specifically shown or not. 7. Railway tracks within switchyard area shall be bonded across fish plates and connected to earthing grid at several locations. 8. Earthing conductor shall be buried 2000 mm outside the switchyard fence. Every post of the fence and gates shall be connected to earthing loop by one lead. 9. Flexible earthing connectors shall be provided where flexible conduits are connected to rigid conduits to ensure continuity. 10. Equipment earthing (Riser & welding of two conductors) shall be done as per standard drawing enclosed in this part. viii. Jointing 1. 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. 2. Connection between equipment earthing lead and between main earthing conductors
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	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. - Steel to copper connections shall be brazed type and shall be treated to prevent moisture ingress. - Resistance of the joint shall not be more than the resistance of the equivalent length of the conductor. - 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. - Bending of large diameter rod/thick conductor shall be done preferably by gas heating. - All arc welding with large diameter conductors shall be done with low hydrogen content electrodes. ix. Power cable earthing Metallic sheaths and armour of all multicore power cables shall be earthed at both equipment and switchgear ends. Sheath and armour of single core power cables shall be earthed at switchgear end only.
3	Earthing for control room at substation Earth mat layout (with electrodes, GI flats, MS rods etc) shall be designed and installed for the ~ 4m x 4m control room at substation. ABT metering panel and C&R panels, AC/DC Distribution boards shall be suitably earthed to the earth mat. Earth chambers with lids shall also be constructed. All supply items shall be in vendor scope of supply.

5.2.12	Civil construction works including supplies
1	- Route survey shall be carried out for the 33kV transmission line as per the related section of this specification. - Geotechnical soil investigation as per applicable standards to assess the soil parameters such as soil bearing capacity etc required for designing the foundation for the RSJ poles of the 33kV transmission line.
2	Geotechnical soil investigation at substation end (a) to assess the soil parameters such as soil bearing capacity etc required for designing the foundation of outdoor GI support structures for the yard equipments such as CT/PT/LA/SF6 etc and (b) also, to assess the soil electrical resistivity required for designing the earth mat.
3	Construction of RCC civil foundations for erection of RSJ poles at (a) 33kV metering end, (b) 33kV transmission line and (c) 33kV switchyard at substation end wherever applicable.
4	Construction of RCC foundations of GI lattice support structures for CT/ PT/ LA/ Isolator/ breaker/ post insulators etc of 33kV/ 132kV switchyards at substation. Supply of all items necessary for this civil foundation shall be in vendor scope.
5	Construction of RCC foundations for erection of the gantry towers / beams wherever applicable. Supply of all items necessary for this civil foundation shall be in vendor scope.

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6	Construction of RCC foundations for (a) 12.5MVA, 33/132kV power transformer supplied by BHEL and also for (b) the GI support structures of the two neutral CTs (of vendor supply) of this transformer. Supply of all items necessary for this civil foundation shall be in vendor scope.
7	Construction of RCC cable trenches, RCC lids with handles for lifting, GI cable trays in three vertical tiers for HT/ LT/ control cables from metering yard/switchyard to the panels such as C&R panel, ABT metering panels, ACDB/ DCDB boards etc in control rooms at both the plant and substation ends as per relevant standards. Top level of RCC trench (including the lid thickness) shall be 200mm minimum above the top level of stone gravels to prevent water entry into the trench. Bottom surface of the cable trench shall be sloped down from control room to divert the water away from the room and also to prevent water stagnation in the trench. A water collection RCC pit of minimum size 450mmx 450mm x 450mm depth shall be provided at the end of the RCC trench so as to facilitate removal of water by pump upon accumulation.
8	Construction of RCC earth chambers with RCC lids for the 33kV metering yard at solar plant, 33kV / 132kV switchyards at substation as detailed in the relevant earthing sections / clauses of this specification. Top level of the lid of earth chambers shall be above the level of stone gravels by at least 200mm.
9	Other related activities such as (a) supply and laying of stone gravels of appropriate size to a layer thickness of 100 mm minimum in the metering yard and switchyards, (b) supply and laying of chain link fencing all around the metering yard with two gates at plant side, (c) supply and laying of chain link fencing with two gates for the 33kV/ 132kV switchyards at substation end, (d) marking / labeling of all the yard equipments, transmission poles and earthing locations, (e) supply and fixing of all applicable danger and sign boards, (f) supply and fixing of anti-climbing devices for all RSJ poles (g) painting of civil foundations all around with cement plaster and water proof cement paint of colour as per BHEL approval, (h) painting of all the exposed MS steel structures of metering yard, transmission poles and switchyards with two coatings of red oxide followed by two coatings of 3-mango silver colour paint for protection against erosions and corruptions. In the case of RSJ poles, two coatings of black colour paint shall be applied over the double coated red-oxide layers for 1m height above ground level and two coatings of 3-mango silver colour paint over the double coated red oxide layers above 1m level.
10	All necessary land development activities including suitable leveling / grading / drainage of 33kV metering yard at plant end and 33kV / 132kV switchyards at substation end to ensure (a) that the yard is at the right level with reference to control room plinth, the surrounding levels etc, (b) that water shall not get stagnated within the yard and (c) that water shall get drained away from the yard, (d) stone pitching/ retention wall etc as suitable, and wherever applicable, to prevent landslides and soil erosions due to rain/storm water, to provide stability to switchyard fencing structure etc. RCC hume pipes of NP3 grade as per IS: 458 (2003) of appropriate diameter and length shall be provided at regular intervals for draining the water out of the yards. Supply of all items necessary for these civil activities shall be in vendor scope.

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5.2.13	Design, drawings and other engineering/ quality/ testing documents
1	Vendor shall submit the following documents for BHEL/BEL approval within 10 days after receipt of purchase order or at every stage of project implementation as applicable and as mutually agreed with BHEL/BEL.
2	Design calculations as per relevant standards together with drawings, layout and bill of materials shall be submitted for BHEL/BEL approval. (a) Underground earth mat grid for 33kV metering yard at solar plant side, 33kV/132kV switchyards at substation end and for the control room in the as per IEEE 80 and IS: 3043 (b) RCC foundations of RSJ poles of four-pole structure of 33kV metering yard (c) RCC foundations of RSJ poles (SP, DP) of 33kV transmission line (d) RCC foundation for 12.5MVA 33/132kV power transformer (e) RCC foundations for the two neutral CTs of the 12.5MVA power transformer (f) RCC foundations for the GI support structures of CT/CVT/PT/LA/ VCB breaker/ SF6 breaker/ GOS isolators/ bus post insulators etc in 33kV/132kV switchyards (g) RCC foundations for gantry towers and towers with lightning mast (h) RCC cable trenches (i) Stone/brick masonry foundations of metering yard / switchyard chainlink fencing (j) Structural stability calculations (STAAD Pro etc) for the four-pole structure, GI lattice support structures of switchyard equipments such as CT/ PT/ LA/ GOS isolators/ breakers etc, GI lattice towers/ beams etc. (k) Sag & tension calculations for ACSR conductors of 33kV transmission line. (l) Pole-to-pole spacing calculations for 33kV transmission line (m) Structural stability calculations for stay/guy/strut arrangements of the SP cut point, DP, FP structures. Vendor shall obtain approval from concerned state / central approval agency such as Transco/ DISCOM/ CEIG/ CEA etc as applicable.
3	Layout drawing of the complete 33kV metering yard showing locations of four-pole structure, auxiliary transformer, earth chambers, cable trenches, marshalling boxes, other panels (if any), chain link fencing, stone jelly, steel gates etc.
4	Cross section diagram of 33kV metering yard showing the overall dimensions (such as height, width, clearances etc) of various electrical equipments mounted on the four-pole structures.
5	Layout drawings of the complete 33kV/ 132kV switchyards at substation end including the 12.5MVA power transformer and their LV & HV side NCTs, RCC cable trench, earth chambers, auxiliary earth mats for operation of motor boxes of isolators, towers, beams, lightning masts, switchyard fencing, gate. Also, the cross-section diagrams.
6	Layout diagram for earthing of all structures/ equipments of (a) 33kV metering yard at plant side and (b) 33kV and 132kV switchyards at substation side.
7	Detailed bill of materials with item description, rating, make, model number, item quantity of (a) 33kV metering yard at plant side and (b) 33kV and 132kV switchyards at substation side.
8	Drawings with BoM of chain link fencing and gate of the yard
9	Drawings of stone pitching/ retaining walls etc wherever applicable
10	Drawings of RCC cable trenches including arrangement of cable tray layers etc.

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11	Numerical relay settings for trip time coordination between substation and plant. For finalization of this, vendor shall interact with BHEL, BEL and Transco at substation and also the relay manufacturers taking into account the overcurrent/ earth fault / overvoltage / under-voltage trip requirements at various levels.
12	Layout/GA drawings with illumination lux calculations, BoM for the lighting system for (a) 33kV metering yard at solar plant end, (b) 33kV/132kV switchyards at substation and (c) in front of control room at substation.
13	GTP, datasheets, GA drawings, Manufacturing quality plan with routine/ type / acceptance tests, sampling plan, O&M manuals shall be submitted for BHEL/BEL approval for all the vendor-supplied items including but not limited to the equipments CTs, PTs, GOS isolators, earth switches, SF6 breaker, OVCB breaker, lightning arrestors, trivector meters, ABT meters, ABT metering panels, MRI instruments, C&R panels, junction boxes, marshalling boxes, bay marshalling kiosks, LT/ control cables, ACSR conductors, RSJ poles, steel support sections, stay/guy sets, GI cable trays, cable ties, pin insulators, disc insulators with accessories, clamps and connectors, motors & motor control boxes etc. Also, for the two neutral CTs of the 12.5MVA power transformer.
14	Test reports of all the supply items – type / routine / acceptance test reports as per manufacturing quality plan approved by BHEL/BEL.

5.2.1 4	Pre-commissioning tests/ commissioning / clearances / liaison etc
A. Basic checks	
A1	Tightness checks:
	1) Terminations of HT(33kV)/LT/Control cables at 33/132kV power transformer, C&R panels, ABT metering panels, marshalling boxes, bay marshalling kiosks, motor/ control boxes etc 2) ACSR conductor terminations 3) Fasteners of all the switchyard structures: bolts/nuts/washers 4) Fasteners of transmission towers: bolts/nuts/washers 5) Fasteners at earthing chambers: bolts/nuts/washers
A2	Electrical continuity checks
A3	Cable megger checks: All LT cables, four pole metering yard structures, transmission lines, switchyard equipments etc
A4	AC/DC power supply checks at all electrical equipments/ panels/ DBs
B. Pre-commissioning electrical tests:	
B1	33/132kV transformer
	1) Oil filtration: Equipment of adequate evacuation/ heating/ oil circulation capacity shall be deployed at site for this purpose. Filtration shall be carried out adequately in order to achieve the BDV, ppm, tan delta values within the limits as per relevant standards and as measured by NABL accredited laboratory. The machine shall have built-in BDV measuring set up for in-situ checking of BDV during filtration process. 2) IR tests LV-HV, HV-E, LV-E 3) Vector group

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	4) Voltage ratio 5) Magnetizing current 6) Magnetic balance 7) Winding resistance at all taps 8) Capacitance, tan delta of HV/LV bushings 9) Fault simulation checks from C&R panel: Buchholz, OTI, WTI, PRV, LOLA, REF, transformer differential etc
B2	Outdoor CT
	1) IR tests (all cores): Pri-Sec, Sec-Sec, Pri-E, Sec-E 2) Ratio tests / primary injection
B3	Outdoor PT
	1) IR tests (all cores): Pri-Sec, Sec-Sec, Pri-E, Sec-E 2) Voltage ratio test 3) Polarity test
B4	SF6/ OVCB breakers
	1) IR tests 2) Contact resistance measurement (CRM) 3) Timing test: close/ open/ close-open 4) Functional checks: breaker open/close, spring-charged motor 5) Remote operation from C&R panel: open/close, command/status, lamp indications 6) Gas pressure checks (for SF6 breakers)
B5	GOS isolator / Earth switch
	IR tests Contact resistance measurement (CRM) Functional checks: open/close manual, open/close motorized operation
B6	Surge arrestor (LA)
	1) IR tests
B7	Bus post insulator
	IR tests
B8	Neutral CT for 33kV side of transformer
	IR tests
B9	Numerical relays at C&R panel
	1) Relay calibration using applicable kit/ software 2) Overcurrent/ earth fault pickup/ tripping time tests
B10	Earth resistance measurements for all chambers
	1) With electrode connected to grid 2) Without connecting electrode to grid
B11	Transmission line
	1) Line megger test 2) Line charging test

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C. Testing agency
Credentials of the testing agencies to be submitted to BHEL for approval prior to awarding of work.
D. Coordination and Liaison activities to be carried out by vendor:
1) Vendor shall prepare and submit the drawings/ schemes/ layouts/ calculations (earth mat, sag & tension etc) to the concerned state/central agency Transco/ DISCOM/ CEIG/ CEA etc for their approval after clearance from BHEL. Liaison with the agency throughout the evaluation/ approval process is the responsibility of vendor. 2) Submission of site test reports to customer (BEL/CEIG etc) after obtaining approval from BHEL. 3) Preparation of application (along with supporting documents: drawings, factory test reports, site test reports etc) to concerned agency (CEIG/CEA etc) for site inspection, obtaining signatures from customer (BEL) and submission to the inspection agency. 4) Coordination with customer (BEL) and liaison with inspection agency (CEIG/CEA etc) for inviting the inspectors for site inspection prior to plant commissioning. 5) Vendor shall organize inspection at site by above agency with all suitable technical and commercial arrangements. All necessary testing kits/ instruments shall be arranged as per the requirements of inspection agency. Basic instruments such as digital multimeter, 5kV digital megger, earth resistance meter, VCB/SF6 breaker response time tester etc shall be organized at site at the time of inspection. Competent electrical technician shall also be made available at the site. 6) Subsequent to site inspection, vendor shall follow-up with the inspection agency, coordinate with the customer to obtain early clearance for plant commissioning. 7) Vendor shall implement all the observations of CEIG so as to secure their final approval that is mandatory to continue with regular operation of the plant.
Notes:
1. Vendor shall take frontline lead in obtaining the clearance of inspection agency for the entire power plant. 2. Vendor shall suitably interact with the contractor of BHEL executing the solar plant side erection works up to the 33kV connecting point to the grid and mobilize all necessary inputs/ documents required from them in the process of getting approval of the inspecting agency for plant commissioning. 3. Vendor scope of coordinating with concerned state/central electricity departments, Transco/ DISCOM/ CEIG/ CEA etc to get their statutory clearances/approvals for the design/ engineering/ testing documents, plant commissioning/ grid synchronization etc includes all commercial transactions associated with the process of liaison with them to successfully obtain their approvals. All fees/ charges that shall be paid to the government in the form of DD/web-based online payment such as charges during the estimation phase, supervision charges during the construction phase, application/inspection fees during commissioning approval phase etc shall be in the scope of BHEL/BEL. All other expenses associated with the above liaison process shall be in the scope of vendor.

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E. Commissioning of power plant
1) Vendor shall organize presence of an HT electrical consultant at site at the time of commissioning with no additional charges to BHEL. The consultant shall have adequate expertise in the form of knowledge/ experience in this field. He shall be able to guide the site team on the steps/ procedure/ precautions to be adopted during commissioning. Also, he shall be cable of extempore trouble-shooting in case of any technical problems encountered on 33kV/132kV side of power plant. 2) Vendor shall organize all necessary tools/ measuring instruments required to operate the various electrical equipments on 33kV/132kV side of power plant at the time of commissioning. 3) It is the responsibility of the vendor to interact technically with the substation/ Transco/ Discom for successful charging of the 33kV transmission line up to the solar plant through the 132kV grid and the 12.5MVA power transformer at substation end. 4) Vendor shall suitably interact with the contractors of BHEL executing the solar plant side erection works to enable successful grid synchronization of inverters. 5) Vendor shall actively participate in the commissioning activity until it is established that there is successful flow of power through the 33kV/132kV grids subsequent to the synchronization of inverters with grid. 6) Vendor shall deploy competent technicians at site to effectively interact with the substation/ Transco/ Discom on every technical aspect so as to ensure resolution of any technical problems related to grid/ transmission line/ switchyards encountered during commissioning.

5.2.15 General conditions during supply, installation and commissioning phases
1 Vendor shall arrange for safe storage of all the materials supplied them. For this purpose, vendor shall construct appropriate storage shed with gates, locks and keys. Security watch and ward shall be deployed round the clock. 2 Vendor shall organize power supply for construction on their own. Accordingly, DG sets of suitable capacity shall be deployed by the vendor. 3 Similarly, water required for construction works shall be organized by vendor. 4 All machinery such as cranes, hydra, JCBs, forklifts, transport trucks, trolleys etc necessary for the movement and installation of materials / panels / equipment etc shall be organized by the vendor. 5 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.

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6	All necessary measuring instruments such as digital multimeters, electrical testers, digital meggers (1kV, 2.5kV, 5kV) with feature to display PI, earth resistance meters, weighing machines, water level indicators etc shall be organized by the vendor.
7	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.
8	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.
9	Vendor shall maintain updated labour register, with name, age, qualification, salary, attendance details etc at the site.
10	Vendor shall use danger boards, appropriate warning/sign boards, wherever required, to ensure safety of the persons during the work at site.
11	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.
12	Vendor shall, at the completion of every work, clear off the debris, which resulted out of the work. In case of excavation work such as cable trench etc, vendor shall finish the land neatly with necessary leveling, rolling etc.
13	Vendor shall carry out the work without causing inconvenience to other contractors of BHEL at site. In case of conflicts with other contractors, it is the responsibility of the vendor to ensure that the matter is resolved at once amicably so that the progress of work is not affected.
14	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.
15	No child labour shall be employed for execution of the present contract.
16	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.
17	BHEL/BEL 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 internal test results in advance. 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/BEL for procurement of the items from dealers.
18	Field Quality Plan / Quality control system Vendor shall set up a field quality control laboratory with full set up to facilitate testing

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	of all civil construction materials in accordance with FQP (Field quality control plan) that shall be submitted for BHEL/BEL approval. Similarly, FQP for electrical works in respect of switchyards / transmission line shall also be submitted to BHEL. Vendor shall deploy a well experienced quality control engineer to monitor all QC activities at site as per approved FQP. Specifically with reference to civil works, vendor shall submit all concrete mix designs and bituminous mix designs for BHEL/BEL approval before starting the work. All the third party testing should be conducted in laboratories approved by BHEL/BEL for which relevant details shall be submitted to BHEL prior to taking up work with the laboratory.
19	Any deviations shall be discussed with BHEL/BEL site engineers and implementation shall be taken up only after approval from BHEL/BEL.
20	Vendor shall submit periodic status report to BHEL on daily as well as weekly consolidated basis.

5.2.16	Operations and maintenance of HT yards and transmission line
1	Date of commencement of operations and maintenance Zero date for O&M shall be the date on which the power plant is fully commissioned as certified by BHEL/BEL following the synchronization/ export of power to the 33kV/ 132kV grid.
2	Period for O&M Vendor shall operate and maintain those portions of the project implemented by them for a period of 10 years from zero date as defined above. O&M shall be for the 33kV metering yard including ABT metering panels and the trivector meters installed by them, 33kV transmission line, 33kV/132kV switchyards at substation and the 12.5 MVA 33/132kV power transformers including the neutral CTs.
3	During O&M period, performance ratio (PR) test will be carried out for a period of 7 days at regular intervals in order to check the continued performance of the plant and to determine the necessary steps to meet the capacity utility factor (CUF) commitment to the customer. Vendor shall organize all activities for equipment monitoring, data collection/ reporting etc in coordination with BHEL/BEL teams, the contractors on SPV plant side (up to 33kV metering yard) and also with substation/ Transco/ Discom for making the test successful.

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4	O&M personnel 1. Vendor shall deploy following minimum personnel: (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) Two 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) Two unskilled persons for regular house-keeping of switchyards and transmission line: cleaning activities such as garbage removal, removal of bushes/ vegetation grown in switchyards etc. (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. 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/BEL shall have right to disallow any O&M employee, if found unfit to perform. BHEL/BEL 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 ordinance factory from time to time and BHEL/BEL shall not be responsible for any injury to personnel arising therefrom. 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
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	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 (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.
5	O&M operations – daily basis (1) Upkeeping of the 33kV metering yard, 33kV/132kV switchyards with removal of garbage / litter, removal of weeds / grass / bush. (2) Monitoring the yards and the associated C&R panels at the control rooms 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 ABT meters, (b) events of any equipment tripping/ breakdown, (c) Grid outage duration, (d) damages / accidents / injuries / theft etc as per BHEL formats. (4) Drinking water and food to be arranged for the deployed O&M personnel at site.
6	O&M activities – monthly basis (1) Monitoring and logging of fire extinguisher levels / pressures as per BHEL formats. (2) Earthing resistance measurements for all the earth chambers. Values shall be recorded in registers and reported to BHEL as per BHEL-approved 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 the ABT meters of 33kV metering yard at solar plant and 132kV switchyard at substation. 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 / ABT meters reading report to be prepared and submitted to the concerned state electricity department. Signatures from BHEL/BEL and substation representatives shall be obtained.

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7	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 within the panel. (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.
8	O&M activities – yearly basis (once during every year of the 10-year O&M period) (1) BDV & PPM measurements for oil samples from 12.5MVA, 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/PPM measurement report as per relevant standards. (3) Dissolved gas analysis (DGA) shall be carried out on the oil every year and the report shall be submitted to BHEL. (4) BDV, PPM, DGA measurements as above shall be carried out at NABL accredited laboratory. (5) Lubrication of moving contacts (GOS isolator switches, Earth switches, OVCB/SF7 breakers etc) with appropriate grease etc as per relevant standards. (6) Checking tightness of hardware and cable terminations in 33kV metering yard, 33kV/132kV switchyards.
9	O&M activities - as and when required (contextual basis) (1) Operation of appropriate fire extinguishers in the yards upon fire incidents. (a) Monitoring and operation of plant electrical equipment as and when required: (b) GOS Air break isolator switches (with / without earth switch) (c) OVCB/SF6 breaker on/off: local operations and remote operations from C&R panels. (2) Settings of numerical relays: review and revision in consultation with BHEL. (3) AC/DC DB operations on LT side (4) Coordinating, on behalf of BHEL, and obtaining renewal of statutory licenses, clearances and approvals from state electricity departments / Transco/ DISCOM/ CEIG etc. (5) 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. (6) Painting of switchyard gate / fencing, earthing chambers, other steel structures in the switchyards, if required, based on conditions of rusting etc. (7) Reporting, on 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

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	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. (8) 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 (within max 2 hours) to BHEL. (9) Coordinating with substation upon grid failures, line problems etc and implementing the needful steps to restore the plant to normal operation. (10) 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. (11) Accidents: immediate reporting to BHEL, coordinating with hospitals, logging of events (data, time) and maintaining records.
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6.0 Switchyard items and installation works – supplementary clauses

6.1	Scope and general information The intent of this specification for various electrical equipments shall cover the following scope: Vendor shall be responsible for design and engineering of overall system/station, and all elements, systems, sub-systems, facilities, equipments, material, etc. Vendor shall submit design calculations, drawings, codes, codes of practices, construction drawings, etc. for BHEL approval. The basic design shall include, but not limited to, the following: (more detailed design/ document requirements brought out separately in this specification) 1. Development of general arrangement. 2. Development of detailed layout (plan & section/elevation) drawings. 3. Development of single line diagram with parameters of equipment and details of protection. 4. Protection and control philosophy and selection of protection, control and annunciation schemes. 5. Development of interlocking schemes. 6. Development of switchyard structure loading details. 7. Development of earthing system. 8. Insulation coordination of the EHV equipment. 9. Calculation of static and dynamic force load, and selection of spacer spans and equipment terminal loading.
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	10. Development of clearance diagrams. 11. Lighting design, Lux level calculation and conduit wiring diagram. 12. Development of power & control cable laying and termination schedules. 13. Relay setting calculations. 14. Development of erection key diagram with bill of material. 15. Foundation design and construction drawings. 16. Development of cable trench layout and sections and construction drawings. Vendor 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. Vendor 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. Vendor 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. 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 vendor. The necessary fees for such clearances shall be borne by BHEL. 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 ASCR conductor. The type of terminal clamps would be finalized 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. 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.
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	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. All the cables used for the switchyard shall be armored type. All equipment shall be suitable for hot line washing. Vendor 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. The sag tension, conductor spacing, short circuit forces, spacer location, conductor swing and clearances shall be carried out in accordance with IEC 60865 to achieve the specified clearances. Post insulators shall be provided at line entry so as to avoid mechanical forces on the LA's etc. 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 earth wire 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. Voltage drop for sizing of power cables shall not be more than 6%. 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. The connectors and clamps shall be rated same as the connected equipments.						
6.2	Clearances The minimum clearances for 132kV switchyard shall be as given below: <table> <tr> <td>Phase to earth clearance</td><td>1300 mm</td></tr> <tr> <td>Phase to phase clearance</td><td>1300 mm</td></tr> <tr> <td>Section clearance</td><td>4000 mm</td></tr> </table> Vendor shall supply the structures suitable to meet the above clearances.	Phase to earth clearance	1300 mm	Phase to phase clearance	1300 mm	Section clearance	4000 mm
Phase to earth clearance	1300 mm						
Phase to phase clearance	1300 mm						
Section clearance	4000 mm						

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6.3	Performance requirement of the equipments All the equipment/materials covered in this specification shall perform all its function satisfactorily without undue strain, restrike etc. under normal operating voltage conditions.
6.4	Supervision of installation/ commissioning of the equipments at site 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.
6.5	Type test requirements of the equipments All equipments to be supplied shall be of type tested design. During detail engineering, vendor shall submit for BHEL/BEL approval the reports of type tests of equipments such as CT, PT, LA, GOS isolator/ earth switch, insulators of various types, VCB breaker, SF6 breaker, Al conductor, earthing conductor, C&R panel etc 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 tests should have been either conducted at an independent laboratory or should have been witnessed by a client. However if vendor 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, vendor shall conduct all such tests under this contract at no additional cost to BHEL either at third party lab or in presence of client/ BHEL 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 offer.

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6.6	Radio interference voltage tests The RIV tests shall confirm to the requirements as per detailed below. 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). Test Levels The test voltage levels for measurement of external RIV are listed under the relevant clauses of the specification. Test Methods for RIV 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. Alternatively, RIV tests shall be in accordance with NEMA standard Publication No. 107 – 1964 except otherwise noted herein. 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. 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. The metering instruments shall be as per CISPR recommendations or equivalent device so long as it has been used by other testing authorities. 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
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6.7 Circuit breaker

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.

Duty requirements

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.

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.

Constructional features

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

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.

Sulphur hexafluoride (SF6) gas circuit breaker

Circuit breakers shall be single pressure type.

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.

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

Operating mechanism

Circuit breaker shall be operated by pneumatic mechanism or electrically spring charged

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mechanism or electro-hydraulic mechanism or a combination of these. It shall be gang operated for 3-phase reclosing operation.

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.

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.

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.

Fittings and accessories

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

Unit compressed air system

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 totalizer.

1. The compressor size shall be such that it is capable of performing following operations satisfactorily.
2. Total running time of compressor not exceeding 45 minutes per day, considering 2% leakage and 2 CO-operations.
3. Air charging time not exceeding 20 minutes after one CO operation of the breaker.

Air Receivers

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

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	provided for shell and dished ends. Receivers shall be hot dip galvanized. Controls and Control Equipment: 1. The compressor control shall be of automatic start stop type initiated by pressure switches on the receiver. Supplementary manual control shall also be provided. 2. 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. 3. Facility to annunciate failure of power supply to the compressor control shall also be provided. Compressed Air Piping, Valves and Fittings: 1. The flow capacity of all valves shall be at least 20% greater than the compressor capacity. 2. 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. 3. All compressed air piping shall be bright annealed, seamless phosphorous Deoxidized Non-Arsenical Copper alloy or stainless steel pipe (C-106 of BS: 2871). Type tests Circuit breaker shall confirm to type tests as per IEC in accordance with the requirement stipulated under clause no. 1.05.00. 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. Sites All routine tests except power frequency voltage dry withstand test on breaker shall be repeated on the completely assembled breaker at site.
6.8	GOS Isolators/ Earth switches General 1. The isolators and accessories shall conform in general to IEC 62271-102 (or equivalent Indian standard) except to the extent explicitly modified in specification. 2. Earth switches shall be provided on isolators wherever called for. 3. The isolators and earth switches shall be AC motor operated. 4. Isolators shall be double break centrally (horizontally) rotated. Duty requirements 1. 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

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	be constructional interlocked so that the earth switches can be operated only when the isolator is open and vice-versa. - In addition to the constructional interlock, isolator and earth switches shall have provision to prevent their electrical and manual operation unless the associated and other interlocking conditions are met. All these interlocks shall be of 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 energized. - Earth 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 electro-dynamic forces on the attached conductor without impairing reliability or current carrying capacity. Constructional features - 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. - The isolator shall be provided with a galvanized 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 earth switch shall be indicated by a mechanical indicator at the lower end of the vertical rod of shaft for the isolator and earth switch. The indicator shall be of metal and shall be visible from operating level. - 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. - 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 earth 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. - The insulator of the isolator shall conform to the requirements stipulated elsewhere and shall have a min. cantilever strength of 600 kg. Earth switches Where earth switches are specified, these shall include the complete operating
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mechanism and auxiliary contacts. The earth switches shall form an integral part of the isolator and shall be mounted on the base frame of the isolator. Earth switches shall be suitable for local operation only. The earth switches shall be constructionally interlocked with the isolator so that the earth switches can be operated only when isolator is open and vice versa.

Operating mechanism and control

- Vendor shall offer motor operated switches having padlock arrangement for both 'ON' and 'OFF' positions.
- 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.
- 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.
- Control cabinet/operating mech. box shall conform to requirements stipulated under auxiliary part and IS: 5039/IS 8623/IEC 60439 as applicable.

Operation

- Isolator shall be electrically/mechanically gang operated for main blades and earth switches. The operation of the three poles shall be well synchronized and interlocked.
- 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 inter-pole operating rods shall be capable of adjustments.
- 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.

Tests

- In continuation to the requirements stipulated elsewhere, the isolator along with 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.
- 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:
 - Bending load test in four directions at 50% min. bending load guaranteed in all insulators.

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	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	Instrument transformers – CT, CVT/PT, Marshalling box Current transformers IEC 60044, BS:3938, IS: 2705 Voltage transformers IEC 60044 IEC 60358, IS:3156 Insulating oil: IS: 335 General 1. 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. 2. The tank as well as top metallic shall be hot dip galvanized or painted with Grey color of shade RAL 9002. 3. The instrument transformers shall be hermetically sealed units. The instrument transformers shall be provided with filling and drain plugs. 4. Polarity marks shall indelibly be marked on each instrument transformer and at the lead terminals at the associated terminal block. 5. The insulators shall have a cantilever strength of more than 350 kg. Current transformers: CT (a) 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: 1. The secondaries shall be totally encased in metallic shielding providing a uniform equipotential surface for even electric field distribution. 2. The lowest part of insulation assembly shall be properly secured to avoid any risk of damage due to transportation stresses. 3. 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. 4. The insulator shall be one piece without any metallic flange joint. (b) 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 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

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	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) CTs shall have provision for taking oil samples from bottom of CT without exposure to atmosphere to carry out dissolved gas analysis periodically. Vendor 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) CT shall have provision for measurement of capacitance and tan delta as erected at site. Voltage transformers CVT/ PT 1. PTs shall be thermally and dielectrically safe when the secondary terminals are loaded with guaranteed thermal burdens. 2. Oil level indicator with danger level marking shall be clearly visible to maintenance personnel standing on ground. 3. The secondary 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. 4. The protection cores shall not saturate at about 1.5 times the rated voltage for a min. duration of 30 secs. 5. The accuracy of metering core shall be maintained through the entire burden range up to 75VA on all three windings without any adjustments during operations. 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.
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	Tests The current and potential 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 : 1. Radio Interference test- As per IS:8263 2. Thermal withstand test i.e. application of rated voltage and rated current simultaneously by synthetic test circuit.(For CT only) 3. 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) 4. Multiple chopped impulse test on Primary winding.
6.10	Surge arrestors/ Lightning arrestors General 1. The surge arrestors shall conform in general to IEC-60099-4 and IS: 3070 except to the extent modified in the specification. 2. Arrestors shall be hermetically sealed units, self-supporting construction, suitable for mounting on lattice/tubular type support structures. Duty requirements 1. Surge arresters shall be capable of discharging over-voltages occurring due to switching of unloaded transformers, reactors and long lines. 2. The reference current of SAs shall be high enough to eliminate the influence of grading and stray capacitance on the measured reference voltage. 3. The SAs shall be capable of withstanding meteorological and short circuit forces under site conditions. Constructional features 1. Each Surge Arrester (SA) shall be hermetically sealed single phase unit. 2. The non-linear blocks shall be sintered metal oxide material. The SA construction shall be robust with excellent mechanical and electrical properties. 3. 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. 4. The SA shall not fail due to porcelain contamination. 5. Seals shall be effectively maintained even when SA discharges rated lightning current. 6. 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. 7. The end fittings shall be non-magnetic and of corrosion proof material. The metal

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	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. 8. Vendor shall furnish the following: - The heat treatment cycle details with necessary quality checks used for individual blocks along with insulation layer formed across each block. - Metalizing coating thickness for reduced resistance between adjacent discs along with procedure for checking the same. - Details of thermal stability test for uniform distribution of current on individual discs. - Detailed energy calculations to prove thermal capability of discs. Fittings and accessories - Each SA shall be complete with insulating base for mounting on structure. - SAs shall be provided with grading and/or corona rings as required. - 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. Notes: - The surge arrestors are provided to protect power transformer, CT/PT, circuit breaker/ GOS isolator. Vendor shall carry out the insulation coordination studies for deciding the location of the surge arrestors. - 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. - The resistive current drawn by the arrestor at rated voltage shall be indicated in the routine test report.
6.11	Post insulators General The post insulators shall conform in general to latest IS: 2544 and IEC – 60815, 60168. Construction features 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.

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	2. Other requirements of insulator as given under auxiliary requirements shall also be applicable. Tests In accordance with the stipulations elsewhere, the post insulators shall conform to type tests, acceptance, sample and routine tests as per IS: 2544, IEC-60168 shall be carried out. In addition to acceptance/ sample/ routine tests as per IS: 2544, the following tests shall also be carried out. - Ultrasonic tests on all cut shells as routine check. - Visual examination and magnaflux test on all flanges prior to fixing. - Check for uniformity of thickness and weight of zinc coating as a sample test from each lot of flanges prior to fixing. - Bending load test shall be carried out at 50% minimum failing load in four directions as a routine test. - 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. - Tests for deflection measurement at 20, 50, 70% of specified minimum failing load on sample. Post insulator shall conform to following type tests : - Lightning Impulse withstand test (dry) - Power frequency withstand test (dry & wet) - Measurement of RIV - Test for deflection under load. - Test for mechanical strength
6.12	Al tube, Al conductor, Earthing conductor, Earth wire Aluminium tubular conductor (In case required) - The aluminium tube shall be grade 63401 WP (range2) as per IS 5082. - There shall be no negative tolerance on OD and thickness of the tube. Other tolerances shall be as per IS: 2678 and 2673. - 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. - Size (outer diameter, thickness, cross section area): as per design requirements - Al grade: 63401 WP (range 2) conforming to IS: 5082 ACSR Conductor: As per IS: 398; Type, overall diameter, wire strands, Al wire diameter, GI wire diameter, weight, UTS to be selected by vendor as per design calculations and as per

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DISCOM/ TRANSCO requirements. Details shall be submitted to BHEL/BEL for approval during detailed engineering.

Earthing conductor

- 1) The main conductor buried in earth shall be 40mm dia rod for main and auxiliary mat. The earth conductors over the ground shall be of 75x12 mm GI flat. The earthing leads for columns and auxiliary structures, cable trenches shall be of 75x12 mm GI flat. The earthing of the lighting fixtures shall be carried out by 16 SWG wire.
- 2) All earthing conductors above the ground level shall be galvanized steel only.

Earthwire for Lightning Protection

1	Number of strands	7 of steel
2	Strand diameter	3.66 mm
3	Overall diameter	10.98 mm
4	Weight	583 Kg/ Km approx.
5	Ultimate tensile strength	68.4 kN minimum
6	Total cross-section area	73.65 sqmm
7	Calculated DC resistance	2.5 Ohms/Km at 20 deg.C
8	Direction of lay of outer layer	Right hand
9	Protective coating for storage	Boiled linseed oil to avoid wet storage stains (white rust)

The earth wire shall be pre-formed and post-formed quality.

6.13 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 Galvanized mild steel for connecting to GI shield wire.
- c) Bolts, nuts and plain washers shall be hot dip galvanized mild steel for sizes M12 and above. For sizes below M12, they shall be electro-galvanized mild steel. The spring washers shall be electro-galvanized mild steel.
- 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.

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	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 at least till erection time.
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6.14	Insulator string hardware for 132kV yard 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. 1) In one span, tension string assembly at one end shall be supplied with suitable turn buckle. 2) Disc Insulator (porcelain type) shall meet the following parameters: a) Type: Anti-fog type insulator b) Size of insulator: 255x145 c) Electro-mechanical strength: 120kN d) Leakage distance: 430mm minimum or as required to meet the total creepage e) Power frequency withstand voltage: 85kV (dry), 50kV (wet) 3) Insulator string shall meet following parameters: a) Type: Porcelain b) Creepage distance: 3625 mm c) Power frequency withstand: 275kV rms, 1min (dry and wet) d) Lightning impulse withstand: +/- 650kV e) Number of disc insulators: 10 Nos (for porcelain type) f) Electro-mechanical strength: 120kN (string-porcelain)
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6.15	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. b) 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. c) 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. d) Glazing of the porcelain shall be uniform brown in colour, free from blisters, burns and other similar defects. e) 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 galvanized. f) 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. g) 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. h) All iron parts shall be hot dip galvanized and all joints shall be air tight. Surface of joints shall be trued, porcelain parts by grinding and metal parts by machining. Insulator/ bushing design shall be such as to ensure a uniform compressive pressure on the joints. i) 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.
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6.16	Cabinets, kiosks, panels, bay marshalling box 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. Bay marshalling box - 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. - It shall have three separate distinct compartments for following purposes: - 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. - To receive three phase incoming from first compartment and to distribute ten (10) single phase ac supplies controlled by 16A two pole MCBs. 150 nos. terminal blocks in vertical formation for interlocking facility.
6.17	Auxiliary switch for circuit breakers The auxiliary switch shall conform of following type tests: - 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. - Mechanical endurance test - A minimum of 5000 operations with a subsequent checking of contact pressure test/ visual examination - Heat run test on contacts - IR/HV test, etc. Type tests All equipment with their terminal connectors, control cabinets, main protective relays, etc. as well as insulators, insulator strings with hardware, 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.
6.18	Fasteners: Bolts, Nuts and Washers 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.

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	b) The bolt shall be of appropriate size and of property class 5.6 minimum as specified in IS: 1367 (Part-III) 1979 and matching nut of property class as specified in IS: 1367 (Part-VI). c) Bolts up to M16 and having length up to 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 galvanized 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 over-tapped beyond 0.4 MM oversize on effective diameter for size up to 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.
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6.19	Installation of switchyards 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. CIVIL WORKS The civil works shall be done in accordance with requirements stipulated elsewhere in the specification. STRUCTURAL STEEL WORKS The structural steel works shall be done in accordance with requirements stipulated elsewhere in the specification. BAY EQUIPMENT - The disposition of equipment to be supplied is shown in enclosed tender drawings. - Vendor shall prepare layout drawings and submit the same for approval of the BHEL. The approval of drg. shall not absolve vendor from his responsibility regarding designing & engineering of switchyard and vendor shall be fully responsible for all works covered in the scope of this specification. EQUIPMENT ERECTION NOTES - All support insulators, circuit breaker interrupters and other fragile equipment shall be handled with cranes with suitable booms and handling capacity. - Where assemblies are supplied in more than one section, vendor shall make all necessary mechanical and electrical connections between sections including the connection between buses. Vendor shall also do necessary adjustments/alignments necessary for proper operation of circuit breakers, isolators and their operating mechanisms. All components shall be protected against damage during unloading, transportation, storage, installation, testing and commissioning. Any equipment damaged due to negligence or carelessness or otherwise shall be replaced by the vendor at his own expense. The vendor shall strictly follow manufacturer's recommendations for handling and erection of equipment. - 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. - 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
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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.

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.

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7.0 C&R panels for the 33kV/ 132kV yards: supplementary clauses

7.1	Control and relay panels for the HT switchyard Control and relay panels for various feeders shall comprise minimum of the equipment as listed below: 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 BHEL for reference. General Requirements of protection system 1. 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. 2. 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. 3. 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. 4. 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. 5. 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.
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Operational Requirements for Numerical Relays and Auxiliary Relays

1. All protection relays to be supplied under this package shall be Numerical type and IEC 61850 compliant.
2. 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 BHEL/BEL 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 BHEL/BEL.
3. Numerical relays shall be suitable for efficient and reliable operation of the protection 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.
4. 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.
5. Except for event logging, alarm and annunciation type of non-trip functions, protective relay contact multiplier relay shall be high speed trip relay only.
6. 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.
7. Pick up range of the Binary inputs shall be minimum 70 V DC /AC.”
8. 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.
9. 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.
10. 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.
11. 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.
12. 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.

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13. 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.

Interface with Existing Bus Bar protection

1. The bidder shall provide all interfacing requirements with the existing 132 kV bus bar protection scheme at switchyard of STU substation. 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.
2. Bidder to take note of existing B/B protection (CAG) relay at STU substation. Details of existing system shall be given to the successful bidder during detail engineering.

Panels

1. 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.
2. 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.
3. Synchronizing socket matching with the existing trolley shall be provided else separate synchronizing trolley shall be provided.
4. 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.
5. 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.
6. The DC supplies at the individual relay and protection panels shall be monitored by suitable relays and failure of DC supplies shall be annunciated.
7. All equipments mounted on front and rear side of the panels should have individual name-plates with equipment designation engraved.
8. Each panel shall also have circuit/feeder designation name plate.
9. 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.
10. Panels shall have removable gland plates with glands made of brass and shall be suitable for armoured cables.
11. 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
12. 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.

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13. All equipment mounted on the panels shall have individual name-plates with equipment designation engraved.
14. Internal wiring to be connected to external equipment shall terminate on terminal blocks. Shall have 20% terminals as spare terminals in each panel.
15. 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.
16. Vendor shall be solely responsible for completeness and correctness of all the wiring, and for proper functioning of the connected equipment.

Earthing

1. The panels shall be equipped with an earth bus of at least 50x6mm² galvanized steel flat bar or equivalent copper.
2. 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.
3. 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.
4. 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.
5. 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.

Control Cabling Philosophy

1. Each three phase secondary core of each CT/VT shall be brought to the associated relay panel through independent cables.
2. 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.
3. 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.
4. 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.
5. 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:
 - a) DC supply to Bay Marshalling box
 - b) DC supply to circuit-breaker cubicle
 - c) DC looping for closing and tripping circuits of circuit-breaker
6. All the interconnections (both AC/DC) within the switchyard and between switchyard and other systems required for the successful implementation of the control, interlocks

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	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 downstream systems of transformer. - Necessary interfacing between Transformer MBs & Control Panel for various Transformer monitoring systems 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. 7. Spare cores shall be provided as per following norms: - Up to 3-core cable: Nil 5-core cable: 1 core minimum 7-14 core cables: 2 cores minimum - More than 14 core cables: 3 cores minimum 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 BHEL/BEL during detailed engineering. 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 BHEL/BEL. - 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. 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. Indicating Instruments - Shall conform to IS: 1248 - Shall be suitable for the instrument transformers as indicated in the drawings enclosed
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	and shall be calibrated to read directly the primary quantities. c) 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. d) 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 e) Current coils shall be 120% of rated current and 10 times for 0.5 sec. without losing accuracy. Recording Instruments (if applicable) The recorders shall a) Shall be draw out type and suitable for back connection. b) Provision for automatic shorting of CT leads shall be provided when recorder is drawn out. c) Shall be dual pen employing potentiometric servo principle. d) Shall record continuously on a calibrated 100mm (min) wide plain paper chart. e) The accuracy of the recording shall be 0.5 % span. Full span response time shall not be less than 2 sec. f) Shall include an inverter for operating on AC supply in case of DC supply failure. Switching shall be automatic. Transducers a) Shall conform to IEC: 60688-1. b) The output of the transducers shall be 4-20mA/0-10mA/10-0-10mA dc as necessary for the instruments. c) Accuracy class shall be 0.5 or better except for frequency transducer, which shall have an accuracy of 0.2. d) Summation transducer shall be suitable for taking multiple inputs from individual MW/MVAR transducers. e) 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 future use. f) Energy transducers shall be suitable for 3 phase, 4 wire connection.
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7.2	Type test requirements Test reports for following type tests shall be submitted for all Bay Control Units (BCU) / Bay Protection Units (BPU) / Energy Meter. Test reports / certificates of tests conducted in laboratories accredited by the national accreditation body of the country (where the lab is located) are also acceptable. A. Insulation tests A1. Dielectric withstand tests as per IEC 60255-5 1. 2kV rms for 1 minute between all case terminals connected together and the case earth. 2. 2kV rms for 1 minute between all terminals of independent circuits with terminals on each independent circuit connected together. A2. Dielectric withstand tests as per ANSI/ IEEE C37.90-1989 1. 1kV rms for 1 minute across the open contacts of the watchdog relays 2. 1kV rms for 1 minute across the open contacts of changeover output relays 3. 1.5kV rms for 1 minute across open contacts of normally open output relays A3. High voltage impulse test As per IEC 60255-5, class-III: 5kV peak, 1.2/50 sec; 0.5J; 3 positive and 3 negative shots at intervals of 5 sec. B. Electrical environmental tests 1. DC supply interruption as per IEC 60255-11 2. AC ripple on DC supply as per IEC 60255-11 3. AC voltage dips and short interruptions as per IEC 61000-4-11 4. High frequency disturbance as per IEC 60255-22-1, class III: at 1MHz, for 2s with 200 source impedance: 2.5kV peak; 1MHz, T=15s, 400 shots/s; duration 2s between independent circuits and case earth. 1kV peak across terminals of the same circuit. 5. Fast transient disturbance as per IEC 60255-22-4, class IV: 4kV, 2.5 kHz applied directly to auxiliary supply; 4kV, 2.5 kHz applied to all inputs. 6. Surge withstand capability as per 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 as per IEC 60255-22-2 class 4: 15kV discharge in air to user interface, display and exposed metal work. 8. Surge immunity as per IEC 61000-4-5: 1995 level 4: 4kV peak, 1.2/50 microsecond between all groups and case earth; 2kV peak, 1.2/50 microsecond between terminals of each group.
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	C. EMC tests 1. Radiated immunity as per C37.90.2: 1995: 25MHz to 1000 MHz 2. Radiated electromagnetic field disturbance test as per IEC 60255-22-3: 80-1000 MHz, amplitude modulated. 3. Disturbances induced by radio frequency fields, amplitude modulated (conducted immunity) as per IEC 60255-22-6: 150 kHz – 80 MHz 4. Power frequency magnetic field as per IEC 61000-4-8, class IV 5. Interference voltage, aux voltage (conducted emission) as per EN 50081-2: 1994 or equivalent 150kHz to 30MHz 6. Interference field strength (radiated emission) as per EN 50081-2: 1994 or equivalent: 30 MHz to 1000 MHz D. Atmospheric environment tests 1. Humidity test as per IEC 60068-2-3 2. Temperature test as per IEC 60255-6, IEC 60068-2-1 for cold, IEC 60068-2-2 for dry heat E. Mechanical stress tests 1. Vibration (during operating and transportation) as per IEC 60255-21-1; IEC 60068-2-6 2. Shock (during operation and transportation) as per IEC 60255-21-2, IEC 68-2-27 3. Seismic vibration (during operation) as per IEC 60255-21-3
7.3	Relay settings The bidder shall provide 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 BHEL/BEL 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

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8.0 ABT metering system: supplementary clauses

8.1	ABT Metering system 1) Metering panel shall have all the constructional features applicable to LT ACDB panel in main control room (Refer details under clause on “LT switchgear panels”). Applicable features include steel frames/ doors/ gland plates/ lifting hooks/ paint finish/ TTBs/ Meter mounting fixtures, routing conduits/trays for aux supply/control wires, cable tie dressing, cable glands/ lugs/ hardware, earthing terminals, panel erection/ grouting/ earthing etc. Cable entry shall be on bottom side. All items shall be in vendor scope of supply. 2) Vendor shall carry out control wiring between CT/PT of outgoer VCB panel and ABT metering panel. Similarly, the aux supply wiring between the Aux AC supply board/panel of the control room. Aux supply and control wires shall be laid on the cable trays in cable trench with appropriate cable tie dressing. 3) The ABT energy meter shall be provided as approved by state DISCOM under the metering scheme, to measure the delivered quantum of energy to the grid for sale. The responsibility of arranging for the meter, its inspection/calibration/testing charges etc rests with the vendor. All charges incurred on Meter testing shall be borne by the vendor. ABT energy metering system is to be approved by state DISCOM. 4) Meter must be provided with the necessary data cables. 5) Vendor shall provide the ABT compliant meter at the interface point. 6) Interface metering shall conform to the Central Electricity Authority (Installation and Operation Meters) Regulation 2006 and amendment thereof Commercial settlement of solar Photovoltaic Grid Interactive based power project. 7) Meter shall be suitable for interfacing for synchronizing the built-in clock of the meter by GPS time synchronization equipment existing at the station either through a synchronization pulse received from the time synchronization equipment or through a remote PC synchronized to GPS clock shall also be in the scope of vendor. 8) All charges for testing and passing of the meter with relevant government agency shall be borne by vendor. BHEL shall assist the vendor for necessary documents as and when required. 9) ABT compliant Energy Meters shall have technical specification as given below (not limited to specified requirement, vendor shall provide Meter with latest facilities): 10) Meters shall be microprocessor-based conforming to IEC 60687 / IEC 6205211/ IEC 62053-22 / IS 14697
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- 11) Meters shall carry out measurement of active energy (both import and export) and reactive energy (import) by 3-phase, 4 wire principle suitable for balanced/ unbalanced 3 phase load.
- 12) Meters shall have an accuracy of energy measurement of at least Class 0.2 for active energy and at least Class 0.5 for reactive energy according to IEC 60687, and shall be connected to Class 0.2s CT cores and Class 0.2 PT windings or as per state grid regulations.
- 13) The active and reactive energy shall be directly computed in CT & VT primary ratings.
- 14) Meters 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.
- 15) 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.
- 16) 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.
- 17) 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	90 days in meter
2.	Aver Frequency	15 min block	90 days in meter
3.	Net MVARH for $V > 103\%$	15 min block	90 days in meter
4.	Cumulative Net MWH	At every midnight	30 days in meter / 90 days in PC
5.	Cumulative Net MVARH for $V > 103\%$	At every midnight	30 days in Meter / 90 days in PC
6.	Date and time blocks of VT failure on any phase.		

- 18) 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.
- 19) Date/time shall be displayed on demand. The clock shall be synchronized by GPS time synchronization equipment existing at the station provided by Bidder.
- 20) The power supply to the meter shall be healthy even with a single- phase PT supply. An automatic backup, in the event of non-availability of voltage in all the phases, shall be

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	provided by a built in long life battery and shall not need replacement for at least 10 years with a continuous PT interruption of at least 2 years. Date and time of PT interruption and restoration shall be automatically stored in a non-volatile memory. 21) Even under the absence of PT input, energy meter display shall be available and it shall be possible to download data from the energy meters. 22) Meters 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. 23) 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. 24) The BHEL/BEL shall have the right to carry out surprise inspections of the Metering Systems from time to time to check their accuracy.
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9.0 General specification for LT switchgear panels

9.1	LT switchgear panels The LT switchgear panels (ACDB, DCDB etc wherever applicable) shall be designed as per the relevant IS codes and as per the approved design for the panel. All the parts of the panels must be rated as per the relevant rated voltage level. All the panels must have multifunction meters (MFM) flushed with the surface of the panels. However, the outgoing feeder can have Tri vector meter (TVM) for the energy accounting. The ACDB panels in main control room shall be rated for the maximum output of the Aux transformer feeding the system. Similarly, ACDB/DCDB boards in inverter rooms shall be rated for the respective capacity on pro-rata basis. The short circuit withstand rating (1 sec) at rated voltage of the switchgear shall be relevant to the existing electrical system short circuit ratings. (1) LT switchgear panels (Construction) (i) Single front / compartmentalized, modular design, degree of protection IP52 with provision of extension on both sides. (ii) Incomer feeders: mains incomer - Electrically operated draw out type Air Circuit Breakers (ACBs)/ Vacuum Circuit breakers (VCBs), as applicable. (iii) Outgoing feeders: Moulded Case Circuit Breakers (MCCBs)/ electrically operated draw out type Air Circuit Breakers (ACBs) / Vacuum Circuit Breakers (VCBs), as applicable. (iv) The colour finish shade of switchgear enclosure for interior shall be glossy white & for exterior it shall be light grey, semi glossy shade 631 of IS: 5. if a different exterior shade is desired by the Employer, the same shall be intimated to the supplier. (v) The LT switchgear panel shall be fabricated out of CRGO sheet steel; 2 mm thick for the outer shall all-round. The internal walls and separators shall be of 1.6 mm thick CRGO sheet steel (vi) The gland plates shall be 3 mm thick
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	(2) Control Circuit - Air Circuit Breaker spring charge motor – 230 V AC, 1 phase - Moulded Case Circuit Breakers – 230 V AC, 1 phase - Space heater, sockets, etc. – 230 V AC, 1 phase - Control supply for breaker closing / tripping - 110V DC - Indications, annunciation – 110V DC (3) Bus Bar & Cable Cavity - The material for main bus bars and tap off bus bars shall be electrolytic grade aluminium with properly colour coded HR PVC sleeved insulation. - Bus bars shall be suitable for short circuit rating and current suitable for all connected load. - Cable entry for incoming and outgoing cables shall be from Bottom. - A suitable gland plate shall be supplied for termination of power, control and instrumentation cables. - Whenever feeders are housed in multi-tier configuration, these tiers shall be segregated by sheet metal barriers. - Earthing: Earthing bus bar shall be terminated at both ends of the switchgear to suit the connections to outside earthing conductor. All components inside the module are required to be earthed individually and are to be looped and connected to the horizontal earth bus. All the non-current carrying parts of the panels, e.g., enclosure, must be connected to earth as per the regulations. (4) Terminals - CT circuit - Isolating link type terminals with shorting facility - PT circuit – clip on type terminals - Spare contacts shall be wired up to terminal block. 10% spare terminals shall be provided for each module (5) Specific requirements - All ACBs/ MCBs, as applicable, shall be 4 pole, electrically operated, draw-out type, with closing coil, spring charge motor, trip coil, TNC switch for close and trip, manual closing and tripping push buttons, door I/L, test and service position micro switches, emergency P.B., safety shutters, etc. The circuit breaker shall be provided with anti-pumping feature. - ACBs/ VCBs, as applicable, shall be complete with microprocessor release and shall be provided with over current, short circuit and earth fault protections. - Minimum 10% spare feeders of each rating shall be provided in the switchgear. - All current transformers shall have 5/1A secondary and all meters shall be suitable for 5/1A operation. - All indicating lamps shall be of LED cluster type. ACB feeders shall be provided with ON, OFF, AUTOTRIP, SPRING CHARGED, TEST, SERVICE, TRIP CIRCUIT HEALTHY indications - All indicating instruments, including MFM, shall be flush mounting, Digital type and of standard size. - Window annunciator with hooter and accept, test, reset button shall be provided. - Necessary auxiliary relays for contact multiplication shall be provided in the panel.
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	(i) The maximum temperature of the bus bars, droppers and contacts at continuous current rating under site reference ambient temperature of 50° C shall not exceed 105° C. (j) Instrumentation: Switchgear instrumentation shall be provided as follows: 1. Mains Incomer – Voltmeter with selector switch 2. Ammeter with selector switch 3. Power Factor meter 4. Frequency meter 5. TVM + MD meter 6. Potential indicating lamps 7. Outgoing Feeders 8. Ammeter with selector switch on all feeders (6) General Technical Specifications (LT Switch gear Panel) (a) The panel shall be self-supporting, free standing, floor mounted, modular type with construction having degree of protection of IP 54 as per IS 2147. (b) The panel shall be fabricated from 14 SWG CRCA sheet steel for frame & load bearing surfaces. Partitions may be fabricated from 16 SWG CRCA if no components are mounted on them. (c) The panel shall be painted with 2 coats of primer after pre-treatment and 2 coats of Polyurethane / epoxy paint with shade as decided BHEL/BEL. (d) Stiffeners shall be provided at corners & between modules to make panel rugged. The stiffeners will necessarily be required for relay compartments or doors where heavy components are mounted. (e) The openable covers will be provided with lift off type hinges, quarter turn door locks and flexible copper wire for earth connection. (f) The panel shall be dust and vermin proof. Synthetic or neoprene gaskets shall be provided at all openings. (g) The panel shall be of dead front construction suitable for front operated and back maintained functioning. (h) Panel shall be provided with fluorescent lamp of 20W capacity operated by door operated limit switch. Panel shall also have space heaters and thermostat arrangement. (i) Panel shall be provided with 3 pin switch socket combined unit of 5 Amp capacity. (j) Lifting hooks shall be provided at the top of the panel. (k) The hardware components used in the panel shall be hot dipped galvanized. (l) The control components shall be fixed on mounting plate by drilling & tapping. (m) Al anodized legend plates shall be provided for all the components. For components mounted on front face, legend plate from inside shall also be provided. (n) Pre-treatment by 7 tank process shall be done before painting / powder coating the panel. (o) Panel shall have provision of drawing pocket. (p) The panel shall be designed to ensure maximum safety during operation inspection, connection of cables and maintenance. Inside panel, checking and removal of components shall be possible without disturbing other units. (q) Cable entries will be from bottom. The opening of cable entry shall be covered by 3 mm thick gland plates. (r) The panel shall be provided with all necessary components / devices and instruments as per the recommended schematic diagram and functional requirements.
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	(s) The components such as protective relays, auxiliary relays, push buttons, switches, instruments shall be flush mounted on the front side of a panel. (t) The control wiring shall be done with PVC insulated flexible copper wire. For CT secondary circuits 2.5 sq.mm wire shall be used. For control wiring 1.5 sq.mm wire will be used. (u) Earthing bus bar of suitable cross section shall be provided throughout the length of panel. (v) The panel shall be fully wired all the terminals shall be brought out for cable connections. 10% spare terminals shall be provided on each terminal block. Separate terminal block shall be provided for different voltages. All wire shall have P.V.C. ferrules as per wiring diagram. (w) Proper shrouding to incoming and outgoing terminals shall be provided to ensure safety during operation, inspection and maintenance. (x) Indicating lamps shall be with multiple LEDs & shall be suitable for the voltage specified. (y) All the components in the panel shall be properly labeled. The labels shall be made of non-rusting metal or engraved PVC material properly fixed by screws. (z) The panel layout shall be made in such a way that it will always facilitate easy removal and reconnection of control cables without disturbing other wiring. (aa) Centre lines of control switches, push buttons and indicating lamps shall be matched so as to give neat appearance. Similarly top lines of indicating instruments and relays shall also be matched. (bb) The panel shall be provided with electrolytic grade Al bus bar of suitable cross section so as to maintain max current density of 0.8 AMP/ Sq.mm. (cc) Bus bars shall be provided with colour coded heat shrinkable insulating sleeves. (dd) Bus bars shall be supported by high quality epoxy insulators provided at specified distances so as to withstand to the given fault level. (ee) The bus bar chambers shall be provided with suitable ventilation arrangements so as to limit the maximum temperature of 85°C while carrying rated current. (ff) Proper clearance of minimum 25 mm shall be maintained between phase bus bars and between bus bars. (gg) The panel shall be inspected at manufactures works before dispatch to site at the discretion of Employer. (hh) All routine tests shall be carried out on the panel in presence of Employer or their representative or its representative. These tests shall include following: (i) Verification of components ratings and operation. (ii) High voltage measurement test. (iii) Insulation Resistance measurement. (iv) Control testing
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10.0 General specification for LT cables

(1) 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.

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

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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:

IS: 1554- 1	PVC insulated (heavy duty) electrical cables for working voltages up to and including 1100V
IS: 3961	Recommended current ratings for cables
IS: 3975	Low carbon galvanized steel wires, formed wires and tapes of 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 up to 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 of decomposition of plastics
IEC 60754 (Part-I)	Tests on gases evolved during combustion of electric cables
IEC 60332	Tests on electric cables under fire conditions. Part-3: Tests on bunched wires or cables (category-B).

(2) LT power cables

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

All 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.

If cables 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.

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:



Sl	Calculated nominal dia of cable under armour	Size and Type of armour
i)	Upto 13 mm	1.4mm dia GS wire
ii)	Above 13 upto 25mm	0.8 mm thick GS formed wire / 1.6 mm dia GS wire
iii)	Above 25 upto 40 mm	0.8mm thick GS formed wire / 2.0 mm dia GS wire
iv)	Above 40 upto 55mm	1.4 mm thick GS formed wire/ 2.5 mm dia GS wire
v)	Above 55 upto 70 mm	1.4mm thick GS formed wire / 3.15mm dia GS wire
vi)	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 aluminium armouring 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 shall be of PVC as per IS: 5831 & black in colour for power 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 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

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- (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.

All cables shall meet the fire resistance requirement as per Category-B of IEC 332 Part-3.

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.

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.

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 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.

CONSTRUCTIONAL FEATURES for LT 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). Cables which are directly buried shall be armoured.

1.1KV grade PVC power cables shall have aluminium/ copper conductor (compacted 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).

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CONSTRUCTIONAL FEATURES for 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.

TESTS

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

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 cable price.

All cables to be supplied shall be of type tested design.

During detailed engineering, the vendor shall submit for BHEL/BEL/SECI 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 vendor 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 vendor shall conduct all such tests under this contract at no additional cost to BHEL either at third party lab or in presence of BHEL/BEL/SECI representative and submit the reports for approval.

The type test reports once approved for any projects shall be treated as reference. Minor changes if any shall be highlighted on the endorsement sheet. **The reports for following type tests shall be furnished:**

Sl	Type Test	Remarks
	Conductor	
1.	Resistance test	
	For Armour Wires / Formed Wires	
2.	Measurement of Dimensions	
3.	Tensile Test	
4.	Elongation test	

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5.	Torsion test	For round wires only
6.	Wrapping test	
7.	Resistance test	
8(a)	Mass & uniformity of Zinc Coating tests	For GS wires/formed wires only.
8(b)	Adhesion test	For GS wires/formed wires only
	For XLPE insulation & PVC Sheath	
9.	Test for thickness	
10.	Tensile strength and elongation test before ageing and after ageing	
11.	Ageing in air oven	
12.	Loss of mass test	For PVC outer sheath only.
13.	Hot deformation test	For PVC outer sheath only.
14.	Heat shock test	For PVC outer sheath only
15.	Shrinkage test	
16.	Thermal stability test	For PVC outer sheath only
17.	Hot set test	For XLPE insulation only
18.	Water absorption test	For XLPE insulation only
19.	Oxygen index test	For PVC outer sheath only
20.	Smoke density test	For PVC outer sheath only
21.	Acid gas generation test	For PVC outer sheath only
22.	Flammability test as per IEC-332 Part-3 (Category -B)	For completed cable only
23.	Insulation resistance (volume resistivity method)	
24.	High voltage test	

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(3) LT control cables

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 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.

Conductor of control cables shall be made of stranded, plain annealed copper.

Outer sheath shall be of PVC as per IS: 5831 & 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.

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.

All cables except module inter-connecting DC cable shall meet the fire resistance requirement as per

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Category-B of IEC 332 Part-3.

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

Cable selection & sizing

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

CONSTRUCTIONAL FEATURES for 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).

(4) Cable Drums

- (a) 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. However, for single core cables up to 6 sqmm size, supplier can do alternative packaging of whole drum/spool to eliminate ingress of water during transportation, storage and erection. Wood preservative anti-termite treatment shall be applied to the entire drum. Wooden drums shall comply with IS: 10418.
- (b) 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.

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11.0 General specification for cable installation methodology

Cable installation Methodology

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 use of steel in overhead transmission line towers
IS: 1079	Hot rolled carbon steel sheet and strips
IS: 1239	Mild steel tubes, tubular and other wrought steel fittings
IS: 1255	Code of practice for installation and maintenance of power cables up to and including 33kV 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 for building and allied structures against lightning
IS: 2629	Recommended practice for hot dip galvanizing of iron and 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 on zinc coated iron and steel articles
IS: 8308	Compression type tubular inline 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 up to 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 and 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

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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.

2. DESIGN AND CONSTRUCTIONAL FEATURE

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 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.

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.

General

The cable slits to be used for motor/equipment power/control supply shall be sand filled & covered with PCC after cabling.

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 sqmm for aluminium conductor and 2.5 sqmm for copper conductor cable.

Conscious exceptions to the above guidelines may be accepted under special conditions but suitable measures should be taken at such location to:

- Meet all safety requirements
- Safeguard against fire hazards, mechanical damage, flooding of water, oil accumulation, electrical faults/interferences etc

3. Cable accessories

3.1 Cable trays, Fittings & Accessories

- 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.
- 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.
- 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.

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- 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 galvanized as per relevant IS. Troughs shall be standard width of 50 mm & 75 mm with depth of 25 mm.

3.2 Support System for Cable Trays

- (a) Cable tray support system shall be pre-fabricated similar or equivalent to "Unistrut make".
- (b) 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:
1. 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.
 2. The system shall be designed such that it allows easy assembly at site by using bolting. All cable supporting steel work, hardwaresfittings and accessories shall be prefabricated factory galvanised.
 3. 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 galvansied surface shall be brushed and red lead primer, oil primer &aluminium paint shall be applied.
 4. All steel components, accessories, fittings and hardware shall be hot dip galvanised after completing welding, cutting, drill ing and other machining operation.
 5. 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.
 - Factor of safety of minimum 1.5 shall be considered.

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) RCC Hume pipes shall be NP3 type as per IS 458.

3.4 Junction Boxes

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- 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.

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 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) 1.1 KV grade Straight Through Joint shall be of proven design.

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.

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.

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

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mechanical strength to withstand the forces generated by the peak value of maximum system short circuit current.

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 exposure to sun rays and outdoor environment.

3.10 Receptacles

Receptacles boxes shall be fabricated out of MS sheet of 2mm thickness and hot dipped 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 polymide 6.6 grade with adequate current rating and size. The welding receptacles shall be provided with inbuilt ELCB rated for suitable mA sensitivity.

3.11 Galvanizing

- Galvanizing of steel components and accessories shall conform to IS: 2629, IS: 4759 & IS: 2633. Additionally galvanizing 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.

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.

4. CABLE INSTALLATION

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

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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) Vendor 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.
- 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 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.

4.2 Conduits/ Pipes/ Ducts Installation

- a) Vendor 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 vendor.
- 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

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

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

4.4 Cable Installation

- b) Cable installation shall be carried out as per IS: 1255 and other applicable standards.
- c) For Cable unloading , pulling etc following guidelines shall be followed in general :
 - o 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.
 - o 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.
- d) Cables shall be laid on cable trays strictly in line with cable schedule
- e) 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 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.

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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.

- f) Bending radii for cables shall be as per manufacturer's recommendations and IS: 1255.
- g) Where cables cross roads/rail tracks, the cables shall be laid in hume pipe/HDPE pipe.
- h) 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.
- i) 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.
- j) Wherever few cables are branching out from main trunk route troughs shall be used.
- k) Wind loading shall be considered for designing support as well Cable trays wherever required.
- l) Where there is a considerable risk of steam, hot oil or mechanical damage cable routes shall be protected by barriers or enclosures.
- m) 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. Vendor 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.

4.5 Separation

At least 300mm clearance shall be provided between :

- HT power & LT power cables,
- LT power & LT control/instrumentation cables,

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.

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d. In switchyard, control cables of each bay shall be laid on separate racks/trays.

4.7 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

4.8 Directly Buried Cables

- 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. Reference drawing for buried cables is included as a tender drawing and enclosed with this specification.
- 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.

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, vendor may also provide cable tags made of nylon, cable marking ties with cable number heat stamped on the cable tags.

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.

5. Cable Terminations & Connections

- The termination and connection of cables shall be done strictly in accordance with cable termination kit manufacturer's instructions, drawings and/or as directed by Project Manager. Cable jointer shall be qualified to carry out satisfactory cable jointing/termination. Vendor shall furnish for review documentary evidence/experience reports of the jointers to be deployed at site.
- 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

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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. Vendor 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 and reliable connections.

12.0 Civil works: supplementary clauses

This section describes the technical requirements of various civil works related to this specification such as brick masonry/ plastering/ painting for earth chambers etc, switchyard fencing works, RCC foundation for switchyard gantry/ tower/ equipment mounting structures, RCC foundation for transmission poles etc.

12.1	Concrete/ RCC Works All RCC works shall be with design mix as per IS: 456 and the materials used viz. Cement, coarse & fine aggregate, Reinforcement steel etc. shall conform to relevant BIS standards. Vendor shall carry out concrete mix design well in advance prior to construction through NABL accredited laboratory/ Reputed Engineering Institute (IITs/NITs/ Government Engineering Institutes only). The minimum grade of RCC shall be M25 except for underground (UG) water tank where the grade of concrete shall be minimum M30. PCC shall be of min. grade M10 (equivalent nominal Mix – 1:3:6) unless otherwise specified. Coarse aggregate for concrete shall be crushed stones chemically inert, hard, strong, durable against weathering of limited porosity and free from deleterious materials. It shall be properly graded. It shall meet the requirements of IS: 383.
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	Sand shall be hard, durable, clean and free from adherent coatings of organic matter and clay balls or pellets. Sand, when used as fine aggregate in concrete shall conform to IS: 383. For plaster, it shall conform to IS: 1542 and for masonry work to IS: 2116 Reinforcement steel shall be of high strength TMT bars of grade Fe500 D conforming to IS: 1786. Ductile detailing in accordance with IS: 13920 shall be adopted for superstructure and sub-structure of all RCC buildings and structures. For grouting works anti shrink ready mix grout of approved make or cement mortar (CM) grout with non-shrink additive shall be used. The grout shall be high strength grout having min. characteristic strength of 30 N/ mm² at 28 days. Foundation system shall be made to transfer loads safely to the soil for structures such as lightning arrestors etc, depending on soil conditions, geographical condition, regional wind speed, bearing capacity, slope stability etc. All foundation system and foundation depth shall be decided based on the approved geotechnical investigation report. No foundation allowed on back filled soil and the foundation depth to reach up to NGL. All loads shall be considered in line with IS: 875. Seismic loads for design shall be in accordance with IS: 1893 and relevant Standards. IS: 2502 Code of Practice for Bending and Fixing of Bars for concrete IS: 5525 and SP: 34 shall be followed for reinforcement detailing. A minimum 75 mm thick PCC shall be provided below RCC wherever RCC is laid over the ground. Proper and sufficient formwork/shuttering shall be provided for the required period as per IS: 456.
12.2	Masonry Works Brick work shall be in cement mortar (CM) 1:6 & 1:4 for 230 mm and 115 mm thick brick wall respectively. Bricks shall be of class designation 7.5 conforming to IS: 1077, IS: 2212 & IS: 3495. All concrete blocks shall be of min. compressive strength of 7.5 N/mm² and shall be of Grade-A conforming to IS: 2185. Bricks/blocks required for masonry work shall be thoroughly soaked in clean water tank for approximately two hours. Brick shall be laid in English bond style. Green masonry work shall be protected from rain. All masonry work shall be kept moist on all the faces for a period of seven days.

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	Suitable damp proof course (DPC) shall be provided. The DPC shall be with PCC (1:2:4) using 6 down coarse aggregate and water proofing admixture. The min. thickness of DPC shall be 40mm
12.3	Plastering, Pointing & Coping Works All brick masonry work shall be provided with plaster. Wall and ceiling plaster shall be in cement mortar (CM) – 1:6 and 1:3 respectively. Thickness of plaster shall be 18mm and 12mm for rough and smooth surface of the brick wall respectively. The ceiling plaster shall be 6mm thick. All joints in stone masonry shall be raked and pointed in cement mortar (CM) – 1:3 except specified otherwise. Exposed top surface of brick or stone masonry shall be provided with 50 thick plain cement concrete (PCC) coping (1:2:4) with trawl finish. All exposed coping shall be provided with suitable slope and projection for easy drainage of water.
12.4	Foundation calculations The foundation system shall be made to transfer loads safely to the soil for the various structures, depending on soil conditions, geographical condition, regional wind speed, bearing capacity, slope stability etc. All foundation system and foundation depth shall be decided based on the approved geotechnical investigation report. No foundation allowed on back filled soil and the foundation depth to reach up to NGL. All loads shall be considered in line with IS: 875. Seismic load for design shall be in accordance with IS: 1893 and relevant Standards. IS: 2502 Code of Practice for Bending and Fixing of Bars for concrete IS: 5525 and SP: 34 shall be followed for reinforcement detailing. A minimum 75 mm thick PCC shall be provided below RCC wherever RCC is laid over the ground. Proper and sufficient formwork/shuttering shall be provided for the required period as per IS: 456.
12.5	Design Loads Unless otherwise specified elsewhere, Dead load, Live load, Wind load and Seismic load for buildings and structures shall be considered as per provisions of relevant IS standards. The following minimum imposed load as indicated for some of the important areas shall, however be considered for the design. If actual expected load is more than the specified minimum load, then actual load is to be considered.

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#	Area	Imposed Load	
a	Roof	150 kg/ Sqm	
b	Building floors	1000 kg/ Sq	
c	RCC Floors (General)	500 kg/ Sqm	
d	Outdoor platforms, Stairs, Landing/	500 kg/ Sqm	
e	Balconies, Walkway, Chequered plate & Grating floor	As per IRC Standard	
f	Road	As per IRC Standard	
f	Road culverts & allied structures over drain & pipe crossings	Design for class -'AA' loading (Wheeled & Tracked both) and check for Class-A loading as per IRC standard	
g	Underground structures such as Sumps, Pits,	In addition to Earth pressure and Ground water table at FGL, a surcharge of 1 T/Sqm shall also be considered	
h	Trench, Drain etc.	In addition to Earth pressure and Ground water table at FGL, a surcharge of 1 T/Sqm shall also be considered	
h	Pre-cast cover over cable trench	400 kg/ Sqm	
	Primary Loads		
	1. Dead Load (DL)		
	2. Live Load (LL)		
	3. Wind Load (WL) – Both along X & Z directions		
	4. Seismic Load (EL) – Both along X & Z direction		
	5.		
	Design Load combinations		
	1. DL+LL		
	2. DL+LL ± WLx		
	3. DL +LL± WLz		
	4. DL+LL ± ELx		
	5. DL+LL ± ELz		
	All buildings, structures and foundations shall be designed to withstand loads corresponding to worst design load combinations. Unless otherwise specified elsewhere in the specifications, the DL, LL, WL and EL shall be estimated as per provisions of relevant BIS standards.		
	Wind Load Factors K2, K2 and K3 – As per IS 875 (Part-3). However, minimum value for K1, K2 and K3 shall be 1.0.		
	Unless otherwise specified elsewhere in the specifications, the Seismic Load shall be considered corresponding to Earth quake zone at site as per IS: 1893 – (Part- 4)		

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12.6	RCC cable trenches Minimum wall and base slab thickness shall be 100mm for depth $\leq$ 750mm and 150mm for depths > 750mm. The trench shall be designed for lateral load due to external soil fill, ground water table at FGL and 50 KN/ Sqm surcharge. External trenches shall be kept minimum 100mm above FGL to avoid entry of rain water. In case of the straight length of the trench being more than 40m, suitable expansion joints with PVC water stop shall be provided. The trench bed shall have a slope of 102pprox.. 1(V):250(H) along and 1(V):50(H) across the length of the trench. The cable trench shall have a dewatering sump of size 450x450x450 mm deep at suitable location to facilitate collection & pumping out of rain water from the trench.
12.7	Metering yard/ switchyard/ transformer yard civil works - Transformer foundations shall be founded on piles/isolated spread footings depending on the geotechnical soil report. - Transformer foundation shall have its own pit that would cover the area of the transformer and radiators so as to collect any spillage of oil or oil drainage in case of emergency. - Oil pit shall be filled with granite stone gravel of 40mm size uniformly graded. The retention capacity of the transformer pit shall be minimum 1/3 volume of the transformer oil which is filled with gravel with 300mm free space above gravel fill. - The individual transformer oil pit shall be connected to an oil collection pit which shall be sized to accommodate full oil volume of the transformer connected to it without backflow. The oil collection pit shall be connected to oily water drainage system. Dimensions of the discharge pipe shall consider rainfall intensity also. Water shall be discharged into the nearest drain by gravity flow or pumping. - Both the transformer pit and the oil collection pit shall be of RCC. The oil collection pit shall be provided with RCC cover. - Area around the transformer, earth chambers and other switchyard equipment structures shall be covered with gravel. - Metering yard and switchyard yard fencing shall be GI chain link fence mesh fabric.

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	a) Mesh size shall be 40x40 mm maximum using wire gauge of 3.15mm minimum thickness, both ends twisted conforming to IS: 2721 with suitable internal corner and stay posts of GI angles along with 230 thick brick/ 300 thick RR masonry toe wall, 150mm height above GL. b) Brick masonry toe wall shall be plastered with 15 thick CM (1:4) plaster on both faces and shall be minimum 50 thick PCC (1:2:4) coping finished smooth and projecting 40mm on either side of the wall and top sloping inwards. c) Height of the chain link above the foundation level shall be 1.8m minimum. d) All vertical, stay and corner posts shall be hot dip galvanized conforming to relevant IS code. Galvanization shall be done after completion of fabrication works, cutting of notches, punching holes etc. Galvanization of fence fabric and tie wire shall conform to IS: 4826. e) Minimum size of GI angle for internal, corner and stay post shall be 50x50x6 mm spaced at 2.5m c/c and conforming to IS: 808-1989. Every corner post shall be provided with two stay posts along either side fence. f) Fencing gate of 3.5m wide shall be of MS pipe frame with welded wire fabric mesh including all accessories and fittings. Top level of the gate shall be on par top level of fence. MS angle posts shall conform to IS: 2062. g) Portion of the fence covering towards rail track shall be made of removable type for movement of transformer during erection/ removal. h) In addition, a small gate, 1.2m wide shall be provide for man entry for maintenance purpose. The transformer yard fencing work shall conform to CEIG requirements. i) Gates as above shall be painted using silver paints as per CEIG requirements. 8. Transformer track rails shall conform to IS: 3443.
12.8	Structural Steel All structural steel shall design shall carried out as per IS 800. Structural steel shall conform IS 2062, Pipe shall be as per medium/high grade of IS 1161, Chequered plates shall conform to 3502 and Hollow steel sections for structural use shall conform to IS: 4923.

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12.9	Grouting Cement mortar (1:2) grout with non-shrink additives shall be used for grouting below base plate of column. The grout shall be high strength grout having a minimum characteristic compressive strength of min 30 N/mm ² at 28 days. The grout shall be chloride - free, cement based, free flowing, non-metallic grout.
12.10	Bore wells Boring and sinking by rig boring system of min 150 mm x 100 mm dia well to be drill to assess potentiality & quantity / availability of water level for deciding filter position through any type of soil, rock & boulders for. Bore well shall be min of 250 mm dia. Minimum 10 deep tube well and supply, installation of casing pipes, submersible pumping set including all mechanical & electrical accessories, fittings etc. complete at site for Solar Module cleaning systems and water supply to buildings requirement. PVC-U casing pipes shall be as per IS 12818.

13.0 List of certain other applicable standards

Apart from the standards referred in various sections / clauses of this specification, list of certain other standards is as below. This list may not be exhaustive. Hence, vendor shall adopt relevant IS/IEC or equivalent standards wherever not explicitly specified in this specification.

IS: 209	Specification of Zinc ingot
IS: 269	Specification of 33 grade ordinary Portland cement
IS: 278	Specification for barbed wire
IS: 383	Coarse and fine aggregates from natural sources for concrete
IS: 398 part-II	Aluminium conductor galvanized steel reinforced
IS: 406	Methods of chemical analysis of slab zinc
IS: 456	Code of practice for plain and reinforced concrete
IS: 731	Porcelain insulators for overhead power lines with a nominal voltage greater than 1000 Volts; Other equivalent standards BS: 137 1973 (I & II), IEC 60274: 1968, IEC 60383: 1976
IS: 800	Code of practice for use of structural steel in general building construction
IS: 802	Code of practice for use of structural steel in overhead transmission line (load, permissible stresses, fabrication, galvanizing, inspection, packing and testing)
IS: 1363	Hexagonal head bolts
IS: 1367	Technical supply conditions for threaded fasteners
IS: 1489	Portland Pozzolana Cement
IS: 1573	Electroplated coating of Zinc on Iron and Steel
IS: 1778	Reels of drums of bare wire
IS: 1786	High strength deformed steel bars and wires for concrete reinforcement
IS: 1893	Criteria of earthquake resistant design of structures

	Specification for design, supply, installation and commissioning, operations and maintenance of 33kV metering yard, 33kV transmission line, 33kV/132kV switchyards for 10MW(AC) solar power plant at Ordnance Factory Bolangir, Odisha	PS-439-1110 Rev 00 Page 105 of 105
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IS: 2016	Plain washers
IS: 2070	Method of impulse voltage testing
IS: 2071	Method of high voltage testing
IS: 2121	Specification for conductors and earth wire accessories for overhead power lines; Part-I armour rods, Part-II Mid-span joints & repair sleeves for conductors
IS: 2131	Method of standard penetration test for soils
IS: 2551	Danger notice plates
IS: 2486	Specification for insulator fittings for overhead power lines with a nominal voltage greater than 1000 Volts; Equivalent standards: BS: 3288, IEC 60120, IEC 60372
IS: 2629	Recommended practice for hot dip galvanizing of iron and steel
IS: 2633	Method of testing uniformity of coating of zinc coated articles
IS: 3043	Code of practice for earthing
IS: 3063	Single coil rectangular section spring washers for bolts, nuts, screws
IS: 3188	Characteristics of string insulator units
IS: 4091	Code of practice for design and transmission line tower and poles
IS: 4218	Metric screw threads
IS: 4759	Hot dip zinc coatings on structural steel and other allied products
IS: 4826	Galvanized coatings on round steel wire
IS: 5300	Porcelain guy strain insulators
IS: 5613	Code of practice for design, installation and maintenance of overhead power lines part-II
IS: 6610	Specification for heavy washers for steel structures
IS: 6639	Hexagonal bolts for structure
IS: 6745	Methods for determination of weight
IS: 7814	Phosphor bronze sheet, strip and foil
IS: 8263	Method of radio interference tests on high voltage insulators; NEEMA 107 – 1964, CISPR/ IEC 60437
IS: 8269	Method of switching impulse test on high voltage insulators
IS: 8500	Structural steel – micro alloyed (medium and high strength qualities)
IS: 9708	Specifications for stock bridge vibration dampers for overhead power lines
IEC 60575	Thermal and mechanical performance test on string insulator units
IS: 12427	Fasteners – threaded steel fasteners – hexagon head transmission tower bolts – specification



DEVELOPMENT OF 7.5MWp AC SOLAR
PHOTOVOLTAIC PLANT BEL- AT OF BOLANGIR



TITLE OF THE DRAWING / DOCUMENT :-

GEOTECHNICAL INVESTIGATION REPORT

BEL DRG NO:- BEL-OFBOL-RP-C001

0	24.01.2016	FOR INFORMATION	MN		HCS		NHK	
REV NO.	DATE	STATUS	INITIALS	SIGN	INITIALS	SIGN	INITIALS	SIGN
			PRPD. BY		CHKD. BY		APPRD. BY	
Project :					BEL-OFBOL-RP-C001		REV	
DEVELOPMENT OF 7.5MWp AC SOLAR							0	
PHOTOVOLTAIC PLANT BEL- AT OF BOLANGIR					24.01.2016		Page 1	

**GEOTECHNICAL INVESTIGATION FOR 10 MWP PV
SOLAR PROJECT AT ORDINANCE FACTORY
BOLANGIR, ODISHA.**

CLIENT

**BHARAT HEAVY ELECTRICALS LIMITED,
ELECTRONICS DIVISION,
BANGALORE.**

TITLE

REPORT

REPORT NO: SI/CHN/16/1352 /02

JANUARY 2017



GEO FOUNDATIONS & STRUCTURES PVT LTD

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SOIL INVESTIGATION REPORT

1.0 INTRODUCTION

- 1.1 The work of sub- soil Investigation for 10 MWp PV Solar Project at ordinance factory Bolangir, Odisha was entrusted to M/s. Geo Foundations and Structures (P) Ltd., Adyar, Chennai – 600 020, by M/s. BHEL EDN, Bangalore.
- 1.2 The soil Investigation and laboratory studies were carried out during **December 2016** and **January 2017**. This report summarizes the results of the soil investigation, and presents recommendation for suitable type of foundations.

2.0 OBJECTIVE OF INVESTIGATION

- 2.1 The objective of soil investigation is to determine the nature and characteristics of sub-soil below the ground level for the proposed structures. The study includes identification of suitable type of foundations for the proposed structures and assessment of safe bearing capacity.

3.0 SCOPE OF WORK

The scope of work at this site comprises of the following:

- 3.1 Mobilization of boring rig with all necessary equipments and personnel.
- 3.2 Boring of **Six** bore holes of 150 mm diameter with Calyx drilling equipments through sand, silt, clay & rock etc up to hard strata.
- 3.3 Conducting Standard Penetration Tests in the bore holes and collecting the representative soil samples including packing and transportation to laboratory.
- 3.4 To conduct the following laboratory tests on soil samples:
- (a) Sieve analysis
 - (b) Index properties:
 - (i) Liquid limit
 - (ii) Plastic limit

- (c) Dry & wet density
 - (d) Water content
 - (e) Specific gravity
 - (f) Direct shear test
 - (g) UCS
- 3.5 Recording ground water level.
- 3.6 Conducting Fifteen CBR Tests.
- 3.7 Conducting Twelve Electrical Resistivity tests.
- 3.8 Conducting Four trial pits.
- 3.9 Preparation and sub submitting detailed report with field and laboratory results and recommendations for foundations.

4.0 FIELD INVESTIGATIONS-GEO-TECHNICAL STUDIES

- 4.1 Boring rig with all requisite equipments and accessories were mobilized at the worksite. A team of technical personnel with skilled labours was also deputed.
- 4.2 **Six** bore holes of 150 mm diameter were bored to a maximum depth up to **10 m** below the existing ground level. The bore holes were made as per relevant Indian Standard IS: 1892.
- 4.3 Representative soil samples were collected at every change of strata of about 1 m depth interval up to the termination depth. The samples so collected were sealed and numbered with full particulars for identification and sent to the laboratory for conducting the required tests.
- 4.4 Standard Penetration tests were conducted in the bore holes, as per the relevant Indian Standard, IS: 2131. In this test, a standard split spoon sampler is driven into the ground at the required depth by means of standard hammer of 63.5 kgs weight, falling from a height of 75 cm. Number of blows for the first 15 cm is not

taken into consideration because of possible disturbances or presence of settled, suspended matters at the bottom of the bore- holes. The total number of blows for the next 30 cm depth of penetration is considered as SPT 'N' value as shown in Figure nos. 1 to 6.

5.0 LABORATORY INVESTIGATION

The following laboratory tests were conducted on the selected soil samples collected from the test bore holes:

- (a) Sieve analysis
- (b) Index properties:
 - (i) Liquid limit
 - (ii) Plastic limit
- (c) Dry & wet density
- (d) Water content
- (e) Specific gravity

The above laboratory tests were carried out as per relevant Indian Standards.

All the soil samples were identified and classified as per relevant Indian Standard, IS: 1498.

The results are shown in Tables Nos. 1 to 6. Trial pit results are shown in Table 6A.

6.0 SOIL PROFILE

Soil profile of the bore holes are as given below:

In bore hole BH 1, Medium dense clayey sand occurs from ground level up to 3 m, followed by dense silty sand up to 4 m, weathered rock up to 7.45 m, there after rock pieces occurs up to **10 m**, at which depth the borehole was terminated.

In bore hole BH 2, medium dense clayey sand/ clayey sand with gravel occurs from ground level up to 3 m dense silty gravely sand up to 4 m, there after weathered rock up to **5 m**, at which depth the borehole was terminated.

In bore hole BH 3, medium dense silty sand occurs from ground level up to 2 m, followed by very dense silty sand up to 4 m, there after rock pieces occurs up to **10 m**, at which depth the borehole was terminated.

In bore hole BH 4, very dense clayey sand occurs from ground level up to 2 m, followed by up very dense silty sand up to 3 m, weathered rock up to 5 m, there after rock pieces up to **6.5 m**, at which depth the borehole was terminated..

In bore hole BH 5, very dense silty gravelly sand occurs from ground level up to 2 m, followed by very dense silty sand up to 3 m, there after rock pieces occurs up to **10 m**, at which depth the borehole was terminated.

In bore hole BH 6, dense silty sand occurs from ground level up to 2m, followed by very dense silty sand up to 4 m, there after rock pieces occurs up to **10 m**, at which depth the borehole was terminated.

7.0 GROUND WATER LEVEL

Ground water level was met at a depth ranging from **1 m** to **2.8 m**, with in the bore holes during the continuous boring from **24.12.2016 to 27.12.2016**.

8.0 DISCUSSION AND RECCOMENDATIONS ON RESULTS AND TYPE OF FOUNDATIONS:

Based on the subsoil conditions discussed in Sl. No. 6, the following recommendations are made for suitable type of foundation for the proposed structure.

Two alternative types of foundations, namely,

1. Open Foundations
2. Pile foundations

Alternative 1: OPEN FOUNDATIONS:

- Open foundations (Individual column footings or combined footings or strip raft combining each row of columns or raft foundation) are recommended.
- Excavation shall be made up to a depth of at least **1.5 m** below the existing ground level, for all foundations, irrespective of the importance of the column or the loading on the column.
- After thorough compaction of the bottom of excavation, PCC for the foundations can be laid on the compacted surface.
- If clayey stratum occurs at the bottom, further excavation of 100 mm is required and after thorough compaction of the bottom of excavation, a layer of clean river sand, 100 mm thickness, shall then be laid. The sand cushion layers shall be at least 200 mm wider on all four sides of the Individual column footings or combined footing or strip raft combining each row of columns. The sand cushion layer shall be watered and well compacted.
- A safe bearing capacity of **15 t/m²** is recommended under the RCC foundations.
- At the time of excavation for foundations, in case ground water table occurs within the recommended depth of excavation, sumps may be made to an additional depth of 0.3 m at one or more corners of the foundation pits for column footings/combined footings or at desired locations along the periphery of excavation for strip raft and the water collected in the sumps may be bailed out. Dewatering shall be maintained until that part of the concrete in the foundations, which comes below the ground water table level, sets.
- The excavated sandy soil can be used for back filling of foundations. Back filling shall be done in layers of not more than 150 mm thickness. Each 150 mm thick layer shall be watered and well compacted (mere spreading the back fill material for back filling is not adequate. Layered compaction shall be done for back filling).

Alternative 2: PILE FOUNDATION :

- Bored cast in-situ concrete pile foundations of **1.5 m** length from existing ground level are recommended.
- The recommended safe load carrying capacities of bored cast in situ concrete piles as per IS 2911 (Part 1/Sec2) for 30 cm pile diameter are presented in Table 7.

TABLE 7

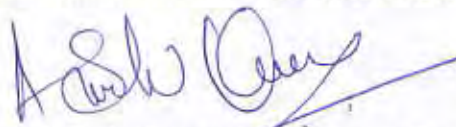
Approximate Length of Pile from G.L (m)	Dia (cm)	Recommended Safe Vertical Capacity (T)	Lateral Capacity (T)	Up lift capacity (T)
1.5	30	4	1	1.8

9.0 CHEMICAL ANALYSIS OF SOIL AND WATER:

The results of chemical analysis of soil and water samples are presented in Appendix V.

- 10.0** The results and recommendations given in this report are based on the results of the soil investigation carried out. In actual execution, if any variation is found, the consultants may also be referred to.

For GEO FOUNDATIONS & STRUCTURES PVT. LTD.



A. Suresh Kumar, M.Tech (Geo technical), M.B.A (T.M)

D.G.M. (Geo Technical)

APPROVED BY,



Dr. K. Muthukrishnaiah BE (Hons), M.Tech., Ph.D.,
(Professor & Head, Ocean Engineering Dept. IIT Madras)(Rtd),
(Chief Consultant)



Annexure – 1

DESIGN PARAMETERS

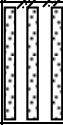
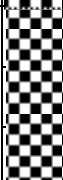
Location	Depth from EGL	Type of sub Soil stratum	Shear Parameters		k_i	γ_{dry}
	(m)		C (kg/cm ²)	ϕ in degree		gm/cc
All Bore holes (BH 1 to BH 6)	0 to 1.5	Silty SAND/ Clayey SAND	-	31	1	1.7
BH 2	1.5 to 2 m	Clayey SAND	-	32	1.2	1.8
All other bore holes except BH 2	1.5 to 2 m	Silty SAND/ Clayey SAND	-	35	1.3	2

Where,

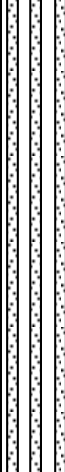
C - Cohesion in kg/cm² ϕ - Angle of internal friction k_i – Earth pressure coefficient γ_{dry} – Dry density in gm/cc

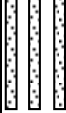
APPENDIX I

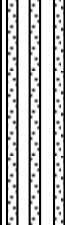
BORELOGS

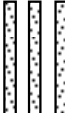
Project : Soil investigation for the proposed 10 MWp PV Solar Project at Ordnance Factory Bolangir, Odisha.																				
 GEO FOUNDATIONS & STRUCTURES PVT. LTD					Bore Hole No : 1 Location : Bolangir Co-ordinates : 739536 E, 2256354 N Type of Boring : Calyx Ground Water Level : 2.10 m from GL on 25.12.2016 Termination Depth : 10.00 m								Drillhole Record -01							
													Fig No. 1							
Start Date : 24.12.2016 End Date : 24.12.2016																				
SOIL DESCRIPTION	COLOUR	STRUCTURE	GROUND LEVEL (m)	LEGEND	TEST NO	SAMPLE TYPE	DEPTH (m)	TEST DEPTH(m)	PENETRATION VALUES			SPT 'N' Blows/300mm	SPT 'N' PROFILE					C.R (%)	R.Q.D(%)	REMARKS
									15cm	30cm	45cm		20	40	60	80	100			
Clayey SAND (SC-CL)	Brown	Medium Dense, Granular	3.00		UDS-1	OT	0.50	0.50-0.95	-	-	-	-								
					SPT-1	SS	1.00	1.00-1.45	7	9	13	22								
					SPT-2	SS	2.00	2.00-2.45	7	16	19	35								
Silty SAND (SM)	Brown	Dense, Granular	4.00		SPT-3	SS	3.00	3.00-3.45	15	19	22	41								
					SPT-4	SS	4.00	4.00-4.13	>50	-	-	>100								
Weathered Rock			7.45		SPT-5	SS	5.00	5.00-5.10	>50	-	-	>100								
					SPT-6	SS	6.50	6.50-6.58	>50	-	-	>100								
					SPT-7	SS	7.45	7.45-7.45	-	-	-	>100								
Rock Pieces			10.00		CR-1	CS	7.45	7.45-8.50	-	-	-	-								
					CR-2	CS	8.50	8.50-10.00	-	-	-	-								
G.W.L: 2.10 m from G.L on 25.12.2016			No of SPT: 07 Nos			No of UDS: 01 Nos			No of CR: 02 Nos			Remarks								

Project : Soil investigation for the proposed 10 MWp PV Solar Project at Ordnance Factory Bolangir, Odisha.																					
 GEO FOUNDATIONS & STRUCTURES PVT. LTD					Bore Hole No : 2 Location : Bolangir Co-ordinates : 739674 E , 2256176 N Type of Boring : Calyx Ground Water Level : 1.00 m from GL on 26.12.2016 Termination Depth : 5.00 m					Drillhole Record -02 Fig No. 2 Start Date : 25.12.2016 End Date : 25.12.2016											
					SOIL DESCRIPTION	COLOUR	STRUCTURE	GROUND LEVEL (m)	LEGEND	TEST NO	SAMPLE TYPE	DEPTH (m)	TEST DEPTH(m)	PENETRATION VALUES			SPT 'N' Blows/300mm	SPT 'N' PROFILE			
									15cm	30cm	45cm		20	40	60	80	100				
Clayey SAND (SC-CL)	Brown	Medium Dense, Granular	2.00		UDS-1	OT	0.50	0.50-0.95	-	-	-	-									
					SPT-1	SS	1.00	1.00-1.45	4	5	7	12									
Brownish, Medium dense, Clayey SAND with Gravel (SC-CL-G)			3.00		UDS-2	OT	1.50	1.50-1.95	-	-	-	-									
					SPT-2	SS	2.00	2.00-2.45	8	8	10	18									
Silty Gravely SAND (SM-G)	Brown	Dense Granular	4.00		SPT-3	SS	3.00	3.00-3.45	19	22	26	48									
					SPT-4	SS	4.00	4.00-4.42	21	27	>50	>100									
Weathered Rock			5.00		SPT-5	SS	5.00	5.00-5.23	29	>50	-	>100									
G.W.L.: 2.50 m from G.L on 27.12.2016			No of SPT: 05 Nos			No of UDS: 02 Nos			Remarks												

Project : Soil investigation for the proposed 10 MWp PV Solar Project at Ordnance Factory Bolangir, Odisha.																				
 GEO FOUNDATIONS & STRUCTURES PVT. LTD					Bore Hole No : 3 Location : Bolangir Co-ordinates : 739853 E , 2256157 N Type of Boring : Calyx Ground Water Level : 2.50 m from GL on 27.12.2016 Termination Depth : 10.00 m					Drillhole Record -03 Fig No. 3 Start Date : 25.12.2016 End Date : 26.12.2016										
SOIL DESCRIPTION	COLOUR	STRUCTURE	GROUND LEVEL (m)	LEGEND	TEST NO	SAMPLE TYPE	DEPTH (m)	TEST DEPTH(m)	PENETRATION VALUES			SPT 'N' Blows/300mm	SPT 'N' PROFILE					C.R (%)	R.Q.D(%)	REMARKS
									15cm	30cm	45cm		20	40	60	80	100			
Silty SAND (SM)	Brown	Medium Dense, Granular	2.00		UDS-1	OT	0.50	0.50-0.95	-	-	-	-								
					SPT-1	SS	1.00	1.00-1.45	8	8	10	18								
	SPT-2	SS	2.00		2.00-2.27	32	>50	-	>100											
	Brown	Very Dense, Granular	4.00		SPT-3	SS	3.00	3.00-3.25	31	>50	-	>100								
SPT-4				SS	4.00	4.00-4.02	>50	-	-	>100										
CR-1				CS	4.02	4.02-5.00	-	-	-	-										
CR-2				CS	5.00	5.00-6.00	-	-	-	-										
Rock Pieces				CR-3	CS	6.00	6.00-7.00	-	-	-	-									
				CR-4	CS	7.00	7.00-8.00	-	-	-	-									
				CR-5	CS	8.00	8.00-9.00	-	-	-	-									
				CR-6	CS	9.00	9.00-10.00	-	-	-	-									
G.W.L: 2.50 m from G.L on 27.12.2016			No of SPT: 04 Nos			No of UDS: 01 Nos			No of CR: 06 Nos			Remarks								

Project : Soil investigation for the proposed 10 MWp PV Solar Project at Ordnance Factory Bolangir, Odisha.																				
 GEO FOUNDATIONS & STRUCTURES PVT. LTD						Bore Hole No : 4 Location : Bolangir Co-ordinates : 739670 E, 2255707 N Type of Boring : Calyx Ground Water Level : 1.30 m from G.L on 27.12.2016 Termination Depth : 6.50 m								Drillhole Record -04						
														Fig No. 4						
														Start Date : 26.12.2016 End Date : 26.12.2016						
SOIL DESCRIPTION	COLOUR	STRUCTURE	GROUND LEVEL (m)	LEGEND	TEST NO	SAMPLE TYPE	DEPTH (m)	TEST DEPTH(m)	PENETRATION VALUES			SPT 'N' Blows/300mm	SPT 'N' PROFILE					C.R (%)	R.Q.D.(%)	REMARKS
									15cm	30cm	45cm		20	40	60	80	100			
Clayey SAND	Brown	Very Dense, Granular	2.00		UDS-1	OT	0.50	0.50-0.95	-	-	-	-							G.W.L 50/11 cm Penetration	
					SPT-1	SS	1.00	1.00-1.41	19	25	>50	>100								
Silty SAND (SM)	Brown	Very Dense, Granular	3.00		SPT-2	SS	2.00	2.00-2.15	>50	-	-	>100							50/15 cm Penetration	
					SPT-3	SS	3.00	3.00-3.03	>50	-	-	>100						50/03 cm Penetration		
Weathered Rock			5.00		SPT-4	SS	4.00	4.00-4.04	>50	-	-	>100							50/04 cm Penetration	
					SPT-5	SS	5.00	5.00-5.00	-	-	-	>100						Rebound		
Rock Pieces			6.50		SPT-1 CR-1	CS	5.00	5.00-6.50	-	-	-	-						Nil Nil		
G.W.L: 1.30 m from G.L on 27.12.2016			No of SPT: 05 Nos			No of UDS: 01 Nos			No of CR: 01 Nos			Remarks								

Project : Soil investigation for the proposed 10 MWp PV Solar Project at Ordnance Factory Bolangir, Odisha.																										
 GEO FOUNDATIONS & STRUCTURES PVT. LTD						Bore Hole No : 5 Location : Bolangir Co-ordinates : 739526 E , 2255858 N Type of Boring : Calyx Ground Water Level : 2.80 m from GL on 28.12.2016 Termination Depth : 10.00 m				Drillhole Record -05 Fig No. 5 Start Date : 26.12.2016 End Date : 27.12.2016																
						SOIL DESCRIPTION					COLOUR	STRUCTURE	GROUND LEVEL (m)	LEGEND	TEST NO	SAMPLE TYPE	DEPTH (m)	TEST DEPTH(m)	PENETRATION VALUES			SPT 'N' Blows/300mm	SPT 'N' PROFILE			
Silty Gravely SAND (SM-G)						Brown	Very Dense Granular	2.00		UDS-1	OT	0.50	0.50-0.95	-	-	-	-	20	40	60	80	100				
Brownish, Very dense, Silty SAND (SM)								3.00		SPT-1	SS	1.00	1.00-1.45	15	22	29	51									
Rock Pieces							SPT-2	SS	2.00	2.00-2.25	40	>50	-	>100	Rebound											
							SPT-3	SS	2.90	2.90-2.90	-	-	-	>100												
							CR-1	CS	2.90	2.90-4.00	-	-	-	-	Nil	Nil										
							CR-2	CS	4.00	4.00-5.00	-	-	-	-												
							CR-3	CS	5.00	5.00-6.00	-	-	-	-	Nil	Nil										
							CR-4	CS	6.00	6.00-7.00	-	-	-	-												
							CR-5	CS	7.00	7.00-8.00	-	-	-	-	Nil	Nil										
						CR-6	CS	8.00	8.00-9.00	-	-	-	-													
						CR-7	CS	9.00	9.00-10.00	-	-	-	-	Nil	Nil											
G.W.L: 2.80 m from G.L on 28.12.2016						No of SPT: 03 Nos		No of UDS: 01 No		No of CR: 07 Nos		Remarks														

Project : Soil investigation for the proposed 10 MWp PV Solar Project at Ordnance Factory Bolangir, Odisha.																						
 GEO FOUNDATIONS & STRUCTURES PVT. LTD					Bore Hole No : 6 Location : Bolangir Co-ordinates : 739600 E , 2255958 N Type of Boring : Calyx Ground Water Level : 2.50 m from GL on 28.12.2016 Termination Depth : 10.00 m					Drillhole Record -06 Fig No. 6 Start Date : 27.12.2016 End Date : 27.12.2016												
					SOIL DESCRIPTION	COLOUR	STRUCTURE	GROUND LEVEL (m)	LEGEND	TEST NO	SAMPLE TYPE	DEPTH (m)	TEST DEPTH(m)	PENETRATION VALUES			SPT 'N' Blows/300mm	SPT 'N' PROFILE				
									15cm	30cm	45cm		20	40	60	80	100					
Silty SAND	Brown	Dense Granular	2.00		UDS-1	OT	0.50	0.50-0.95	-	-	-	-										
		SPT-1	SS		1.00	1.00-1.45	14	19	22	41												
	Very Dense, Granular				SPT-2	SS	2.00	2.00-2.45	17	23	27	50										
					4.00	SPT-3	SS	3.00	3.00-3.45	19	24	29	53									
Rock Pieces				SPT-4	SS	4.00	4.00-4.20	27	>50	-	>100											
				CR-1	CS	4.00	4.00-5.00	-	-	-	-											
				CR-2	CS	5.00	5.00-6.00	-	-	-	-											
				CR-3	CS	6.00	6.00-7.00	-	-	-	-											
				CR-4	CS	7.00	7.00-8.00	-	-	-	-											
				CR-5	CS	8.00	8.00-9.00	-	-	-	-											
				CR-6	CS	9.00	9.00-10.00	-	-	-	-											
G.W.L: 2.50 m from G.L on 28.12.2016			No of SPT: 04 Nos			No of UDS: 01 No			No of CR: 06 Nos			Remarks										

Note: SPT-Standard Penetration Test SS-Soil Sample
OT - Open Tube

UDS-Un Disturbed Sample CS-Core Sample

CR-Core Recovery, RQD-Rock Quality Designation

APPENDIX II

**LABORATORY TEST
RESULTS**

TEST RESULTS			Project : Soil Investigation work for the Proposed 10 MWp PV Solar Project at Ordnance factory Bolangir, Odisha.					Boring Start: 24.12.2016			Termination Depth(m)			Table No.				
								Boring End : 24.12.2016			10.00			1				
								Location			G.W.T (m)			Bore-Hole No.				
								739536 E 2256354 N										
N VALUE	DEPTH (m)	SAMPLE	SOIL DESCRIPTION	IS. CLASSIFICATION	GRAIN SIZE ANALYSIS			ATTERBERG LIMITS			DRY DENSITY, gm/cc	WET DENSITY, gm/cc	WATER CONTENT, %	SPECIFIC GRAVITY	FREE SWELL INDEX, %	SHEAR PARAMETERS		
					GRAVEL, %	SAND, %	SILT & CLAY %	LIQUID LIMIT.%	PLASTIC LIMIT.%	PLASTICITY INDEX						TEST METHOD	C in Kg/cm²	φ in degrees
-	0.50	UDS-1	Clayey SAND	SC-CL	1	52	47	28	10	18			20	2.66		DS		30
22	1.00	SPT-1	Clayey SAND	SC-CL	1	55	44	31	10	21			21					
35	2.00	SPT-2	Clayey SAND	SC-CL	0	52	48	33	11	22			20					
41	3.00	SPT-3	Silty SAND	SM	4	68	28						13					
>100	4.00	SPT-4	Weathered Rock															
>100	5.00	SPT-5	Weathered Rock															
>100	6.50	SPT-6	Weathered Rock															
>100	7.45	SPT-7	Rock pieces															
-	7.45-8.50	CR-1	Rock pieces															
-	8.50-10.00	CR-2	Rock pieces															

TEST RESULTS			Project : Soil Investigation work for the Proposed 10 MWp PV Solar Project at Ordnance factory Bolangir, Odisha.					Boring Start: 25.12.2016		Termination Depth(m)		Table No.						
								Boring End : 25.12.2016		5.00		2						
								Location		G.W.T (m)		Bore-Hole No.						
								739674 E 2256176 N										
N VALUE	DEPTH (m)	SAMPLE	SOIL DESCRIPTION	IS. CLASSIFICATION	GRAIN SIZE ANALYSIS			ATTERBERG LIMITS			DRY DENSITY, gm/cc	WET DENSITY, gm/cc	WATER CONTENT, %	SPECIFIC GRAVITY	FREE SWELL INDEX, %	SHEAR PARAMETERS		
					GRAVEL, %	SAND, %	SILT & CLAY %	LIQUID LIMIT, %	PLASTIC LIMIT, %	PLASTICITY INDEX						TEST METHOD	C in Kg/cm²	φ in degrees
-	0.50	UDS-1	Clayey SAND	SC-CL	9	52	39	31	11	20			18	2.65		DS		31
12	1.00	SPT-1	Clayey SAND	SC-CL	8	52	40	30	9	21			17					
-	1.50	UDS-2	Clayey SAND	SC-CL	8	53	39	31	10	21			15	2.67		DS		32
18	2.00	SPT-2	Clayey SAND with Gravel	SC-CL-G	10	56	34	28	18	10			12					
48	3.00	SPT-3	Silty Gravely SAND	SM-G	36	47	17						11					
>100	4.00	SPT-4	Weathered Rock															
>100	5.00	SPT-5	Weathered Rock															

TEST RESULTS			Project : Soil Investigation work for the Proposed 10 MWp PV Solar Project at Ordnance factory Bolangir, Odisha.					Boring Start: 25.12.2016		Termination Depth(m)		Table No.						
								Boring End : 26.12.2016		10.00		3						
								Location		G.W.T (m)		Bore-Hole No.						
								739853 E 2256157 N										
N VALUE	DEPTH (m)	SAMPLE	SOIL DESCRIPTION	IS. CLASSIFICATION	GRAIN SIZE ANALYSIS			ATTERBERG LIMITS			DRY DENSITY, gm/cc	WET DENSITY, gm/cc	WATER CONTENT, %	SPECIFIC GRAVITY	FREE SWELL INDEX, %	SHEAR PARAMETERS		
					GRAVEL, %	SAND, %	SILT & CLAY %	LIQUID LIMIT, %	PLASTIC LIMIT, %	PLASTICITY INDEX						TEST METHOD	C in Kg/cm²	Φ in degrees
-	0.50	UDS-1	Silty SAND	SM	1	71	28						18	2.66		DS		31
18	1.00	SPT-1	Silty SAND	SM	0	68	32	Non plastic					14					
>100	2.00	SPT-2	Silty SAND	SM	0	75	25						21					
>100	3.00	SPT-3	Silty SAND	SM	1	75	24						11					
>100	4.00	SPT-4	Weathered Rock															
-	4.02-5.00	CR-1	Rock pieces															
-	5.00-6.00	CR-2	Rock pieces															
-	6.00-7.00	CR-3	Rock pieces															
-	7.00-8.00	CR-4	Rock pieces															
-	8.00-9.00	CR-5	Rock pieces															
-	9.00-10.00	CR-6	Rock pieces															

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TEST RESULTS			Project : Soil Investigation work for the Proposed 10 MWp PV Solar Project at Ordnance factory Bolangir, Odisha.					Boring Start: 26.12.2016			Termination Depth(m)				Table No.			
								Boring End : 26.12.2016			6.50				4			
								Location			G.W.T (m)				Bore-Hole No.			
								739670 E 2255707 N										
N VALUE	DEPTH (m)	SAMPLE	SOIL DESCRIPTION	IS. CLASSIFICATION	GRAIN SIZE ANALYSIS			ATTERBERG LIMITS			DRY DENSITY, gm/cc	WET DENSITY, gm/cc	WATER CONTENT, %	SPECIFIC GRAVITY	FREE SWELL INDEX, %	SHEAR PARAMETERS		
					GRAVEL, %	SAND, %	SILT & CLAY %	LIQUID LIMIT.%	PLASTIC LIMIT.%	PLASTICITY INDEX						TEST METHOD	C in Kg/cm ²	Φ in degrees
-	0.50	UDS-1	Clayey SAND	SC-CL	3	62	35	31	15	16			15			DS		35
>100	1.00	SPT-1	Clayey SAND	SC-CI	5	62	33	38	18	20			15					
>100	2.00	SPT-2	Silty SAND	SM	1	73	26						13					
>100	3.00	SPT-3	Weathered Rock															
>100	4.00	SPT-4	Weathered Rock															
>100	5.00	SPT-5	Rock pieces															
-	5.00-6.50	CR-1	Rock pieces															

TEST RESULTS			Project : Soil Investigation work for the Proposed 10 MWp PV Solar Project at Ordnance factory Bolangir, Odisha.					Boring Start: 26.12.2016		Termination Depth(m)		Table No.						
								Boring End : 27.12.2016		10.00		5						
								Location		G.W.T (m)		Bore-Hole No.						
								739526 E 2255858 N										
N VALUE	DEPTH (m)	SAMPLE	SOIL DESCRIPTION	IS. CLASSIFICATION	GRAIN SIZE ANALYSIS			ATTERBERG LIMITS			DRY DENSITY, gm/cc	WET DENSITY, gm/cc	WATER CONTENT, %	SPECIFIC GRAVITY	FREE SWELL INDEX, %	SHEAR PARAMETERS		
					GRAVEL, %	SAND, %	SILT & CLAY %	LIQUID LIMIT, %	PLASTIC LIMIT, %	PLASTICITY INDEX						TEST METHOD	C in Kg/cm²	Φ in degrees
-	0.50	UDS-1	Silty Gravely SAND	SM-G	22	51	27						12	2.65		DS		33
51	1.00	SPT-1	Silty Gravely SAND	SM-G	41	43	16						10					
>100	2.00	SPT-2	Silty SAND	SM	9	75	16						11					
>100	2.90	SPT-3	Rock pieces															
-	2.90-4.00	CR-1	Rock pieces															
-	4.00-5.00	CR-2	Rock pieces															
-	5.00-6.00	CR-3	Rock pieces															
-	6.00-7.00	CR-4	Rock pieces															
-	7.00-8.00	CR-5	Rock pieces															
-	8.00-9.00	CR-6	Rock pieces															
-	9.00-10.00	CR-7	Rock pieces															

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TEST RESULTS			Project : Soil Investigation work for the Proposed 10 MWp PV Solar Project at Ordnance factory Bolangir, Odisha.					Boring Start: 27.12.2016		Termination Depth(m)		Table No.						
								Boring End : 27.12.2016		10.00		6						
								Location		G.W.T (m)		Bore-Hole No.						
								739600 E 2255958 N										
N VALUE	DEPTH (m)	SAMPLE	SOIL DESCRIPTION	IS. CLASSIFICATION	GRAIN SIZE ANALYSIS			ATTERBERG LIMITS			DRY DENSITY, gm/cc	WET DENSITY, gm/cc	WATER CONTENT, %	SPECIFIC GRAVITY	FREE SWELL INDEX, %	SHEAR PARAMETERS		
					GRAVEL, %	SAND, %	SILT & CLAY %	LIQUID LIMIT, %	PLASTIC LIMIT, %	PLASTICITY INDEX						TEST METHOD	C in Kg/cm²	Φ in degrees
-	0.50	UDS-1	Silty SAND	SM	4	71	25						16					
41	1.00	SPT-1	Silty SAND	SM	2	65	33	Non plastic					15					
50	2.00	SPT-2	Silty SAND	SM	1	78	21						23					
53	3.00	SPT-3	Silty SAND	SM	0	75	25						13					
>100	4.00	SPT-4	Rock pieces															
-	4.20-5.00	CR-1	Rock pieces															
-	5.00-6.00	CR-2	Rock pieces															
-	6.00-7.00	CR-3	Rock pieces															
-	7.00-8.00	CR-4	Rock pieces															
-	8.00-9.00	CR-5	Rock pieces															
-	9.00-10.00	CR-6	Rock pieces															

APPENDIX III

CBR TEST RESULT

2.0 CALIFORNIA BEARING RATIO TEST RESULTS

2.1.0 INTRODUCTION

- The soil samples were collected from the site and the laboratory testing on the soil samples were carried out during **December 2016 and January 2017**. This report summarizes the results of the investigation and furnishes result of California Bearing ratio Tests on soil samples.

2.2.0 OBJECTIVE OF THE SOIL INVESTIGATION

- The objectives of the soil investigation are to evaluate the California Bearing ratio values of soil sample collected from fifteen locations at a depth of 0.5 m from the existing ground level.

2.3.0 SCOPE OF WORK

The scope of work at this site comprised the following:

- Mobilization of all necessary equipments and personnel.
- Collecting soil samples from the specified locations, packing and transporting to laboratory.
- Conducting California Bearing Ratio Tests.
- Preparation and submission of the laboratory results.

2.4.0 LABORATORY INVESTIGATION

- California bearing ratio tests were conducted on the soil samples at maximum dry density, as per the relevant Indian Standard, IS 2720: Part 16 : 1987, The results of CBR tests are presented in **Table 2.1**.

2.5.0 CONCLUSIONS

The field and laboratory tests were carried out as per the relevant Indian Standard and the results show that the CBR value varies from 4.5 to 13.6 at the maximum dry density and optimum moisture content.

Table 2.1			
SL.NO	SAMPLE TYPE	SAMPLE NAME	CBR %
1	Sandy CLAY	CBR-1	5.0
2	Sandy CLAY	CBR-2	4.5
3	Sandy CLAY	CBR-3	4.6
4	Clayey SAND	CBR-4	13.6
5	Clayey SAND	CBR-5	12.2
6	Silty SAND	CBR- 6	12.4
7	Clayey SAND	CBR- 7	12.8
8	Silty SAND	CBR- 8	13.2
9	Silty SAND	CBR- 9	12.6
10	Silty SAND	CBR- 10	13.5
11	Silty SAND	CBR- 11	12.5
12	Silty SAND	CBR- 12	11.8
13	Silty SAND	CBR- 13	13.2
14	Silty SAND	CBR- 14	13.5
15	Silty SAND	CBR- 15	12.8

APPENDIX IV

ELECTRICAL RESISTIVITY **TEST**

3.0 ELECTRICAL RESISTIVITY TEST

3.1.0 INTRODUCTION

3.1.1 The field studies were carried out in **December 2016**. This report summarizes Earth Resistivity values for 12 different locations.

3.2.0 OBJECT OF INVESTIGATION

3.2.1 The object of investigation is to ascertain the variation in apparent resistivity of sub-soil below the ground level and to obtain an idea about the variation in soil profile at the proposed site. Electrical Resistivity values are required for designing safety grounding system in the area.

3.3.0 FIELD INVESTIGATIONS

- 3.3.1 The method depends on the difference in the electrical resistance of different soil strata. These are several methods by which the field resistivity measurements are made. The most popular method is by Wenner's four-electrode configuration. The test is carried out as per IS 3043-1987.
- 3.3.2 The particular location required for conducting the tests were cleared and made free from disturbances.
- 3.3.3 Four electrodes were driven into the ground at equal spacing and designed depth. The four electrodes are connected to the terminals of the earth resistivity meter. The resistivity meter is pressed "ON" to allow the current to flow through the electrodes. On pressing the "TEST" switch available in the meter for 10 ohms and 1000 ohms, the resistance value is displayed in the meter, which is noted down.
- 3.3.3 Readings of resistance for different electrode spacing in different directions are noted as per the said procedure.

3.4.0 METHOD OF COMPUTING OF RESISTIVITY VALUE

Earth resistivity is calculated by according to the formula.

$$= 2 \pi d R$$

Where

R = resistance in Ohms (megger reading for 10 ohm)

d = is the distance between spikes if spikes are placed at equal distances (m).



3.5.0 RESULTS

The values of resistivity, calculated as per formula given in section 4.0 above are as enclosed. After finding out the resistivity, average resistivity value at very test locations were also calculated and given in Table No: 3.1. The polar resistivity curves were drawn as per IS: 3043-1987 under Clause: 36.6. and corresponding other graphs are also drawn as show in **Annexure - I.**



Table No.3.1

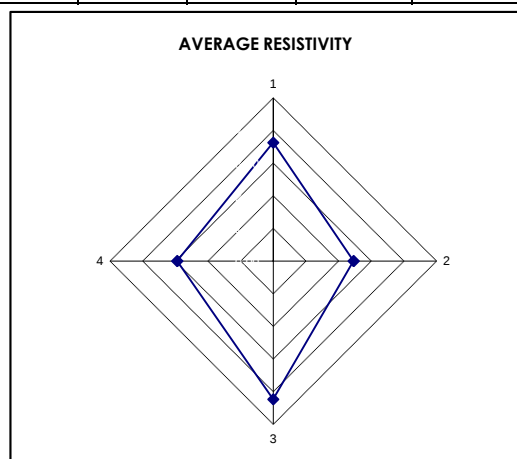
MARKINGS	Average Resistivity in each direction (Ω m)				
	1 m	2 m	5 m	10 m	15 m
ERT 1	1.23	2.17	3.30	4.71	4.71
ERT 2	17.70	7.38	5.10	6.60	5.42
ERT 3	18.47	15.20	17.99	26.70	28.27
ERT 4	38.36	23.34	18.77	11.62	8.65
ERT 5	18.50	18.47	17.51	16.34	11.55
ERT 6	6.66	6.00	6.20	16.65	5.89
ERT 7	6.42	6.09	4.71	2.83	
ERT 8	18.16	7.32	6.13	7.23	8.01
ERT 9	3.03	2.98	4.95	6.60	5.42
ERT 10	17.01	19.01	25.21	27.33	7.78
ERT 11	7.68	8.61	6.13	4.40	3.77
ERT 12	11.58	13.85	19.79	14.92	5.65



GRAPHICAL REPRESENTATION 1 - POLAR GRAPH AS PER IS 3043 - 1987

ERT 1

Direction	Average Resistivity in each direction					
	1 m	2 m	5 m	10 m	15 m	Avg.
N	1.19	1.88	3.46	5.03	6.59	3.63
E	0.88	1.38	2.51	3.77	3.77	2.46
S	1.76	3.39	3.77	5.65	6.60	4.23
W	1.07	2.01	3.46	4.40	3.77	2.94



Average Resistivity at 15 m (ohm-meter) : 3.32

The term 1,2,3,4 in Polar graph indicates direction N, E, S, W respectively.
 Each axis unit indicates 1 Ohm - m

ERT 1

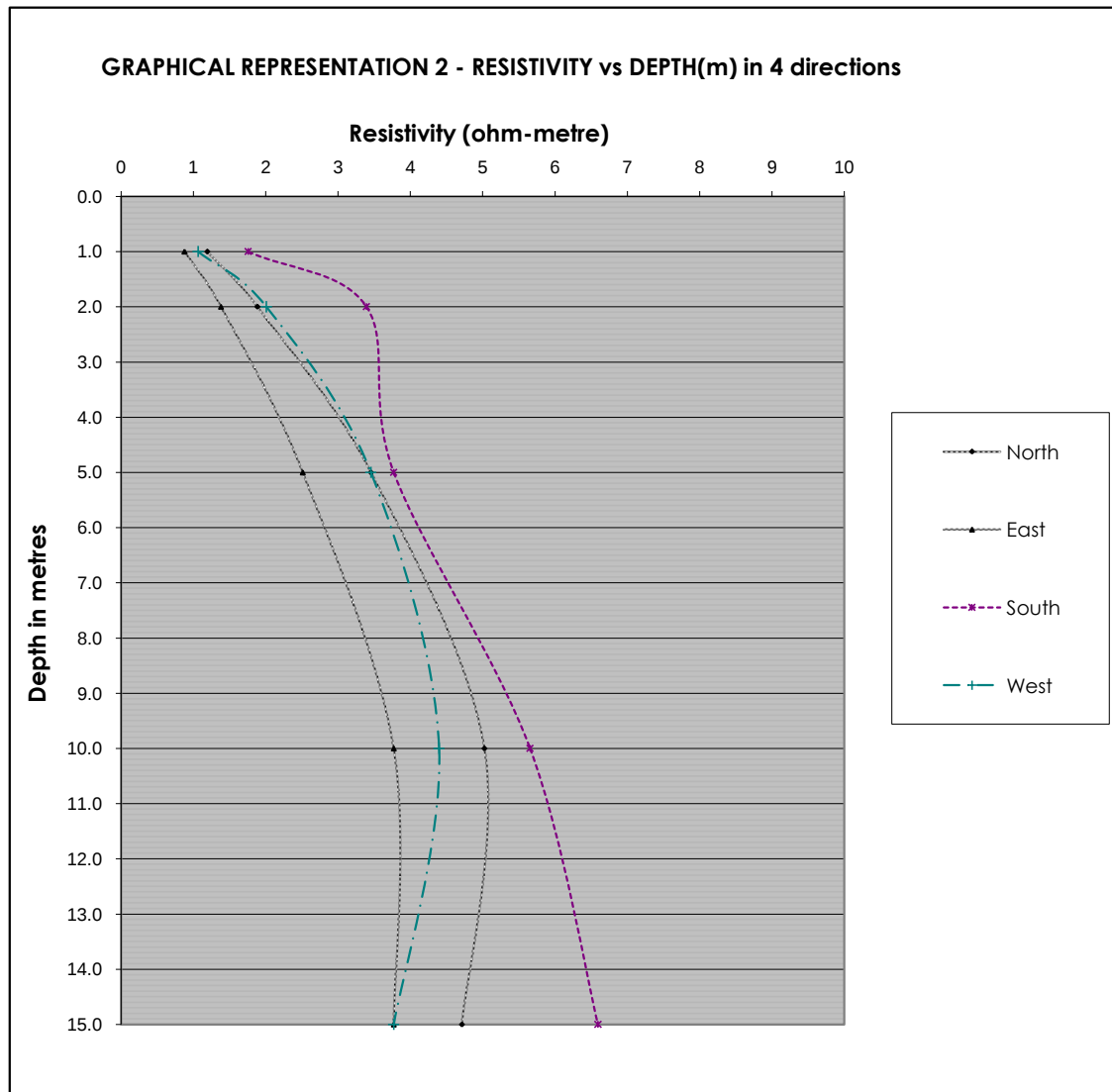


Fig No : 2.1.2

ERT 1

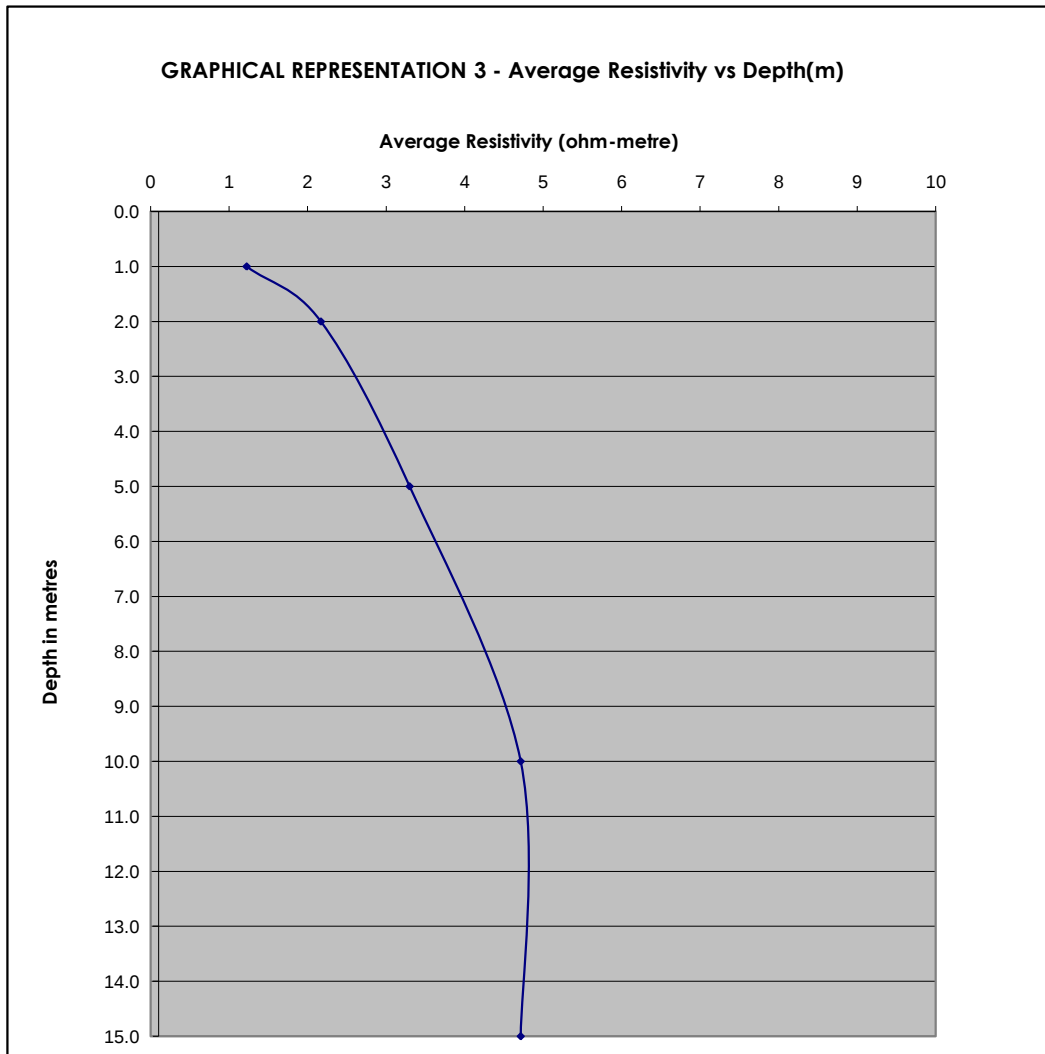
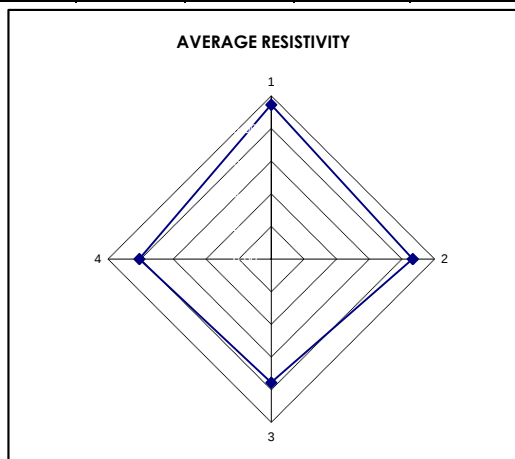


Fig No : 2.1.3

GRAPHICAL REPRESENTATION 1 - POLAR GRAPH AS PER IS 3043 - 1987

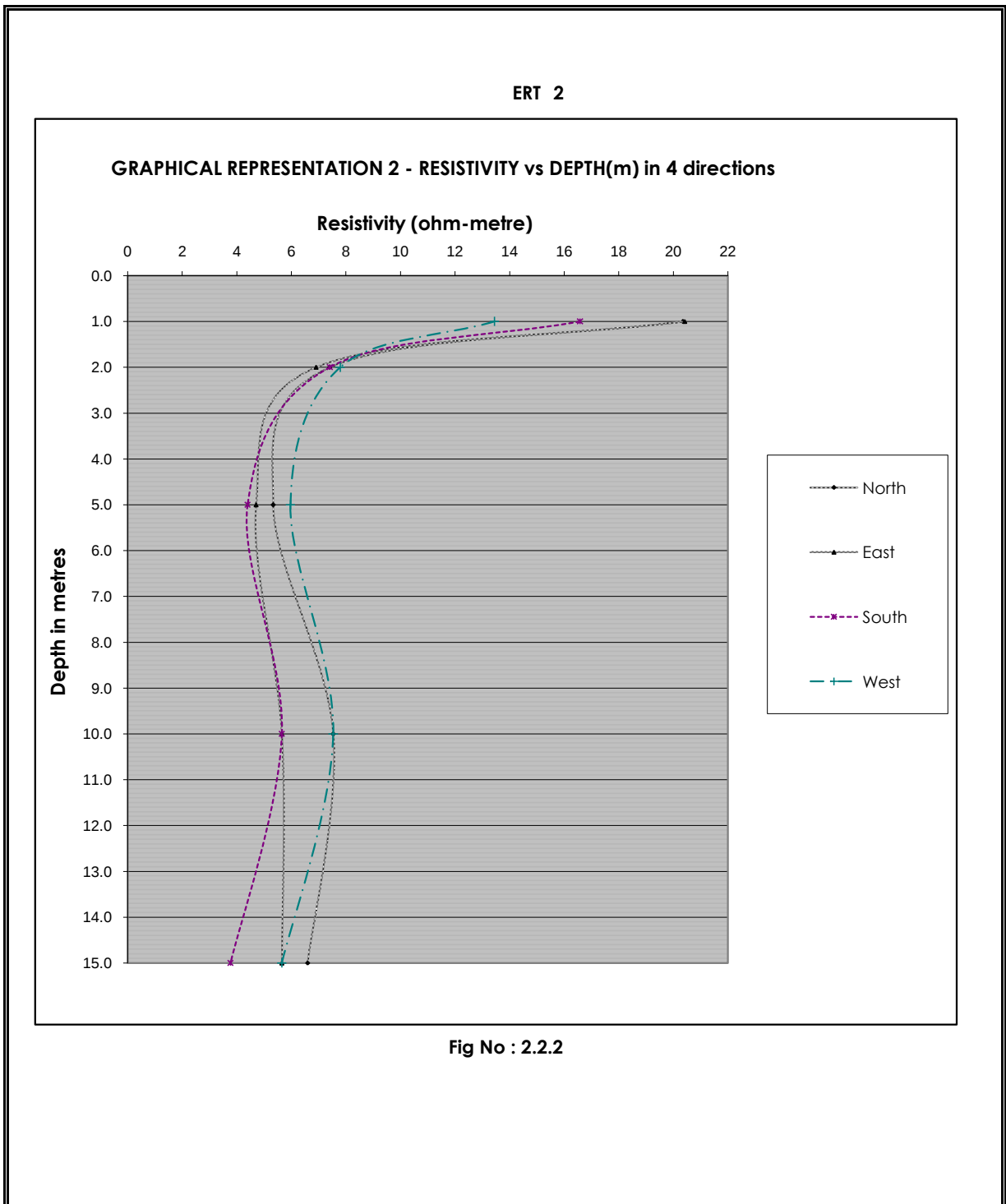
ERT 2

Direction	Average Resistivity in each direction					
	1 m	2 m	5 m	10 m	15 m	Avg.
N	20.36	7.41	5.34	7.54	6.60	9.45
E	20.42	6.91	4.71	5.65	5.65	8.67
S	16.59	7.41	4.40	5.65	3.77	7.56
W	13.45	7.79	5.97	7.54	5.65	8.08



Average Resistivity at 15 m (ohm-meter) : 8.44

The term 1,2,3,4 in Polar graph indicates direction N, E, S, W respectively.
 Each axis unit indicates 2 Ohm - m



ERT 2

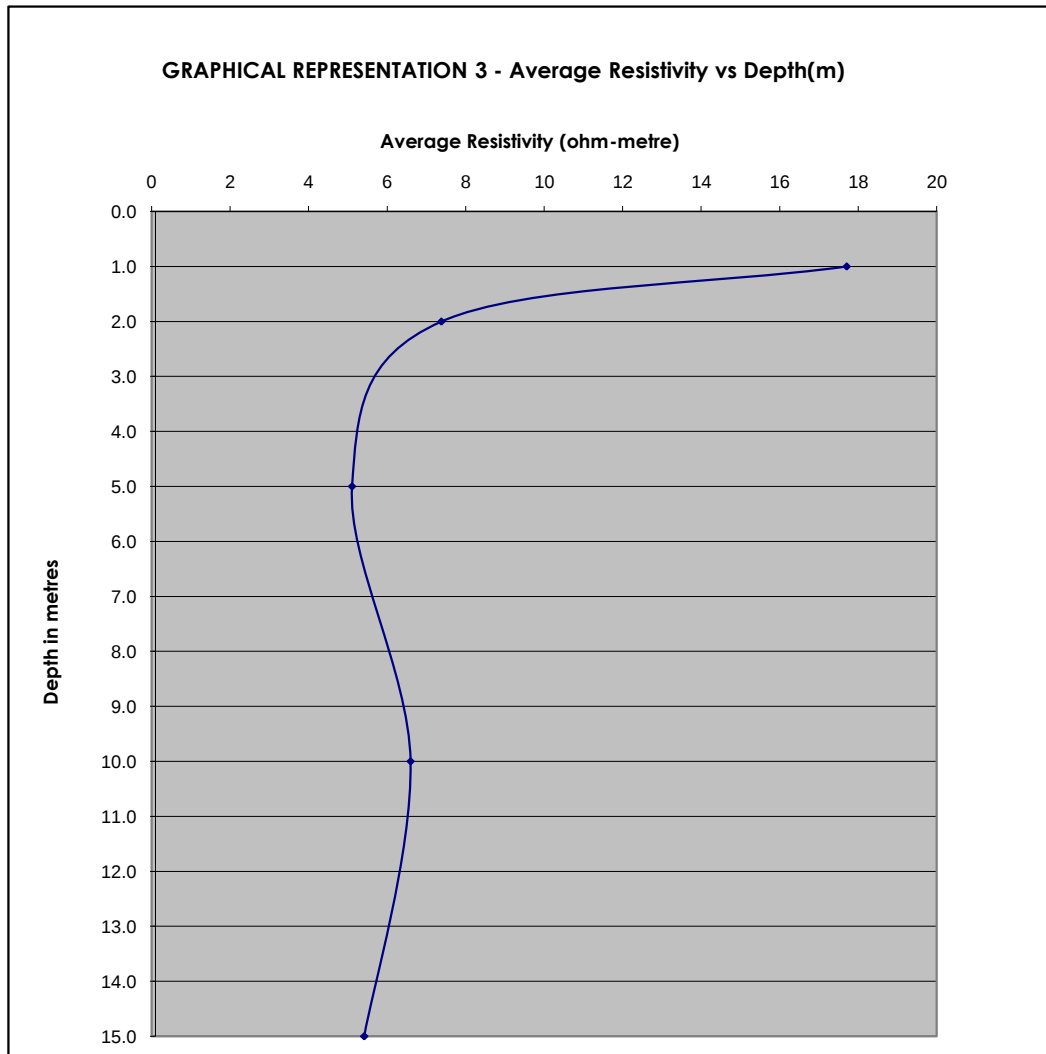
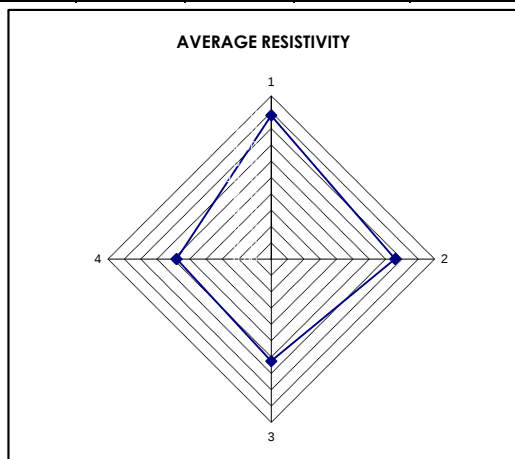


Fig No : 2.2.3

GRAPHICAL REPRESENTATION 1 - POLAR GRAPH AS PER IS 3043 - 1987

ERT 3

Direction	Average Resistivity in each direction					
	1 m	2 m	5 m	10 m	15 m	Avg.
N	24.13	21.74	20.11	33.93	32.04	26.39
E	17.28	20.23	19.48	25.76	31.10	22.77
S	18.35	12.31	19.16	25.13	18.85	18.76
W	14.14	6.53	13.19	21.99	31.10	17.39



Average Resistivity at 15 m (ohm-meter) : 21.33

The term 1,2,3,4 in Polar graph indicates direction N, E, S, W respectively.

Each axis unit indicates 3 Ohm - m

ERT 3

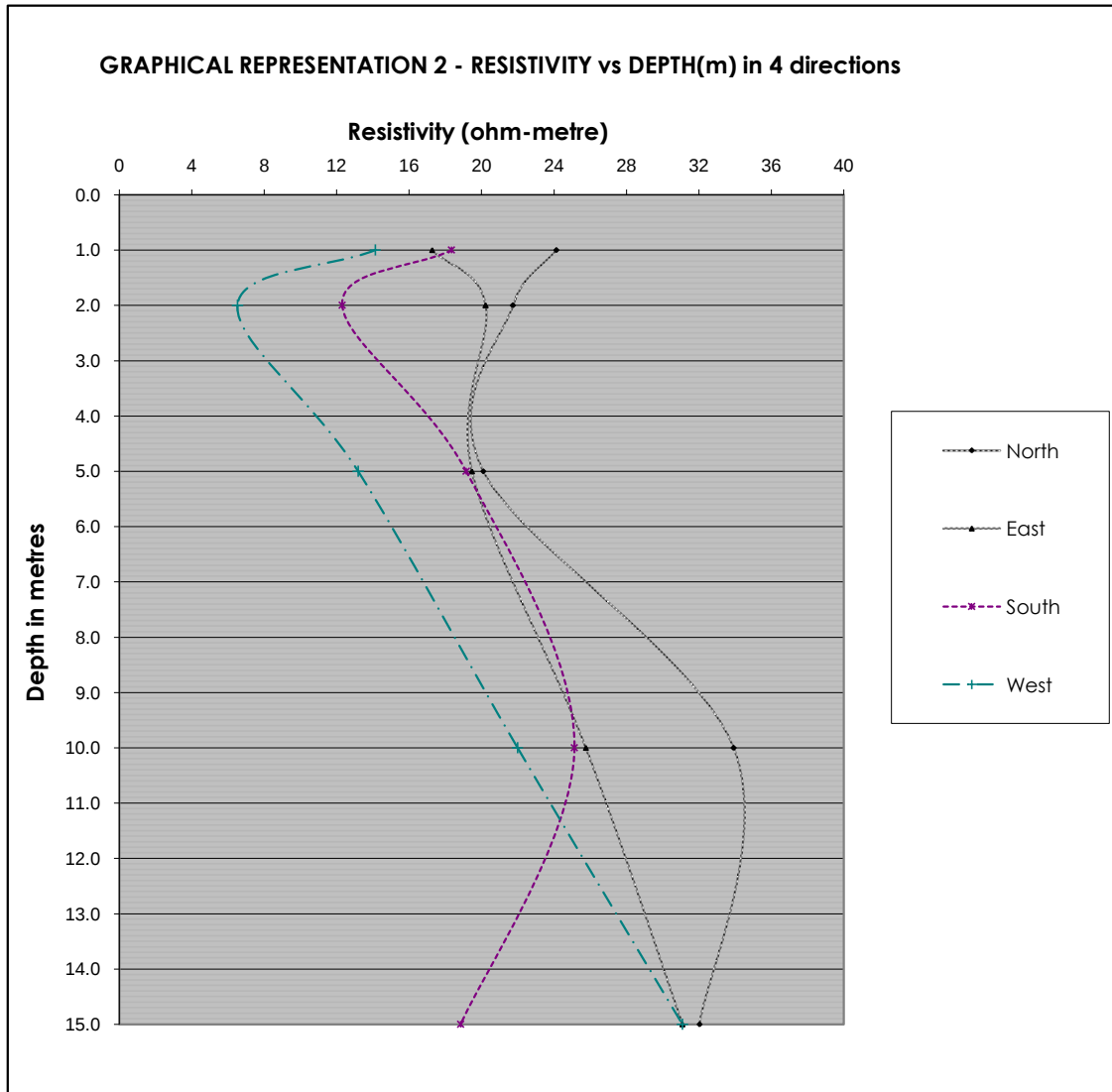


Fig No : 2.3.2

ERT 3

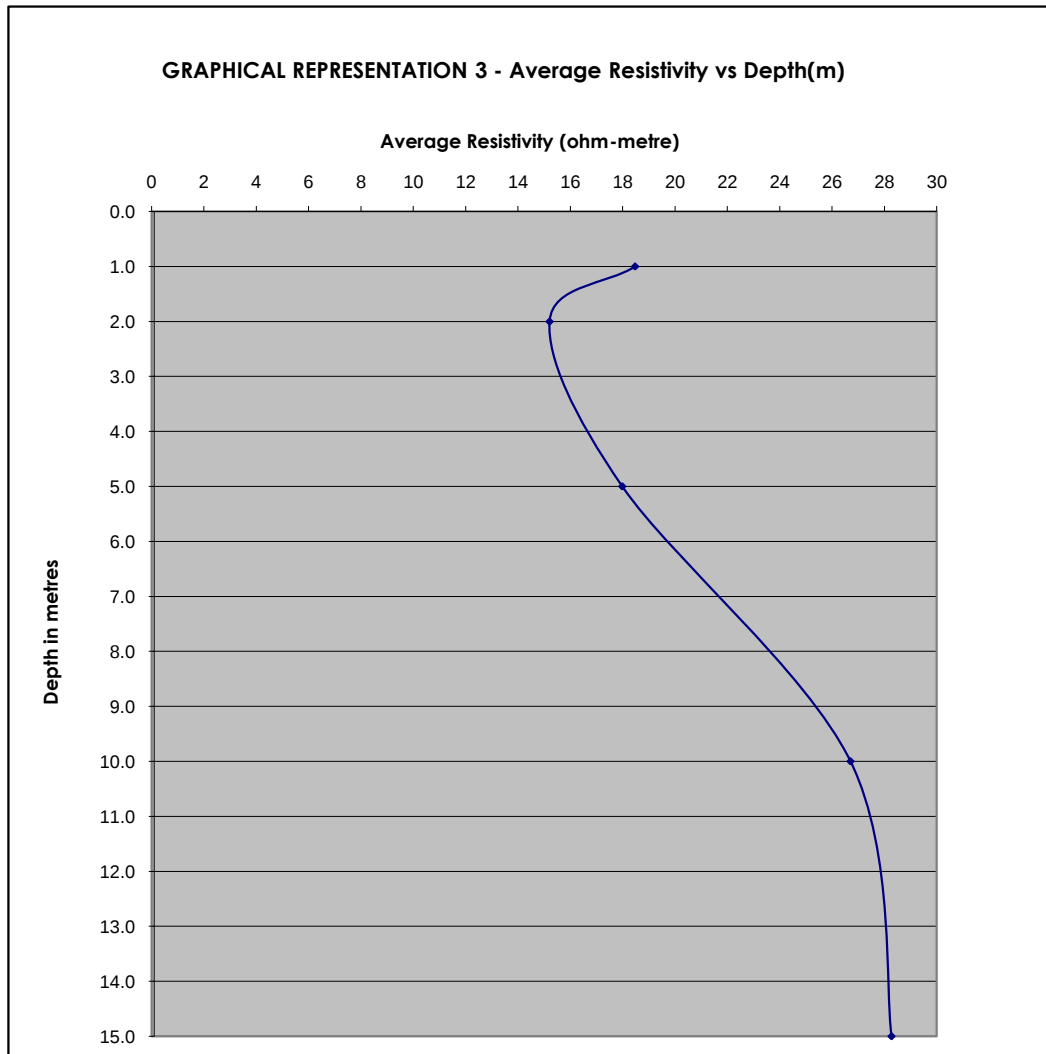
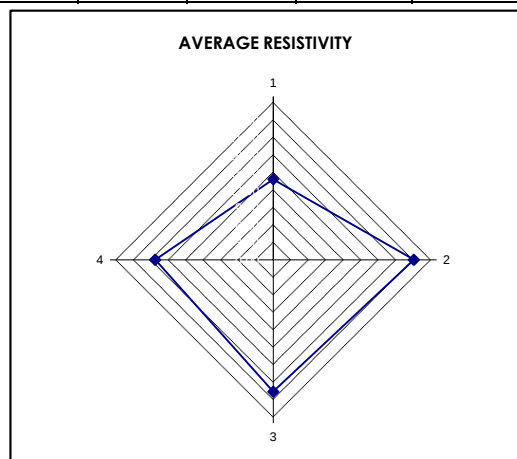


Fig No : 2.3.3

GRAPHICAL REPRESENTATION 1- POLAR GRAPH AS PER IS 3043 - 1987

ERT 4

Direction	Average Resistivity in each direction					
	1 m	2 m	5 m	10 m	15 m	Avg.
N	32.73	15.96	6.60	10.05	3.77	13.82
E	44.30	26.14	29.22	12.57	8.48	24.14
S	38.14	24.13	25.76	11.94	13.19	22.63
W	38.26	27.14	13.51	11.94	10.37	20.24



Average Resistivity at 15 m (ohm-meter) : 20.21

The term 1,2,3,4 in Polar graph indicates direction N, E, S, W respectively.

Each axis unit indicates 3 Ohm - m

ERT 4

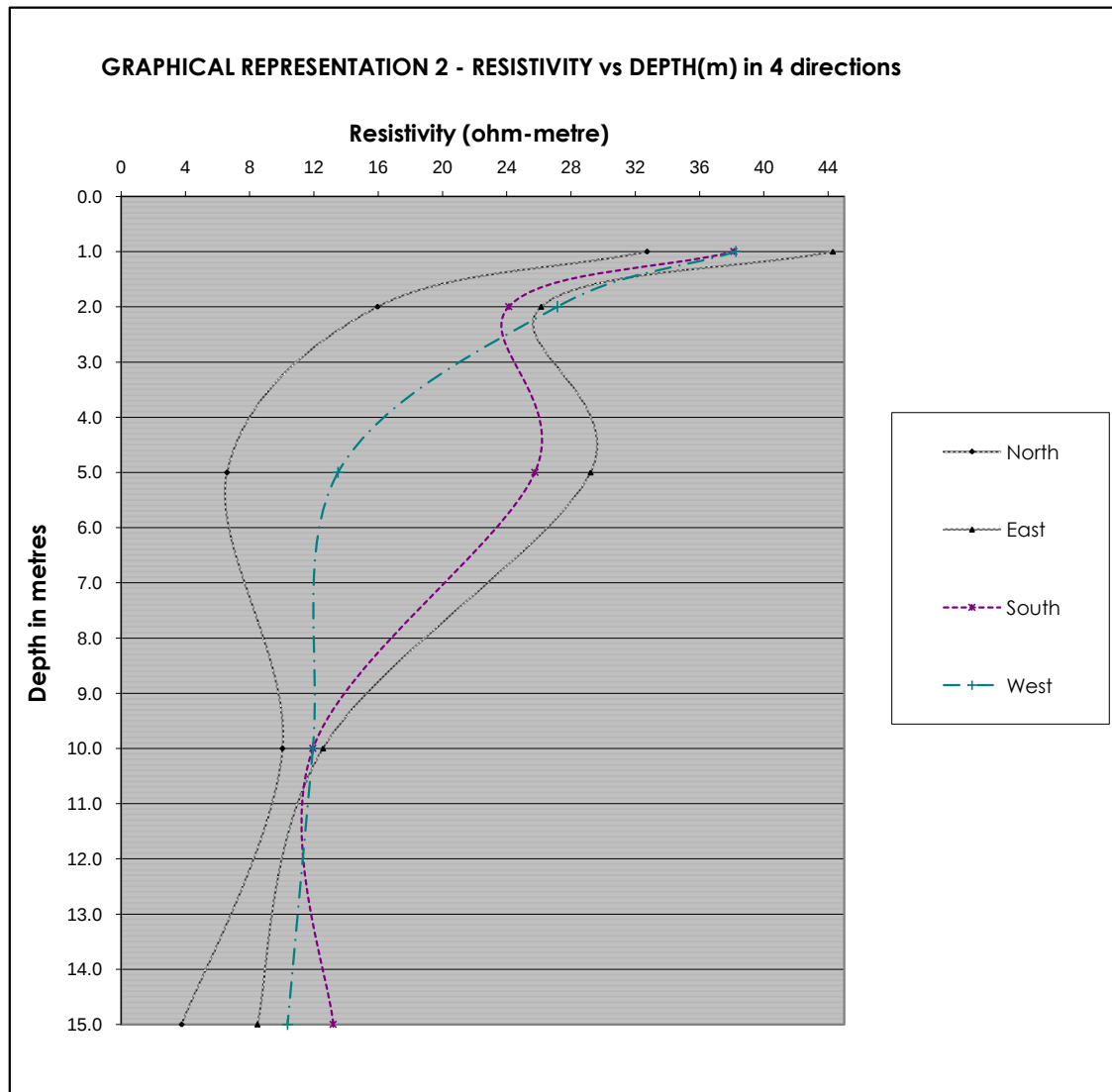


Fig No : 2.4.2

ERT 4

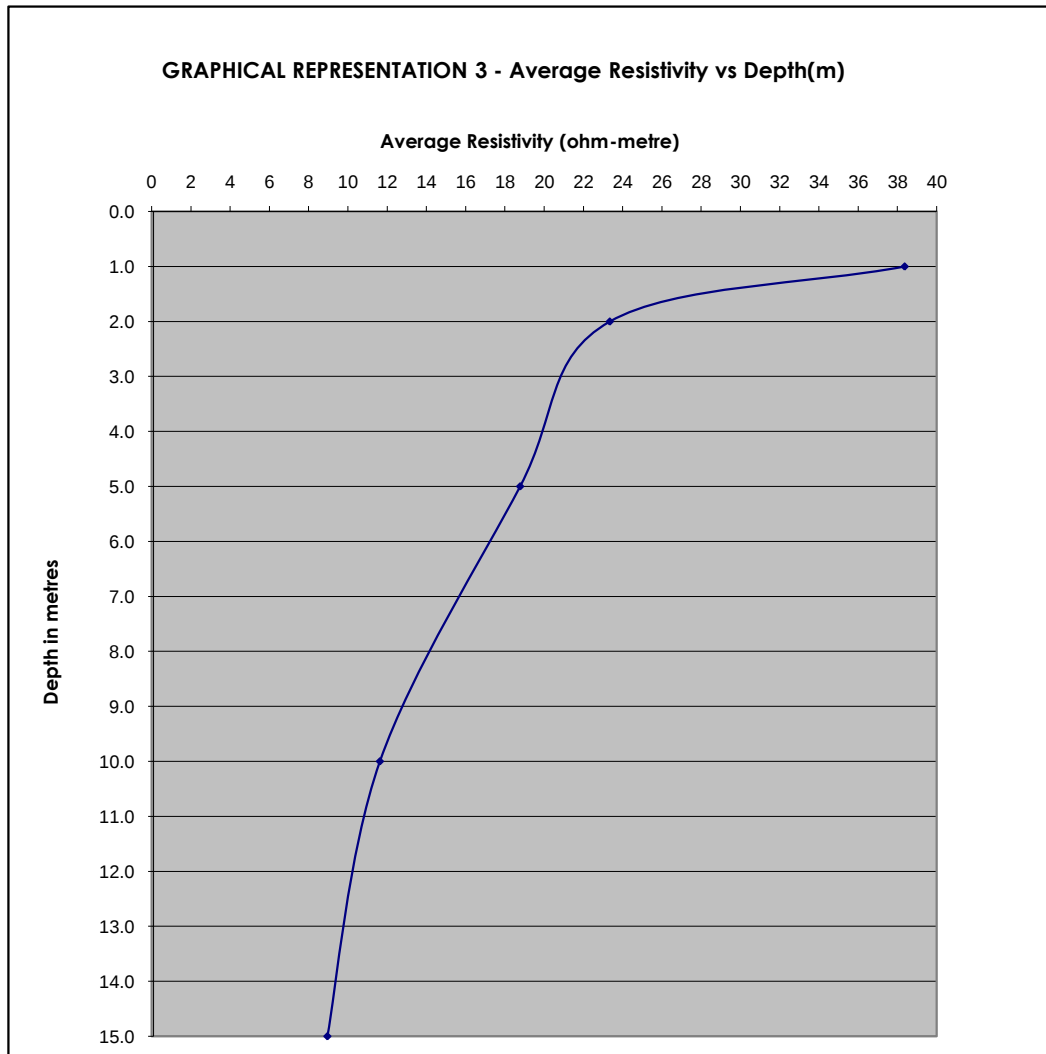
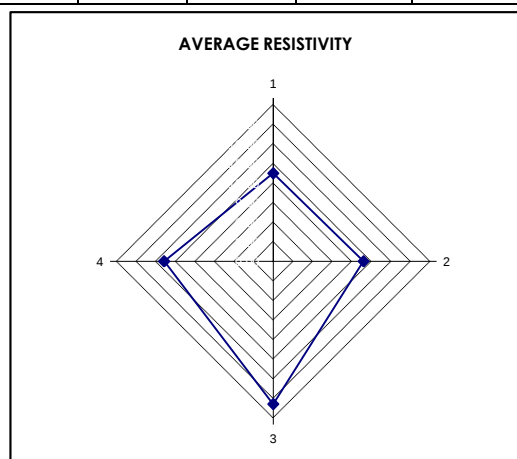


Fig No : 2.4.3

GRAPHICAL REPRESENTATION 1 - POLAR GRAPH AS PER IS 3043 - 1987

ERT 5

Direction	Average Resistivity in each direction					
	1 m	2 m	5 m	10 m	15 m	Avg.
N	17.66	15.20	16.02	10.05	8.48	13.48
E	18.53	16.34	12.57	11.31	10.37	13.82
S	18.28	24.63	22.30	32.04	12.25	21.90
W	19.54	17.72	19.16	11.94	15.08	16.69



Average Resistivity at 15 m (ohm-meter) : 16.47

The term 1,2,3,4 in Polar graph indicates direction N, E, S, W respectively.

Each axis unit indicates 3 Ohm - m

ERT 5

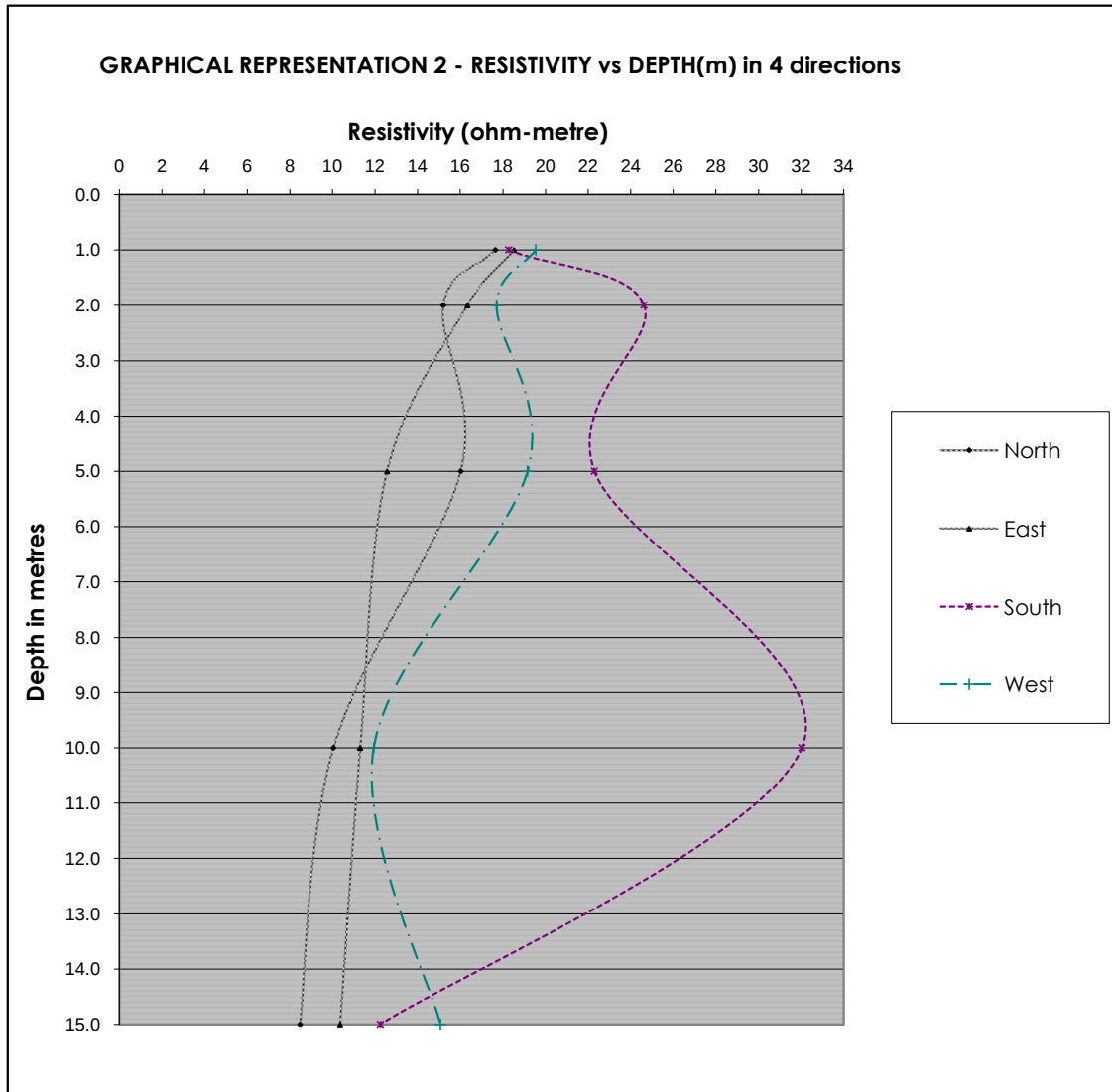


Fig No : 2.5.2

ERT 5

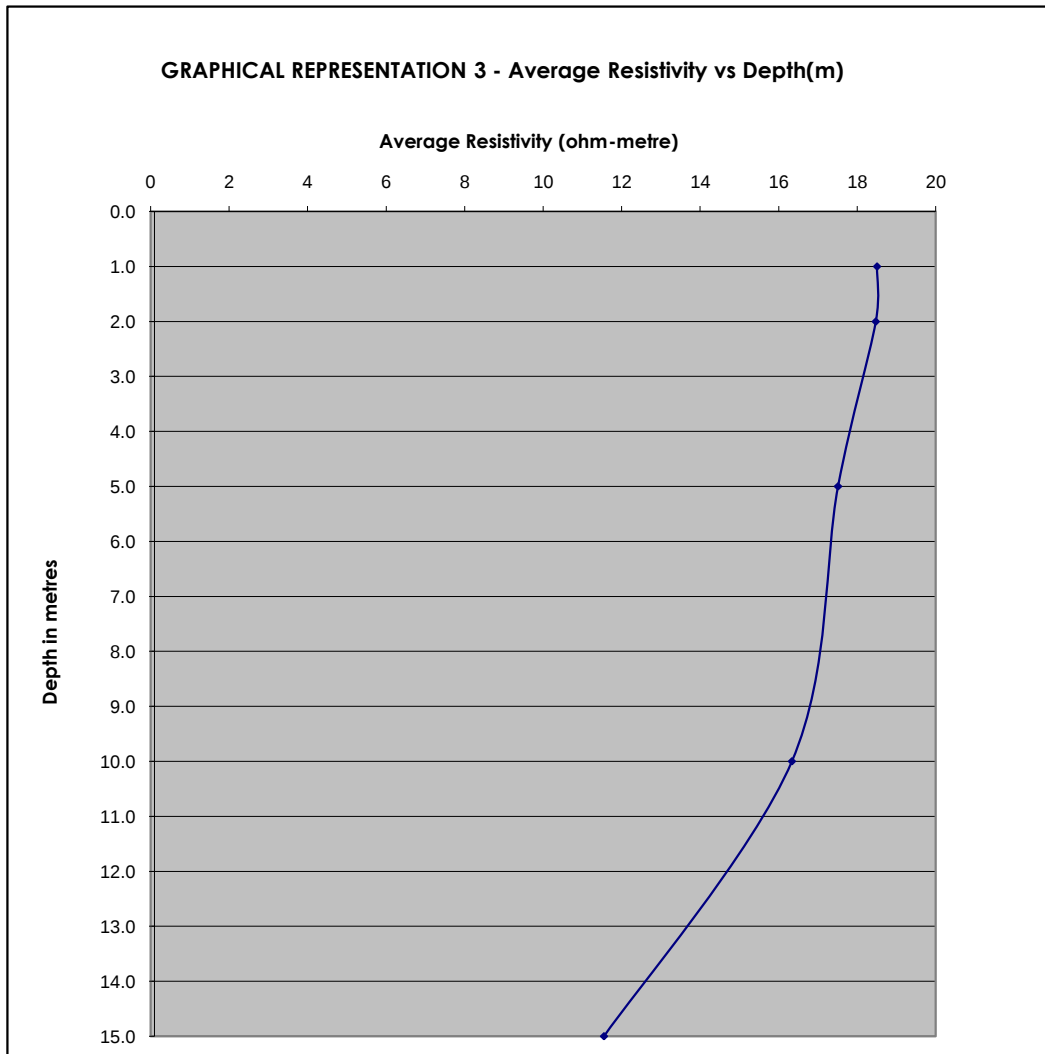
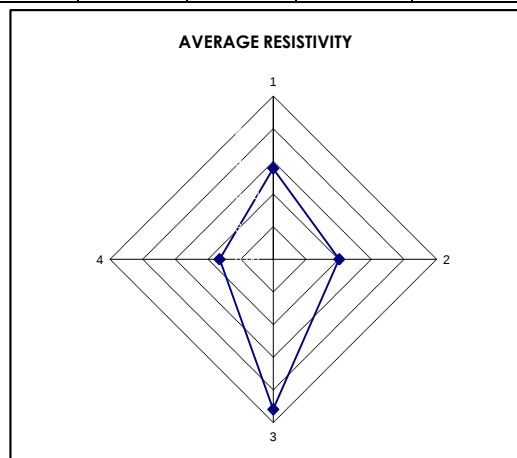


Fig No : 2.5.3

GRAPHICAL REPRESENTATION 1- POLAR GRAPH AS PER IS 3043 - 1987

ERT 6

Direction	Average Resistivity in each direction					
	1 m	2 m	5 m	10 m	15 m	Avg.
N	7.04	6.41	8.80	11.94	7.54	8.34
E	9.11	8.29	4.71	4.40	3.77	6.06
S	5.97	6.16	6.60	44.61	5.65	13.80
W	4.52	3.14	4.71	5.65	6.60	4.93



Average Resistivity at 15 m (ohm-meter) : 8.28

The term 1,2,3,4 in Polar graph indicates direction N, E, S, W respectively.
 Each axis unit indicates 3 Ohm - m

ERT 6

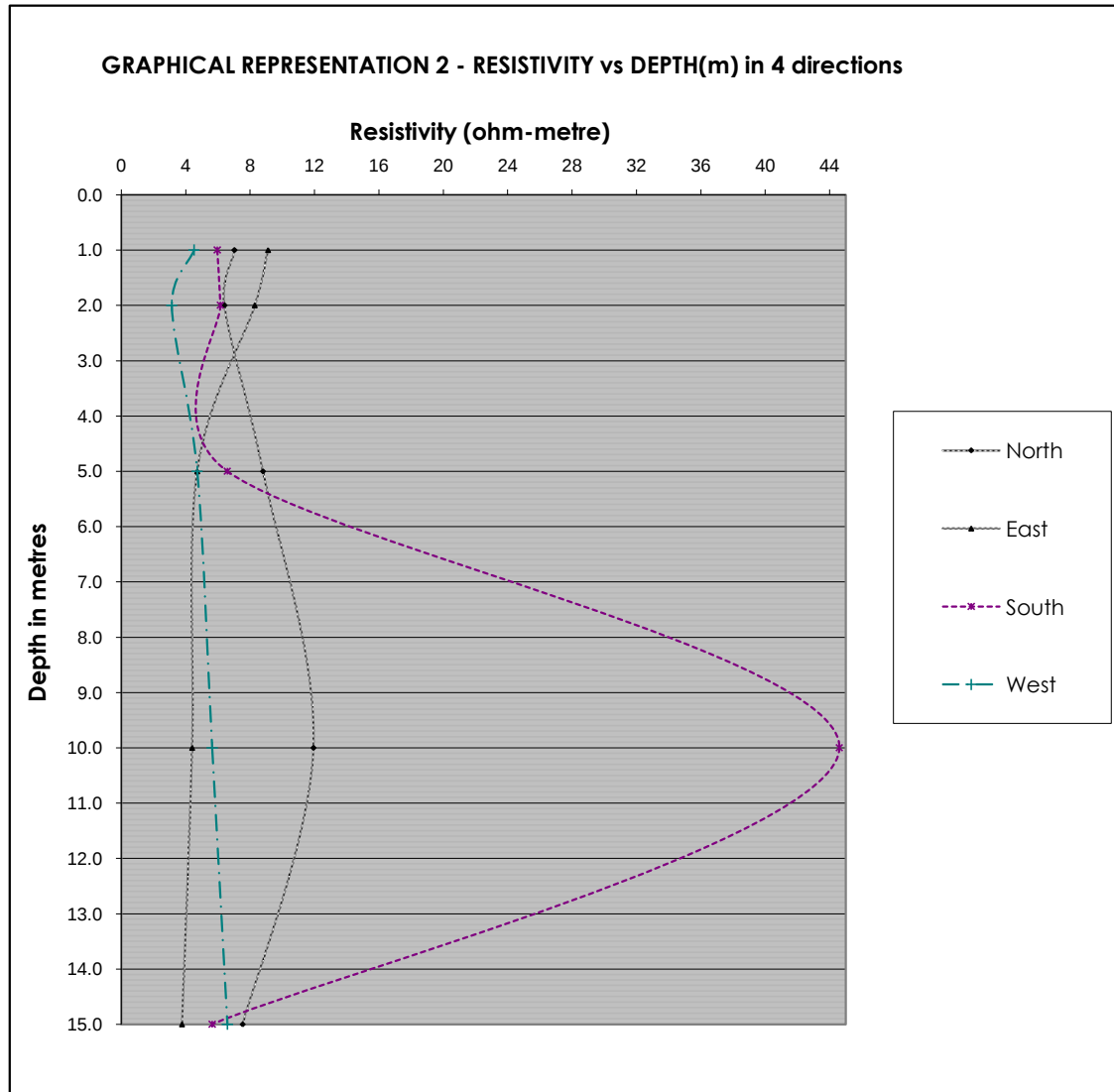


Fig No : 2.6.2

ERT 6

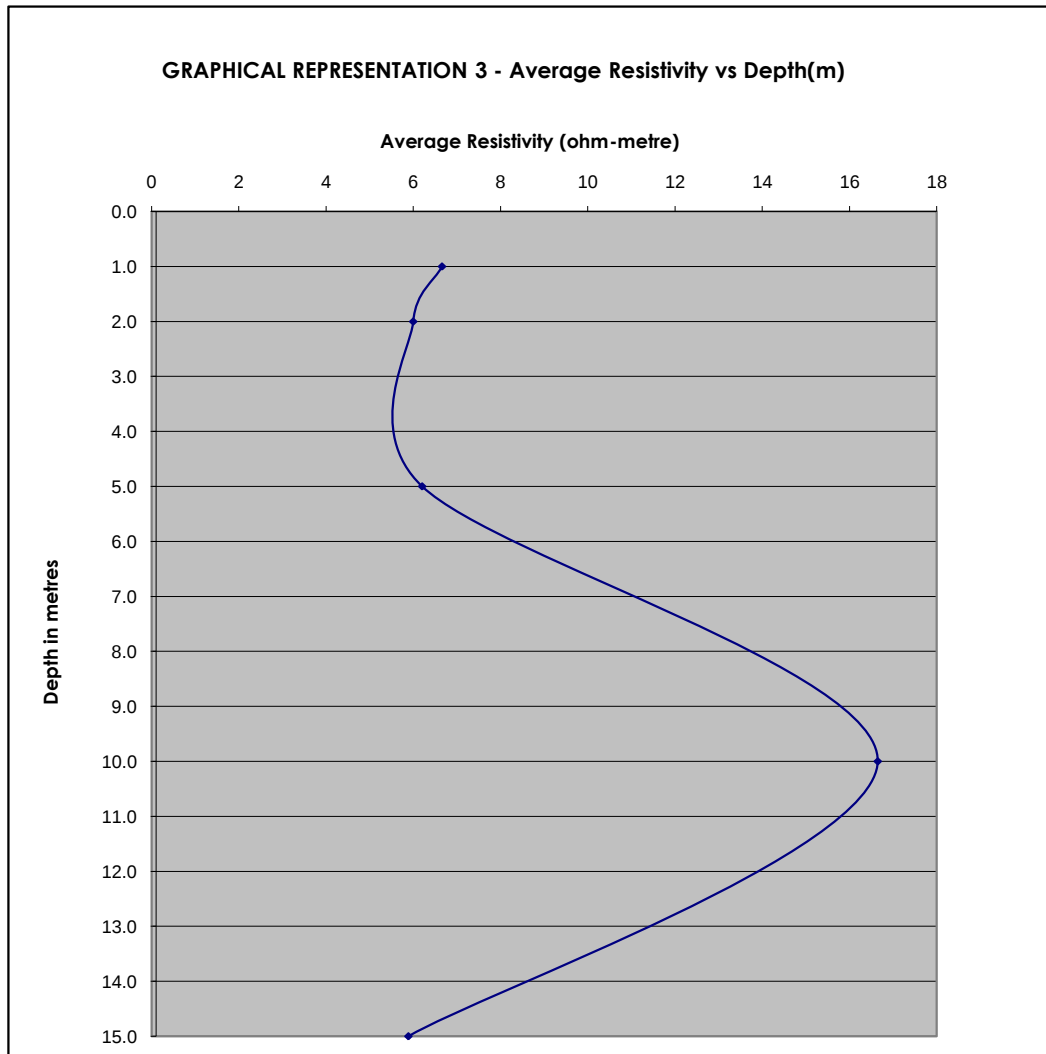


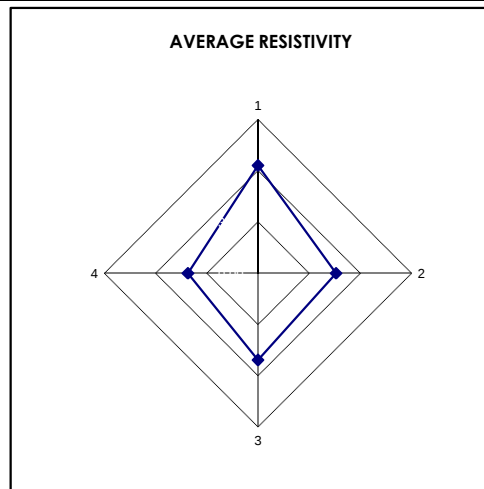
Fig No : 2.6.3

Client: Bharat Heavy Electricals Limited, EDN
 Project: Soil Investigation works for proposed 10
 MWp PV Solar Project at Ordnance factory
 Bolangir, Odisha.

GRAPHICAL REPRESENTATION 1- POLAR GRAPH AS PER IS 3043 - 1987

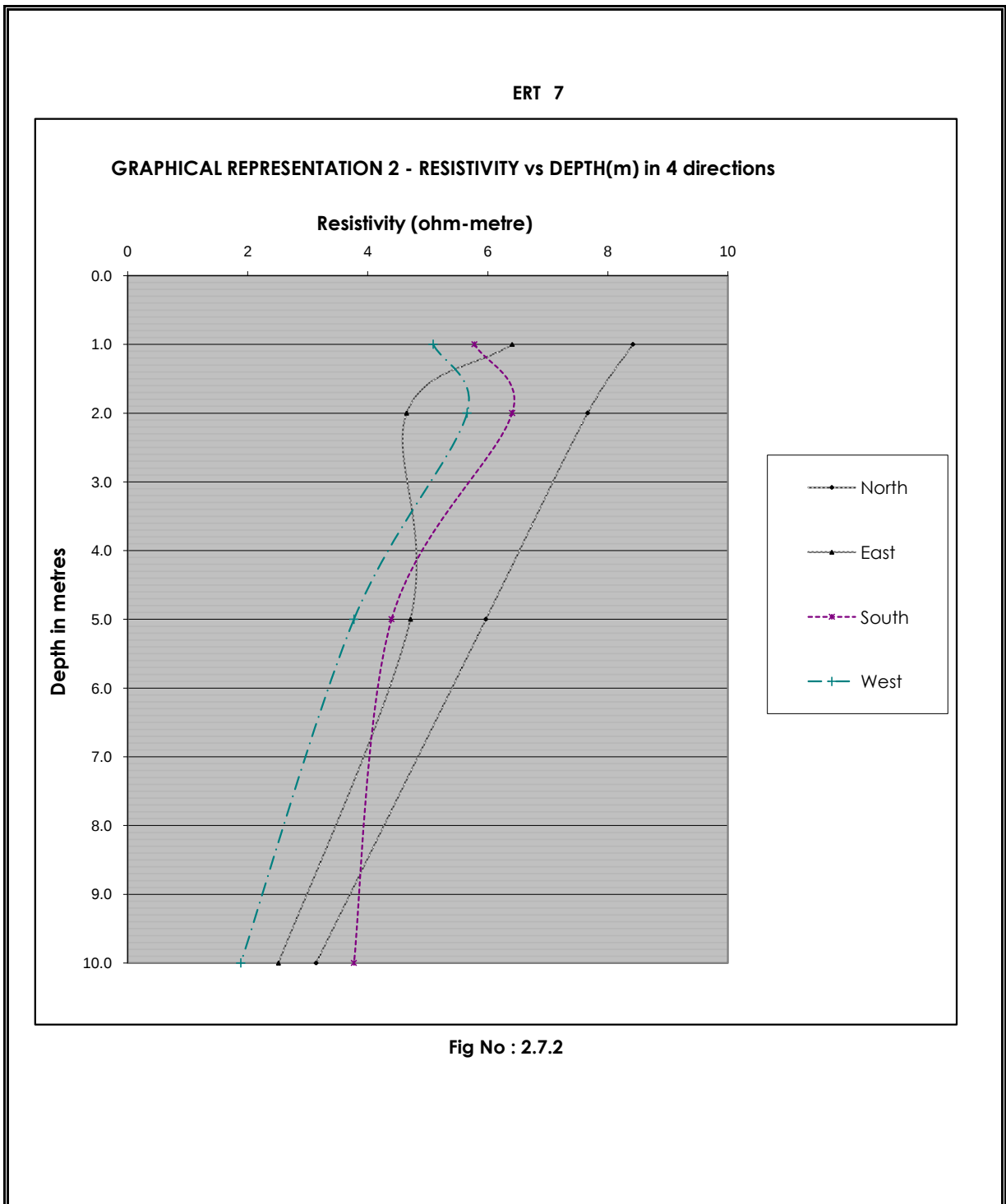
ERT 7

Direction	Average Resistivity in each direction				
	1 m	2 m	5 m	10 m	Avg.
N	8.42	7.67	5.97	3.14	6.30
E	6.41	4.65	4.71	2.51	4.57
S	5.78	6.41	4.40	3.77	5.09
W	5.09	5.65	3.77	1.88	4.10



Average Resistivity at 15 m (ohm-meter) : 5.01

The term 1,2,3,4 in Polar graph indicates direction N, E, S, W respectively.
 Each axis unit indicates 3 Ohm - m



ERT 7

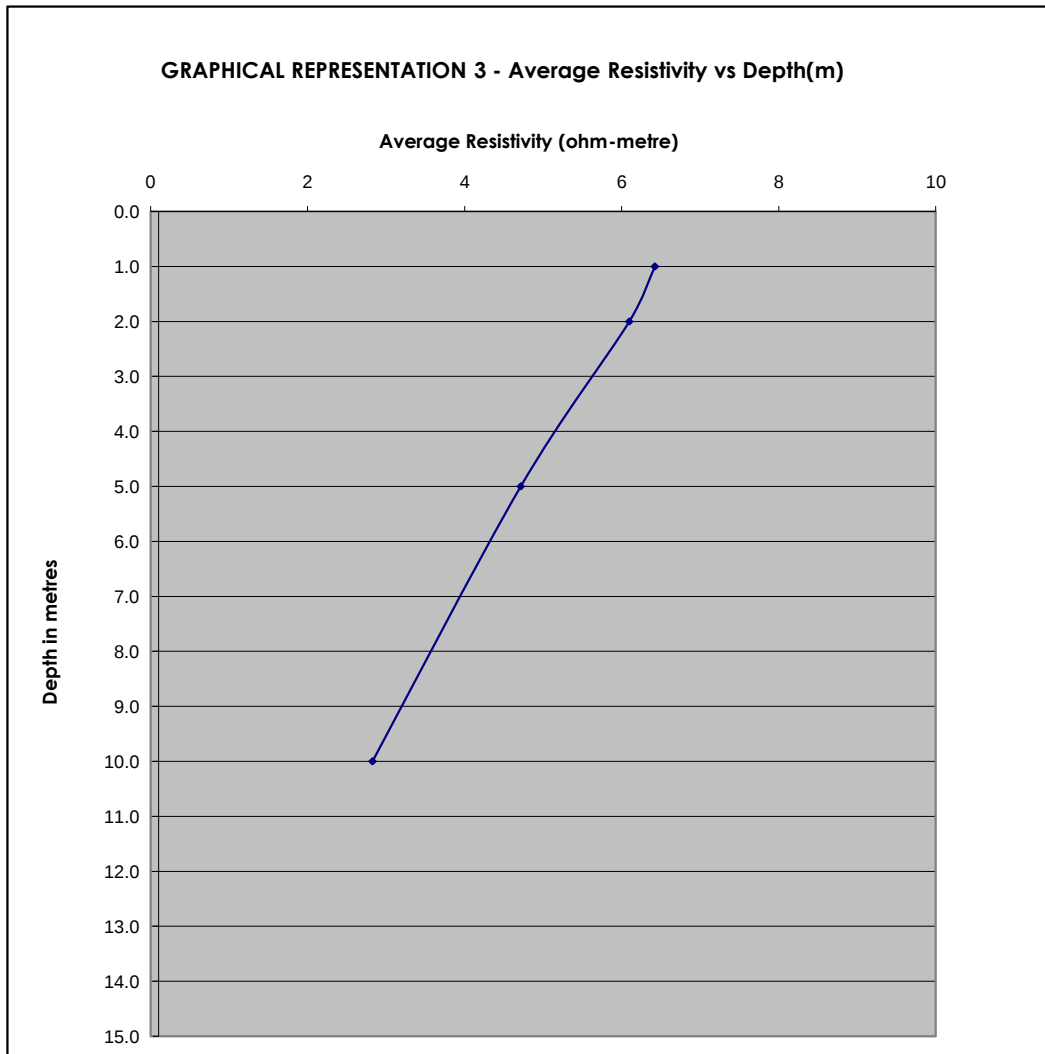
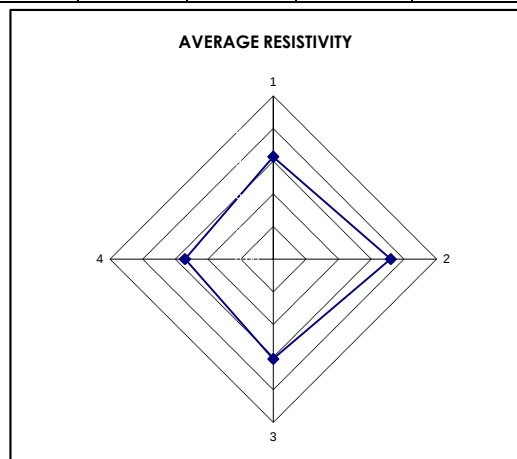


Fig No : 2.7.3

GRAPHICAL REPRESENTATION 1- POLAR GRAPH AS PER IS 3043 - 1987

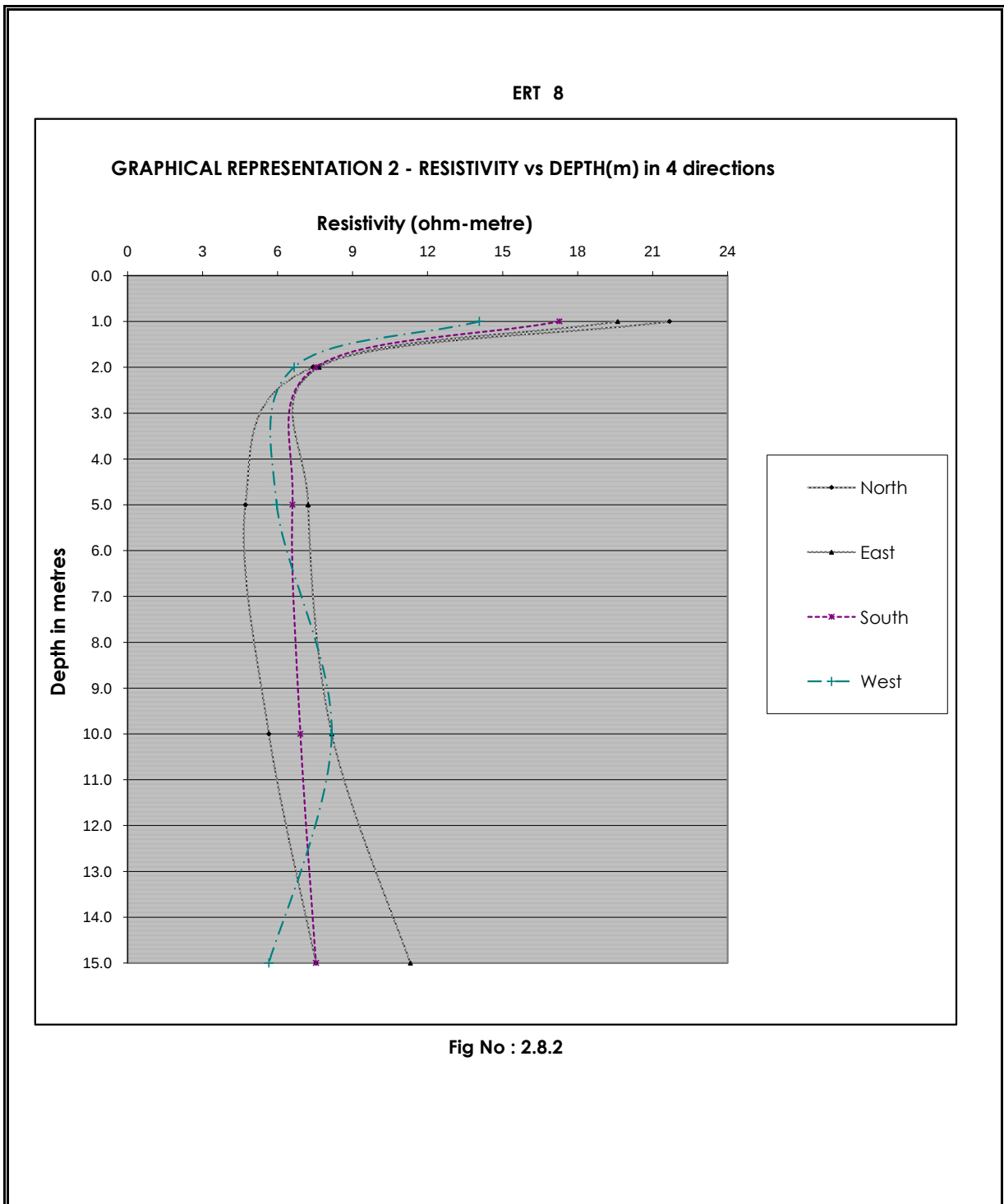
ERT 8

Direction	Average Resistivity in each direction					
	1 m	2 m	5 m	10 m	15 m	Avg.
N	21.68	7.41	4.71	5.65	7.54	9.40
E	19.60	7.67	7.23	8.17	11.31	10.79
S	17.28	7.54	6.60	6.91	7.54	9.17
W	14.07	6.66	5.97	8.17	5.65	8.11



Average Resistivity at 15 m (ohm-meter) : 9.37

The term 1,2,3,4 in Polar graph indicates direction N, E, S, W respectively.
 Each axis unit indicates 3 Ohm - m



ERT 8

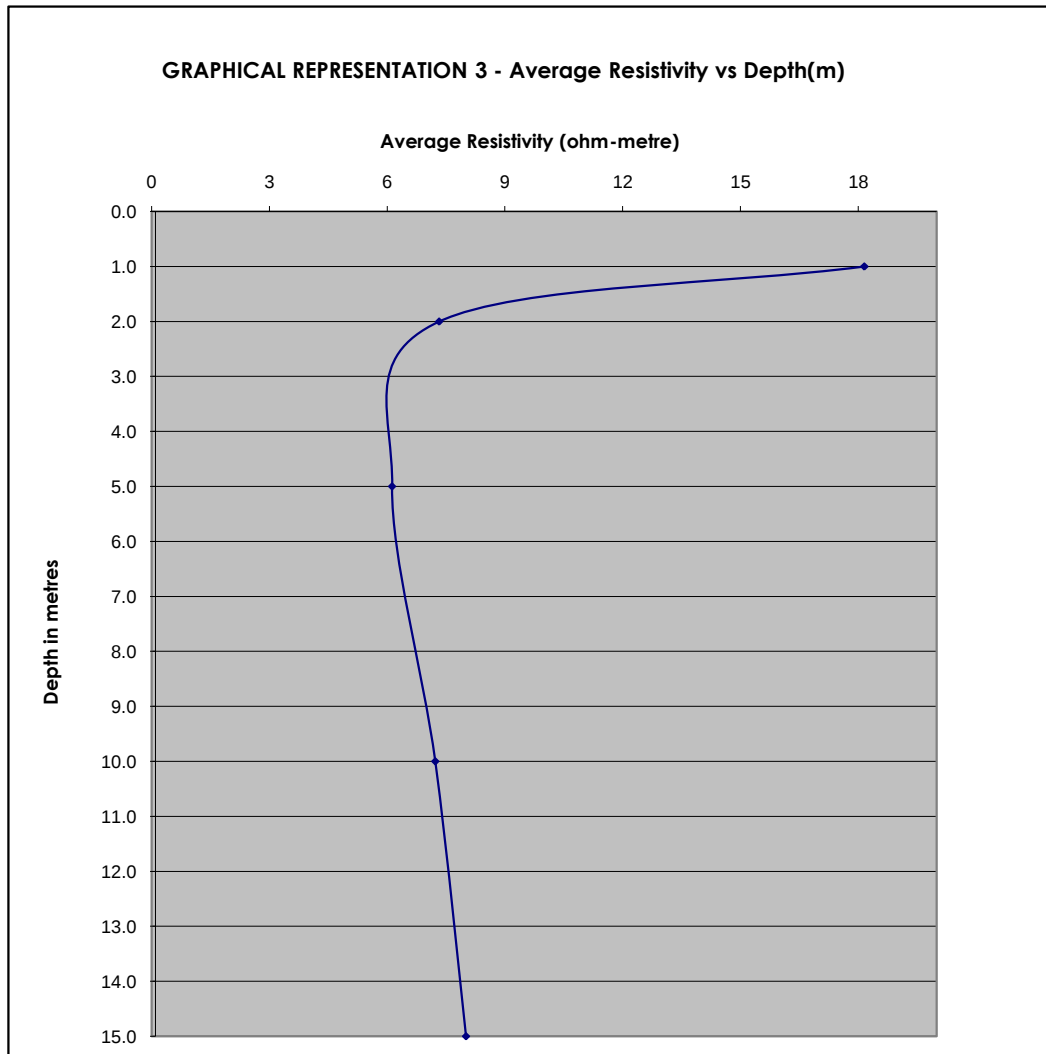
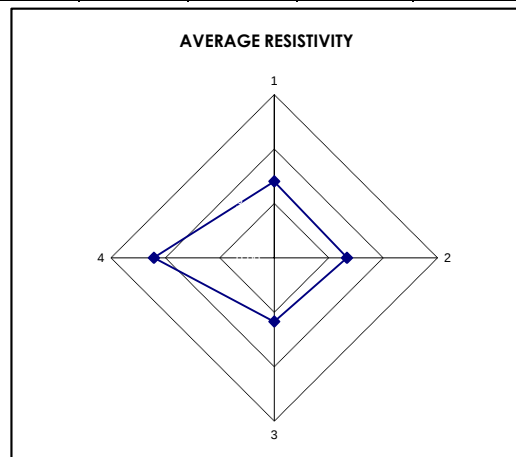


Fig No : 2.8.3

GRAPHICAL REPRESENTATION 1- POLAR GRAPH AS PER IS 3043 - 1987

ERT 9

Direction	Average Resistivity in each direction					
	1 m	2 m	5 m	10 m	15 m	Avg.
N	3.27	3.64	4.71	5.65	3.77	4.21
E	3.77	1.88	2.83	5.03	6.60	4.02
S	1.88	2.51	3.46	5.03	4.71	3.52
W	3.20	3.90	8.80	10.68	6.60	6.63



Average Resistivity at 15 m (ohm-meter) : 4.60

The term 1,2,3,4 in Polar graph indicates direction N, E, S, W respectively.

Each axis unit indicates 3 Ohm - m

ERT 9

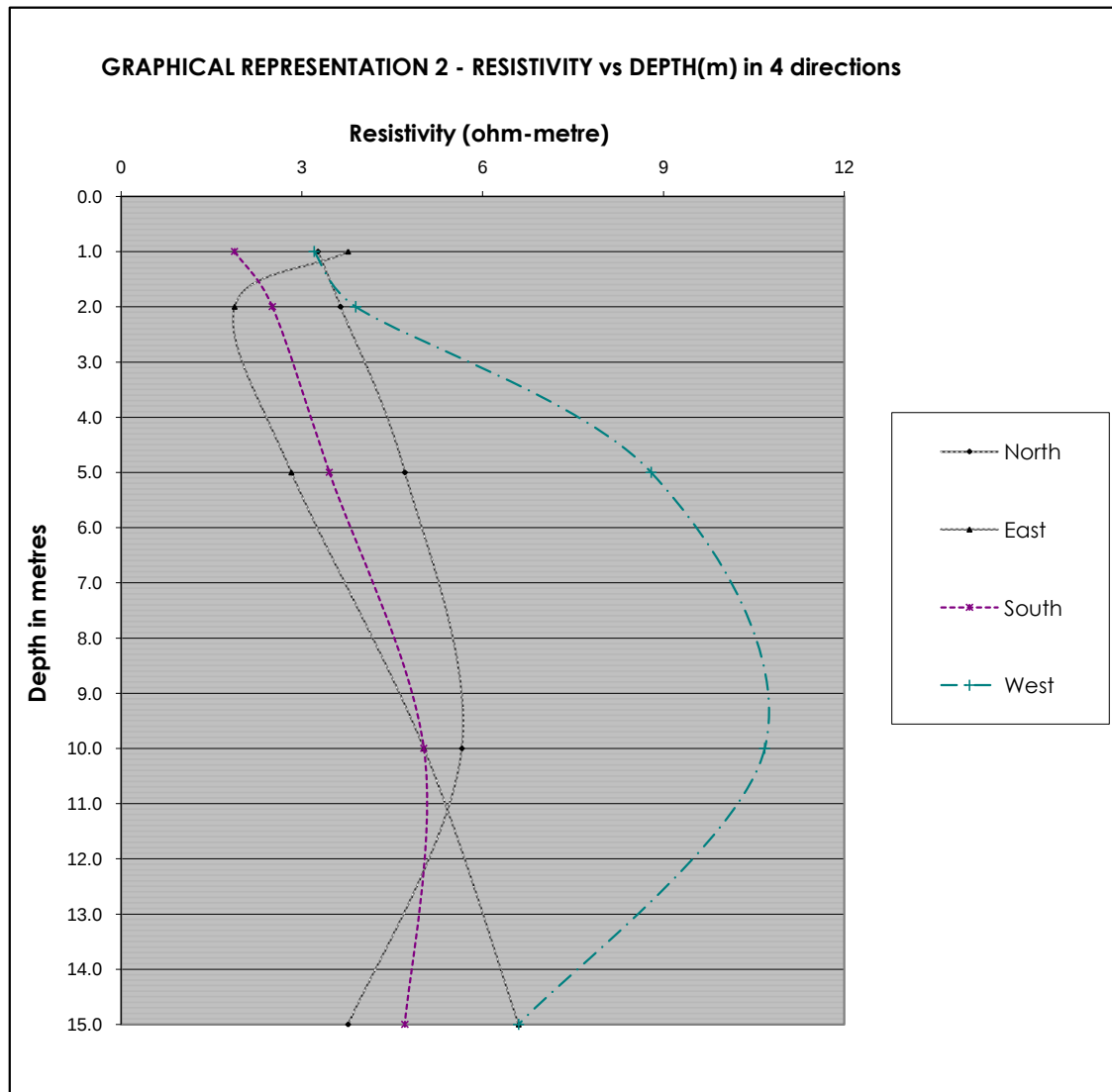


Fig No : 2.9.2

ERT 9

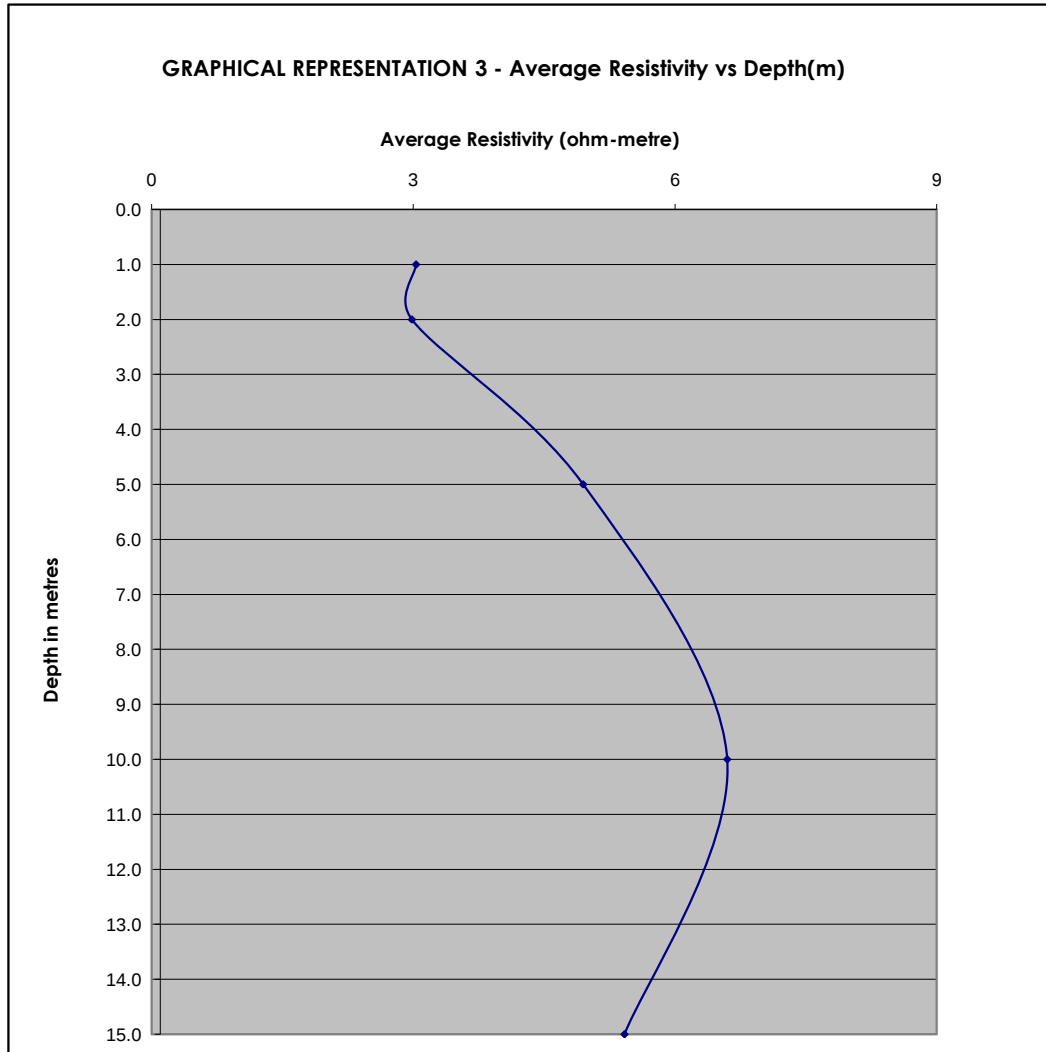
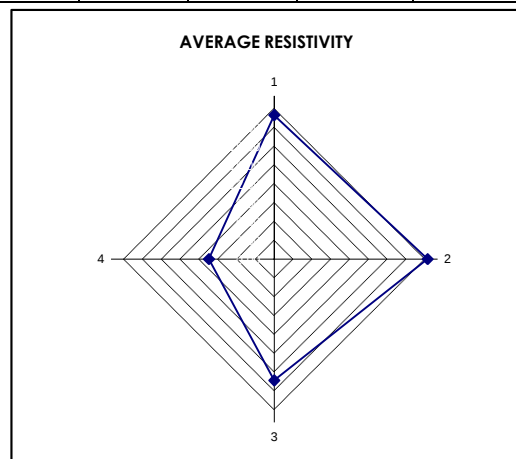


Fig No : 2.9.3

GRAPHICAL REPRESENTATION 1- POLAR GRAPH AS PER IS 3043 - 1987

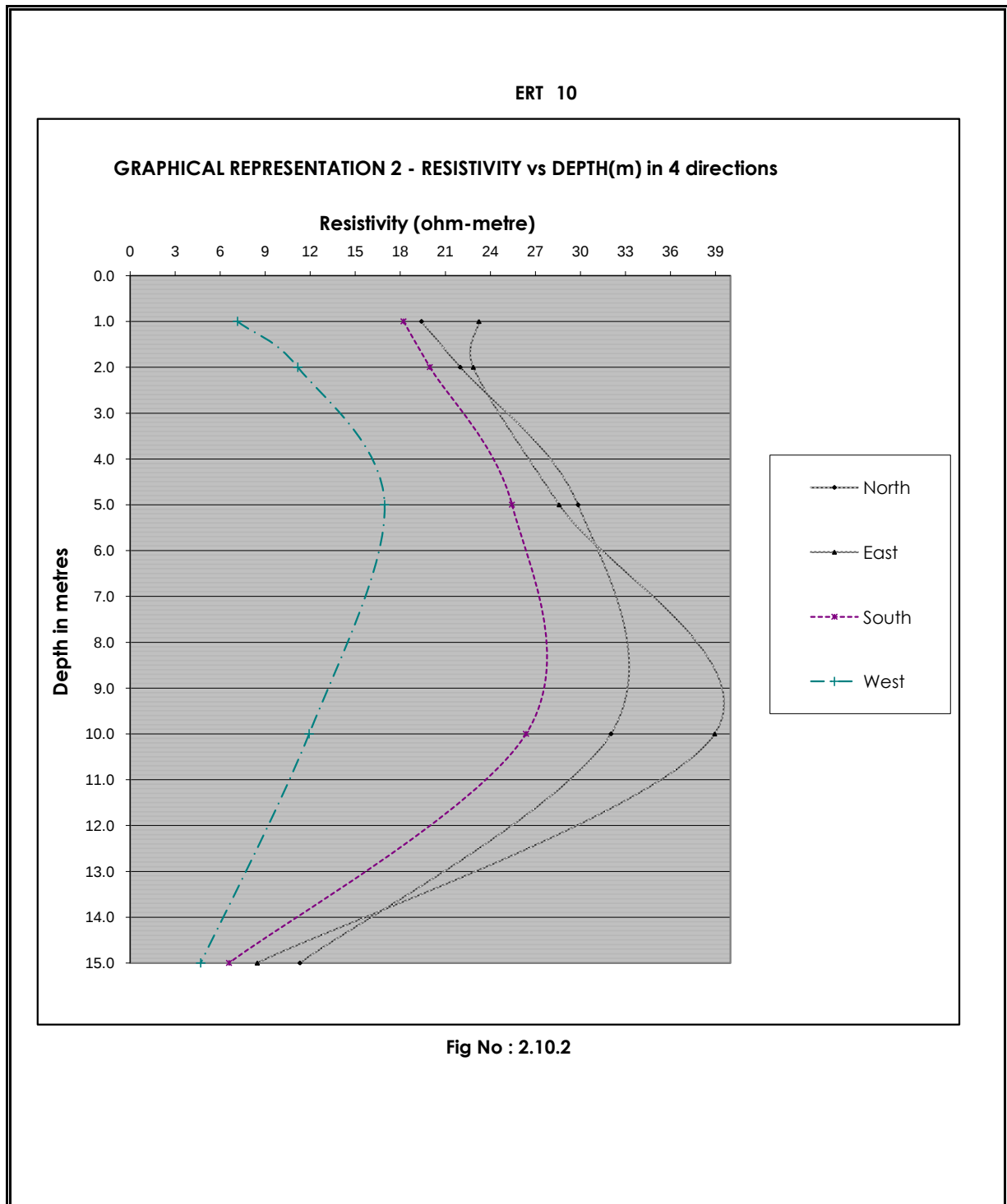
ERT 10

Direction	Average Resistivity in each direction					
	1 m	2 m	5 m	10 m	15 m	Avg.
N	19.41	21.99	29.84	32.04	11.31	22.92
E	23.25	22.87	28.59	38.95	8.48	24.43
S	18.22	19.98	25.45	26.39	6.60	19.33
W	7.16	11.18	16.96	11.94	4.71	10.39



Average Resistivity at 15 m (ohm-meter) : 19.27

The term 1,2,3,4 in Polar graph indicates direction N, E, S, W respectively.
 Each axis unit indicates 3 Ohm - m



ERT 10

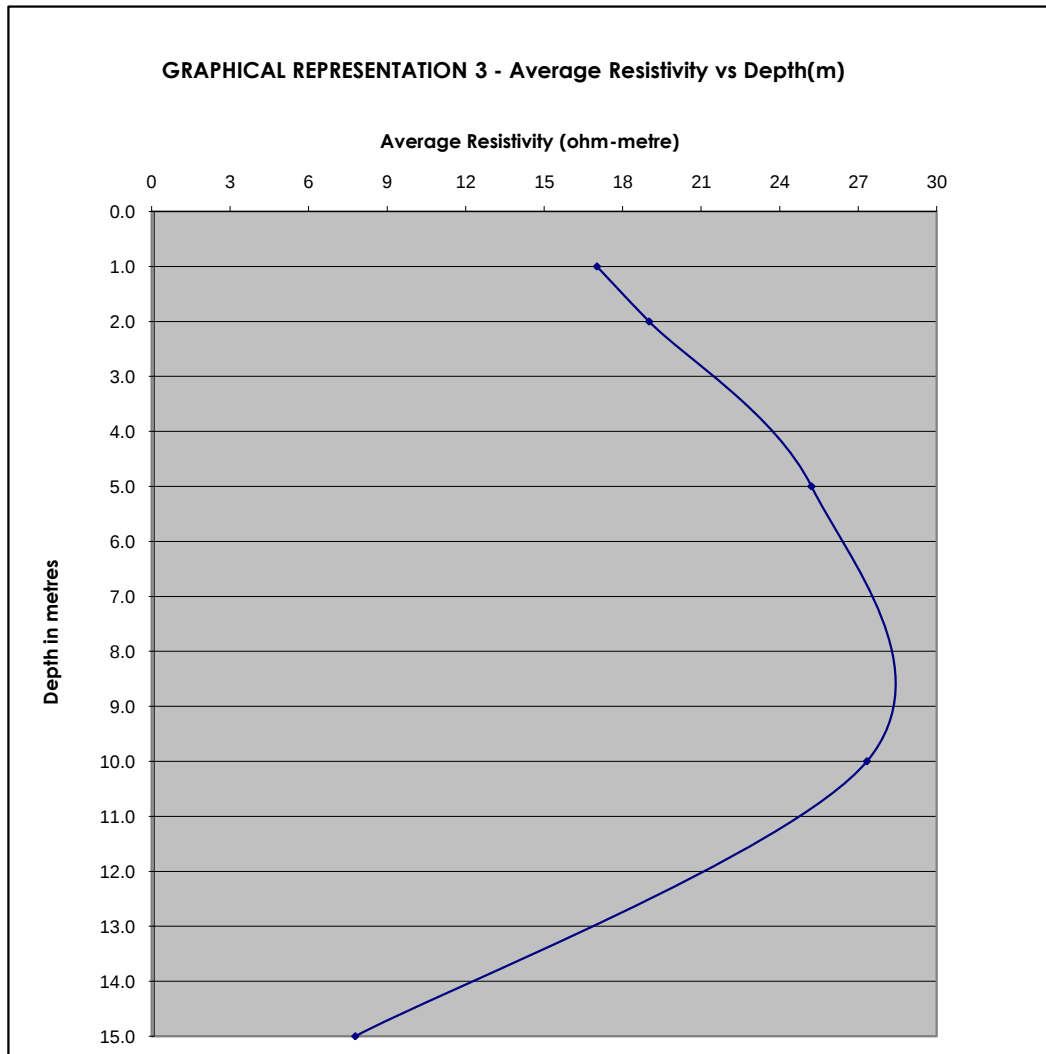
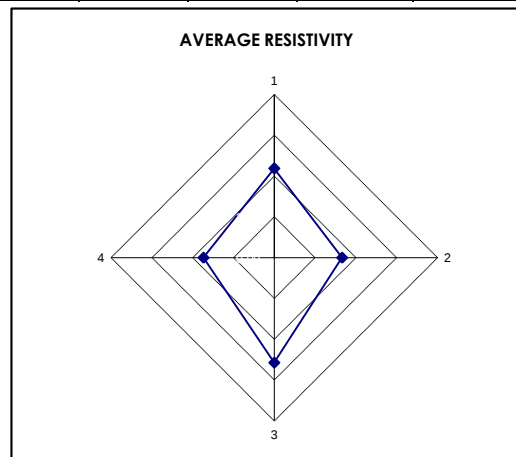


Fig No : 2.10.3

GRAPHICAL REPRESENTATION 1- POLAR GRAPH AS PER IS 3043 - 1987

ERT 11

Direction	Average Resistivity in each direction					
	1 m	2 m	5 m	10 m	15 m	Avg.
N	8.98	9.05	7.23	3.77	3.77	6.56
E	5.97	7.67	5.34	3.14	2.83	4.99
S	8.80	10.30	8.17	5.65	5.65	7.72
W	6.97	7.41	3.77	5.03	2.83	5.20



Average Resistivity at 15 m (ohm-meter) : 6.12

The term 1,2,3,4 in Polar graph indicates direction N, E, S, W respectively.
 Each axis unit indicates 3 Ohm - m

ERT 11

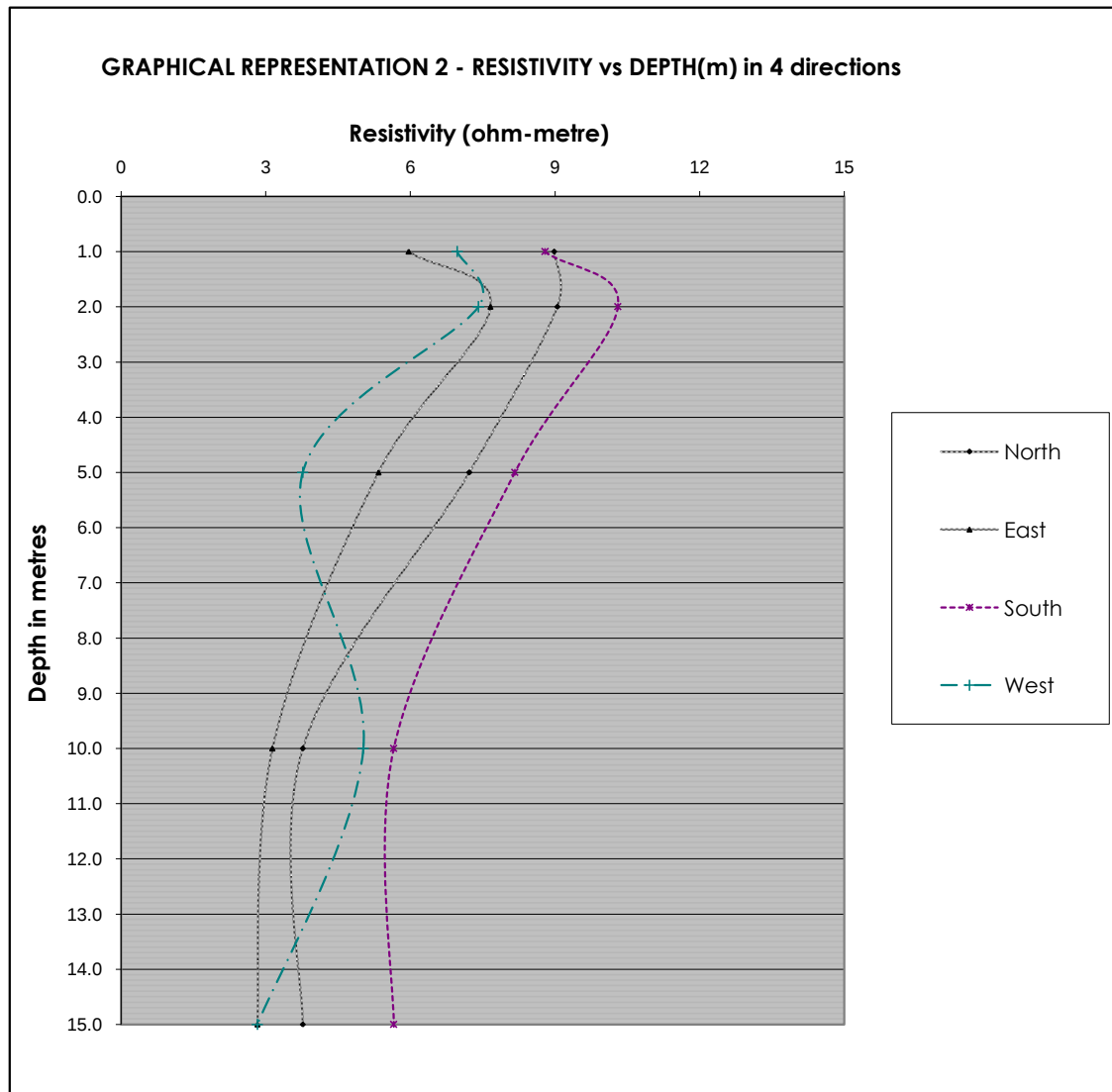


Fig No : 2.11.2

ERT 11

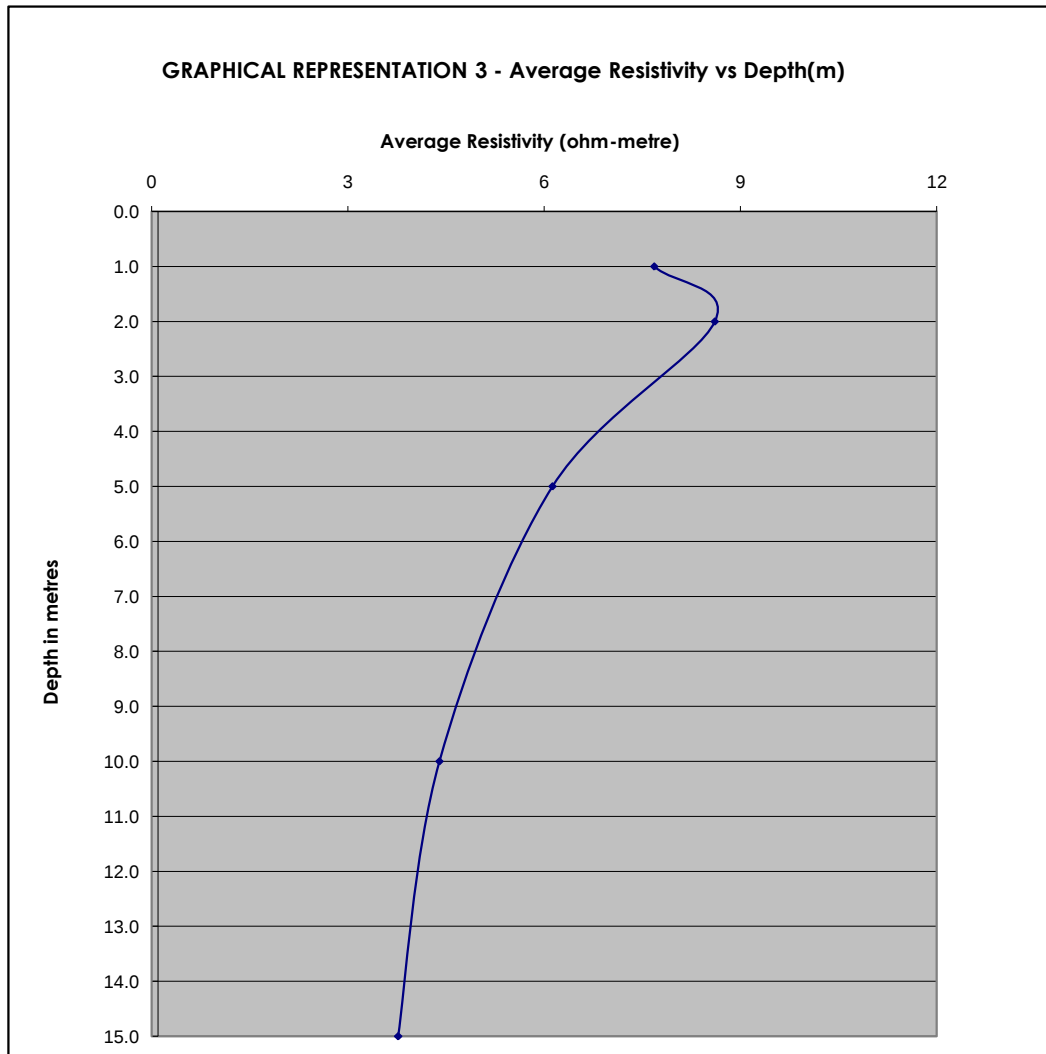
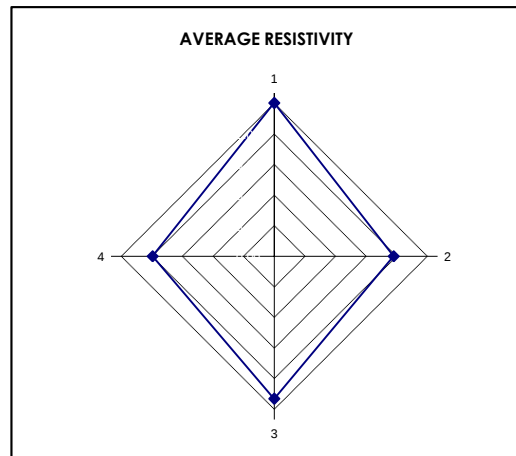


Fig No : 2.11.3

GRAPHICAL REPRESENTATION 1- POLAR GRAPH AS PER IS 3043 - 1987

ERT 12

Direction	Average Resistivity in each direction					
	1 m	2 m	5 m	10 m	15 m	Avg.
N	12.06	17.84	18.53	18.22	8.48	15.03
E	9.86	11.56	19.16	13.19	4.71	11.70
S	11.87	12.82	22.30	16.34	6.60	13.99
W	12.50	13.19	19.16	11.94	2.83	11.93



Average Resistivity at 15 m (ohm-meter) : 13.16

The term 1,2,3,4 in Polar graph indicates direction N, E, S, W respectively.
 Each axis unit indicates 3 Ohm - m

ERT 12

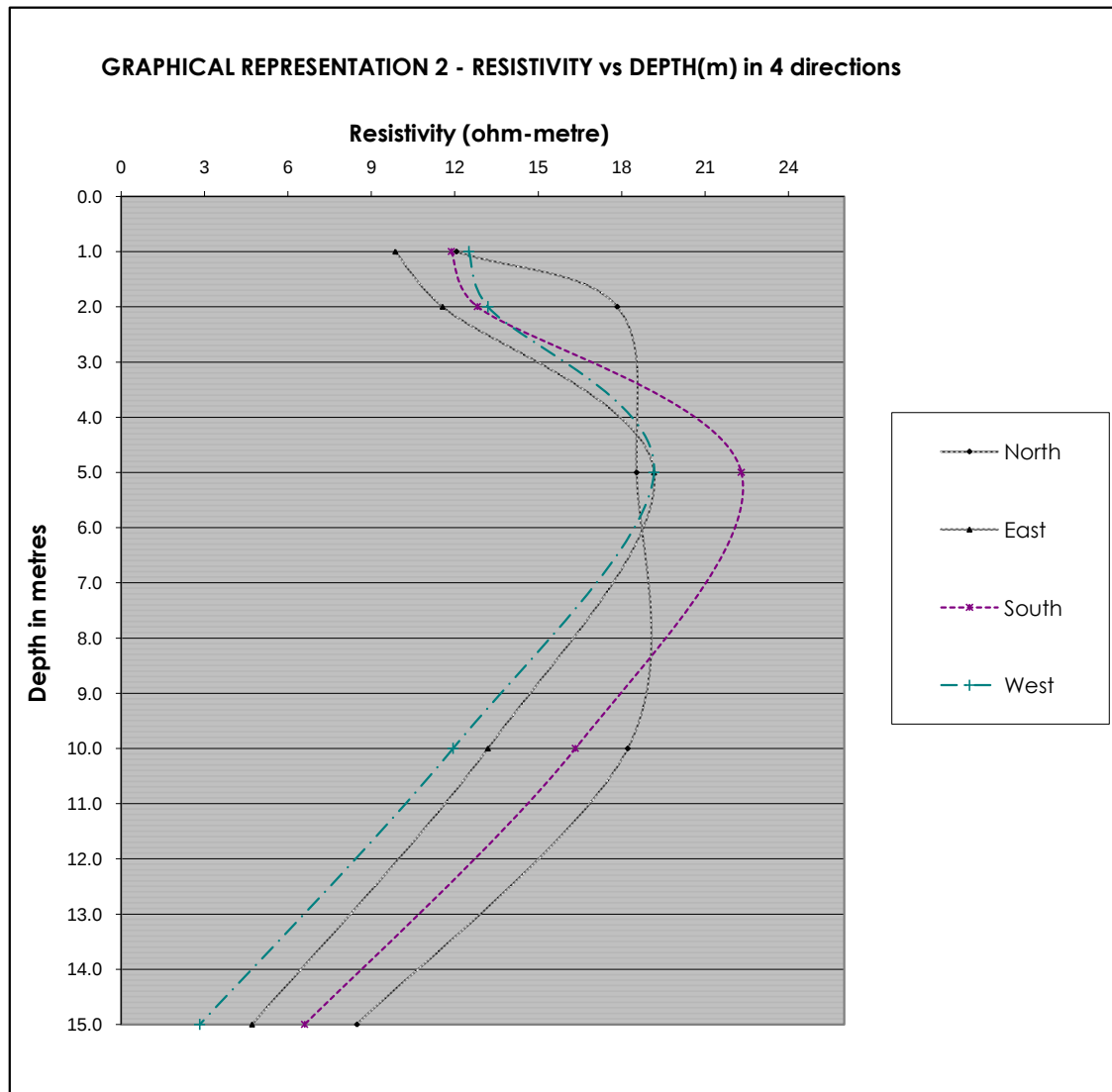


Fig No : 2.12.2

ERT 12

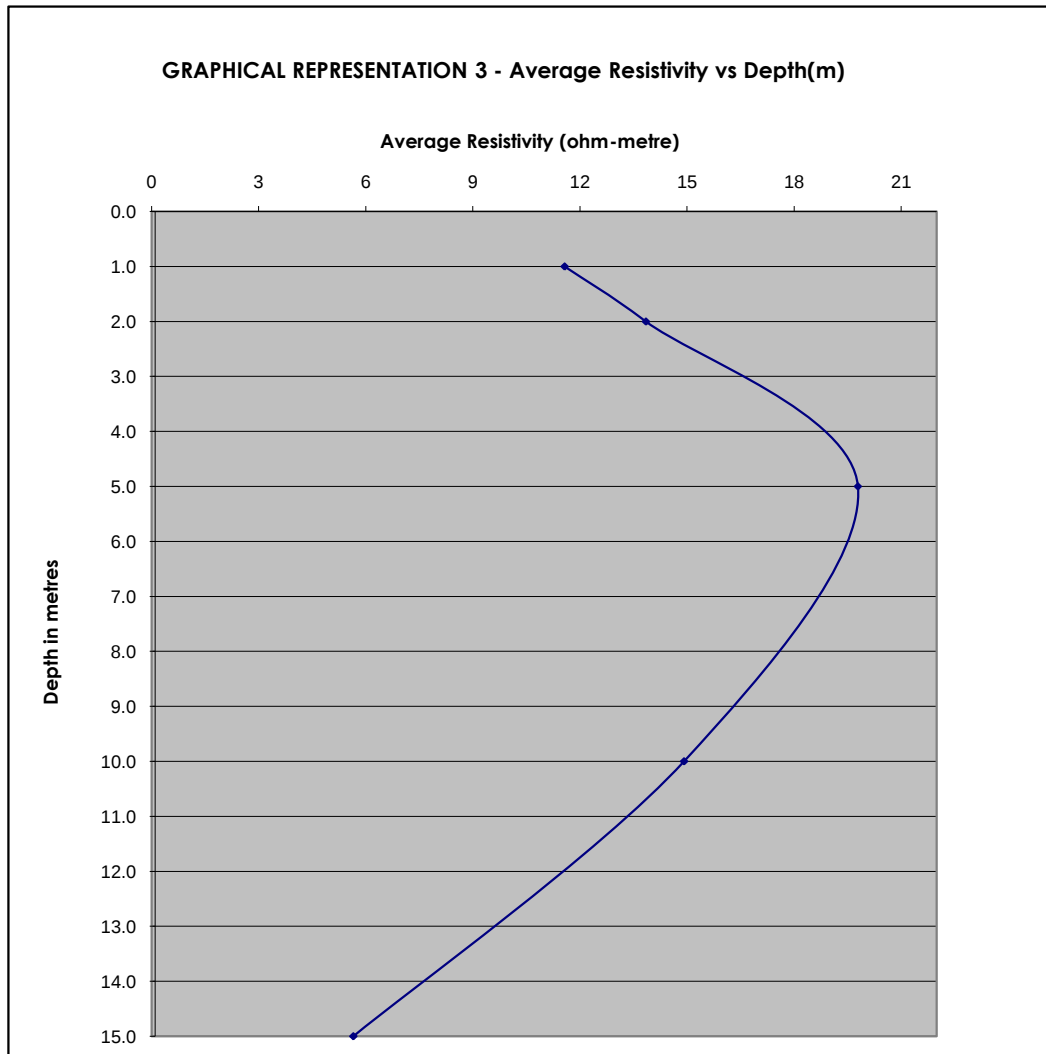


Fig No : 2.12.3

APPENDIX V

CHEMICAL ANALYSIS OF **SOIL AND WATER**

		GEO FOUNDATIONS & STRUCTURES PVT. LTD	
Client : Bharat Heavy Electricals Limited			
Project : soil Investigation for the 10 MWp PV Solar Project at ordinance factory Bolangir, Odisha			
Report No. : SI/CHN/16/1352/			
<u>Chemical Analysis of Soil Sample</u>			
TESTS	Result Obtained		
	BH -2	BH-1	
Depth	3 m	3 m	
p ^H	6.21	6.31	
Chloride asCl	100 ppm	113 ppm	
Sulphate as SO ₃	0.050%	0.046%	



ISO 9001 : 2008 Certified

GEO FOUNDATIONS & STRUCTURES PVT LTD

No.89, Ist Main Road, Gandhi Nagar, Adyar, Chennai – 600 020. Ph: 044 - 24430399

Website: www.geofoundations.net Email: geogfs@gmail.com

PROJECT NAME: Soil Investigation for 10 MWp PV Solar Project at ordinance factory Bolangir, Odisha.

A) NATURE OF SAMPLE : WATER
B) REFERENCE NO. : SI/CHN/16/1352/01

RESULTS OF ANALYSIS

<u>TESTS</u>	<u>Limits as per IS 456-2000</u>	
	BH-1	
a) To neutralize 100 ml. of water using Phenolphthalein as indicator	2.60 ml	Not more than 5.0ml. of 0.02N NaOH
b) i) Organic solids mg/l	96	200 max
ii) Inorganic solids mg/l	262	3000 Max
iii) Sulphate as SO ₃ mg/l	Nil	400 Max.
iv) Chloride as Cl mg/g	14	I.2000 Max for Plain concrete II. 500 Max for reinforced concrete
v) Suspended matter mg/l	3	2000 Max
vi) pH @ 25°C	7.44	6.0 Min

Remarks: The sample submitted conforms to I.S. 456-2000. Hence, it can be used for construction purposes.

APPENDIX VI

TRIAL PITS --- **RESULTS**

TEST RESULTS			Project : Soil Investigation work for the Proposed 10 MWp PV Solar Project at Ordnance factory Bolangir, Odisha.										Termination Depth(m)		Table No.			
													2.00		6A			
													Location				TP 1 TO TP 4	
N VALUE	DEPTH (m)	SAMPLE	SOIL DESCRIPTION	IS. CLASSIFICATION	GRAIN SIZE ANALYSIS			ATTERBERG LIMITS			DRY DENSITY, gm/cc	WET DENSITY, gm/cc	WATER CONTENT, %	SPECIFIC GRAVITY	FREE SWELL INDEX, %	SHEAR PARAMETERS		
GRAVEL, %	SAND, %	SILT & CLAY %			LIQUID LIMIT:%	PLASTIC LIMIT:%	PLASTICITY INDEX	TEST METHOD	C in Kg/cm²	Φ in degrees								
TP-1	0.50	DS-1	Silty SAND	SM	2	72	26						21	2.66		DS		30
	1.00	DS-2	Silty SAND	SM	1	70	29						20			DS		32
	1.50	DS-3	Silty SAND	SM	6	64	30	Non- Plastic					22					
	2.00	DS-4	Silty SAND	SM	5	75	20						18					
TP-2	0.50	DS-1	Clayey SAND	SC-CL	8	51	41	31	12	19			22	2.65		DS		31
	1.00	DS-2	Clayey SAND	SC-CL	9	53	38	29	10	19			24			DS		32
	1.50	DS-3	Clayey SAND	SC-CL	10	56	34	30	14	16			21	2.67				
	2.00	DS-4	Clayey SAND	SC-CL	8	52	40	28	10	18			19					
TP-3	0.50	DS-1	Clayey SAND	SC-CL	0	55	45	30	11	19			21	2.67		DS		31
	1.00	DS-2	Clayey SAND	SC-CL	0	58	42	28	10	18			22					
	1.50	DS-3	Clayey SAND	SC-CL	0	62	38	31	14	17			21					
	2.00	DS-4	Clayey SAND	SC-CL	1	64	35	30	14	16			18					
TP-4	0.50	DS-1	Silty SAND	SM	2	70	28						18	2.66		DS		32
	1.00	DS-2	Silty SAND	SM	1	75	24						21					
	1.50	DS-3	Silty SAND	SM	5	64	31	Non- Plastic					19					
	2.00	DS-4	Silty SAND	SM	4	72	24						22					

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APPENDIX VII

BORE HOLES LOCATION **DRAWING**



NABL

**National Accreditation Board for
Testing and Calibration Laboratories**
Department of Science & Technology, India

CERTIFICATE OF ACCREDITATION

GEO FOUNDATIONS AND STRUCTURES PRIVATE LIMITED

has been assessed and accredited in accordance with the standard

ISO/IEC 17025:2005

"General Requirements for the Competence of Testing & Calibration Laboratories"

for its facilities at

6th Floor, Alpha Plaza, K. P. Vallon Road, Kadavanthra, Kochi, Kerala

in the discipline of

MECHANICAL TESTING

(To see the scope of accreditation of this laboratory, you may also visit NABL website www.nabl-india.org)

Certificate Number T-1613

Issue Date 24/05/2014



Valid Until 23/05/2016

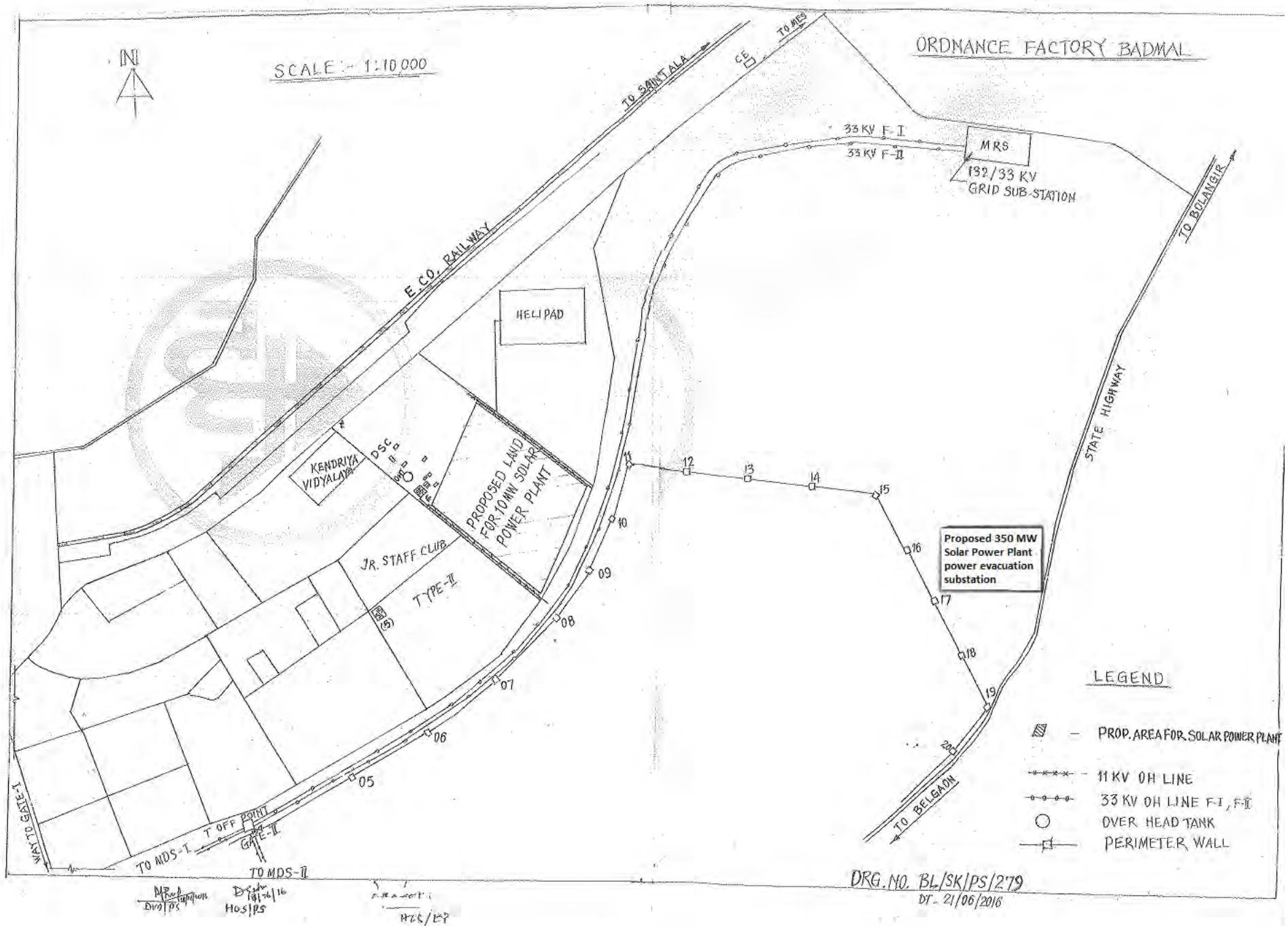
This certificate remains valid for the Scope of Accreditation as specified in the annexure subject to continued satisfactory compliance to the above standard & the additional requirements of NABL.

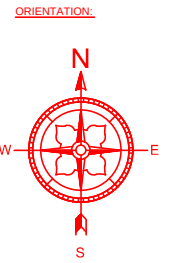
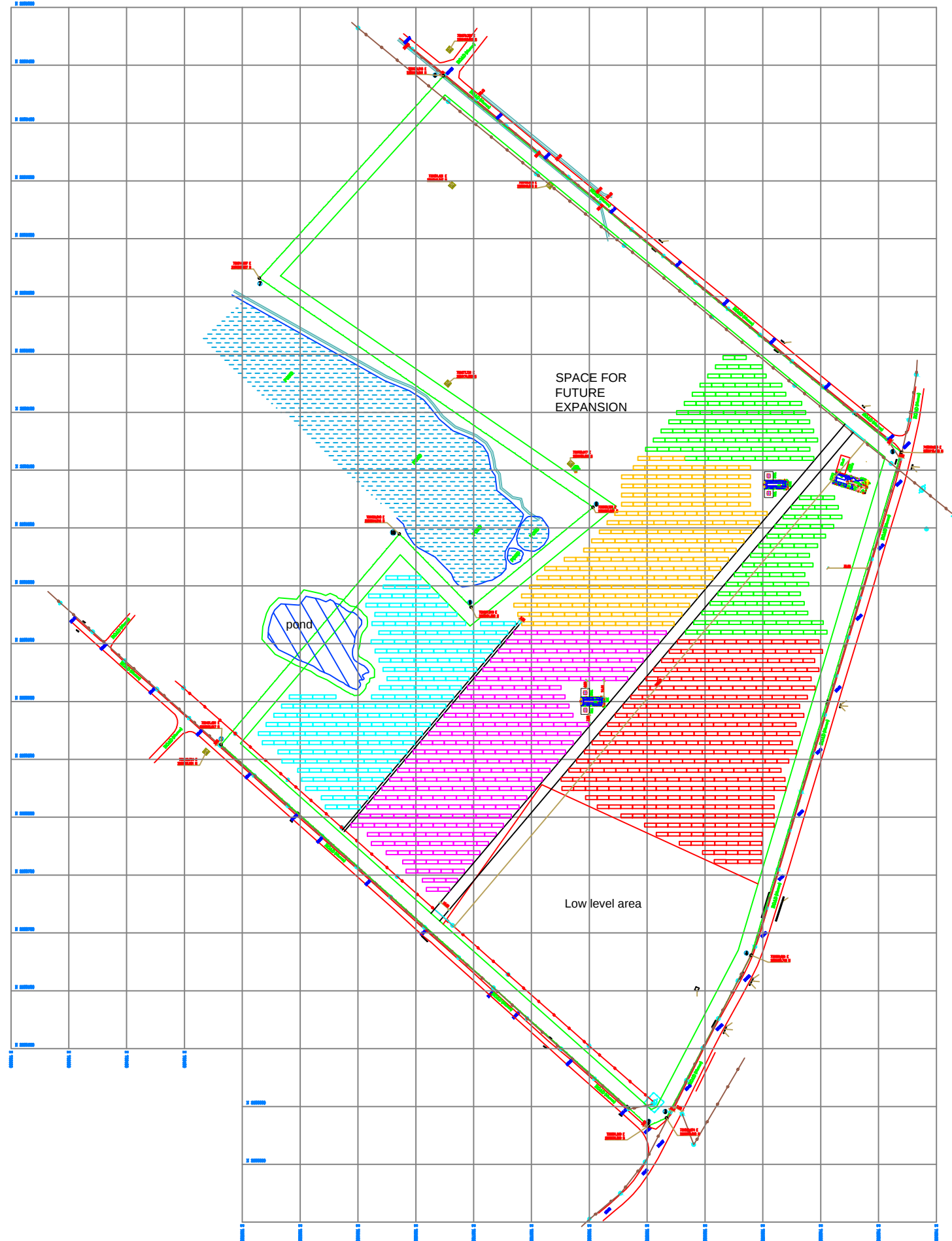
Signed for and on behalf of NABL

John Varughese
Convenor

Anil Relia
Director

Prof. K. VijayRaghavan
Chairman





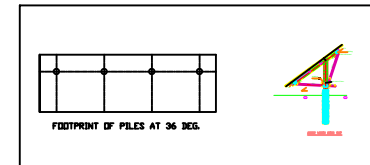
PV ARRAY CAPACITY	- 8.3 MWp
PV Modules (=>300Wp)	- 26880 nos
PV Modules in series string	- 20 nos
Total No. of strings	-1344 nos
Inverter 1250KVA	- 6 nos
String per Inverter	-222 (4 inv),226(1inv) & 230(1 inv)

	STRING or TABLE (10 X 3.952m)
	STRING MONITORING UNIT (SMB)
	INVERTER ROOM (20.5X7.5m) (FOR 4 INV)
	CONTROL ROOM (29.5x11m)
	SWITCH YARD (15x8m)

ALL AROUND BOUNDARY DISTANCE IS 12m

PATHWAY DISTANCE IS 10m

Diagram illustrating a vertical curve. A downward-sloping line is labeled with a 3% grade. A horizontal distance of 4.7m is indicated between two points on the curve. The vertical distance between the two points is labeled as 2.36m. The text "ROW TO ROW DISTANCE 4.7m" is written below the diagram.



ALL DIMENSIONS ARE IN METRES

[illegible]

NAME OF CUSTOMER/PROJECT										BEL																			
 BHARAT HEAVY ELECTRICALS LIMITED. ELECTRONICS DIVISION, BANGALORE										DRN		NAME				SIGN.				DATE									
												ASN								04.01.2017									
												CKD				VKY								04.01.2017					
												APPD				VKG								04.01.2017					
												REF. TO ASSY. DRG.								ITEM NO.				No. OF ITEM				No. OF VAR	
DEPT. SCPV			FOR UNSPECIFIED-TOLERANCES										SCALE			WEIGHT(Kg)			H										
CODE 439			REFER EDR 0230499										NTS																
TITLE										DRAWING NO.										REV.									
PV ARRAY LAYOUT-7.5MW										BEL-OFBOL-LY-E001										01									
										SHEET NO. 01										NO. OF SHEETS 01									

SPECIAL COMMERCIAL CONDITIONS OF CONTRACT (SCC) - for indigenous vendors				
RFQ No. BKC0000006		Dtd. 21.2.2017		Due Date (Tech Bid): 03.03.2017
SI No.	Terms	BHEL Term	Confirmation	Deviation / Remarks
1	PQC	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.Vendor should have supplied and installed transmission lines of 33kV and above in India.Evidence of certificates of installations from clients for successful completion and copies of purchase orders from clients shall be submitted along with the offer. 3.In case vendor has experience in substations/switchyards of 110kv and above (as per clause 1 above) but not in transmission lines of 33kV and above(as per clause 2 above), the vendor shall submit evidence for experience of sub vendor in the form of certificates from clients and copies of purchase order from clients, along with technical offer.		
2	Bidding	(a) Bid has to be submitted as Two Part – Techno Commercial Bid (Part-I) & Price Bid (Part-II).Bids shall be submitted through e-Procurement portal https://bheleps.buyjunction.in of M/s. Mjunction Services Limited.	Complied	
		(b) SCC & Annexure A1 to be submitted along with technical bid (Part-I) & Annexure A2 to be submitted along with Price bid (Part-II).	Complied	
		(c) 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).	Complied	
3	Evaluation of L1 vendor	Over all L1 of Supply + Spares(if applicable) + I&C + O&M on "FOR" basis to site will only be considered.	Complied	
4	Octroi / Entry Tax	Any Entry Tax / Octroi if applicable for supplies to these project location, the same has to borne by the vendor.	Complied	
5	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).	Complied	
6	Terms of Delivery	Free On Road Basis to Project site :BEL 10MW SOLAR PLANT,BOLANGIR,ODISA.	Complied	
7	Delivery Period	(a) Supply : 8 weeks from GTP/DRAWING approval. Drawing/GTP Submission : 1 week from PO.	Acceptable / Not acceptable	
		(b) I&C/Supervision : 4 weeks from supply.	Acceptable / Not acceptable	
		(c) O&M : as per clause no 5.2.16 of PS-439-1110	Acceptable / Not acceptable	
8	Payment Term	1) 80% of basic Supply value + 100% of taxes, duties and freight charges will be paid with 45 days credit from the receipt of material at site or 15 days credit from the date of submission of complete set of documentation whichever is later. 2) 10% of basic supply value will be paid on completion of I&C against submission of supplementary invoice along with proof of completion of I&C along with I&C charges (if any). 3) Balance 10% (retention money) against submission of supplementary invoice along with PBG valid for Warranty Period+3months Claim Period from BHEL Consortium Bank. I&C/Supervision: 100% on completion of I&C/Supervision and certification line item wise on pro-rata basis. FOR O&M: mONTHLY payment of 100% O&M charges shall be done against report certified by BHEL. Note: In exceptional cases, if vendor fails to submit PBG after supplies, vendors can also accept for the final 10% payment, payable after the warranty period + 3 months of claim period against supplementary invoice subject to the completion of commissioning (if applicable) as PBG is linked to Warranty period.	Acceptable / Not acceptable	
		(b) For any deviation in payment term, the offer will be liable for loading as per Clause G of ITB.	Acceptable / Not acceptable	
9	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 through MNRE. Successful bidder shall support with all relevant documents failing which ED shall not be reimbursed.	Complied	
10	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.	Acceptable / Not acceptable	

		(c) Wherever E1/E2 transactions are made, CST paid by sub vendor will not be reimbursed (As it is input cost to vendor)	Complied	
11	Value Added Tax	Both are in the same State, VAT is applicable please indicate VAT applicable.	Applicable / Not applicable	Prevailing rate of VAT : %
12	Service Tax	To confirm whether applicable, if applicable indicate current rate of Service Tax.	Applicable / Not applicable	Prevailing rate of Service Tax: %
		Furnish Service Tax Regn. No. Confirmation that Service Tax register is maintained.		Service Tax Regn. No. S.Tax Register maintained : Yes/No
13	Warranty	(a) Warranty for Supply : 18 MONTHS FROM SUPPLY OR 12 MONTHS FROM I&c WHICHEVER IS EARLIER. (b) Workmanship / I&C : 12 MONTHS FROM I&C.	Acceptable / Not acceptable	
14	Pre Shipment Inspection	(a) Pre Shipment Inspection will be carried out by BHEL/Customer for which test report shall be sent atleast one week in advance.	Acceptable / Not acceptable	
		(b) Pre Shipment Inspection charges , if any, shall be considered while evaluating your offer to arrive at "Total Cost to BHEL". The charges for the same shall be informed to you before Price Bid Opening/Reverse Auction.	Acceptable / Not acceptable	
15	Penalty	(a) Supply: 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.	Acceptable / Not acceptable	
		(b) For any deviation in penalty term, the offer will be liable for loading as per Clause No. G, Point No.(b) of ITB.	Acceptable / Not acceptable	
16	Road Permit	Road permit if applicable will be given by BHEL before Dispatch of ordered Items.However, vendor shall give request for road permit 24 hours in advance.	Complied	
17	PBG	PBG shall be furnished in the BHEL prescribed format.Deviation if any to be specified.	Acceptable / Not acceptable	
18	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, PSI letter Copy, Proof of delivery such as MRC (Material Receipt Certificate)/ original acknowledged LR, Insurance intimation letter and Warranty certificate. One set of Invoice, Packing list and L/R shall be emailed immediately after despatch to BHEL-EDN, Bangalore.	Complied	
19	Reverse Auction	BHEL reserves the right to conduct Reverse auction.Procedure for the same will be informed by BHEL .	Acceptable / Not acceptable	
20	Other terms & conditions	For any other Terms and Conditions, kindly refer to the following: A: ITB (document ref:SCPV: BOS: ITB - Rev 01) B: GCC (document ref: SCPV: BOS: GCC - Rev 01)	Acceptable / Not acceptable	
21	Validity	Quotation should remain valid for a period of 90 days from the due date.	Acceptable / Not acceptable	
22	Shipment	Kindly indicate the state from where the shipment will take place.	State/Place	
23	Documents Submission	All the documents pertaining to I&C and O&M as per Annexure-C to be submitted as applicable.	Acceptable/ Not acceptable	
24	BOS %	The percentage of Supply and I&C and O&M values shall be in the range indicated below (with overall tallying to 100%) : (a) Supply : 52 % to 58 % (b) I&C : 9% to 15 % (c) O&M : 29% to 35 % Successful bidder shall submit detailed billing break up for BHEL approval after placement of Purchase order	Acceptable/ Not acceptable	

25	Integrity Pact	(a) IP is a tool to ensure that activities and transactions between the Company and its Bidders/Contractors are handled in a fair, transparent and corruption free manner. A panel of Independent External Monitors (IEMs) have been appointed to oversee implementation of IP in BHEL. The IP as enclosed with the tender (total 7 sheets) is to be submitted (duly signed by authorized signatory who signs in the offer) along with technocommercial bid. Only those bidders who have entered into such an IP with BHEL would be competent to participate in the bidding. In other words, entering into this Pact would be a preliminary qualification. Details of IEM for this tender is furnished below: Mrs. Pravin Tripathi, IA & AS (Retd.), D-243, Anupam Gardens, Lane, IB, Neb Sarai, Sainik Farms, New Delhi – 110 068 pravin.tripathi@gmail.com (b) Please refer Section-8 of the IP for Role and Responsibilities of IEMs. In case of any complaint arising out of the tendering process, the matter may be referred to the IEM mentioned in the tender. No routine correspondence shall be addressed to the IEM (phone/post/email) regarding the clarifications, time extensions or any other administrative queries, etc. on the tender issued. All such clarification/issues shall be addressed directly to the tender issuing (procurement) department.”	Acceptable/Not acceptable	
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AUTHORISED SIGNATORY WITH SEAL

TECHNICAL BID ENCLOSURE FOR COMPLIANCE OF QUOTE : UNPRICED BID (Indigenous vendors)											
RFQ No. BKC0000006 Dtd.21.02.2017 Due Date (Tech Bid): 03.03.2017											
Sl No.	Material Code	DESCRIPTION	ADDITIONAL DESCRIPTION	QUOTED	QTY	UNIT	TAXES				REMARKS
							ED %	CST %	VAT %	S. TAX%	
1	PS0679069119	Supply of 33kv Metering yard-Elec items.	As per clause 3.1 of PS-439-1110	YES/NO	1	ST	NA			NA	TAXES INCLUDED
2	PS0679069127	Supply of 33kv Tr line-Electrical items	As per clause 3.2 of PS-439-1110	YES/NO	1	ST	NA			NA	TAXES INCLUDED
3	PS0679069135	Supply of 33kv meter yard/Tr line-struct	As per clause 3.3 of PS-439-1110	YES/NO	1	ST	NA			NA	TAXES INCLUDED
4	PS0679069143	Supply of 33kv Switchyard substation	As per clause 3.4 of PS-439-1110	YES/NO	1	ST	NA			NA	TAXES INCLUDED
5	PS0679069151	Supply of 132kv Switchyard substation	As per clause 3.5 of PS-439-1110	YES/NO	1	ST	NA			NA	TAXES INCLUDED
6	PS0679069160	Supply of structure items for 33 and 132kv Switchyard.	As per clause 3.6 of PS-439-1110	YES/NO	1	ST	NA			NA	TAXES INCLUDED
7	PS0679069178	Supply of spare items.	As per clause 3.10 of PS-439-1110	YES/NO	1	ST	NA			NA	TAXES INCLUDED
8	PS0679069186	I&C of 33kv metering yard.FP structure	As per clause 3.7 of PS-439-1110	YES/NO	1	AU	NA	NA	NA		TAXES INCLUDED
9	PS0679069194	I&C of 33kv & 132kv S/yards-substation.	As per clause 3.9 of PS-439-1110	YES/NO	1	AU	NA	NA	NA		TAXES INCLUDED
10	PS0679069208	I&C of 33kv transmission line.	As per clause 3.8 of PS-439-1110	YES/NO	1	AU	NA	NA	NA		TAXES INCLUDED
11	PS0679069216	Commissioning and state dept clearance	As per clause 3.11 of PS-439-1110	YES/NO	1	AU	NA	NA	NA		TAXES INCLUDED
12	PS0679069224	O&M	As per clause 3.12 of PS-439-1110	YES/NO	120	AU	NA	NA	NA		TAXES INCLUDED
13	Freight Charge including Service Tax on Freight: Included in Quoted rates										

Note: 1. The quoted prices shall be on "FOR" basis to project site: ORDNANCE FACTORY,BOLANGIR,ODISA
 2. The quoted prices shall be inclusive of all Taxes & Duties, Packing & Forwarding charges and Freight.
 3. However, the percentage of taxes considered against each item shall be indicated in the column for Taxes for the purpose of availing Tax Credit.
 4. **ED shall not be considered as the project is under MNRE approval. Hence all inclusive rate for Supply is to be quoted without ED for Supply. However, the prevailing rate of ED shall be indicated in SCC (Annexure B). In case any item is rejected by MNRE, ED shall be reimbursed for that item at actuals.
 5. The above format only shall be used for compliance. (reproducing on your letter head is acceptable).
 6. Insurance will be in BHEL scope.

AUTHORISED SIGNATORY WITH SEAL

PRICED BID (Indigenous Vendors)											
RFQ No. BKC0000006 Dtd.21.02.2017 Due Date (Tech Bid): 03.03.2017											
Sl No.	Material Code	DESCRIPTION	QTY	UNIT	Unit Rate (Rs.)	Total Value (Rs.) (Rate X Qty)	TAXES				Remarks
							ED %	CST%	VAT %	S TAX%	
1	PS0679069119	Supply of 33kv Metering yard-Elec items.	1	ST			NA			NA	Taxes Extra
	Unit rate in words :										
2	PS0679069127	Supply of 33kv Tr line-Electrical items	1	ST			NA			NA	Taxes Extra
	Unit rate in words :										
3	PS0679069135	Supply of 33kv meter yard/Tr line-struct	1	ST			NA			NA	Taxes Extra
	Unit rate in words :										
4	PS0679069143	Supply of 33kv Switchyard substation	1	ST			NA			NA	Taxes Extra
	Unit rate in words :										
5	PS0679069151	Supply of 132kv Switchyard substation	1	ST			NA			NA	Taxes Extra
	Unit rate in words :										
6	PS0679069160	Supply of structure items for 33 and 132kv Switchyard.	1	ST			NA			NA	Taxes Extra
	Unit rate in words :										
7	PS0679069178	Supply of spare items.	1	ST			NA			NA	Taxes Extra
	Unit rate in words :										
8	PS0679069186	I&C of 33kv metering yard.FP structure	1	AU			NA	NA	NA		Taxes Extra
	Unit rate in words :										
9	PS0679069194	I&C of 33kv & 132kv S/yards-substation.	1	AU			NA	NA	NA		Taxes Extra
	Unit rate in words :										
10	PS0679069208	I&C of 33kv transmission line.	1	AU			NA	NA	NA		Taxes Extra
	Unit rate in words :										
11	PS0679069216	Commissioning and state dept clearance	1	AU			NA	NA	NA		Taxes Extra
	Unit rate in words :										
12	PS0679069224	O&M	120	AU			NA	NA	NA		Taxes Extra
	Unit rate in words :										
13	Freight Charge including Service Tax on Freight		Lumpsum								

Note:1. The quoted prices shall be on "FOR" basis to project site: ORDNANCE FACTORY,BOLANGIR,ODISA

2. The quoted prices shall be inclusive of all Taxes & Duties, Packing & Forwarding charges and Freight.

3. However, the percentage of taxes considered against each item shall be indicated in the column for Taxes for the purpose of availing Tax Credit.

4. **ED shall not be considered as the project is under MNRE approval. Hence all inclusive rate for Supply is to be quoted without ED for Supply. However, the prevailing rate of ED shall be indicated in SCC (Annexure B). In case any item is rejected by MNRE, ED shall be reimbursed for that item at actuals.

5. The above format only shall be used for compliance. (reproducing on your letter head is acceptable).

6. Insurance will be in BHEL scope.

ANNEXURE - C

List of Documents to be submitted by Vendors/Subcontractors for SPV Contracts.		Confirmation on submission	Deviation / Remarks
IR Documents (Type - A): For all Civil & I&C & O&M			
Sl No.	Documents		
1	Wage Sheet (Form 17)	YES / NO	
2	Attendance Register (w.r.t Sl No.1)	YES / NO	
3	Workman Policy & Additional Insurance (Automotive Liability, Group Servis Insuarncce Policy e	YES / NO	
4	PF Challan	YES / NO	
5	ESI (Employee State Insurance)	YES / NO	
6	ECR (Electronic Challan Receipt)	YES / NO	
7	Bank Statement for PF deposit	YES / NO	
8	RCS (Remittance Confirmation Slip)	YES / NO	
Quality Documents (Type - B): For all MMS Civil Works			
Sl No.	Documents		
1	FQA (Field Quality Assuarance)	NA	
2	Field Content, Slump Test	NA	
3	Gradation of Aggregate (10mm, 20mm)	NA	
4	Fine Aggregate Test (for Sand)	NA	
5	Cube Test Registered	NA	
6	Material Test Certificate for Steel & Cement	NA	
7	Consumption Register for Steel & Invoice	NA	
8	Pour Card for Concreting purpose	NA	
9	Royalty Reports (10mm, 20mm, Sand)	NA	
10	Sand Soundess Test Reports	NA	
11	Slump Test Register	NA	
12	Sieve Analysis, Flakiness Index, Elongation Index - Register to be maintained	NA	
13	Moisture Content Coarse and Fine Aggregate - Register to be maintained	NA	
14	Water Test Report for Concrete	NA	
15	Design Mix Report for Concrete	NA	
Quality Documents (Type - B): For all Civil related Works			
Sl No.	Documents		
1	FQA (Field Quality Assuarance)	YES / NO	
2	Field Content, Slump Test	YES / NO	
3	Gradation of Aggregate (10mm, 20mm)	YES / NO	
4	Fine Aggregate Test (for Sand)	YES / NO	
5	Cube Test Registered	YES / NO	
6	Material Test Certificate for Steel & Cement	YES / NO	
7	Consumption Register for Steel & Invoice	YES / NO	
8	Pour Card for Concreting purpose	YES / NO	
9	Royalty Reports (10mm, 20mm, Sand)	YES / NO	
10	Sand Soundess Test Reports	YES / NO	
11	Warpage of Bricks Test Reports	YES / NO	
12	Core Cutting (Compaction Test) - Roads & Pathways	YES / NO	
13	Slump Test Register	YES / NO	
14	Sieve Analysis, Flakiness Index, Elongation Index - Register to be maintained	YES / NO	
15	Moisture Content Coarse and Fine Aggregate - Register to be maintained*	YES / NO	
16	Brick Test Reports	YES / NO	
17	Plastering profile and thickness	YES / NO	
18	Compaction test beneath floor of all buildings. - Reports	YES / NO	
19	Test Certificates for Paint, Glan, Glazing, etc.	YES / NO	
20	Test Certificates Aluminium Section for doors and windows (Anodisation Certificates also)	YES / NO	
21	BBS for Buildings	YES / NO	
22	Water Test Report for Concrete	YES / NO	
23	Design Mix Report for Concrete	YES / NO	
Quality Documents: for Electrical & Mechanical Installation Works (BOS)			
Sl No.	Documents		
1	FQA (Field Quality Assuarance)	YES / NO	
2	Inspection Reports	YES / NO	
3	Guarantee Certificates	YES / NO	
4	Factory Acceptance Test Reports	YES / NO	
5	Commissioning Reports	YES / NO	

NOTE:

* This list of documents is indicative and intended towards all Solar Projects.

* Apart from the above, any other document required by the Customer and which are mandatory for Billing by BHEL to the Customer, the same needs to be provided by the respective vendors.



ಭಾರತ್ ಹೆವಿ ಎಲೆಕ್ಟ್ರಿಕಲ್ಸ್ ಲಿಮಿಟೆಡ್
भारत हेवी इलेक्ट्रिकल्स लिमिटेड

Bharat Heavy Electricals Ltd.,
(A Government of India undertaking)
Electronics Division

PB 2606 , Mysore Road Bangalore , 560026 INDIA

SCPV: BOS: ITB - Rev 01

INSTRUCTIONS TO BIDDERS (ITB)

Bidders are requested to read the instructions carefully and submit their quotations covering all the points:

A. GENERAL INSTRUCTIONS:

1. Any Purchase Order resulting from this enquiry shall be governed by the Instructions to Bidders (document reference: SCPV: BOS: ITB – Rev 01), General Conditions of Contract (document reference: SCPV: BOS: GCC - Rev 01) and Special Conditions of Contract (document reference: SCPV: BOS: SCC: I - Rev 01/ SCPV: BOS: SCC: F - Rev 01), if any, of the enquiry.
2. Any deviations from or additions to the “General Conditions of Contract” or “Special Conditions of Contract” require BHEL’s express written consent. The general terms of business or sale of the bidder shall not apply to this tender.
3. Bidders (also includes the term suppliers / contractors wherever used in this document) are instructed to quote their most competitive price and best delivery, etc. in the offer. Prices should be indicated in both figures & words. **(Please also refer clause 11 under section B)**
4. Regret letter (either through post or by mail) indicating reasons for not quoting must be submitted without fail, in case of non-participation in this tender. If a bidder fails to respond against 3 consecutive tenders for the same item, he will be liable for removal as a registered vendor of BHEL.
5. Procurement directly from the manufacturers shall be preferred. However, if the OEM / Principal insist on engaging the services of an agent, such agent shall not be allowed to represent more than one manufacturer / supplier in the same tender. Moreover, either the agent could bid on behalf of the manufacturer / supplier or the manufacturer / supplier could bid directly but not both. In case bids are received from the manufacturer / supplier and his agent, bid received from the agent shall be ignored.
6. Consultant / firm (and any of its affiliates) shall not be eligible to participate in the tender/s for the related goods for the same project if they were engaged for consultancy services for the same project.
7. If an Indian representative / associate / liaison office quotes on behalf of a foreign based bidder, such representative shall furnish compulsorily the following documents:
 - a. Authorization letter to quote and negotiate on behalf of such foreign-based bidder.
 - b. Undertaking from such foreign based bidder that such contract will be honored and executed according to agreed scope of supply and commercial terms and conditions.
 - c. Undertaking shall be furnished by the Indian representative stating that the co-ordination and smooth execution of the contract and settlement of shortages / damages / replacement / repair of imported scope till system is commissioned and handed over to customer will be the sole responsibility of the Indian representative / associates / agent / liaison office.
8. In case of imported scope of supply, customs clearance & customs duty payment will be to BHEL account after the consignment is received at Indian Airport / Seaport. Bidders must provide all original documents required for completing the customs clearance along with the shipment. Warehousing charges due to incomplete or missing documentation will be recovered from the supplier’s bill. All offers for imported scope of supply must be made from any of the gateway ports (within the country) indicated. **(Refer Annexure I)**
9. The offers of the bidders who are on the banned list and also the offers of the bidders, who engage the services of the banned firms, shall be rejected. The list of the banned firms is available on BHEL website: **www.bhel.com**.

10. Business dealings with bidders will be suspended if they are found to have indulged in any malpractices / misconduct which are contrary to business ethics like bribery, corruption, fraud, pilferage, cartel formation, submission of fake/false/forged documents, poor quality, certificates, information to BHEL or if they tamper with tendering procedure affecting the ordering process or fail to execute a contract, or rejection of 3 consecutive supplies or if their firms / works are under strike / lockout for a long period.

B. GUIDELINES FOR PREPARATION OF OFFER:

1. Quotation shall be submitted in Single Part Bid, Two Part Bid or Three Part Bid, as called for in the tender:
 - **SINGLE PART BID:** Technical and Commercial Bid with prices along with price summary & filled in BHEL Standard Commercial terms and conditions in a single sealed envelope.
 - **TWO PART BID:** Unpriced offer i.e. "Techno-commercial Bid" with filled in BHEL Standard Commercial terms and conditions in a sealed envelope **along with the copy of the "Price Bid" without the prices** should be enclosed in one cover and the cover must be super scribed "**Techno-commercial offer** and Priced offer i.e. "Price Bid" containing price summary in a separate sealed envelope and must be super scribed "**Price Bid**". Both these envelopes shall be enclosed in a single sealed envelope super scribed with enquiry number, due date of tender and any other details as called for in the tender document.
 - **THREE PART BID:** Pre-qualification Bid (Part-I), Techno Commercial Bid with filled in BHEL Standard Commercial terms and conditions (Part-II), and Price Bid (Part-III). All three envelopes shall be enclosed in a single sealed envelope super scribed with enquiry number due date of tender and any other details as called for in the tender document.

If any of the offers (Part I, Part II or Part III) are not submitted before the due date and time of submission at the venue/place specified or if any part of the offer is incomplete the entire offer of the bidder is liable for rejection.

2. Supplier shall ensure to super scribe each envelope with RFQ number, RFQ Date, RFQ Due date and time, Item Description and Project clearly & boldly. Also mention on the envelope whether it is "Techno Commercial Bid" or "Price Bid" or "Pre-Qualification Bid". Please ensure complete address, department name and purchase executive name is mentioned on the envelope (before dropping in the tender box or handing over) so that the tender is available in time for bid opening.
3. BHEL standard Commercial Terms and Conditions shall be duly filled, signed & stamped and must accompany Technical-Commercial offer without fail and should be submitted in original only. Photocopy will not be accepted. All documents submitted along with the offer shall be signed and stamped in each page by authorized representative of the bidder.
4. Any of the terms and conditions not acceptable to supplier, shall be explicitly mentioned in the Techno-Commercial Bid. If no deviations are brought out in the offer it will be treated as if all terms and conditions of this enquiry are accepted by the supplier without any deviation.
5. Deviation to this specification / item description, if any, shall be brought out clearly indicating "DEVIATION TO BHEL SPECIFICATION" without fail, as a part of Techno-Commercial Bid. If no deviations are brought out in the offer it will be treated as if the entire specification of this enquiry is accepted without deviation.
6. Suppliers shall submit one set of original catalogue, datasheets, bill of materials, dimensional drawings, mounting details and / or any other relevant documents called in purchase specification as part of Technical Bid.
7. "Price Bid" shall be complete in all respects containing price break-up of all components along with all applicable taxes and duties, packing & forwarding charges (if applicable), freight charges (if applicable) etc. Once submitted no modification / addition / deletion will be allowed in the "Price Bid." Bidders are advised to thoroughly check the unit price, total price to avoid any discrepancy.
8. In addition, bidder shall also quote for erection & commissioning charges (I&C charges), documentation charges, service charges, testing charges (type & routine), training charges, service tax, etc. wherever applicable. The price summary must indicate all the elements clearly.
9. Vendors should indicate "lump sum" charges (including To & Fro Fare, Boarding, Lodging, Local Conveyance etc.) for Supervision of Erection, Commissioning and handing over to customer. The quotation shall clearly indicate scope of work, likely duration of commissioning, pre-commissioning checklist and service tax (if any).
10. Wherever bidders require PAC (Project Authority Certificate) for import of raw materials, components required for Mega

Power Projects, Export Projects, MNRE Concession or other similar projects wherein supplies are eligible for customs duty /Excise duty benefits, lists and quantities of such items and their values (CIF) has to be mentioned in the offer. Prices must be quoted taking into account of such benefits.

11. All quotations shall be free from corrections /overwriting. Corrections if any should be authenticated with signature and seal. Any typographical error, totaling mistakes, currency mistake, multiplication mistake, summing mistakes etc. observed in the price bids will be evaluated as per **Annexure VI** "Guidelines for dealing with Discrepancy in Words & Figures – quoted in price bid". BHEL decision will be final.

C. GUIDELINES FOR OFFER SUBMISSION:

1. Offers / Quotations must be dropped in tender box before 13.00 Hrs. on or before due date mentioned in RFQ. The offers are to be dropped in the proper slot of the Tender Box kept in our reception area with caption "CE, SC&PV, DEFENCE." Tenders are opened on 3 days in a week (Monday/Wednesday/Friday). Tender must be deposited in the slot corresponding to the day (Monday - Box no.4/Wednesday - Box no. 6 /Friday - Box no.8) while depositing the offer. **(This clause will not be applicable for e-tenders).**
2. E-Mail / Internet / EDI offers received in time shall be considered only when such offers are complete in all respects. In case of offers received through E-mail, please send the offer to the email IDs within time of submission of tender.
3. In cases where tender documents are bulky, or due to some reasons tender documents are required to be submitted by hand or through posts/couriers, the offers are to be handed over to purchase officers.
4. Tenders will be opened on due date, time and venue as indicated in the RFQ in the presence of bidders at the venue indicated in the RFQ. In case of e-procurement, bidders can see tender results till seven days after due date and time.
5. Vendor will be solely responsible:
 - a. For submission of offers before due date and time. Offers submitted after due date and time will be treated as "Late offers" and will be rejected.
 - b. For submission of offers in the correct compartment of the tender box based on the day of due date (Monday/Wednesday/Friday). Please check before dropping your offer in the correct tender box.
 - c. For depositing offers in proper sealed condition in the tender box. If the bidder drops the tender in the wrong tender box or if the tender document is handed over to the wrong person BHEL will not be responsible for any such delays.
 - d. For offers received through email/courier etc., suppliers are fully responsible for lack of secrecy on information and ensuring timely receipt of such offers in the tender box before due date & time.
 - e. In case of e-tender, all required documents should be uploaded before due date and time. Availability of power, internet connections, etc. will be the sole responsibility of the vendor. Wherever assistance is needed for submission of e-tenders, help line numbers and executives of service provider of BHEL may be contacted.
Service provider: M-junction
Website address: <https://bheleps.buyjunction.in/>
Helpline no.: 033-66106426/6217/6013/6046/6176 (9:30 am to 5:30 pm)
9163348283/9163348284/9163348285/9163348286/8584008116 (5:30 pm to 8:30 pm)

Purchase Executive / BHEL will not be responsible for any of the activities relating to submission of offer.

D. PROCESSING OFFERS RECEIVED:

1. Any discount / revised offer submitted by the supplier on its own shall be accepted provided it is received on or before the due date and time of offer submission (i.e. Part-I bid). The discount shall be applied on pro-rata basis to all items unless specified otherwise by the bidder.
2. Changes in offers or Revised offers given after Part-I bid opening shall not be considered as a part of the original offer unless such changes / revisions are requested by BHEL.
3. In case there is no change in the technical scope and / or specifications and / or commercial terms & conditions by BHEL, the supplier will not be allowed to change any of their bids after Technical bids are opened (after the due date and time of tender opening of Part-1 Bid).

4. In case of changes in scope and/ or technical specifications and/ or commercial terms & conditions by BHEL and it accounts for price implications from vendors, all techno-commercially acceptable bidders shall be asked by BHEL (after freezing the scope, technical specifications and commercial terms & conditions) to submit the impact of such changes on their price bid. Impact price will be applicable only for changes in technical specification / commercial conditions by BHEL. The impact price must be submitted on or before the cut-off date specified by BHEL and the original price bid and the price impact bid will be opened together at the time of price bid opening. Impact price means only for those items which have been impacted by addition / deletion / changes in the technical specifications or commercial conditions. The impact may be +/- incremental value of the currency in which originally quoted. The impact price bid to be submitted on the cut-off date, time & venue as specified by BHEL. The impact price bid shall be opened along with original price bid.
5. Un-opened bids (including price bids) will be returned to the respective bidders after release of PO and receipt of order acknowledgement from the successful bidder.
6. After receipt of Purchase Order, supplier should submit required documents like drawings, bill of materials, datasheets, catalogues, quality plan, test procedure, type test report , O & M Manuals and / or any other relevant documents as per Specification / Purchase Order, as and when required by BHEL / Customer.
7. Any deviation to the terms and conditions not mentioned in the quotation by supplier in response to this enquiry will not be considered, if put forth subsequently or after issue of Purchase Order, unless clarification is sought for by BHEL EDN and agreed upon in the Purchase Order.
8. Evaluation shall be on the basis of delivered cost (i.e. "Total Cost to BHEL"). As per RFQ terms.
"Total Cost to BHEL" shall include total basic cost, packing & forwarding charges, taxes and duties, inspection charges, freight charges, test charges, insurance, service tax for services, any other cost indicated by vendor for execution of the contract and loading factors (for non-compliance to BHEL Standard Commercial Terms & Conditions). Benefits arising out of Nil Import Duty on Mega Projects, Physical Imports or such 100% exemptions & MNRE Exemptions (statutory benefits), customer reimbursements of statutory duties (like Excise Duty, CST, VAT) will also be taken into account at the time of tender evaluation. (Wherever applicable and as indicated in SCC document of tender)
9. For evaluation of offers in foreign currency, the exchange rate (TT selling rate of SBI) shall be taken as under:

Single part bids:	Date of tender opening
Two/three part bids:	Date of Part-I bid opening
Reverse Auction:	Date of Part-I bid opening

In case of Performance Bank Guarantee (PBG) also, exchange rate will be considered as mentioned above for converting foreign currency to Indian currency and vice versa.

If the relevant day happens to be a bank holiday, then the exchange rate as on the previous working day of the bank (SBI) shall be taken.
10. Ranking (L-1, L-2 etc.) shall be done only for the techno-commercially acceptable offers and on the basis or evaluation of Total Cost to BHEL.

E. INFORMATION ON PAYMENT TERMS:

1. All payments will be through Electronic Fund transfer (EFT). Vendor has to furnish necessary details as per BHEL standard format (**Refer Annexure IV**) for receiving all payments through NEFT. (Applicable for Indian vendors only)
2. Statutory deductions, if any, will be made and the deduction certificate shall be issued. In case vendor does not provide PAN details, the TDS deduction shall be at the maximum percentage stipulated as per the provisions of Income Tax Act. (Applicable for Indian vendors only). Foreign vendors shall submit relevant details of their bankers like Swift Code, Banker's Name & Address etc.
3. Vendors must submit bills & invoices along with required supporting documents in time. Incomplete documentation / delayed submission of invoice / documents will result in corresponding delay in payment.

F. STANDARD PAYMENT TERMS OF BHEL-EDN**Purchase Orders for indigenous procurement****(a) SUPPLY WITH I&C/SUPERVISION:****Supply:**

- 1) 80% of basic Supply value + 100% of taxes, duties and freight charges will be paid with 45 days credit from the receipt of material at site or 15 days credit from the date of submission of complete set of documentation whichever is later.
- 2) 10% of basic supply value will be paid on completion of I&C against submission of supplementary invoice along with proof of completion of I&C along with I&C charges (if any).
- 3) Balance 10% (retention money) against submission of supplementary invoice along with PBG valid for Warranty Period+3 months Claim Period from BHEL Consortium Bank.

I&C/Supervision: 100% on completion of I&C/Supervision and certification line item wise on pro-rata basis.

O&M: 100% O&M charges are payable as per RFQ terms against report certified by BHEL.

(b) SUPPLY ONLY:

- 1) 100% of Basic value with taxes, duties and freight will be paid with 45 days credit from the receipt of material at site or 15 days credit from the date of submission of complete set of documentation whichever is later)+ submission of PBG valid for Warranty Period+ 3 months Claim Period from BHEL Consortium Bank ,if applicable.

Purchase orders for import procurement:**(c) SUPPLY WITH I&C/SUPERVISION:****Supply:**

- 1) 80% of the basic value (excluding I&C charges) will be paid with 45 days credit, against Sight draft, from the date of AWB/BOL on submission of complete set of documents as in PO.
- 2) 10% of basic supply value will be paid on completion of I&C against submission of supplementary invoice along with proof of completion of I&C along with I&C charges (if any).
- 3) Balance 10% (retention money) against submission of supplementary invoice along with PBG valid for Warranty Period+3 months Claim Period from BHEL Consortium Bank.

I&C: 100% on completion of I&C/Supervision and certification line item wise on pro-rata basis.

(d) SUPPLY ONLY:

- 1) 100% of PO value will be paid against Sight draft with 45 days Credit from the date of dispatch or 15 days credit from the date of submission of complete set of documents whichever is later)+ submission of PBG valid for Warranty Period+3 months Claim Period from BHEL Consortium Bank ,if applicable.

Note for (a), (b), (c) and (d): In exceptional cases, if vendor fails to submit PBG after supplies, vendors can also accept for the final 10% payment, payable after the warranty period + 3 months of claim period against supplementary invoice subject to the completion of commissioning (if applicable) as PBG is linked to Warranty period.

G. LOADING FACTORS FOR PAYMENT TERMS & DELAYED DELIVERY:

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.

SI No	Deviation on	Nature of Deviation / Offered Terms	Loading %
1.	Payment Terms	For Purchase within India :-	
		1) Credit period less than 45 days	15
		* For Foreign Purchase :-	
		1) Payment through At Sight Letter of Credit	10
		2) Payment through Letter of Credit with usance credit of 45 days	5
		3) Sight Draft with credit period less than 45 days	5
2.	Penalty for Delayed Delivery	1) Non – Acceptance	10
		2) Partial Acceptance (X%)	(10 – X)

*** All bank charges shall be to seller's account. If bank charges of BHEL banker are to BHEL's account then additional loading of 2% on the quoted basic value is applicable.**

Offer/s with payment terms other than the standard payment terms indicated at Clause No.F or Deviated Payment Terms with loading indicated at Clause No.G above are liable for rejection.

NOTES:

1. ADVANCE PAYMENT/LC: Quotations with "Advance payment/Inland LC" shall be rejected.
2. Basic value of Purchase Order mentioned above will include all components of the purchase order and will exclude only taxes, duties, freight and I&C charges (wherever applicable).
3. Wherever the Purchase Order is split into import portion and indigenous portion of supply the retention money will be 10% (as applicable) of both purchase order values put together.
4. Non-Compliance of Warranty terms. Offers not complying with Warranty terms as per RFQ Terms is liable for rejection.
5. SALE IN TRANSIT/ LOCAL VAT: Sale in transit under section 6(2) of CST is allowed if movement of goods is interstate. In case intra state movement of goods, benefit of sale in transit is not available.
6. In case of intrastate movement i.e. supply within same state and VAT is applicable, the vendor shall furnish the respective BHEL's nodal agency TIN no. and address in their invoice. (Refer **Annexure IX**)

H. BANK GUARANTEE (BG) / PERFORMANCE BANK GUARANTEE (PBG):

1. Bank guarantee (BG) / Performance bank guarantee (PBG) will be applicable as called in the tender documents. Such PBG shall be valid for a period of Warranty Period + claim period of 3 months for a value equal to 10 % of the basic value of the purchase order. No deviation for the duration of PBG / BG will be permitted.
 - a. PBG shall be from any of the BHEL consortium of bankers (**refer Annexure V**).
 - b. PBGs from nationalized banks are also acceptable.

- c. PBG should be sent directly by the bank to the dealing executive mentioned in the purchase order located at the address mentioned in the purchase order. PBG should be in the format indicated. **(Refer Annexure III)**. No deviation to these formats will be allowed.
- d. Confirmation from any of the BHEL consortium of banks or any of the Indian Public Sector Banks is essential for the acceptance of PBGs issued by foreign banks (located outside India).
- e. Expired BGs / PBGs will be returned only after expiry of the claim period or on completion of the contractual obligation.
- f. In case vendor does not accept for submission of PBG, the vendor is liable for rejection on commercial grounds.

I. DOCUMENTS (TRIPLICATE COPIES) REQUIRED AT THE TIME OF DISPATCH FOR PROCESSING OF BILL:

1. FOR INDIGENOUS SCOPE OF SUPPLY:

For Supply: Invoice in Triplicate, Lorry receipt (LR) copy, Packing List, PSI Call Letter Copy, Proof of delivery such as MRC (Material Receipt Certificate)/ original acknowledged LR, Insurance intimation Letter and Warranty Certificate. Note that document pertaining to Proof of delivery shall clearly mention number of boxes/panels etc which shall be in line with the Packing list.

For I&C: Supplementary Invoice in Triplicate with copy of I&C Certificate (Proof of Completion of I&C).

For PBG: Supplementary Invoice in Triplicate with copy of PBG. However, PBG should reach concerned Purchase Officer directly from the Bank.

2. FOR IMPORTED SCOPE OF SUPPLY:

For Supply: Invoice in Triplicate, Air Way Bill/Bill of Lading, Packing List, PSI Call Letter Copy, and Warranty Certificate.

For I&C: Supplementary Invoice in Triplicate with copy of I&C Certificate (Proof of Completion of I&C).

For PBG: Supplementary Invoice in Triplicate with copy of PBG. Both PBG & supplementary invoice should reach concerned Purchase Officer directly from the Bank.

J. PROVISIONS APPLICABLE FOR MSE VENDORS (MICRO AND SMALL ENTERPRISES)

Vendors who qualify as MSE vendors are requested to submit applicable certificates (as specified by the Ministry of Micro, Small and Medium Enterprises) at the time of vendor registration. Vendors have to submit any of the following documents along with the tender documents in the Part I / Technical bid cover to avail the applicable benefits.

- a. Valid NSIC certificate or
- b. Entrepreneur's Memorandum part II (EM II) certificate (deemed valid for 2 years).
- c. EM II certificate with CA certificate **(in the prescribed format given in Annexure VIII)** applicable for the year certifying that the investment in plant and machinery of the vendor is within permissible limits as per the MSME Act 2006 for relevant status where the deemed validity is over.
- d. Documents submitted for establishing the credentials of MSE vendors must be valid as on the date of part I / technical bid opening for the vendors to be eligible for the benefits applicable for MSE vendors. Documents submitted after the Part I / Technical bid opening date will not be considered for this tender.

PURCHASE PREFERENCE FOR MSE VENDORS:

- e. MSE vendors quoting within a price band of L1 + 15% shall be allowed to supply up to 20% of the requirement against this tender provided.
 - 1. The MSE vendor matches the L1 price.
 - 2. L1 price is from a non MSE vendor.
 - 3. L1 price will be offered to the nearest vendor nearest to L1 in terms of price ranking (L2 - nearest to L1). In case of non-acceptance by the MSE vendor (L2) next ranking MSE vendor will be offered who is within the L1 + 15% band (if L3 is also within 15% band).
 - 4. 20% of the 20% (i.e. 4% of the total enquired quantity) will be earmarked for SC/ST owned MSE firms provided conditions as mentioned in (1) and (2) are fulfilled.
 - 5. In case no vendor under SC / ST category firms are meeting the conditions mentioned in (1) and (2) or have not participated in the tender, in such cases the 4% quantity will be distributed among the other eligible MSE vendors who have participated in the tender.

6. Serial no. 1 to 5 will not be applicable wherever it is not possible to split the tendered quantity / items on account of customer contract requirement, or the items tendered are systems. Such information that tendered quantity will not be split will be indicated in the SCC.

K. INTEGRITY COMMITMENT IN THE TENDER PROCESS, AND EXECUTION OF CONTRACTS:

1. Commitment by BHEL:

BHEL commits to take all measures necessary to prevent corruption in connection with the Tender process and execution of the Contract. BHEL will, during the tender process, treat all bidder / suppliers in a transparent and fair manner, and with equity.

2. Commitment by Bidder(s)/ Contractor(s):

- a. The Bidder(s)/ Contractor(s) commit(s) to take all measures to prevent corruption and will not directly or indirectly try to influence any decision or benefit which he is not legally entitled to.
- b. The Bidder(s)/ Contractor(s) will not enter with other Bidder(s) into any undisclosed agreement or understanding or any actions to restrict competition.
- c. The Bidder(s)/ Contractor(s) will not commit any offence under the relevant Acts. 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 BHEL as part of business relationship.
- d. 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 and shall adhere to the relevant guidelines issued from time to time by Government of India/ BHEL.

If the Bidder(s) / Contractor(s), before award or during execution of the Contract commit(s) a transgression of the above or in any other manner such as to put his reliability or credibility in question, BHEL is entitled to disqualify the Bidder(s) / Contractor (s) from the tender process or terminate the contract and/ or take suitable action as deemed fit.

L. FRAUD PREVENTION POLICY:

The bidder along with its associate/collaborators/sub-contractors/sub-vendors/consultants/service providers shall strictly adhere to BHEL Fraud Prevention Policy displayed on BHEL website <http://www.bhel.com> and shall immediately bring to the notice of BHEL Management about any fraud or suspected fraud as soon as it comes to their notice. Fraud Prevention policy and List of Nodal Officers shall be hosted on BHEL website, vendor portals of Units/regions intranet.

PURCHASE EXECUTIVE



ಭಾರತ್ ಹೆವಿ ಎಲೆಕ್ಟ್ರಿಕಲ್ಸ್ ಲಿಮಿಟೆಡ್
भारत हेवी इलेक्ट्रिकल्स लिमिटेड

Bharat Heavy Electricals Ltd.,
(A Government of India undertaking)
Electronics Division

PB 2606 , Mysore Road Bangalore , 560026 INDIA

SCPV: BOS: GCC - Rev 01

GENERAL COMMERCIAL CONDITIONS FOR CONTRACT (GCC)

These 'General Commercial Conditions for Contract for Purchase' hereinafter referred to as GCC apply to all enquiries, tenders, requests for quotations, orders, contracts and agreements concerning the supply of goods and the rendering of related services (hereinafter referred to as "deliveries") to Bharat Heavy Electricals Limited and any of its units, regions or divisions (hereinafter referred to as "BHEL" or the Purchaser) or its projects / customers.

Any deviations from or additions to these GCC require BHEL's express written consent. The general terms of business or sale of the vendor shall not apply to BHEL. Acceptance, receipt of shipments or services or effecting payment shall not mean that the general terms of business or sale of the vendor have been accepted.

Orders, agreements and amendments thereto shall be binding if made or confirmed by BHEL in writing. Only the Purchasing department of BHEL is authorized to issue the Purchase Order or any amendment thereof.

Definitions: Throughout these conditions and in the specifications, the following terms shall have the meanings assigned to them, unless the subject matter or the context requires otherwise.

- a) 'The Purchaser' means Bharat Heavy Electricals Limited, Electronics division, Mysore road, Bangalore 560 026, a Unit of Bharat Heavy Electricals Limited (A Govt. of India Undertaking) incorporated under the Companies Act having its registered office at BHEL House, Siri Fort, New Delhi-110049, India and shall be deemed to include its successors and assigns. It may also be referred to as BHEL.
- b) 'The vendor' means the person, firm, company or organization on whom the Purchase Order is placed and shall be deemed to include the vendor's successors, representative heirs, executors and administrator as the case may be. It may also be referred to as Seller, Contractor or Supplier.
- c) 'Contract' shall mean and include the Purchase Order incorporating various agreements, viz. tender/ RFQ, offer, letter of intent / acceptance / award, the General Conditions of Contract and Special Conditions of Contract for Purchase, Specifications, Inspection / Quality Plan, Schedule of Prices and Quantities, Drawings, if any enclosed or to be provided by BHEL or his authorized nominee and the samples or patterns if any to be provided under the provisions of the contract.
- d) 'Parties to the Contract' shall mean the 'The Vendor' and the Purchaser as named in the main body of the Purchase Order.
- e) "Bidder" shall mean duly established reputed organisation, manufacturer etc. having requisite financial and technical capability and experience of participating in the bid invited by the purchaser for the tender.
- f) Bid- The term "bid" or "bidding" can also relate to the documented Offer submitted in response to a request for quotation (RFQ) /Tender.

Interpretation:

In the contract, except where the context requires otherwise:

- a) words indicating one gender include all genders;
- b) words indicating the singular also include the plural and words indicating the plural also include the singular;
- c) provisions including the word "agree", "agreed" or "agreement" require the agreement to be recorded in writing, and
- d) "Written" or "in writing" means hand-written, type-written, printed or electronically made, and resulting in a permanent record.

Applicable Conditions:

1. **Price Basis:** All prices shall be firm until the purchase order is executed / completed in all respects. No price variations / escalation shall be permitted unless otherwise such variations / escalations are provided for and agreed by BHEL in writing in the purchase order.
2. **Validity:** The offer will be valid for a period of 90 days from the date of technical bid opening date. Validity beyond 90 days, if required, will be specified in the SCC (special conditions of contract).
3. **Taxes & Duties:** Taxes as mentioned in the Contract Price or Price Schedule shall be paid to the Contractor subject to the Contractor complying with all the statutory requirements and furnishing the relevant documents including error free invoices containing detailed break-up of the taxes. Any duties, levies or taxes not mentioned in Contract Price or Price Schedule but applicable as per any statute(s) shall be deemed to be included in the Contract price and shall be to the account of the Contractor.
The Contractor shall bear and pay all the costs, liabilities, levies, interest, penalties in respect of non-compliances of any legal requirements as per various statutory provisions. The contractor shall keep the owner indemnified at all times from any tax liability, interest, penalties or assessments that may be imposed by the statutory authorities for non-compliances or non-observation of any statutory requirements by the Contractor.
4. **Ordering and confirmation of Order:** Vendor shall send the order acceptance on their company letter head within two weeks from the date of Purchase Order or such other period as specified / agreed by BHEL. BHEL reserves the right to revoke the order placed if the order confirmation differs from the original order placed. The acceptance of goods/services/supplies by BHEL as well as payments made in this regard shall not imply acceptance of any deviations.
The purchase order will be deemed to have been accepted if no communication to the contrary is received within two weeks (or the time limit as specified / agreed by BHEL) from the date of the purchase order.
5. **Documentation:** After receipt of Purchase Order, vendor should submit required documents like drawings, bill of materials, datasheets, catalogues, quality plan, test procedure, type test report , O & M Manuals and/or any other relevant documents as per Specification/Purchase Order, as and when required by BHEL/Customer.
At any stage within the contract period, the vendor shall notify of any error, fault or other defect found in BHEL's documents /specifications or any other items for reference. If and to the extent that (taking account of cost and time) any vendor exercising due care would have discovered the error, fault or other defect when examining the documents/specifications before submitting the tender, the time for completion shall not be extended. However if errors, omissions, ambiguities, inconsistencies, inadequacies or other defects are found in the vendor's documents, they shall be corrected at his cost, notwithstanding any consent or approval.
6. **TERMS OF DELIVERY:**
FOR IMPORTED PURCHASE:
Price offered shall be for goods packed and delivered CIF Seaport/ International Airport (FCA) 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. The consignment shall be handed over to BHEL approved freight forwarder as mentioned in PO.

FOR INDIGENOUS PURCHASE:

Equipment shall be delivered on "FOR SITE" basis, inclusive of freight, packing, insurance & forwarding charges.

Packing shall be Road / Rail / Air / Sea worthy, best suitable for transshipment and to take care of transit damages. Smaller consignments can be dispatched through Courier services/ RPP with the prior approval of the purchasing Executive.

Deviation for the delivery term is liable for rejection.

7. Penalty:

For delay in delivery: In the event of delay in agreed contractual delivery as per Purchase Order, penalty @ 0.5 % (half percent) per week or part thereof but limited to a max of 10% (ten percent) value of undelivered portion (basic material cost) will be applicable. Delivery will commence from the date of document approval by customer / BHEL or date of issue of manufacturing clearance, whichever is later. The date for which Inspection call is issued by vendor along with test certificates / test reports / Certificate of Conformance / calibration reports, as proof of completion of manufacturing will be treated as date of deemed delivery for penalty calculation. In the absence of furnishing such document indicated above as proof of completion of manufacturing along with inspection call, actual date of inspection will be considered as date of deemed delivery and BHEL will not be responsible for delay in actual date of inspection.

Penalty for delayed delivery, if applicable, shall be deducted at the time of first payment. If penalty is applicable for duration of less than a week, penalty @ 0.5% (half percent) of the basic material value will be deducted.

8. **Contract variations (Increase or decrease in the scope of supply):** BHEL may vary the contracted scope as per requirements at site. If vendor is of the opinion that the variation has an effect on the agreed price or delivery period, BHEL shall be informed of this immediately in writing along with technical details. Where unit rates are available in the Contract, the same shall be applied to such additional work. Vendor shall not perform additional work before BHEL has issued written instructions / amendment to the Purchase Order to that effect. The work which the vendor should have or could have anticipated in terms of delivering the service(s) and functionality (i.e.) as described in this agreement, or which is considered to be the result of an attributable error on the vendor's part, shall not be considered additional work.
9. **Reverse Auction:** BHEL reserves the right to go for Reverse Auction (RA) (Guidelines as available on www.bhel.com) instead of opening the sealed envelope price bid, submitted by the bidder. This will be decided after techno-commercial evaluation. Bidders to give their acceptance with the offer for participation in RA. Non-acceptance to participate in RA may result in non- consideration of their bids, in case BHEL decides to go for RA.

Those bidders who have given their acceptance to participate in Reverse Auction will have to necessarily submit 'Process compliance form' (to the designated service provider) as well as 'Online sealed bid' in the Reverse Auction. Non-submission of 'Process compliance form' or 'Online sealed bid' by the agreed bidder(s) will be considered as tampering of the tender process and will invite action by BHEL as per extant guidelines for suspension of business dealings with suppliers/ contractors (as available on www.bhel.com).

The bidders have to necessarily submit online sealed bid less than or equal to their envelope sealed price bid already submitted to BHEL along with the offer. The envelope sealed price bid of successful L1 bidder in RA, if conducted, shall also be opened after RA and the order will be placed on lower of the two bids (RA closing price & envelope sealed price) thus obtained. The bidder having submitted this offer specifically agrees to this condition and undertakes to execute the contract on thus awarded rates.

If it is found that L1 bidder has quoted higher in online sealed bid in comparison to envelope sealed bid for any item(s), the bidder will be issued a warning letter to this effect. However, if the same bidder again defaults on this count in any subsequent tender in the unit, it will be considered as fraud and will invite

action by BHEL as per extant guidelines for suspension of business dealings with suppliers/ contractors (as available on www.bhel.com).

10. **Pre Shipment Inspection:** Prior written notice of at least one week shall be given along with internal test certificates / COC and applicable test certificates. Materials will be inspected by BHEL-EDN-QS/CQS or BHEL nominated Third Party Inspection Agency (TPIA) or BHEL authorized Inspection Agency or Customer / Consultant or jointly by BHEL & Customer / consultant. All tests have to be conducted as applicable in line with approved Quality plan or QA Checklist or Purchase specification and original reports shall be furnished to BHEL-EDN, Bangalore for verification / acceptance for issue of dispatch clearance.
All costs related to inspections & re-inspections shall be borne by vendor. Whether the Contract provides for tests on the premises of the vendor or any of his Sub-contractor/s, vendor shall be responsible to provide such assistance, labour, materials, electricity, fuels, stores, apparatus, instruments as may be required and as may be reasonably demanded to carry out such tests efficiently. Cost of any type test or such other special tests shall be borne by BHEL only if specifically agreed to in the purchase order.
11. **Transit Insurance:** Transit insurance coverage between vendor's works and project site shall be to the account of BHEL, unless specifically agreed otherwise. However, vendor shall send intimation directly to insurance agency through fax/courier/e-mail, immediately on dispatch of goods for covering insurance. A copy of such intimation sent by vendor to insurance agency shall be given to BHEL along with dispatch documents. Dispatch documents will be treated as incomplete without such intimation copy. BHEL shall not be responsible for sending intimations to insurance agency on behalf of the vendor.
12. **Packaging and dispatch:** The Seller shall package the goods safely and carefully and pack them suitably in all respects considering the peculiarity of the material for normal safe transport by Sea / Air / Rail / Road to its destination suitably protected against loss, damage, corrosion in transit and the effect of tropical salt laden atmosphere. The packages shall be provided with fixtures / hooks and sling marks as may be required for easy and safe handling. If any consignment needs special handling instruction, the same shall be clearly marked with standard symbols / instructions. Hazardous material should be notified as such and their packing, transportation and other protection must conform to relevant regulations.
The packing, shipping, storage and processing of the goods must comply with the prevailing legislation and regulations concerning safety, the environment and working conditions. Any Imported/Physical Exports items packed with raw / solid wood packing material should be treated as per ISPM – 15 (fumigation) and accompanied by Phytosanitary / Fumigation certificate. If safety information sheets (MSDS – Material Safety Data Sheet) exist for an item or the packaging, vendor must provide this information without fail along with the consignment.
Each package must be marked with Consignee name, Purchase order number, Package number, Gross weight and net weight, dimensions (L x B x H) and Seller's name. Packing list of goods inside each package with PO item number and quantity must also be fixed securely outside the box to indicate the contents of each box. Total number of packages in the consignment must also be indicated.
Separate packing & identification of items should be as follows.
 1. Main Scope - All items must be tagged with part no. & item description.
 2. Commissioning spares - All items must be tagged with part no. & item description.
 3. Mandatory spares - All items must be tagged with part no. & item description.
13. **Assignment of Rights & Obligations; Subcontracting:** Vendor is not permitted to subcontract the delivery or any part thereof to third party or to assign the rights and obligations resulting from this agreement in whole or in part to third parties without prior written permission from BHEL. Any permission or approval given by the BHEL shall, however, not absolve the vendor of the responsibility of his obligations under the Contract.
14. **Progress report:** Vendor shall render such report as to the progress of work and in such form as may be called for by the concerned purchase officer from time to time. The submission and acceptance of such reports shall not prejudice the rights of BHEL in any manner.
15. **Non-disclosure and Information Obligations: Vendor** shall provide with all necessary information pertaining to the goods as it could be of importance to BHEL. Vendor shall not reveal confidential information that may be divulged by BHEL to Vendor's employees not involved with the tender/ contract &

its execution and delivery or to third parties, unless BHEL has agreed to this in writing beforehand. Vendor shall not be entitled to use the BHEL name in advertisements and other commercial publications without prior written permission from BHEL.

16. **Cancellation / Termination of contract:** BHEL shall have the right to completely or partially terminate the agreement by means of written notice to that effect. Termination of the Contract, for whatever reason, shall be without prejudice to the rights of the parties accrued under the Contract up to the time of termination.
BHEL shall have the right to cancel/foreclose the Order/ Contract, wholly or in part, in case it is constrained to do so, on account of any decline, diminution, curtailment or stoppage of the business.
17. **Risk Purchase Clause:** In case of failure of supplier, BHEL at its discretion may make purchase of the materials / services NOT supplied / rendered in time at the RISK & COST of the supplier. Under such situation, the supplier who fails to supply the goods in time shall be wholly liable to make good to BHEL any loss due to risk purchase.
In case of items demanding services at site like erection and commissioning, vendor should send his servicemen /representatives within 7 days from the service call. In case a vendor fails to attend to the service call, BHEL at its discretion may also make arrangements to attend such service by other parties at the **RISK & COST** of the supplier. Under such situation the supplier who fails to attend the service shall be wholly liable to make good to BHEL any loss due to risk purchase / service including additional handling charges due to the change.
18. **Shortages:** In the event of shortage on receipt of goods and/or on opening of packages at site, all such shortages shall be made good within a reasonable time that BHEL may allow from such intimation and free of cost.
Transit Damages: In the event of receipt of goods in damaged condition or having found them so upon opening of packages at site, Supplier shall make good of all such damages within a reasonable time from such intimation by BHEL.
19. **Remedial work:** Notwithstanding any previous test or certification, BHEL may instruct the vendor to remove and replace materials/goods or remove and re-execute works/services which are not in accordance with the purchase order. Similarly BHEL may ask the vendor to supply materials or to execute any services which are urgently required for any safety reasons, whether arising out of or because of an accident, unforeseeable event or otherwise. In such an event, Vendor shall provide such services within a reasonable time as specified by BHEL.
20. **Indemnity Clause:** Vendor shall comply with all applicable safety regulations and take care for the safety of all persons involved. Vendor is fully responsible for the safety of its personnel or that of his subcontractor's men / property, during execution of the Purchase Order and related services. All statutory payments including PF, ESI or other related charges have to be borne by the vendor. Vendor is fully responsible for ensuring that all legal compliances are followed in course of such employment.
21. **Product Information, Drawings and Documents:** Drawings, technical documents or other technical information received by Vendor from BHEL or vice versa shall not, without the consent of the other party, be used for any other purpose than that for which they were provided. They may not, without the consent of the Disclosing party, otherwise be used or copied, reproduced, transmitted or communicated to third parties. All information and data contained in general product documentation, whether in electronic or any other form, are binding only to the extent that they are by reference expressly included in the contract.
Vendor, as per agreed date/s but not later than the date of delivery, provide free of charge information and drawings which are necessary to permit and enable BHEL to erect, commission, operate and maintain the product. Such information and drawings shall be supplied in as many numbers of copies as may be agreed upon.
All intellectual properties, including designs, drawings and product information etc. exchanged during the formation and execution of the Contract shall continue to be the property of the disclosing party.
22. **Intellectual Property Rights, Licenses:** If any Patent, design, Trade mark or any other intellectual property rights apply to the delivery (goods / related service) or accompanying documentation shall be the exclusive

property of the Vendor and BHEL shall be entitled to the legal use thereof free of charge by means of a non-exclusive, worldwide, perpetual license. All intellectual property rights that arise during the execution of the Purchase Order/ contract for delivery by vendor and/or by its employees or third parties involved by the vendor for performance of the agreement shall belong to BHEL. Vendor shall perform everything necessary to obtain or establish the above mentioned rights. The Vendor guarantees that the delivery does not infringe on any of the intellectual property rights of third parties. The Vendor shall do everything necessary to obtain or establish the alternate acceptable arrangement pending resolution of any (alleged) claims by third parties. The Vendor shall indemnify BHEL against any (alleged) claims by third parties in this regard and shall reimburse BHEL for any damages suffered as a result thereof.

23. **Force Majeure:** Notwithstanding anything contained in the purchase order or any other document relevant thereto, neither party shall be liable for any failure or delay in performance to the extent said failures or delays are caused by the "Act of God" and occurring without its fault or negligence, provided that, force majeure will apply only if the failure to perform could not be avoided by the exercise of due care and vendor doing everything reasonably possible to resume its performance.

A party affected by an event of force majeure which may include fire, tempest, floods, earthquake, riot, war, damage by aircraft etc., shall give the other party written notice, with full details as soon as possible and in any event not later than seven (7) calendar days of the occurrence of the cause relied upon. If force majeure applies, dates by which performance obligations are scheduled to be met will be extended for a period of time equal to the time lost due to any delay so caused.

Notwithstanding above provisions, in an event of Force Majeure, BHEL reserves for itself the right to cancel the order/ contract, wholly or partly, in order to meet the overall project schedule and make alternative arrangements for completion of deliveries and other schedules.

24. **Guarantee / Warranty:** Wherever required, and so provided in the specifications / Purchaser Order, the Seller shall guarantee that the stores supplied shall comply with the specifications laid down, for materials, workmanship and performance. The guarantee / warranty period as described shall apply afresh to replaced, repaired or re-executed parts of a delivery. If the vendor fails to take proper corrective action to repair/replace defects satisfactorily within a reasonable period, Purchaser shall be free to take corrective action as may be deemed necessary at vendor's risk and cost after giving notice to the vendor, including arranging supply of goods from elsewhere at the sole risk and cost of the vendor. Unless otherwise specifically provided in the Purchase Order, Vendor's liability shall be co terminus with the expiration of the applicable guarantee / warranty period.

25. **Limitation of Liability:** Vendor's liability towards this contract is limited to a maximum of 100% of the contract value and consequential damages are excluded. However the limits of liability will have no effect in cases of criminal negligence or wilful misconduct.

The total liability of Vendor for all claims arising out of or relating to the performance or breach of the Contract or use of any Products or Services or any order shall not exceed the total Contract price.

26. **Liability during guarantee / warranty:** Vendor shall arrange replacement / repair of all the defective materials / services under its obligation under the guarantee / warranty period. The rejected goods shall be taken away by vendor and replaced / repaired. In the event of the vendor's failure to comply, BHEL may take appropriate action including disposal of rejections and replenishment by any other sources at the cost and risk of the vendor.

In case, defects attributable to vendor are detected during first time commissioning or use, vendor shall be responsible for replacement / repair of the goods as required by BHEL at vendor's cost. In all such cases expiry of guarantee / warranty will not be applicable.

27. **Liability after guarantee / warranty period:** At the end of the guarantee / warranty, the Vendor's liability ceases except for latent defects (latent defects are defects / performance issues noticed after the guarantee / warranty has expired). The Contractor's liability for latent defects warranty for the plant and equipment including spares shall be limited to a period of six months from the end of the guarantee / as specified in RFQ.

28. **Compliance with Laws:** Vendor shall, in performing the contract, comply with all applicable laws. The vendor shall make all remittances, give all notices, pay all taxes, duties and fees, and obtain all permits, licences and approvals, as required by the laws in relation to the execution and completion of the contract and for remedying of any defects; and the Contractor shall indemnify and hold BHEL harmless against and from the consequences of any failure to do so.
29. **Settlement of Disputes:** Except as otherwise specifically provided in the Purchase Order, decision of BHEL shall be binding on the vendor with respect to all questions relating to the interpretation or meaning of the terms and conditions and instructions herein before mentioned and as to the completion of supplies/work/services, other questions, claim, right, matter or things whatsoever in any way arising out of or relating to the contract, instructions, orders or these conditions or otherwise concerning the supply or the execution or failure to execute the order, whether arising during the schedule of supply/work or after the completion or abandonment thereof. Any disputes or differences among the parties shall to the extent possible be settled amicably between the parties thereto, failing which the disputed issues shall be settled through arbitration. Vendor shall continue to perform the contract, pending settlement of dispute(s).
30. **Arbitration Clause:** In case amicable settlement is not reached in the event of any dispute or difference arising out of the execution of the Contract or the respective rights and liabilities of the parties or in relation to interpretation of any provision in any manner touching upon the Contract, such dispute or difference shall (except as to any matters, the decision of which is specifically provided for therein) be referred by either party to the sole arbitration of an Arbitrator appointed by the Executive Director/ General Manager of the purchasing unit/ region/ division of BHEL. Vendor shall have no objection even if the Arbitrator so appointed is an employee of BHEL or has ever dealt/ had to deal with any matter relating to this Contract. Subject as aforesaid the provisions of the Arbitration and Conciliation Act, 1996 of India or any statutory modification or re-enactment thereof and the rules made there under and for the time being in force shall apply to the arbitration proceedings under this clause. It is a term of contract that the party initiating arbitration shall specify the dispute or disputes to be referred to arbitration under this clause together with the amount or amounts claimed in respect of each such dispute. The venue for the arbitration shall be Bangalore, India. The award of the arbitrator shall be a speaking award and shall be final, conclusive and binding on all parties to this contract.
The cost of arbitration shall be borne equally by the parties. Notwithstanding the existence of any dispute or difference or any reference for the arbitration, the vendor shall proceed with and continue without hindrance the performance of the work under the contract with due diligence and expedition in a professional manner.
31. **Applicable Laws and Jurisdiction of Courts:** Prevailing Indian laws both substantive and procedural, including modifications thereto, shall govern the Contract. Subject to the conditions as aforesaid, the competent courts in BANGALORE alone shall have jurisdiction to consider over any matters touching upon this contract.
32. **General Terms:** That any non-exercise, forbearance or omission of any of the powers conferred on BHEL and /or any of its authorities will not in any manner constitute waiver of the conditions hereto contained in these presents.
That the headings used in this agreement are for convenience of reference only.
That all notices etc., to be given under the Purchase order shall be in writing, type script or printed and if sent by registered post or by courier service to the address given in this document shall be deemed to have been served on the date when in the ordinary course, they would have been delivered to the addressee.

ANNEXURE - I
LIST OF INTERNATIONAL GATEWAY AIRPORTS

SCHEDULE NO	COUNTRY	CURRENCY CODE	AIRPORT
D01	UK	GBP	LONDON (HEATHROW)
D02	UK	GBP	NEW CASTLE
D03	UK	GBP	OXFORD. CHETLAM
D04	UK	GBP	BRISTOL. WELLINGBOROUGH
D05	UK	GBP	BIRMINGHAM
D06	UK	GBP	EAST MIDLANDS
D07	UK	GBP	MANCHESTER
D08	UK	GBP	LEEDS
D09	UK	GBP	GLASGOW
D10	FRANCE	EURO	PARIS (ROISSY) & LYON
D11	SWEDEN	EURO	STOCKHOLM
D12	SWEDEN	EURO	GOTHENBERG & MALMO
D13	ITALY	EURO	ROMA, MILAN
D14	ITALY	EURO	TURIN, BOLOGNA, FLORENCE
D15	NETHERLANDS	EURO	AMSTERDAM, ROTTERDAM
D16	AUSTRIA	EURO	VIENNA, LINZ, GRAZ
D17	BELGIUM	EURO	ANTWERP, BRUSSELS
D18	DENMARK	DKK	COPENHAGEN
D19	JAPAN	JPY	TOKYO, OSAKA
D20	SINGAPORE	SGD	SINGAPORE
D21	CANADA	CAD	TORONTO
D22	CANADA	CAD	MONTREAL
D23	USA	USD	NEW YORK, BOSTON
D24	USA	USD	CHICAGO
D25	USA	USD	SAN FRANCISCO, LOS ANGELES
D26	USA	USD	ALANTA, HOUSTON
D27	GERMANY	EURO	MUNICH, KOLN, DUSSELDORF, HANNOVER, HAMBURG, STUTTGART, DAMSTADT, MANIHIEM, NURUMBERG
D28	GERMANY	EURO	FRANKFURT
D29	GERMANY	EURO	BERLIN
D30	SWITZERLAND	SFR	BASLE, ZURICH, GENEVA
D31	SPAIN	EURO	BARCELONA
D32	AUSTRALIA	AUD	SYDNEY
D33	AUSTRALIA	AUD	MELBOURNE
D34	AUSTRALIA	AUD	PERTH
D35	CZECH	EURO	PRAGUE
D36	HONG KONG	HKD	HONG KONG
D37	NEW ZELAND	NZD	AUCKLAND
D38	RUSSIA	USD	MOSCOW
D39	SOUTH KOREA	USD	KIMPO INTERNATIONAL, INCHEON
D40	FINLAND	EURO	HELSINKI
D41	ROMANIA	EURO	BUCHAREST
D42	NORWAY	EURO	OSLO
D43	IRELAND	EURO	DUBLIN
D44	ISRAEL	USD	TEL AVIV
D45	UAE	USD	DUBAI
D46	OMAN	USD	MUSCAT
D47	EGYPT	USD	CAIRO
D48	TAIWAN	USD	TAIPEI
D49	UKRAINE	USD	KIEV
D50	CHINA	USD	SHANGHAI, SHENZHEN
D51	PHILIPINES	USD	MANILA
D52	MALAYSIA	USD	KUALALUMPUR, PE NANG
D53	CYPRUS	USD	LARNACA
D54	SOUTH AFRICA	USD	JOHANNESBERG, DURBAN
D55	SLOVAKIA	EURO	BARTISLOVA
D56	SAUDI ARABIA	SAR	RIYADH
D57	TURKEY	EURO	ISTANBUL
D58	THAILAND	USD	BANGKOK
D59	BRAZIL	USD	SAO PAULO, RIO DE JANEIRO

ANNEXURE - II
REQUEST FOR C FORM

NAME OF VENDOR :

VENDOR CODE ALLOTTED BY BHEL :

E mail id for c form correspondence :

BHEL PO NO	INVOICE NO	INVOICE DATE	INVOICE AMOUNT	SUPPLY FROM - STATE	SUPPLY TO - STATE	CST TIN NUMBER (SUPPLIER)	INVOICE AMOUNT EXCLUDING FREIGHT	C FORM QTR	YEAR	SUPPLY TO BHEL EDN / SITE
---------------	---------------	-----------------	-------------------	---------------------------	-------------------------	-------------------------------------	---	---------------	------	---------------------------------

Please note that one 'C' form will be issued for a quarter.

Any modification and cancellation of c form is not possible from our end since it is generated online therefore include all invoices pertaining to quarter in your request
Also check the data are correct in all respect

General Instruction:

1. C form request should be given only in this file.
2. Amount should be 100% of Invoice value but should Not include freight, Insurance etc.
3. PO No. should be numeric, starting with 4 and has 10 digits
4. For every quarter separate file to be provided
5. All Invoices pertaining to the relevant quarter to be included.
6. No corrections will be entertained once c-form is issued.

ANNEXURE-III

BANK GUARANTEE FOR PERFORMANCE SECURITY

Bank Guarantee No:

Date:

To

NAME

& ADDRESSES OF THE BENEFICIARY

Dear Sirs,

In consideration of the Bharat Heavy Electricals Limited ¹ (hereinafter referred to as the 'Employer' which expression shall unless repugnant to the context or meaning thereof, include its successors and permitted assigns) incorporated under the Companies Act, 1956 and having its registered office at _____ through its Unit at.....(name of the Unit) having awarded to (Name of the Vendor / Contractor / Supplier) having its registered office at _____ ² hereinafter referred to as the 'Contractor/Supplier', which expression shall unless repugnant to the context or meaning thereof, include its successors and permitted assigns), a contract Ref No.....dated³ valued at Rs.....⁴ (Rupees -----)/FC.....(in words.....) for⁵ (hereinafter called the 'Contract') and the Contractor having agreed to provide a Contract Performance Guarantee, equivalent to% (.... Percent) of the said value of the Contract to the Employer for the faithful performance of the Contract,

we,, (hereinafter referred to as the Bank), having registered/Head office at and inter alia a branch at being the Guarantor under this Guarantee, hereby, irrevocably and unconditionally undertake to forthwith and immediately pay to the Employer a maximum amount Rs ----- (Rupees -----) without any demur, immediately on a demand from the Employer, .

Any such demand made on the Bank shall be conclusive as regards the amount due and payable by the Bank under this guarantee. However, our liability under this guarantee shall be restricted to an amount not exceeding Rs. _____.

We undertake to pay to the Employer any money so demanded notwithstanding any dispute or disputes raised by the Contractor/ Supplier in any suit or proceeding pending before any Court or Tribunal relating thereto our liability under this present being absolute and unequivocal.

The payment so made by us under this Guarantee shall be a valid discharge of our liability for payment thereunder and the contractors/supplier shall have no claim against us for making such payment.

We thebank further agree that the guarantee herein contained shall remain in full force and effect during the period that would be taken for the performance of the said Contract and that it shall continue to be enforceable till all the dues of the Employer under or by virtue of the said Contract have been fully paid and its claims satisfied or discharged.

We BANK further agree with the Employer that the Employer shall have the fullest liberty without our consent and without affecting in any manner our obligations hereunder to vary any of the terms and conditions of the said Contract or to extend time of performance by the said Contractor/Supplier from time to time or to postpone for any time or from time to time any of the powers exercisable by the Employer against the said Contractor/Supplier and to forbear or enforce any of the terms and conditions relating to the said Agreement and we shall not be relieved from our liability by reason of any such variation, or extension being granted to the said Contractor/Supplier or for any forbearance, act or omission on the part of the Employer or any indulgence by the Employer to the said Contractor/Supplier or by any such matter or thing whatsoever which under the law relating to sureties would but for this provision have effect of so relieving us.

The Bank also agrees that the Employer at its option shall be entitled to enforce this Guarantee against the Bank as a principal debtor, in the first instance without proceeding against the Contractor and notwithstanding any security or other guarantee that the Employer may have in relation to the Contractor's liabilities.

This Guarantee shall remain in force upto and including.....⁶ and shall be extended from time to time for such period as may be desired by Employer.

This Guarantee shall not be determined or affected by liquidation or winding up, dissolution or change of constitution or insolvency of the Contractor/Supplier but shall in all respects and for all purposes be binding and operative until payment of all money payable to the Employer in terms thereof.

Unless a demand or claim under this guarantee is made on us in writing on or before the⁷ we shall be discharged from all liabilities under this guarantee thereafter.

We, BANK lastly undertake not to revoke this guarantee during its currency except with the previous consent of the Employer in writing.

Notwithstanding anything to the contrary contained hereinabove:

- a) The liability of the Bank under this Guarantee shall not exceed.....⁸
- b) This Guarantee shall be valid up to⁹
- c) Unless the Bank is served a written claim or demand on or before _____¹⁰ all rights under this guarantee shall be forfeited and the Bank shall be relieved and discharged from all liabilities under this guarantee irrespective of whether or not the original bank guarantee is returned to the Bank.

We, _____ Bank, have power to issue this Guarantee under law and the undersigned as a duly authorized person has full powers to sign this Guarantee on behalf of the Bank.

For and on behalf of
(Name of the Bank)

Dated.....

Place of Issue.....

¹ NAME AND ADDRESS OF EMPLOYER I.e Bharat Heavy Electricals Limited

² NAME AND ADDRESS OF THE VENDOR /CONTRACTOR / SUPPLIER.

³ DETAILS ABOUT THE NOTICE OF AWARD/CONTRACT REFERENCE

⁴ PROJECT/SUPPLY DETAILS

⁵ BG AMOUNT IN FIGURES AND WORDS

⁶ VALIDITY DATE

⁷ DATE OF EXPIRY OF CLAIM PERIOD

⁸ BG AMOUNT IN FIGURES AND WORDS.

⁹ VALIDITY DATE

¹⁰ DATE OF EXPIRY OF CLAIM PERIOD

Note:

1. In Case of Bank Guarantees submitted by Foreign Vendors-

- a. **From Nationalized/Public Sector / Private Sector/ Foreign Banks (BG issued by Branches in India)** can be accepted subject to the condition that the Bank Guarantee should be enforceable in the town/city or at nearest branch where the Unit is located i.e. Demand can be presented at the Branch located in the town/city or at nearest branch where the Unit is located.
- b. **From Foreign Banks (wherein Foreign Vendors intend to provide BG from local branch of the Vendor country's Bank)**
 - b.1 In such cases, in the Tender Enquiry/ Contract itself, it may be clearly specified that Bank Guarantee issued by **any of the Consortium Banks only** will be accepted by BHEL. As such, Foreign Vendor needs to make necessary arrangements for issuance of Counter- Guarantee by Foreign Bank in favour of the Indian Bank (BHEL's Consortium Bank). It is advisable that all charges for issuance of Bank Guarantee/ counter- Guarantee should be borne by the Foreign Vendor. The tender stipulation should clearly specify these requirements.
 - b.2 **In case, Foreign Vendors intend to provide BG from Overseas Branch of our Consortium Bank** (e.g. if a BG is to be issued by SBI Frankfurt), the same is acceptable. However, the procedure at **sl.no. b.1** will required to be followed.
 - b.3 The BG issued may preferably be subject to Uniform Rules for Demand Guarantees (URDG) 758 (as amended from time to time). In case, of Foreign Vendors, the BG Format provided to them should clearly specify the same.
 - b.4 The BG should clearly specify that the demand or other document can be presented in electronic form.

ANNEXURE - IV

Electronic Funds Transfer (EFT) OR Paylink Direct Credit Form

Please Fill up the form in **CAPITAL LETTERS** only.

TYPE OF REQUEST(Tick one): _____ CREATE _____ CHANGE

BHEL Vendor / Supplier Code:	
Company Name :	
Permanent Account Number(PAN):	
Address	

City: _____	PINCODE _____	STATE _____
-------------	---------------	-------------

Contact Person(s)	
Telephone No:	
Fax No:	
e-mail id:	

1 Bank Name:	
2 Bank Address:	
3 Bank Telephone No:	
4 Bank Account No:	
5 Account Type: Savings/Cash Credit	
6 9 Digit Code Number of Bank and branch appearing on MICR cheque issued by Bank	
7 Bank swift Code(applicable for EFT only)	
8 Bank IFSC code(applicable for RTGS)	
9 Bank IFSC code(applicable for NEFT)	

- A I hereby certify that the particulars given above are true, correct and complete and that I, as a representative for the above named Company, hereby authorise BHEL, EDN, Bangalore to electronically deposit payments to the designated bank account.
- B If the transaction is delayed or not effected at all for reasons of incomplete or incorrect information, I would not hold BHEL / transferring Bank responsible.
- C This authority remains in full force until BHEL, EDN, Bangalore receives written notification requesting a change or cancellation.
- D I have read the contents of the covering letter and agree to discharge the responsibility expected of me as a participant under ECS / EFT.

Date:

Authorised Signatory:

Designation:

Telephone NO. with STD Code

Company Seal

Bank Certificate

We certify that _____ has an Account No _____ with us and we confirm that the bank details given above are correct as per our records.

Date: _____ (.....)

Place: _____ Signature

Please return completed form along with a blank cancelled cheque or photocopy thereof to:

Bharath Heavy Electricals Ltd,

Attn:

Electronics Division, Mysore Road,

BANGALORE - 560 026

In case of any Query, please call : 080-26998xxx / 2674xxxx or fax no. 080-2674xxxx

ANNEXURE-V
BHEL MEMBER BANKS (LIST OF CONSORTIUM BANKS)

BANK GUARANTEE (BG) SHALL BE ISSUED FROM THE FOLLOWING BANKS ONLY:

	Nationalised Banks		Nationalised Banks
1	Allahabad Bank	19	Vijaya Bank
2	Andhra Bank		Public Sector Banks
3	Bank of Baroda	20	IDBI
4	Canara Bank		Foreign Banks
5	Corporation Bank	21	CITI Bank N.A
6	Central Bank	22	Deutsche Bank AG
7	Indian Bank	23	The Hongkong and Shanghai Banking Corporation Ltd. (HSBC)
8	Indian Overseas Bank	24	Standard Chartered Bank
9	Oriental Bank of Commerce		
10	Punjab National Bank	26	J P Morgan
11	Punjab & Sindh Bank		Private Banks
12	State Bank of India	27	Axis Bank
13	State Bank of Hyderabad	28	The Federal Bank Limited
14	Syndicate Bank	29	HDFC Bank
15	State Bank of Travancore	30	Kotak Mahindra Bank Ltd
16	UCO Bank	31	ICICI Bank
17	Union Bank of India	32	IndusInd Bank
18	United Bank of India	33	Yes Bank

Note:

- All BGs must be issued from BHEL consortium banks listed above.
- BHEL may accept BG from other Nationalised Banks also which are not listed above.
- BG will not be accepted from Scheduled Banks and Co-operative Banks.
- In case BG is issued from a bank located outside Indian territory and is issued in foreign currency, the BG must be routed through and confirmed by any one of the above mentioned consortium banks or any of the Indian Public Sector Banks.
- This list is subject to changes. Hence vendors are requested to check this list every time before issuing BGs.

ANNEXURE - VI

DISCREPANCY IN WORDS & FIGURES – QUOTED IN PRICE BID

Following guidelines will be followed in case of discrepancy in words & figures-quoted in price bid:

- (a) If, in the price structure quoted for the required goods/services/works, there is discrepancy between the unit price and the total price (which is obtained by multiplying the unit price by the quantity), the unit price shall prevail and the total price corrected accordingly, unless in the opinion of the purchaser there is an obvious misplacement of the decimal point in the unit price, in which case the total price as quoted shall govern and the unit price corrected accordingly.
- (b) If there is an error in a total corresponding to the addition or subtraction of subtotals, the subtotals shall prevail and the total shall be corrected; and
- (c) If there is a discrepancy between words and figures, the amount in words shall prevail, unless the amount expressed in words is related to an arithmetic error, in which case the amount in figures shall prevail subject to (a) and (b) above.
- (d) If there is such discrepancy in an offer, the same shall be conveyed to the bidder with target date upto which the bidder has to send his acceptance on the above lines and if the bidder does not agree to the decision of the purchaser, the bid is liable to be ignored.

ANNEXURE - VII

BENEFITS FOR MSE SUPPLIERS AS PER MSMED ACT 2006 AND PUBLIC PROCUREMENT POLICY 2012

MSE suppliers can avail the intended benefits only if they submit along with the offer, attested copies of either EM II certificate having deemed validity (five years from the date of issue of Acknowledgement in EM II).

Or

Valid NSIC certificate or EM II certificate along with attested copy of CA certificate (Format enclosed: ANNEXURE VIII) where deemed validity of EM II certificate of five years has expired) applicable for the relevant financial year (latest audited).

Date to be reckoned for determining the deemed validity will be the date of bid opening (Part 1 in case of two part bid).

Non-submission of such documents will lead to consideration of their bid at par with other bidders.

No benefit shall be applicable for this enquiry if any deficiency in the above required documents are not submitted before price bid opening. If the tender is to be submitted through e-procurement portal, then the above required documents are to be uploaded on the portal. Documents should be notarized or attested by a Gazette officer.

ANNEXURE - VIII
CERTIFICATE BY CHARTERED ACCOUNTANT ON LETTER HEAD

This is to certify that M/s
.....(Hereinafter referred to as 'Company') having
its registered office at is registered under MSMED Act 2006, (Entrepreneur
Memorandum No ((Part-II) dtd Category:
(Micro/Small). (Copy enclosed).

Further verified from the Books of Accounts that the investment of the company as per the
latest audited financial year **as per MSMED Act 2006 is as follows:**

1. For Manufacturing Enterprises: Investment in plant and machinery (i.e., original cost excluding land
and building and the items specified by the Ministry of Small Industries vide its notification No.S.O.1722
(E) dated October 5, 2006:

Rs.Lacs.

2. For Service Enterprises: Investment in equipment (original cost excluding land and building
and furniture, fittings and other items not directly related to the service rendered or as may be
notified under the MSMED Act, 2006:

Rs.Lacs.

The above investment of Rs. Lacs in within permissible limit of Rs..... Lacs
for.....Micro / Small (Strike off which is not applicable) Category under MSMED
Act 2006.

(or)

The company has been graduated from its original category (Micro/Small) (Strike off which is not
applicable) and the date of graduation of such enterprise from its original category is
.....(dd/mm/yy) which is within the period of 3 years from the date of graduation of such enterprise
from its original category as notified vide S.O.No.3322(E) dated 01.11.2013 published in the gazette
notification dated 04.11.2013 by Ministry of MSME.

Date:

(Signature)

Name -

Membership Number -

Seal of Chartered Accountant

ANNEXURE - IX

In case of intrastate movement i.e. supply within same state and VAT is applicable, the vendor shall furnish the respective BHEL™s nodal agency TIN no. and address in their invoice.

List of Statewise Nodal Officers with Contact Details

Region	State	Nodal Unit responsible for all other units except those in column 4	Contact Details- Landline No.	E-mail	TIN No.	CST No.
1	2	3		7	8	9
Norther States	Jammu & Kashmir	PSNR	0120-2510488/2416452	rahulb@bhelspsnr.co.in / a.chadha@bhelspsnr.co.in	01291101313	
	Himachal Pradesh	PSNR			02011000622	
	Punjab	PSNR			03451148722	
	Haryana	PSNR			06962606884	
	Rajasthan	PSNR			08232903345	
	Uttar Pradesh	PSNR	0120-2416536	rahulb@bhelspsnr.co.in / smittal@bhelspsnr.co.in	09365800914	
	Uttarakhand	Hardwar	01334-285449	alok@bhelhwr.co.in	05001757277 Dated 30th Sep 2005	5000030 Dated 13/03/1965
	Delhi	TBG	0120-6748429	skindal@bhel.in	07472001760	07472001760
Western States	Madhya Pradesh	Bhopal	0755-2503231	meeta@bhelbpl.co.in	23573600001 (HEL/05/01/0001/S dated 15/11/1979 under MPCT)	HEL/05/01/0004/C dated 15/11/1979
	Chattisgarh	PSWR	0712-3048609	mgupta@bhelspswr.co.in	22173202974	
	Gujarat	PSWR	0265-2370321	bhavin@bhelspswr.co.in	24190101571	
	Maharashtra	ROD Mumbai	022-22126061/22187850	mahajani@bhel.in	27060300130V	27060300130C
	Daman & Diu	EDN	080-26998724 / 26998830	theerthagiri@bheledn.co.in	25000009902	
Southern States	Orissa	PSSR	044-28286773	sparida@bhelspsr.co.in . lakshmi@bhelspsr.co.in	21031301916	
	Tamil Nadu	Trichy	0431-2577757/ 2577229	msrao@bheltry.co.in / bharaths@bheltry.co.in	33243560005	239383 dt.11.6.91
	Kerala	PSSR	044-28286773	lakshmi@bhelspsr.co.in	32072043622	
	Karnataka	EDN	080-26998724 / 26998830	theerthagiri@bheledn.co.in	29180069268	00850081
	Telangana	HPEP RC, Puram	040-23185406/ 040-23182238	chand@bhelhyd.co.in / sbsv@bhelhyd.co.in	36360151179	
	Andhra Pradesh	HPVP, Vizag	0891-6681298	sarmaass@bhpvl.com	37418632431	
	Puducherry	PSSR				
Eastern States	West Bengal	PSER	033-23216130-3238	amitavac@bhelpser.co.in	19200936019	19200936213
	Bihar	PSER	0612-2231275	rakesh@bhelpser.co.in	10010994046	10010994046
	Jharkhand	PSER	06549-266351(Sh. Parmanand Swaroop)/06534-292179 (Sh. K.K. Ajeet)	pswaroop@bhelpser.co.in (Bokaro) kk.ajit@bhelpser.co.in (Koderma/Abhijeet/North Karanpura) manishk.jain@bhelpser.co.in (Chandrapura)/ kpsubbu@bhelpser.co.in	20352205642 (Bokaro) 20082005255 (Maithon) 20512405410 (Koderma) 20122200394 (Chandrapura) 20620905730(Adhunik) 20650507026(Abhijeet) 20452110016 (North Karanpura)	TG-729(C)
	Mizoram	PSER	033-23216130-3249	anindya@bhelpser.co.in	15501465017	
	Arunachal Pradesh	PSER	033-23216130-3249	anindya@bhelpser.co.in	12020122182	Not Applied
	Assam	PSER	033-23216130-3249	anindya@bhelpser.co.in	18790101415	18179903204
	Tripura	PSER	03821-265209	mkmahato@bhelpser.co.in	16060947071	16060947273
	Sikkim	PSER				
	Meghalaya	PSER				
	Manipur	PSER				
	Nagaland	PSER				

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)_____
