Nepal Electricity Authority

Amendment to Bids

(Amendment-III)

Date of Publication:….. March, 2022			
Project No. and Title	54107-002: Electricity Grid Modernization Project-Additional Financing		
OCB No. and Title	PMD/EGMPAF/ADSP-078/79-01: Design, Supply, Installation, Testing and Commissioning of 132/33/11 kV AIS Substation at Dumkibas, Binayi Triveni Rural Municipality, Nawalparasi (Bardaghat Susta East) District (Package-4)		
Sr. No.	Clause Reference	Existing	Amended As
1.	Chapter 5, VOLUME II A	"**Battery and Battery Charger**" specification of 220 V DC	"**Battery and Battery Charger**" specification of 110 V DC
3.	Clause 6.1, row no. 9, (Principal Tap), column no. 5, chapter 8, VOLUME II A	>8	>10
2.	Chapter 9, VOLUME II A	"**Power and Control Cable**" specification of Aluminum Cable	"**Power and Control Cable**" specification of Copper Cable
4.	Item no. 6, serial no. C (7.1), chapter 21, volume II B	Continuous at 45 degree ambient Incomer A **2500** Outgoing A **1250**	Continuous at 45 degree ambient Incomer A **2000** Outgoing A **800**
5.	Item no. 7, after serial no. 1.3, Chapter 21, Volume II B	"**5. Indicating Instruments**" missing	"**5. Indicating Instrument**"
6.	Item no. 7, after serial no. 6.2 (xvi), chapter 21, Volume II B	"**6.3. Directional Overcurrent Relay**" missing	" **6.3. Directional Overcurrent Relay**"

7.	Item no. 7, after 6.4 (xiii), chapter 21, Volume II B	" **6.5. Transformer Differential Relay**" missing	" **6.5. Transformer Differential Relay**"
8.	Item no. 8, after 5.4 (iv), chapter 21, Volume II B	" **5.5 Voltmeter, V**" missing	"**5.5 Voltmeter, V**"
9.	Item no. 8, after 5.6 (iii), chapter 21, Volume II B	"**5.7 Annunciators**" missing	"**5.7 Annunciators**"
10.	Item no. 8, after 6.4 (iii), Chapter 21, Volume II B	"**Serial no. 6.5**" missing	"**Serial no. 6.5**"
11.	Item no. 9, after 6.1 (x), Chapter 21, Volume II B	" **6.2 Earth Fault Relays**" missing	"**6.2 Earth fault relays**"
12.	Item no. 1.12.2, Schedule 1, Volume III	" 110 V, 600 AH maintenance free lead acid sealed type battery complete with all accessories to complete the specified scope of work (one for 132 kV and one for 33 kV)"	" 110 V, 600 AH maintenance free lead acid sealed type battery complete with all accessories to complete the specified scope of work"
13.	Item no. 1.22.2, Schedule 1, Volume III	"Existing earthing system of substation with **100** sq. mm copper conductors, copper clad steel earth rod with necessary connectors/connections, risers etc. complete in all respect as per technical specifications and drawings"	"Earthing system of substation with **100** sq. mm copper conductors, copper clad steel earth rod with necessary connectors/connections, risers etc. complete in all respect as per technical specifications and drawings

CHAPTER 5

BATTERY AND BATTERY CHARGER

Table of contents

CHAPTER 5

BATTERY & BATTERY CHARGER

1.1. GENERAL TECHNICAL REQUIREMENTS

1.1.1. All materials/components used in battery chargers and batteries shall be free from flaws and defects and shall conform to the relevant Indian/IEC standards and good engineering practice.

1.1.2. DC System shall consist of two (2) float-cum-boost chargers and one (1) battery sets for each of 110 V and 48 V systems respectively. The standard scheme drawing is enclosed with this specification. All the necessary connections for main and standby float cum boost chargers shall be make available by the contractor so that any charger can be used at necessitate time.

1.1.3. Bidder shall select number of cells, float and Boost voltage to achieve following system requirement:

110 Volt	121 Volt	99 Volt	54
48 Volt	52.8 Volt	43.2 Volt	23

Bidder shall furnish calculation in support of battery sizing, selection of number of cells, float and Boost voltages during detailed engineering for Employer's acceptance.

Battery sizing calculations shall be done as per IEEE- 485 on the basis of following duty cycle:

	Load	**Duration**	**Type Of Loads**
110V DC System	Continuous Load	3 hours	Relays, IEDs, Station HMIs, spring charging, Isolator interlocking load, Miscellaneous permanently connected loads etc.
	Emergency Load	1 hour	Substation emergency lighting loads.
	Momentary Load	1 minute	Breaker closing, Tripping loads (taking simultaneous occurrence as per system)
48V DC System	Continuous Load	3 hours	Continuous load associated with PLCs.(when speech is not working)

	Momentary Load	15 minutes	Loads associated with PLCs (when speech is working)

1.2. **Battery**

1.2.1. **Type**

The DC Batteries shall be VRLA (Valve Regulated Lead-Acid) type and shall be Normal Discharge type. These shall be suitable for a long life under continuous float operations and occasional discharges. Air-conditioning shall be provided in Battery room the requirement of which has been specified elsewhere in the Technical Specification. The 110 V DC system is unearth and 48 V DC system is positive earth system.

1.2.2. **Constructional Requirements**

The design of battery shall be as per field proven practices. Partial plating of cells is not permitted. Paralleling of cells externally for enhancement of capacity is not permitted. Protective transparent front covers with each module shall be provided to prevent accidental contact with live module/ electrical connections.

1.2.3. **Container**

The container material shall have chemical and electro-chemical compatibility and shall be acid resistant. The material shall meet all the requirements of VRLA batteries and be consistent with the life of battery. The container shall be fire retardant and shall have an Oxygen Index of at least 28 %. The porosity of the container shall be such as not to allow any gases to escape except from the regulation valve. The tensile strength of the material of the container shall be such as to handle the internal cell pressure of the cells in the worst working condition. Cell shall not show any deformity or bulge on the sides under all working conditions. The container shall be capable of withstanding the rigours of transport, storage and handling. The containers shall be enclosed in a steel tray.

1.2.4. **Cell Covers**

The cell covers shall be made of suitable material compatible with the container material and permanently fixed with the container. It shall be capable to withstand internal pressure without bulging or cracking. It shall also be fire retardant. Fixing of Pressure Regulation Valve & terminal posts in the cover shall be such that the seepage of electrolyte, gas escapes and entry of electro-static spark are prevented.

1.2.5. **Separators**

The separators used in manufacturing of battery cells, shall be of glass mat or synthetic material having high acid absorption capability, resistant to sulphuric

acid and good insulating properties. The design of separators shall ensure that there is no misalignment during normal operation and handling.

1.2.6. Pressure Regulation Valve

Each cell shall be provided with a pressure regulation valve. The valve shall be self re-sealable and flame retardant. The valve unit shall be such that it cannot be opened without a proper tool. The valve shall be capable to withstand the internal cell pressure specified by the manufacturer.

1.2.7. Terminal Posts

Both the +Ve and –Ve terminals of the cells shall be capable of proper termination and shall ensure its consistency with the life of the battery. The surface of the terminal post extending above the cell cover including bolt hole shall be coated with an acid resistant and corrosion retarding material. Terminal posts or any other metal part which is in contact with the electrolyte shall be made of the same alloy as that of the plates or of a proven material that does not have any harmful effect on cell performance. Both +ve and –ve posts shall be clearly and unambiguously identifiable.

1.2.8. Connectors, Nuts & Bolts, Heat Shrinkable Sleeves

Where it is not possible to bolt the cell terminals directly to assemble a battery, separate non-corroding lead or copper connectors of suitable size shall be provided to enable connection of the cells. Copper connections shall be suitably lead coated to withstand corrosion due to sulphuric acid at a very high rate of charge or discharge.

Nuts and bolts for connecting the cells shall be made of copper, brass or stainless steel. Copper or brass nuts and bolts shall be effectively lead coated to prevent corrosion. Stainless steel bolts and nuts can be used without lead coating.

All inter cell connectors shall be protected with heat shrinkable silicon sleeves for reducing the environmental impact including a corrosive environment.

1.2.9. Flame Arrestors

Each cell shall be equipped with a Flame Arrestor to defuse the Hydrogen gas escaped during charge and discharge. Material of the flame arrestor shall not affect the performance of the cell.

1.2.10. Battery Bank Stand

All batteries shall be mounted in a suitable metallic stand/frame. The frame shall be properly painted with the acid resistant paint. The suitable insulation shall be provided between stand/frame and floor to avoid the grounding of the frame/stand.

1.2.11. **Capacity Requirements**

When the battery is discharged at 10 hour rate, it shall deliver 80% of C (rated capacity, corrected at 27º Celsius) before any of the cells in the battery bank reaches 1.85V/cell.

The battery shall be capable of being recharged from the fully exhausted condition (1.75V/cell) within 10 hrs up to 90% state of charge. All the cells in a battery shall be designed for continuous float operation at the specified float voltage throughout the life.

The capacity (corrected at 27ºCelcius) shall also not be less than C and not more than 120% of C before any cell in the battery bank reaches 1.75V/cell. The battery voltage shall not be less than the following values, when a fully charged battery is put to discharge at C/10 rate:

(a) After Six minutes of discharge : 1.98V/cell

(b) After Six hours of discharge : 1.92V/cell

(c) After 8 hours of discharge : 1.85V/cell

(d) After 10 hours of discharge : 1.75V/cell

Loss in capacity during storage at an average ambient temperature of 35º Celsius for a period of 6 months shall not be more than 60% and the cell/battery shall achieve 85% of its rated capacity within 3 charge/discharge cycles and full rated capacity within 5 cycles, after the storage period of 6 months. Voltage of each cell in the battery set shall be within 0.05V of the average voltage throughout the storage period. Ampere hour efficiency shall be better than 90% and watt hour efficiency shall be better than 80%.

1.2.12. **Expected Battery Life**

The battery shall be capable of giving 1200 or more charge/discharge cycles at 80% Depth of discharge (DOD) at an average temperature of 27º Celsius. DOD (Depth of Discharge) is defined as the ratio of the quantity of electricity (in Ampere-hour) removed from a cell or battery on discharge to its rated capacity. The battery sets shall have a minimum expected life of 20 years at float operation.

1.2.13. **Routine Maintenance of Battery system**

For routine maintenance of battery system, the contractor shall supply 1 set of following tools:

a) Torque wrench.

b) Cell test voltmeter (-3-0-+3) volts with least count of 0.01Volt

1.2.14. **Type Test of Battery**

1.2.14.1. Contractor shall submit type test reports of following tests as per IEC 60896-21 & IEC 60896-22, 2004. The type test reports shall be submitted in accordance with the requirements stipulated in clause no. 9.2 of Technical Specification, Chapter 2: GTR except that the requirement of tests having been conducted within last five to ten years as mentioned therein shall not be applicable.

S. No	Description of test
1.	Gas emission
2.	High current tolerance
3.	Short circuit current and DC internal resistance
4.	Protection against internal ignition from external spark sources
5.	Protection against ground short propensity
6.	Content & durability of required markings
7.	Material identification
8.	Valve operation
9.	Flammability rating of materials
10.	Inter cell connector performance
11.	Discharge Capacity
12.	Charge retention during storage
13.	Float service with daily discharges for reliable mains power
14.	Recharge behaviour
15.	Service life at an operating temperature of 40^0 C for brief duration exposure time.
16.	Impact of a stress temperature of 60^0 C for brief duration exposure time with 3 h rate discharge test.
17.	Abusive over-discharge
18.	Thermal runaway sensitivity

19.	Low temperature sensitivity
20.	Dimensional sensitivity at elevated internal pressure and temperature
21.	Stability against mechanical abuse of units during installation

Tests shall be conducted in accordance with IEC 60896-21 & IEC 60896-22, 2004

1.2.14.2. **List of Factory & Site Tests for Battery**

Sl. No.	Test	Factory Tests	Site Tests
1.	Physical Verification		√
2.	C/10 Capacity test on the cell	√	
3.	8 Hrs. Charge and 15 minutes discharge test at full rated load		√

1.2.15. **Installation and commissioning**

1.2.15.1. Manufacturer of Battery shall supervise the installation and commissioning and perform commissioning tests as recommended in O&M manual / or relevant standards. All necessary instruments, material, tools and tackles required for installation, testing at site and commissioning are to be arranged by Battery manufacturer/ Contractor

1.2.16. Contractor shall be submitted following documents for approval:

a) Data sheet as per Annexure-I

b) GA of cell and layout drawing

c) Discharge Data for 10 Hour, 8 Hour, 3 Hour, 2 Hour, 1 Hour, 15 Minutes and One Minute indicating capacity factors for end cell voltage of 1.75 V & 1.85 V

d) Temperature correction factors

e) Installation and commissioning Instructions

f) O & M Manual

1.3. Battery Charger

The DC system for 110 V DC is unearthed and for 48 V DC is +ve earthed. The Battery Chargers as well as their automatic regulators shall be of static type and shall be compatible with offered VRLA batteries. All battery chargers shall be capable of continuous operation at the respective rated load in float charging mode, i.e Float charging the associated Lead-Acid Batteries at 2.13 to 2.27 Volts per cell while supplying the DC load. The chargers shall also be capable of Boost charging the associated DC Battery at 2.28 to 2.32 volts per cell at the desired rate.

Charger shall regulate the float/ boost voltage in case of prescribed temperature rise of battery as per manufacturer's recommendation to avoid thermal runaway. Necessary temperature sensors shall be provided in mid location of battery banks and shall be wired up to the respective charger for feedback control. The manufacturer shall demonstrate this feature during testing of each charger.

1.3.1. All Battery Chargers shall be provided with facility for both automatic and manual control of output voltage and current. A selector switch shall be provided for selecting the mode of output voltage/current control, whether automatic or manual. When on automatic control mode during Float charging, the Charger output voltage shall remain within ±1% of the set value, for AC input voltage variation of ±10%, frequency variation of ±2.5%, a combined voltage and frequency variation of ±10%, and a DC load variation from zero to full load.

1.3.2. All battery chargers shall have constant voltage characteristics throughout the range (from zero to full load) at the floating value of the voltage so as to keep the battery fully charged but without harmful overcharge.

1.3.3. All chargers shall have load limiters having drooping characteristic, which shall cause, when the voltage control is in automatic mode, a gradual lowering of the output voltage when the DC load current exceeds the Load limiter setting of the Charger. The Load-limiter characteristics shall be such that any sustained overload or short circuit in DC System shall not damage the Charger, nor shall it cause blowing of any of the Charger fuses. The Charger shall not trip on overload or external short circuit.

1.3.4. Uniform and step less adjustments of voltage setting (in both manual and automatic modes) shall be provided on the front of the Charger panel covering the entire float charging output range specified. Step less adjustments of the Load-limiter setting shall also be possible from 80% to 100% of the rated output current for charging mode.

1.3.5. During Boost Charging, the Battery Charger shall operate on constant current mode (when automatic regulator is in service). It shall be possible to adjust the Boost charging current continuously over a range of 50 to 100% of the rated output current for Boost charging mode.

1.3.6. The Charger output voltage shall automatically go on rising, when it is operating on Boost mode, as the Battery charges up. For limiting the output voltage of the Charger, a potentiometer shall be provided on the front of the panel, whereby it

shall be possible to set the upper limit of this voltage any where in the output range specified for Boost Charging mode.

1.3.7. The Charger manufacturer may offer an arrangement in which the voltage setting device for Float charging mode is also used as output voltage limit setting device for Boost charging mode and the Load-limiter of Float charging mode is used as current setting device in boost charging mode.

1.3.8. Suitable filter circuits shall be provided in all the chargers to limit the ripple content (Peak to Peak) in the output voltage to 1%, irrespective of the DC load level, when they are not connected to a Battery.

1.3.9. **MCCB**

All Battery Chargers shall have 2 Nos. MCCBs on the input side to receive cables from two sources. Mechanical interlock should be provided such that only one shall be closed at a time. It shall be of P2 duty and suitable for continuous duty. MCCB's should have auxiliary contacts for annunciation.

1.3.10. **Rectifier Transformer**

The rectifier transformer shall be continuously rated, dry air cooled (A.N) and of class F insulation type. The rating of the rectifier transformer shall have 10% overload capacity.

1.3.11. **Rectifier Assembly**

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

1.3.12. **Instruments**

One AC voltmeter and one AC ammeter alongwith selector switches shall be provided for all chargers. One DC voltmeter and DC ammeter (with shunt) shall be provided for all Chargers. The instruments shall be flush type, dust proof and moisture resistant. The instruments shall have easily accessible means for zero adjustment. The instruments shall be of 1.5 accuracy classes. In addition to the above a centre zero voltmeter with selector switch shall also be provided for 110 V chargers for testing purpose.

1.3.13. **Air Break Switches**

One DC output switch shall be provided in all chargers. They shall be air break type suitable for 500 volts AC/ 250 DC. The contacts of the switches shall open and close with a snap action. The operating handle of the switch shall be fully insulated from circuit. `ON' and `OFF' position on the switch shall be clearly indicated. Rating of switches shall be suitable for their continuous load. Alternatively, MCCB's of suitable ratings shall also acceptable in place of Air Break Switch.

1.3.14. Fuses

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

1.3.15. Blocking Diode

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

1.3.16. Annunciation System

Audio-visual indications through bright LEDs shall be provided in all Chargers for the following abnormalities:

a) AC power failure

b) Rectifier/chargers fuse blown.

c) Over voltage across the battery when boost charging.

d) Abnormal voltage (High/Low)

e) Any other annunciation if required

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

1.3.17. Name Plates and Marking

The name plates shall be white with black engraved letters. On top of each Charger, on front as well as rear sides, larger and bold name plates shall be provided to identify the Charger. Name plates with full and clear inscriptions shall also be provided on and inside of the panels for identification of the various equipments and ease of operation and maintenance

1.3.18. Charger Construction

The Chargers shall be indoor, floor-mounted, self-supporting sheet metal enclosed cubicle type. The Contractor shall supply all necessary base frames, anchor bolts and hardware. The Chargers shall be fabricated from 2.0mm cold rolled sheet steel and shall have folded type of construction. Removable gland plates for all cables and lugs for power cables shall be supplied by the Contractor.

The lugs for power cables shall be made of electrolytic copper with tin coat. Power cable sizes shall be advised to the Contractor at a later date for provision of suitable lugs and drilling of gland plates. The Charger shall be tropicalised and vermin proof. Ventilation louvers, if provided shall be backed with screens. All doors and covers shall be fitted with synthetic rubber gaskets. The chargers shall have hinged double leaf doors provided on front and on backside for adequate access to the Charger's internals. All the charger cubicle doors shall be properly earthed. The degree of protection of Charger enclosure shall be at least IP-42 as per IEC:- 60947 Part 1.

1.3.18.1. All indicating instruments, control switches and indicating lamps shall be mounted on the front side of the Charger.

1.3.18.2. Each Charger shall be furnished completely wired up to power cable lugs and terminal blocks and ready for external connections. The control wiring shall be carried out with PVC insulated, 1.5 sq. mm stranded copper wires. Control terminals shall be suitable for connecting two wires, with 2.5 sq. mm stranded copper conductors. All terminals shall be numbered for ease of connections and identification. Each wire shall bear a ferrule or tag on each end for identification. At least 20% spare terminals shall be provided for control circuits.

1.3.18.3. The insulation of all circuits, except the low voltage electronic circuits shall withstand test voltage of 2 KV AC for one minute. An air clearance of at least ten (10) mm shall be maintained throughout for such circuits, right up to the terminal lugs. Whenever this clearance is not available, the live parts shall be insulated or shrouded.

1.3.19. **Painting**

All sheet steel work shall be pre-treated, in tanks, in accordance with IEC/International Standards. Degreasing shall be done by alkaline cleaning. Rust and scale shall be removed by pickling with acid. After pickling, the parts shall be washed in running water. Then these shall be rinsed in slightly alkaline hot water and dried. The phosphate coating shall be in accordance with IEC/International Standards. Welding shall not be done after phosphating. The phosphating surfaces shall be rinsed and passivated prior to application of stoved lead oxide primer coating. After primer application, two coats of finishing synthetic enamel paint of shade-692 (smoke grey) shall be applied, unless required otherwise by the Employer. The inside of the chargers shall be glossy white. Each coat of finishing synthetic enamel paint shall be properly staved. The paint thickness shall not be less than fifty (50) microns.

1.3.20. **TESTS**

1.3.20.1. Battery chargers shall conform to all type tests as per relevant International Standard. Performance test on the Chargers as per Specification shall also be carried out on each Charger as per specification. Rectifier transformer shall conform to all type tests specified in IEC: 60146 and short circuit test as per IEC: 60076. Following type tests shall be carried out for compliance of specification requirements:

i) Voltage regulation test

ii) Load limiter characteristics test

iii) Efficiency tests

iv) High voltage tests

v) Temperature rise test

vi) Short circuit test at no load and full load at rated voltage for sustained short-circuit.

vii) Degree of protection test

viii) Measurement of ripple by oscilloscope.

ix) Temperature compensation feature demonstration

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

i) Insulation resistance test

ii) Checking of proper annunciation system operation.

1.3.20.3. If a Charger fails to meet the specified requirements, the Contractor shall replace the same with appropriate Charger without affecting the commissioning schedule of the Sub-station, and without any extra cost to the EMPLOYER.

1.3.20.4. The Contractor shall present for inspection, the type and routine test certificates for the following components whenever required by the EMPLOYER.

(i) Switches.

(ii) Relays/ MCCBs

(iii) Instruments.

(iv) DC fuses.

(v) SCR.

(vi) Diodes.

(vii) Condensers.

(viii) Potentiometers.

(ix) Semiconductor

(x) Annunciator.

(xi) Control wiring

(xii) Push buttons and contactors.

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

BATTERY SYSTEM DATA SHEETS **Annexure-I**

S.No.	Description of Data	Unit	110 V	48 V
1	General Data			
a)	Battery Type:			
	Grid alloy: Pure lead(Pb), lead calcium (Pb-Ca),lead antimony (Pb-Sb), or lead selenium (Pb-Se) or other pl. specify			
	Cell type: Absorbed glass mat or gel cell or other please specify			
	Seller's type number			
	Number of positive plates per cell			
b)	Does each battery and battery [rack]/ [cabinet] meet the seismic requirements	[Yes] [No]		
c)	Manufacturer's Designed Life of Battery	Yrs		
d)	Recommended Battery Charger Data:			
	Floating voltage range	V		
	Boost charge	V		
	Current rating	Amps.		
	Recharge time	hr		
e)	Heat Released During:			
	Discharge duty cycle	Watt		
	Float charge	Watt		
	Boost Charge	Watt		
f)	Maximum Amount of Hydrogen Gas Evolved			
	During Battery-Boost Charge (2.33 V per cell) at Maximum Battery Temperature	(Litre /h)		
	Hydrogen Gas Evolution at Float	(Litre /h)		
g)	Time Battery may be Stored Without a Freshening Charge	months		
h)	Temperature Compensation Provided and its Details			

S.No.	Description of Data	Unit	220 V/ 110 V		48 V	
2.	Physical Description.					
a)	Battery Cell:					
	Size (L x W x H)	mm				
	Weight	Kg				
	Volume of electrolyte gal	L				
	Jar cover material					
	Jar container material					
	Separator material					
	Retainer material					
	Limiting-oxygen index (LOI)					
b)	Battery [Rack] [Cabinet]:					
	Outline or catalog number					
	Quantity of [racks][cabinets] for the battery					
	Description (tier or step type)					
c)	Total Net Weight of Battery Including [Racks] [Cabinets]	kg				
d)	Total Shipping Weight of Each Battery Jar and Associated Equipment	kg				
e)	Connectors:					
	Intercell:					
	Type					
	Material					
	No. per connection					
	Inter-[Tier] [Step]:					
	Type					
	Material					
	No. per connection					
	Terminal Detail:					
	Type					
	Material					
f)	Terminal Lugs for Power Cable:					
g)	Torque Data:		**Initial Torque Value**	**Re-torque Value**	**Initial Torque Value**	**Re-torque Value**
	Intercell Connectors					
	Inter-[Tier] [Step]:					

S.No.	Description of Data	Unit	220 V/ 110 V	48 V
3.	Performance Data.			
	Battery String Designation No. [1] [ ]			
	Float Voltage Without Boost	V/cell		
	Float Voltage With Boost	V/cell		
	Boost Charge Voltage	V/cell		
	Recommended Frequency of Boost Charge			
	Recommended Duration of Boost Charge			
	Open-Circuit Voltage	V/cell		
	Short-Circuit Current at Battery Terminals at Float Voltage at (27°C):			
	Battery Discharge Characteristics	A or A		
		/positive		
		plate		
	Guaranteed Amp-Hour Capacity (at the 10-hr rate) to Specified Final Voltage	AH		
	One-minute	A/cell		
	Fifteen-minute	A/cell		
	One-hour	A/cell		
	Two-hour	A/cell		
	Three-hour	A/cell		
	Eight-hour	A/cell		
	Ten-hour	A/cell		
4.	Required operating environment.			
	Battery Room Ambient Temperature Range	(°C to		
		°C)		
	Battery Room Ambient Design Temperature	°C		
	Battery Room Minimum/Maximum Design Temperature	(°C to		
		°C)		
	Maximum temperature at which battery can be stored	°C		

Table of contents

CHAPTER 9

POWER AND CONTROL CABLE

1. General

This specification covers the design, manufacture, factory test, supply, delivery, installation, field-testing and commissioning of all XLPE Power, Control, and Instrumentation cables required for the entire project.

Manufacturer of power, control, and instrumentation cables shall hold valid ISO 9001 quality certificate.

The equipment and installation works specified in this Section shall conform to the latest edition of the appropriate IEC specifications and/or other recognized international standards

1.1 The equipment to be furnished shall strictly be in accordance with the specifications and the Price Schedule.

1.2 **Equipment to be furnished**

1.2.1 The following cables shall be furnished in accordance with specification

a) 132 kV XLPE Power Cable, termination equipments and Sealing ends

b) 33 kV XLPE Power Cable, termination equipments and Sealing ends

c) 12 kV XLPE Power Cable and termination equipments

d) 600-volt power cable

e) Control and instrumentation cable

f) Other Miscellaneous materials

1.2.2 The Contractor shall be responsible for estimating and supplying the quantity of various types and sizes of the cables. In course of actual execution, if it is found that additional cross-sections, types or quantities of cables for the transformer are required other than those indicated in his proposal; the same shall be supplied without any additional charge to the employer.

All other materials necessary for proper operation of the Plant and not mentioned in these specifications shall be supplied under the Contract. The prices of such materials shall be deemed to be included in the prices of the miscellaneous materials without any additional cost to the Employer unless stated otherwise in the Price Schedule.

1.3 132, 33 AND 11 KV POWER CABLES, STRAIGHT JOINTS AND SEALING ENDS

1.3.1 DESIGN REQUIREMENTS

1.3.1.1 General

The following 132, 33 & 11 kV power cables, straight through joints and sealing ends shall be supplied and installed according to approved Drawings and the requirements as hereafter specified. Non erasable Sequential Marking of length shall be provided by embossing on outer sheath of the cable for each meter length. The quality of insulation should be good and insulation should not be deteriorated when exposed to the climatic conditions.

2. Requirement

A) 132 kV, 33kV & 11 kV Power cable

The 132 kV, 33 kV and 11 kV power cables and spare shall be supplied and installed to the following connections;

- 132 kV power cable as per specification and price schedule.
- 33 kV power cable shall be from 33 kV Gantry to Outside substation area upto distribution feeder point.
- 11 kV power cable as per specification and price schedule.

The 132/33/11 kV power cable shall be of single-core, cross linked polyethylene (XLPE) insulated, screened and steel tape red, PVC sheathed, copper conductor type and shall have a conductor size as per BOQ. Cable shall conform to BS 6622 & IEC 60502–2.

Operating temperature:- 90°C

Short circuit temperature:- 250°C

Conductor

Annealed Plain Copper Stranded compacted circular conductor conform to BS 6360 and IEC 60228, class 2

Conductor Screening

Semi-Conducting layer over conductor

IS: 7098 Part 2, IEC: 60502 Part – 2, BS: 6622, BS: 7835.

Insulation

Cross linked Polyethylene to (XLPE)

IS: 7098 Part 2, IEC: 60502 Part – 2, BS: 6622, BS: 7835.

Insulation Screening

Semi-Conducting layer over insulation, in combination with Copper tape.

Bedding

Extruded PVC

Armour

Single Core - Galvanized steel round wire. Non magnetic

Outer Sheath

Extruded PVC / Special PVC compound such as Flame Retardant (FR), Flame Retardant Low Smoke (FRLS), and Low Smoke Zero Halogen (LSOH) or equivalent compatible with the system can be used for outer sheath to suit a variety of environment and fire risk conditions. Flammability test confirms to IEC 332. For installation where fire and associated problems such as emission of smoke and toxic fumes offer a serious potential threat, special LSF (Low smoke & fumes) compound can be provided. LSF compound is Halogen free (Fluorine, Chlorine, Bromine) when tested as per BS 6425 (Pt 1) & IEC 60754 (Pt 1). The acid gas evolved during combustion is less than 0.5% by weight of material.

The 132 kV power cables shall be rated as follows:

a) Rated voltage, phase to phase (Uo) 132 kV

b) Highest voltage of three-phase system (Um) 145 kV

c) Rated lightning impulse withstand voltage 650 kV

d) Rated power-frequency short duration withstand voltage for one minute 275 kV

(e) Maximum short-circuit current 31.5 kA

(f) Maximum time for short-circuit current 3 second

The 33 kV power cables shall be rated as follows:

e) Rated voltage, phase to phase (Uo) 33 kV

f) Highest voltage of three-phase system (Um) 36 kV

g) Rated lightning impulse withstand voltage 170 kV

h) Rated power-frequency short duration withstand voltage for one minute 70 kV

(e) Maximum short-circuit current 25/31.5 kA

(f) Maximum time for short-circuit current 3 second

The 132 and 33 kV XLPE cables shall be installed in the flexible pipe conduits as per approved Drawing. Flexible pipes shall be provided by Contractor and shall be included in cost of cable. The necessary civil trench works / other works shall be carried accordingly.

At the opening of the civil structures where the power cables are passing through, suitable sealing means shall be provided by the Contractor to keep out rain from the outside.

The method of cable laying shall be designed by the Contractor to ensure higher security and reliability during and after the installation. The cable installation shall be carried out by the Contractor in accordance with the approved procedures.

11 kV power cable

The 11 kV power cables shall be rated as follows:

a) Rated voltage, phase to phase (Uo) 11 kV

b) Highest voltage of three-phase system (Um) 12 kV

c) Rated lightning impulse withstand voltage 75 kV

d) Rated power-frequency short duration withstand voltage for one minute 17 kV

e) Maximum short-circuit current 25 kA

f) Maximum time for short-circuit current 3 second

The 11 kV XLPE cables shall be installed in the flexible pipe conduits. Flexible pipes shall be provided by Contractor and shall be included in cost of cable. The necessary civil works shall be carried accordingly.

At the opening of the civil structures where the power cables are passing through, suitable sealing means shall be provided by the Contractor to keep out rain from the outside.

The method of cable laying shall be designed by the Contractor to ensure higher security and reliability during and after the installation. The cable installation shall be carried out by the Contractor in accordance with the approved procedures.

B) Cable termination/Sealing ends

Outdoor type sealing ends with post insulator support shall be supplied and installed for termination of the 132/33/11 kV XLPE power cables. Straight through shall be provided as per requirement.

Each sealing end shall be complete with porcelain/Polymer insulator, leading conductor, condenser cone, stress relief cone, insulating compound, shielding cover, protective case, grounding terminal, lower metal with rigid flange and other necessary materials to properly seal the cable terminal.

Thermal expansion and contraction of the cable due to temperature change shall be considered for designing the joint insulation of the sealing end.

Cross bond earthing (or any other) shall be employed so that shielding of both sides of each joint shall be connected to the shielding of the other phase, so as to suppress the induced voltage. Necessary design and materials for such cross-bond earthing shall be provided by the Contractor.

The minimum creepage distance of outdoor sealing-ends shall be as required for heavily polluted atmospheres in line with the IEC 137 standard.

C) Accessories

The following accessories shall be provided with the 132, 33 and 11 kV power cable for each end.

(i) Name plates

(ii) Phase Identification

Phase identification for conductor cables shall be in accordance with the following:

Phase A (R): Red

Phase B (Y): Yellow

Phase C (B): Blue

(i) Voltage Identification

The plastic covering shall be embossed with the name of the manufacturer, number of conductors, the cross sections and type of insulation.

D) Cable Drum

Cable drum shall be non- returnable and shall be made of steel, suitably protected against corrosion for spare length. Drum Schedule shall be finalized after detail layout in substation.

3. Installation Works

Scope of Works

The installation of the transmission materials and substation equipment specified under this subsection shall cover the following works:

Installation works for transmission facilities in:

132 kV substation area upto feeder termination with overhead line.

33 kV Gantry to Outside substation area upto feeder termination with overhead line.

33/11 kV transformer to indoor 11 kV Switchgear Busbar

11 kV switchgear Busbar to public road for termination with overhead line.

Any other facility if any as per field requirement.

(a) Installation of 132/33/11 kV underground cables for single circuit line (three conductors separately) with flexible pipes and civil structure as required including its termination on both end.

(b) Installation of out door type sealing ends for 33 kV cables with post insulators at out side Public Road or as directed by employer.

(c) Inspection and test.

a) Installation of Underground Lines

The contractor shall lay cables in accordance with approved Drawing by using flexible pipes and necessary civil works.

Termination works for the cables shall be made with utmost care by the skilled workers. Extra loop of approximately 5 m length at cable termination and joint shall be made as far as the space is available. The contractor shall install the steel and/or concrete cable mark as approved by the Employer at 50 m intervals along the cable route.

The cables shall be terminated with sealing ends and post insulators. Each terminal shall be provided with phase identification marks of A-B-C (R-Y-B).

Arrangement of flexible pipes for cable installation is shown in Tender Drawing. Terminations of those pipes shall be properly made so that penetration of water inside the flexible pipes after completion of the works is not allowed.

Prior to pull-through of the cable into the flexible pipes, the Contractor shall calculate the pull-through length of the cable and confirm that the pull-through tension is not more

than permissible tension. The shields of the 132/33 kV power cables shall be grounded in the approved manner at each joint.

b) Installation of Sealing Ends of 132/33 kV Cable

The 132/33 kV cable end shall be made as per IEC standard. Necessary additional steel structure with concrete foundation shall be constructed if required for the installation of bushings as well as Lightning arrestors (LA).

c) Inspection and Tests

Through the work execution, various inspections and tests on the progressing works will be ordered to the Contractor by the Employer.

Following inspections and tests will be carried out after completion of the works section by section. The Contractor shall perform all the inspections and tests in accordance with IEC Standard.

Underground Power Cables

a) Visual inspection of the underground cable lines

- Back filling and grade
- Cable and joint marks
- Cable termination and connection

b) Measurement insulation resistance of the lines

3.1 TESTS FOR 132/33/11 KV POWER CABLES, SEALING ENDS AND ACCESSORIES

Test at works:

The following tests shall be carried out at the manufacturer's premises before shipment as far as applicable for type of conductors and cables:

a) 132/33/11 kV XLPE power cable

(i) Appearance check

(ii) Conductor resistance measurement

(iii) Capacitance measurement

(iv) Insulation resistance measurement

(v) A.C. withstand voltage

(vi) A.C. long duration withstand voltage

(vii) Impulse withstand voltage

(viii) A.C. long duration breakdown voltage

(ix) Impulse break-down voltage

(x) Dielectric loss tangent

(xi) Temperature-voltage characteristic

(xii) Dimension

- Conductor outermost diameter
- Insulation thickness
- Sheath thickness
- Over-sheath thickness
- Thickness of each tape
- Interval of tape lapping
- Total diameter

(xiii) Bending withstand characteristic

(xiv) Over-sheath, tensile strength

(xv) - do. - , thermal aging

(xvi) - do. - , oil-proof

(xvii) - do. - , non-in flammability

(xviii) - do. - , thermal deformation

(xix) - do. - , hardness

b) Sealing ends

i) Construction

ii) A.C. long duration withstand voltage

iii) Impulse withstand voltage

iv) A.C. long duration breakdown voltage

v) Impulse breakdown voltage

vi) Porcelain or epoxy insulator, construction

vii) - do. - , power frequency flash-over voltage (dry)

viii) - do. - , power frequency flash-over voltage (wet)

ix)- do. - , 50% impulse flash-over voltage

x) - do. - , cantilever strength

xi)- do. - , thermal mechanical performance

(c) Other conductors

i) Construction test

ii) Resistance tests

iii) Withstand voltage test

iv) Insulation resistance test

v) High temperature insulation resistance test

vi) Tensile strength test

vii) Coiling test

viii) Thermal deformation test

ix) Oil proof test

x) Non-inflammability test

xi) Shield conductivity test

xii) Thermal shrinkage test

xiii) A.C. breakdown voltage test

xiv) Impulse breakdown voltage test

xv) Tin plating test

xvi) Acid and alkaline proof test

xvii) Oxygen index measurement

xviii) Chlorine gas measurement

Test on Completion:

After completely installing the 132/ 33 kV XLPE power cables, sealing ends and other conductors at site, the following tests shall be carried out by the Contractor.

a) DC High voltage test

Payment:

Payment for Construction and Installation of Contract item for "132/33/11 kV XLPE HT copper power cable" shall be made at the unit price per running meter of the cable as per bid. Therefore, in the Price schedules, such unit prices shall include full compensation for all costs incurred in furnishing, construction (Cutting of asphalt road, Construction of Cable trench, Man hole, laying of flexible pipe, placing of find sand, laying of power cable, making the road same as it was before digging, placing of route marker) and installing all power cable. In case of the material that are quoted in LS basis in BOQ they are also converted into the run meter and payment is made.

3.2 600 VOLT POWER CABLE

a) General

The low voltage cables shall be 600 V grade polyethylene insulated and PVC sheathed. Low voltage AC power systems will be solidly grounded neutral with phase-to-phase voltage level of 400 V and phase to neutral voltage of 230 V AC system and the DC system with 110 V. The size of the single core conductor shall not be less than 2.5 sq. mm for lighting and 4 sq. mm for power. The main (incomer) cable to AC distribution panel shall be three & half (3.5) core.

Sizing of power cables shall be done by the contractor, keeping in view continuous current, voltage drop & short-circuit consideration of the system. Relevant calculations shall be submitted by bidder during detailed engineering for employer's approval.

While preparing cable schedules for control/protection purpose following shall be ensured:

- Separate cables shall be used for AC & DC.
- Separate cables shall be used for DC1 & DC2.
- For different cores of CT & CVT separate cable shall be used
- At least one (1) core shall be kept as spare in each copper control cable of 4C, 5C or 7C size whereas minimum no. of spare cores shall be two (2) for control cables of 10 core or higher size.

- For control cabling, including CT/VT circuits, 2.5 sq. mm size copper cables shall be used per connection. However, if required from voltage drop/VA burden consideration additional cores shall be used. Further for potential circuits of energy meters separate connections by 2 cores of 2.5 sq. mm size shall be provided

b) Conductor

Conductor shall consist of stranded annealed copper wires. They shall comply with IEC publication. The cable is intended for use at normal conductor operating temperatures not exceeding 75-degree C.

c) Insulation

The electrically and thermally stable polyethylene insulation shall be extruded onto the conductor so as to prevent contamination and voids in the insulation.

d) Current Rating

The Contractor shall state the maximum continuous current rating and conditions of installation for low voltage power cables.

e) Jacket

The cable core assembly shall be covered with a flame-retardative and moisture resistant PVC jacket, which is free stripping from the insulation. The overall jacket shall be clean, dry, and free of grease and shall be suitable for ink or paint application.

f) Anti-- Termite Covering

Anti-termite protection shall be applied to the cable and shall consist of either a non-magnetic metallic barrier or layer of nylon sheathing

g) Identification

- Each cable shall have a printed legend on the overall jacket with the manufacturer's name, voltage class, the number and size of conductors, type of insulation

- The colours for core identification and colour sequence shall be in accordance with follows

  - Single-core : Black
  - Double-core : Red and black
  - Three-core : Red, yellow and blue
  - Four-core : Red, yellow, blue and black

3.3 CONTROL AND INSTRUMENTATION CABLE

a) General

All control and instrumentation cable shall be 600 V grade as per IEC standard, multi conductor, color-coded, PVC insulated armored cable. Each multicore cable shall have not less than 20 percent or 2 spare cores, whichever is the greater.

b) Conductor

Copper conductor shall be stranded circular non-compacted cross-section of a minimum 2.5 sq. mm. The Contractor shall calculate the load of CT core considering all connected loads and submit to the employer for approval. In case of CT burden constrain, CT circuit cable cross sectional area shall be increased. In this case the Contractor shall supply and install the cable required cross-section area without any additional cost to the Employer.

c) Insulation

The electrically and thermally stable PVC insulation shall be extruded onto the conductor so as to prevent contamination and voids in the insulation.

d) Assembly

1) Multi-core conductor cables shall be assembled in accordance with applicable IEC standards.

2) A flame-retardative binder tape may be used underneath the overall jacket of multi-conductor cables, if required, to achieve the desired flame retardative characteristics. Tapes, if used, shall be non-hygroscopic.

e) Jacket

1) The cable core assembly shall be covered with a flame retardative and resistant jacket, which is free stripping from the insulation.

2) The overall jacket shall be clean, dry, and free of grease and shall be suitable for ink or paint application.

3) Cable jacketing and the interstices within the jacket shall be free of water. Evidence of water shall be the ground for rejection of the cable.

f) Anti- Termite Covering

Anti-termite protection shall be applied to the cable and shall consist of either a non-magnetic metallic barrier or layer of nylon sheathing.

g) Identification

Each cable shall have a printed legend on the overall jacket, with the manufacturer's name, voltage class, the number and size of conductors, and a unique number or code indicating the production run or batch. The identification shall remain legible for the life of the cable

3.4 COMMUNICATION CABLE

a) All cables and wiring shall have copper conductors and PVC insulation and shall comply with IEC standards

b) Each communication cable shall have not less than 20 percent or 4 spare twisted pairs whichever is the greater. Cabling and wiring installations shall be arranged to minimize the risk of fire and damages, which might be caused in the event of fire.

c) For telephone type cables, 2 conductor wires of not less than 0.6 mm dia shall be used. Where twin or quad make up is required in any cable, the cores shall be uniformly twisted and the lays arranged such that cross talk is reduced to a minimum.

d) No conductor smaller than 32/0.2mm (1mm^2), or having less than three strands, shall be used for interconnecting the cables except in the case of telephone extensions. All cables shall have insulation, which will withstand the highest temperature to be experienced in service.

e) Each conductor of a multicore cable shall be readily identified by a numbered marker tape or, in the case of telephone type cables, colour coded insulation.

3.5 SPECIAL REQUIREMENTS

3.5.1 The Contractor shall be responsible for estimating and supplying the quantity of various types and sizes of the cables. In course of actual execution, if it is found that additional cross-sections, types or quantities of cables are required for the completion of the specified works the same shall be supplied without any additional charge to the employer.

3.5.2 Small cut piece lengths of cables will not be accepted. Cables up to 500 meters in length or as approved by Employer shall be of one length shipped in a drum of adequate size. For higher quantities, multiple lengths/drums may be shipped subject to the approval of Employer.

3.5.3 DRAWINGS, DATA & MANUALS

The following information shall be furnished along with the bid.

(a) Manufacturer's leaflets giving constructional details, dimensions and characteristics of different cables.

(b) Current rating of cables including derating factor due to grouping, ambient temperature and type of various installation.

3.5.4 TESTS FOR LOW VOLTAGE CONTROL, INSTRUMENT AND COMMUNICATION CABLES

3.6 Routine and Design Tests

Power cable shall be subjected to following routine tests. As far as practical, the procedure of IEC shall be followed:

a) Measurement of the electrical resistance of conductor

b) Partial discharge test

c) Voltage test

The power cable design tests shall include following:

a) Partial discharge test

b) Bending test, followed by a partial discharge test

c) Tan delta measurement

d) Heating cycle test, followed by a partial discharge test

e) Impulse test, followed by voltage test

f) Voltage test for 4 hours.

The Bidder shall submit copy of design test report from recognized testing laboratory for the offered power cable along with the bid.

3.6.1 Field Tests

After installation at Site, cables shall be subjected but not limited to the following tests:

a) Measurement of insulation resistance

b) DC dielectric test

3.6.2 TYPE TESTS

3.6.3 All cables shall conform to all type, routine and acceptance tests listed in the relevant IEC.

3.6.4 XLPE INSULATED POWER CABLES (For working voltages up to and including 1100V):-

3.6.5 Following type tests (on one size in a contract) as per IEC: 60502 (Part 1) including its amendments shall be carried out as a part of acceptance tests on XLPE insulated power cables for working voltages up to and including 1100 V:

a) Physical tests for insulation

i) Hot set test

ii) Shrinkage test

b) Physical tests for outer sheath

i) Shrinkage test

ii) Hot deformation

iii) Heat shock test

iv) Thermal stability

3.6.6 Contractor shall submit type test reports as per clause no. 9.2 of Technical Specification, Chapter 2: GTR for the following tests-

a) Water absorption (gravimetric) test.

b) Ageing in air oven

c) Loss of mass in air oven

d) Short time current test on power cables of sizes 240 sq.mm and above on

i) Conductors.

ii) Armours.

e) Test for armouring wires/strips.

f) Oxygen and Temperature Index test.

g) Flammability test.

3.7 PVC INSULATED POWER & CONTROL CABLES (For working voltages up to and including 1100V)

3.8 Following type tests (on one size in a contract) as per IEC: 60502 (Part 1) including its amendments shall be carried out as a part of acceptance tests on PVC insulated power & control cables for working voltages up to and including 1100 V:

a) Physical tests for insulation and outer sheath

i) Shrinkage test

ii) Hot deformation

iii) Heat shock test

iv) Thermal stability

b) High voltage test.

3.8.1 Contractor shall submit type test reports as per clause no. 9.2 of Technical Specification, Chapter 2: GTR for the following-

a) High voltage test.

b) Ageing in air oven.

c) Loss of mass in air oven.

d) Short time current test on power cables of sizes 240 sq. mm and above on

i) Conductors.

ii) Armours.

e) Test for armouring wires/strips.

f) Oxygen and Temperature Index test.

g) Flammability test.

3.8.2 XLPE INSULATED HV POWER CABLES (For working voltages from 3.3 kV and including 33 kV)-

3.8.3 Contractor shall submit type test reports as per clause no. 9.2 of Technical Specification, Chapter 2: GTR for XLPE insulated HV power cables (as per IEC: 60502 Part-2).

3.8.4 Terminating/jointing accessories as per IEC 60840:1999/ IEC62067

3.9 PERFORMANCE GUARANTEE

The performance figures quoted on schedule of Technical Data shall be guaranteed within the tolerance permitted by relevant standards and shall become part of the Contract. In case of failure of the cables to meet the guarantees, the Employer reserves the right to reject the item. The Contractor shall have to rectify/ replace the defect/ defective part at no extra cost to the Employer and without delaying the commissioning schedule.

The Contractor shall conduct the above-mentioned tests in presence of Employer before dispatch of the Power and control cables (Low voltage up to 1.1 kV). All the cost of tests

including cost of travelling, lodging and fooding of two NEA personnel shall be borne by the Contractor. With in seven days after the completion of tests the contractor has to furnish the final three certified copies of report of all tests to the Employer.