TECHNICAL SPECIFICATION FOR PACKAGED SUBSTATION/COMPACT SUBSTATION AND 11KV RMU

PROJECT: SITE ENABLING WORKS FOR FABRICATION AT SEA FRONT FACILITY

C O N T E N T S

TECHNICAL SPECIFICATION OF 500KVA COMPACT SUBSTATION &RMU

Ref no: WE-29082020-01

TECHNICAL SPECIFICATION OF COMPACT SUBSTATION

1. INTENT OF SPECIFICATION

This specification is intended to cover the design, manufacture, assembly, testing at manufacturer's works, supply & delivery, properly packed for transport of the Packaged Substation(PSS)/Compact Substation(CSS), 11kV Ring Main Unit (RMU) and supervision of erection & commissioning as specified herein under, complete with all accessories, fittings and auxiliary equipment as required for efficient &trouble-free operation. The packaged(PSS)/Compact substation shall be suitable for installation and operation near the sea front.

2. CODES & STANDARDS:

2.1 All equipment and material shall be designed manufactured and tested in accordance with the latest applicable IEC standards.

2.2 The Package Sub-station offered shall in general comply with the latest issues including amendments of the following standards.

Title	Standards
High Voltage Low Voltage Pre-Fabricated Substation	IEC:61330/62271-202
High Voltage Switches	IEC 60265
Metal Enclosed High Voltage Switchgear	IEC 60298/62271-200
High Voltage Switchgear	IEC 60694/62271-100
Low Voltage Switchgear and Control gear	IEC 60439/60947
Power Transformers	IEC 60076

3. SCOPE & SPECIFIC REQUIREMENTS

3.1 Supply of 1 nos. 500kVA, 11kV, Package Substations with fault level of 21KA for 1 sec. Following equipment details part of each Package substation.

S. No	Description
i)	**11kV RMU: Quantity:1 no.** Three way 11KV Non-Extensible Ring Main Unit Compact switchgear consisting of 630A two numbers SF6 insulated fixed manual fault making / Load break Switches & 630A one number of Fixed manual SF6 insulated Vacuum circuit breaker. SF6 insulated Vacuum circuit breakers with self- powered relay having Transformer protection, over current and earth fault protection. Interconnection between RMU and transformer shall be by using suitable Copper unarmoured 11KV (UE) 1CX1RX95 sq.mm per phase cable which is in the scope of Bidder. Incomer break switches shall

	be suitable for termination of 2 runs of 3C X 240 Sq.mm aluminium armoured XLPE Cable
	Make of RMU switchgear: ABB/ Siemens/ Alstom / Schneider/L&T make only.
	Make of relay to be used with VCB: L&T/ABB / Areva / Siemens / Schneider make only
	Transformer Feeder Metering 3 Nos 11KV Single core Ring type metering CTs with 40/5A or 50/5A for each transformer feeder.
ii)	**500kVA 11kV/0.433KV Dry type/Oil type Transformer: Quantity: 1 No.** 500 KVA, 11KV / 0.433V, Dyn11, **Dry Type /Oil type Transformer** with off circuit tap links 5% to -5% @ 2.5% on HT side of transformer with WTI Scanner with Alarm and trip contact.
	Make of the transformer: **Should be same as CSS**.
	Impedance, no-load/ load losses, efficiency, temperature rise above ambient of winding of the transformer should be as per IS/IEC/CBIP standards.
	Suitable surge arrestor shall be provided between VCB & Transformer
iii)	**LV Switchgear: (Inside CSS)** **Quantity:** 1 No: 800A ACB Incomer 1 No: 800A MCCB outgoing feeder 1 No. 200A MCCB Outgoing Feeder 1 No.100A MCCB Outgoing feeders 415V indoor LV panel with Aluminum Bus bars, fabricated using CRCA sheet steel, Ingress Protection IP4X, Compartmentalized complete with internal wiring consisting of following. **Incomer:** 800 A, TPN, 415V, 3P, 50Hz, 21KA, Fixed manual type ACB with Microprocessor based O/L, S/C, and E/F (IDMTL+Inst.) release. Rated Insulation Voltage Ui = 1000V, Utilization category = B LT Switchgear should be suitable for termination of 2run X 3 ½ C X 240 Sq.mm aluminum armored Cable.
	Make of the ACB - L&T/ Siemens / GE/ABB/ Schneider /Areva make only.

	LV Switchgear : Metering (for Incomer) Maximum demand controller as per the specification at pg no:22 shall be provided (Conzerv/L&T/Secure/Schneider/elmeasure) – 1 No. Controller shall be suitable to trip the MCCBs as per the settings. LT Metering CT's – 3 Nos, 800/5A, Cast Resin Type, Cl – 1.0, R, Y, B, ON, OFF,TRIP LED Indicating Lamps - 6 Nos. (MakeTechnic/Vaishno/STS/Rep.) Control MCB, 6A, SP - As required
iii	**LV Switchgear : Outgoing (Inside CSS)** **800A,200A and 100 A,TPN** ,415V, 3P, 50Hz, 21KA, Fixed manual type MCCB with **Microprocessor based O/L,S/C & E/F release** and trip contacts suitable for Digital Multifunction Meter with A,V,KW,KWH,PF, Cl-0.5 with RS 485 Port (Conzerv/L&T/Secure/Schneider) for each outgoing feeder LT Metering CT's, Cast Resin Type, 100/1A, Cl-0.5 (Matrix/AE/G&M Make). Control MCB, 6A, 4P-As required (MDS/L&T/GE/SCHNEIDER/ABB) Outgoing MCCBs of LT Switchgear should be suitable for termination of 1run X 3 ½ C X 240 Sq.mm aluminum armoured Cable. 800A outgoing MCCB must be suitable for termination of 3 runsX3.5CX 240 Sq mm Al armoured cable. Make of the MCCB - L&T/Siemens/GE/ABB/ Schneider /Areva make only.
iv	**Enclosure: Quantity:1 No.** Outdoor type enclosure having modular construction of Galvanized Sheet Steel. The degree of protection for HT & LT switchgear compartment shall be IP55 & degree of protection of transformer compartment of the enclosure shall be minimum IP23. Painting of the enclosure exterior shall be suitable for sea shore conditions.Each compartment will be provided with the door and pad locking arrangement. The Compartment illumination lamp with door-operated switch shall be provided for each compartment. Structure of the substation shall be able to withstand the gross weight of all equipment. It should be possible to transport the equipment along with transformer, RMU & LT Panel from one site to another. This shall be installed at sea front, hence, accordingly design parameters to be taken into account.
v	Interconnection between HT switchgear & Transformer using XLPE cable & Interconnection between Transformer & LT switchgear using high conductivity Aluminium busbars(E91E) . Internal earthing connections by GI strips.
vi	**DC supply for PSS shall be through in built 24V power pack. Separate DC supply shall be not provided for auxiliary power requirement purpose.**
vii	All power cables except 3Rx1Cx95 Sq.mm Cu (Between VCB and Transformer H.T) will be by BHEL.

3.2 Supply of 1 no. 11kV, Ring Main Unit with fault level of 21KA for 1 sec. Following equipment details part of 11kV RMU.

S. No	Description
i)	**11kV RMU: Quantity:1 no.** CCC NE with three way Motorized Outdoor Ring Main Unit consisting of three numbers 630A SF6 insulated fixed motorized fault making / Load break Switch and earth switch. The RMU shall be suitable for installation at Sea shore.
	Enclosure: Quantity: 1 No. Outdoor type enclosure having modular construction of Galvanized Sheet Steel. The degree of protection shall be IP55.The painting of the enclosure exterior shall be suitable for sea shore conditions. Each compartment will be provided with the door and pad locking arrangement. The Compartment illumination lamp with door-operated switch shall be provided for each compartment. Structure of the substation shall be able to withstand the gross weight of all equipment.
	DC supply for RMU shall be through in built 24V power pack. Separate DC supply shall be not provided for auxiliary power requirement purpose.
	FEEDER REMOTE TERMINAL UNIT (FRTU)
	11kV RMU shall be supplied with FRTU along with necessary hardware and software/gateway required for hooking with SCADA. Gateway & Protocol requirements. The Feeder RTUs should be fully integrated as per the requirements of BHEL with the Master station based on IEC 870-5-104 protocol. The Bidder should furnish the details of his implementation of IEC 870-5-104 protocol and interoperability profile of the supplied FRTU. FRTU shall be stand-alone equipment powered by 24V DC positive earthed system capable of performing the following functions. 1. Collecting, processing and transmitting status changes, analog values, sequence of Events (SOE) and accumulator values. 2. Receiving and processing digital commands from the master station(s). 3. Accepting polling messages from the master station(s). 4. Supporting at least three (3) serial communication ports and multiple concurrent protocols like IEC 870-5-101, MODBUS, etc 5. 1 No. Ethernet port with supporting IEC 104 / TCP/IP protocols. 6. 1 No. USB 2.0 interface for diagnosis and maintenance purposes 7. The RTU clock shall be provided with an internal battery backup 8. It shall support 250 data points. The FRTUs shall use microprocessor based function control logic, consisting of a microprocessor with sufficient speed and memory to accept commands via the communication interface and process these commands in accordance with the

	predetermined protocol with minimal turn around delays. They shall process received messages for control and data and activate the appropriate FRTU process I/O circuits to provide a functional response to these commands and requests. The FRTU shall assemble response messages in accordance with the received messages and transmit the responses to the requesting control Centre. The design of software and database shall not restrict the integration with any other master / server and future expansion beyond the sizing parameters
	The FRTU's shall have an architecture that supports convenient installation, maintenance and expansion features. Their configuration shall include a central processing module and I/O modules. **CPU Modules:** The Processor card must have minimum RAM of 64MB.Minimum Storage capacity possible should be 4GB (Internal or through SD card) for storing of archive events. **I/O Modules:** FRTU shall have 48 Nos. Digital Inputs, 16 Nos. Digital Outputs and 6 Nos. Analog Inputs.
	Communication with Control Centers The FRTU must be capable of communicating with a Master Station using the tele-control communication protocol IEC 60870-5-104. It must be possible to communicate simultaneously with up to 8 Master Stations. The FRTU shall provide serial communication interfaces RS232 as well as Ethernet interfaces 10/100 BaseT for the communication in digital networks
	Time Management and Synchronization The internal time management shall be controlled by the CPU communication modules. The time resolution of the FRTU shall be 1 ms for events, scanned by the directly connected I/O modules. Synchronization with absolute time shall support any one of the following methods. Time synchronization of the FRTU by the network control centre (NCC) via a periodically transmitted synchronization instruction with a communication protocol supporting this function. The FRTU time management system shall have hardware and software logic with a high control quality incorporated on the CPU communication modules to manage real time within the FRTU.

3.3. All necessary foundation bolts and accessories are in the scope of Bidder.
3.4. Supply of commissioning spares as per Annexure 3 .
3.5. Supervision of installation, testing & commissioning of 11kV CSS & 11kV RMU including FRTU is in the scope of Bidder.

4. Design Criteria

4.1 Package Sub-station consisting of 3 way 11KV SF6 insulated Switchgear with 630A 2no. of LBS +1 no. of 630A 11KV vacuum Circuit Breaker + 11kV/415V, 500KVA, DYn11 Transformer + LT 415V, 800A ACB incoming with all connection, accessories, fitting & auxiliary equipment in an enclosure to supply Low-voltage energy from high-voltage system and 11kV RMU as detailed in this specification. The complete unit shall be installed on a substation plinth (base) as Outdoor substation.

4.2 The prefabricated-package substation shall be designed for a) Compactness, b) fast installation, c) maintenance free operation, d) safety for worker/operator & public .

4.3 The Switchgear and component thereof shall be capable of withstanding the mechanical and thermal stresses of short circuit listed in ratings and requirements clause without any damage or deterioration of the materials.

4.4 For continuous operation at specified ratings temperature rise of the various switchgear components shall be limited to permissible values stipulated in the relevant standard and / or this specification.

4.5 Service Conditions:

The Package substation shall be suitable for continuous operation under the basic service conditions indicated below

Ambient Temperature:	50 Deg C
Relative Humidity	upto 95%
Altitude of Installation	upto 1000m

The Enclosure of High Voltage switchgear-control gear, Low Voltage switchgear-control gear & Transformer of the package substation shall be designed for use at sea shore. The enclosure should take minimum space for the installation including the space required for approaching various doors & equipment inside.

5. DESIGN REQUIREMNT OF 11kV CSS & 11kV RMU

The main components of a prefabricated package substation are Transformer, High-voltage switchgear-control gear, Low-voltage switchgear-control gear and corresponding interconnections (cable, flexible bus bars) & auxiliary equipment and 11kV RMU. The components shall be enclosed, by either common enclosure or by an assembly of enclosure. All the components shall comply with their relevant IEC standards.

5.1 OUTDOOR ENCLOSURE:

5.1.1 The enclosure shall be made of 2.0mm thickness galvanized Sheet Steel tropicalized to local weather conditions including all partition sheets and doors. The out door enclosure wall of the USS are designed in a corrugated wall type design for robust construction and heat dissipation. The base of enclosure shall be 4mm thick Hot dip Galvanized sheet steel.

5.1.2 The metal base shall ensure rigidity for easy transport & installation.

5.1.3 The protection degree of the Enclosure shall be IP55 for LT & HT switchgear compartment & IP23 for Transformer compartment. Proper / adequate ventilation aperture shall be provided for natural ventilation by way of Louvers etc.

5.1.4 IP 55 for 11kV RMU.

5.1.5 The doors shall be provided with proper interlocking arrangement for safety of operator.

5.1.6 The H.V. & L.V. outgoing of the transformer are to be connected to Vacuum Circuit Breaker of 3 way 11kV RMU & incomer of the Low Voltage Switchgear by means of Aluminum Cables / Flexible Busbars.

5.1.7 **Internal Fault**: Failure within the package substation & 11kV RMU due either to a defect, an exceptional service condition or mal-operation may initiate an internal arc. Such an event may lead to the risk of injury, if persons are present. It is desirable that the highest practicable degree of protection to persons shall be provided. The Design for Internal arc fault shall be tested for 20KA for 0.1sec as per IEC 61330/62271-200.

5.1.8 **Covers & Doors**: Covers & doors are part of the enclosure. When they are closed, they shall provide the degree of protection specified for the enclosure. Ventilation openings shall be so arranged or shielded that same degree of protection as specified for enclosure is obtained. Additional wire mesh may be used with proper Danger board for safety of the operator. All covers, doors or roof shall be provided with locking facility or it shall not be possible to open or remove them before doors used for normal operation have been opened. The doors shall open outward at an angle of at least 90^0 & be equipped with a device able to maintain them in an open position.

5.1.9 **Earthing**: All metallic components shall be earthed to a common earthing point. It shall be terminated by an adequate terminal intended for connection to the earth system of the installation, by way of flexible jumpers/strips & Lug arrangement. The continuity of the earth system shall be ensured taking into account the thermal & mechanical stresses caused by the current it may have to carry. The components to be connected to the earth system shall include:

a) The enclosure of Package substation,
b) The enclosure of High voltage switchgear & control gear from the terminal provided for the purpose,
c) The metal screen & the high voltage cable earth conductor,
d) The transformer tank or metal frame of transformer,
e) The frame &/or enclosure of low voltage switchgear,

5.1.10 There shall be an arrangement for internal lighting activated by associated switch for HV, Transformer & LV compartments separately.

5.1.11 **Labels**: Labels for warning, manufacturer's operating instructions etc. shall be durable & clearly legible.

5.1.12 Cleaning & Painting:

The paints shall be carefully selected to withstand sea shore conditions. The paint shall not scale off or crinkle or be removed by abrasion due to normal handling.

5.2 11KV SF6 Non-extensible RMU Circuit Breaker:

5.2.1 **11KV SF6 RMU Circuit Breaker:** The requirement of 11kV Ring Main Unit SF6 Gas filled comprising of 3 panels as indicated below is as under.

5.2.2 **Panel No.1 & 2**: Manual operated Load break switch with integral earth switch having full making capacity shall be used for Incoming / outgoing cables.

5.2.3 **Panel No. 3:** Vacuum Circuit Breaker complete with operating mechanism, protection system for transformer and cable box.

5.2.4 11kV RMU shall be provided with CCC NE with three way Motorized outdoor Ring Main Unit consisting of three numbers 630A SF6 insulated fixed motorized fault making / Load break Switch and earth switch

5.2.5 The above breakers, Busbars should be mounted inside a robotically welded sealed for life, stainless steel tank. The tank should be filled with SF6 gas at adequate pressure.

5.2.6 The Circuit Breaker is required to control 11kV/415 volts distribution Transformer of rating 500KVA and relay settings shall be selected accordingly.

5.2.7 **General Finish**: Totally enclosed, metal clad, vermin and dust proof suitable for tropical climate use as detailed in the specification.

5.2.8 **Ratings**: The busbars shall have continuous rating of 800 Amps. Circuit Breaker shall have a continuous rating of 800 Amps. in accordance with relevant IEC standard

5.2.9 **Breaking & Making Capacity**: Circuit Breaker shall be capable of having rupturing capacity of 20kA symmetrical at 11KV.

5.2.10 **Busbars**: Switchgear shall be complete with all connections, busbars etc. The continuous rating of copper busbars shall be 630 Amps and they shall be fully encapsulated by SF6 gas inside the steel tank. Busbar should be rated to withstand dynamic and thermal stresses for full length of switchgear.

5.2.11 **Cable switch**: It should be switch-disconector and earthing switch using SF6/VCB gas as on arc-quenching medium. The switch position are closed-open-earthed. In open position switch satisfies the disconnector requirement.

5.2.12 **Earth Switch**: Earth switch should be rated equal to switchgear rating. Earth switch should be quick make type capable of making rated fault current. Earth switch should be operated from front of the cubicle.

5.2.13 **The Mechnism**: All the mechanism should be situated in the mechanism compartment behind the front covers outside SF6 tank. Mechanism for switch and earth switch is operating both the switches via one common shaft.

5.2.14 **Front covers**: Front covers contains the mimic diagram of the main circuit with the position indicator for the switching devices. The voltage indicator should be situated in front covers. Access to the cable bushing in the lower part of each module.

5.2.15 **Position Indicator**: Position indicator are visible through the front covers and are directly linked the operating shafts of switch devices.

5.2.16 **Voltage indicator**: Voltage indicator situated in front covers, one of each module and indicate the voltage condition of each incoming cable. Identification of phase is achieved through labels L1,L2, and L3 on the front of the voltage indicator. Voltage indicator should complies requirement of IEC61243.

5.2.17 **Cable Compartment:** It should be possible terminate the cables as specified in the specification. The access to the compartment shall be possible by removing the cable cover and bolted to the main frame. Removable steel covers close the cable compartment. Arc proof cable covers should be available. Each module should

have separate compartment that is segregated from each other by means of partition wall. A partition wall should be fitted to divide the cable compartment from the rear side of the switchgear. In case arc inside the tank, followed by opening of pressure relief device the partition wall prevent the hot gases flowing out from the pressure relief to enter the cable compartment.

5.2.18 **Power Connection:** The cable are installed in the dedicated compartment below the mimic front cover. At bottom of cable compartment, an earthing bar system made of copper with a minimum cross section area of 120 sq.mm should be fitted. In each compartment the earthing bar should be fitted with 4 screws M10.The earthing system is connected to the tank by copper bar which rises upto the connecting point of the tank behind the rear portion wall on the middle of the switchgear.

5.2.19 **Fault passage Indicator:** Each RMU should be equipped with display phase current of feeder circuit. Each RMU should be provided with fault passage indicator to on isolator to indicate earth fault. This facilitate quick detection of fault section of line the unit shall be self contained requiring no auxiliary power and shall be integral part of RMU to avoid thefts. The fault shall be displayed by LED/flag indication with three options for reset. (Manual/on restoration of supply/Settable time

5.3 Switchgear:

The SF6 RMU shall be sealed for life, the enclosure shall meet the "sealed pressure system" criteria in accordance with IEC: 298. There shall be no requirement to 'top up' the SF6 gas. It shall provide full insulation, making the switchgear insensitive to the environment. Thus assembled, the active parts of the switchgear unit shall be maintenance free.

The switchgear & switchboard shall be designed so that the position of different devices is visible to the operator on the front of the switchboard & operations are visible as well. The switchboard shall be designed so as to prevent access to all live parts during operation without the use of tools.

RMU should be tested for internal arc fault test.

5.3.1 Isolator (Load Break Switch):

The Isolators offered shall conform to IS: 4710/9920 as amended to date. The isolator shall be ON Load type, triple pole, spring assisted, hand/motorized operated, non-automatic type with quick break contacts and fault indication. The operating handle shall have three positions 'ON', 'OFF' and 'EARTH' which shall be clearly marked with suitable arrangement to padlock in any position. A safety arrangement for locking shall be provided which shall prevent from the isolator operation 'ON' position to 'EARTH' position or vice versa.

5.3.2 Vacuum Circuit Breaker:

The Unit shall consist 630A Tee-off spring assisted three position, three pole circuit breaker, with integral fault making / dead breaking earth switch. The function shall be naturally interlocked to prevent the main & earth switch from being switched 'ON' at the same time & the CB not allowed to trip in 'Earth On'

position. The selection of the main/earth switch lever on the panel, which is allowed to move only if the main or earth switches in the off position. The lever shall be able to pad locked in either the main or earth position.

The manual operation of the circuit breaker shall not have an effect on the trip spring. This should only be discharged under a fault (electrical) trip condition; the following manual reset operation should recharge the trip spring & reset the CB mechanism in 'main off' position.

5.3.3 Air Circuit Breaker:

The Unit shall consist 630A Tee-off spring assisted three position, three pole circuit breaker, with integral fault making / dead breaking earth switch. The function shall be naturally interlocked to prevent the main & earth switch from being switched 'ON' at the same time & the CB not allowed to trip in 'Earth On' position. The selection of the main/earth switch lever on the panel, which is allowed to move only if the main or earth switches in the off position. The lever shall be able to pad locked in either the main or earth position.

The manual operation of the circuit breaker shall not have an effect on the trip spring. This should only be discharged under a fault (electrical) trip condition; the following manual reset operation should recharge the trip spring & reset the CB mechanism in 'main off' position.

5.3.4 Protection Relay:

The CB shall be fitted with self-powered relay inside the front cover to avoid any tampering. The relay should be 3 Over Current + 1 Earth Fault, fed by protection CTs mounted in the cable box.

5.3.5 Cable Box:

Every VCB shall be provided with suitable and identical cable boxes in front for connecting 3 core X 50 Sq.mm, 11kV cable from vertically below. The cable boxes shall be so located at convenient height to facilitate easy cable jointing work. The height available for cable termination should be minimum 500 mm. The Cable termination shall be done by Heat shrinkable Termination method so adequate clearances shall be maintained between phases for Termination. It shall be possible to terminate 2 runs of 3 Core X 50 sq.mm or 1 run of 1 core X 300 Sq.mm XLPE cable.

5.3.6 Locking Arrangement:

Suitable padlocking arrangements shall be provided as stated below.

a) CB manual operating handle in the "OFF" position.
b) Each feeder Panel operating handle in 'Closed' 'Open" or 'Earth' position.

6. General Requirements:

6.1 Compact Sub-Station & RMU shall be outdoor plinth mounted type.

6.2 Erection, Commissioning and Civil work for package substation & RMU is in the scope of BHEL. However, Supervision of erection, testing and commissioning is in the scope of Bidder. Further, the Vendor shall furnish the foundation details & foundation bolts & accessories.

6.3 Package sub-station & RMU will be complete with the internal interconnections & earthing (GI) and extending of earth bar of Neutral and body terminals to the frame of the CSS for connecting to the earth pits. External earthing from CSS frame to earth pit is in the scope of BHEL.

6.4 Vendor shall assemble the Compact substation & RMU at factory and no assembly of the same shall be allowed at site.

6.5 Required technical data sheet of the transformer, HV/ MV switchgear, relay etc. should be furnished with the offer.

6.6 Colour of paint to be mentioned in the offer and to be decided mutually. Tentative paint shade shall be RAL-7032.

6.7 The CSS & RMU shall be should be SCADA compatible.

6.8 Vendor shall supply suitable & required no. of HT & LT Cable termination kits along with CSS for HT & LT Cable terminations.

7. Pre-Dispatch Inspection:

Vendor shall offer for pre-dispatch inspection at vendor's works. Only after the equipment's are cleared by BHEL in writing, the vendor can dispatch the equipment. Routine tests to be conducted and original test certificates to be submitted at the time of PDI.

8. Training (Optional)

8.1 Two BHEL persons shall be trained at vendor's principles in the area of design, maintenance, and operation of Compact Substation for a period of 5 working days each.

8.2 Air-fare, boarding & lodging for the trainees shall be borne by BHEL.

8.3 Competent, English speaking experts shall be arranged by the vendor for satisfactory & effective training of BHEL personnel.

9. Commissioning Spares & Tool and Tackles:

The following additional commissioning spares required – Digital Multifunction Meter-1No; MCB(each type & rating)- 5Nos. ; Indicating Lamps(Each Color) -10Nos ; 11KV,3.15A H.T fuse(each type & rating) – 2No ; Spring Charging handles-2 Nos ;Panel Keys – 2 Nos; Control fuses (each type & rating) – 5Nos.

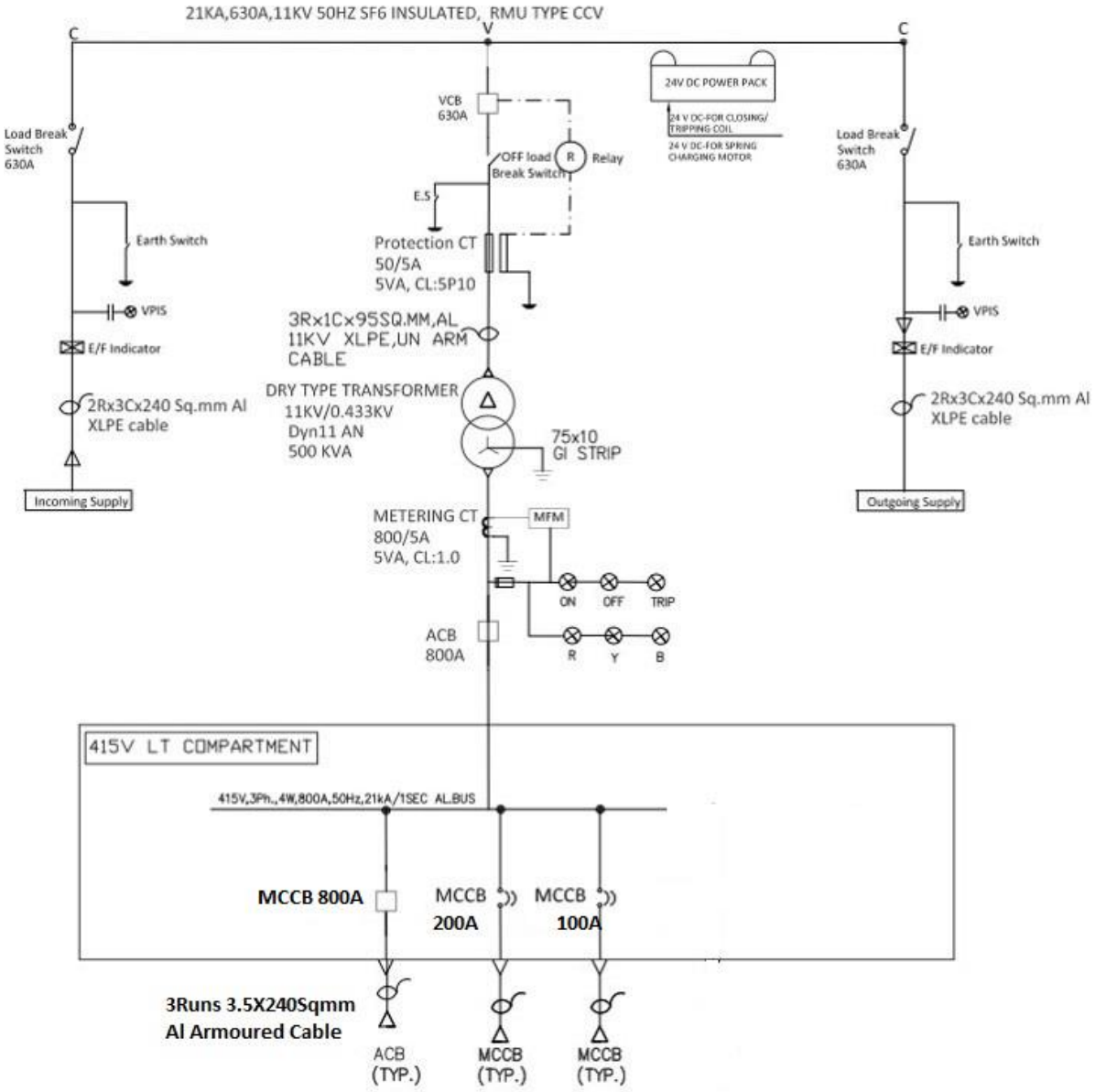
Any special Tools & Tackles required for O&M operation of CSS/PSS will be supplied by bidder.

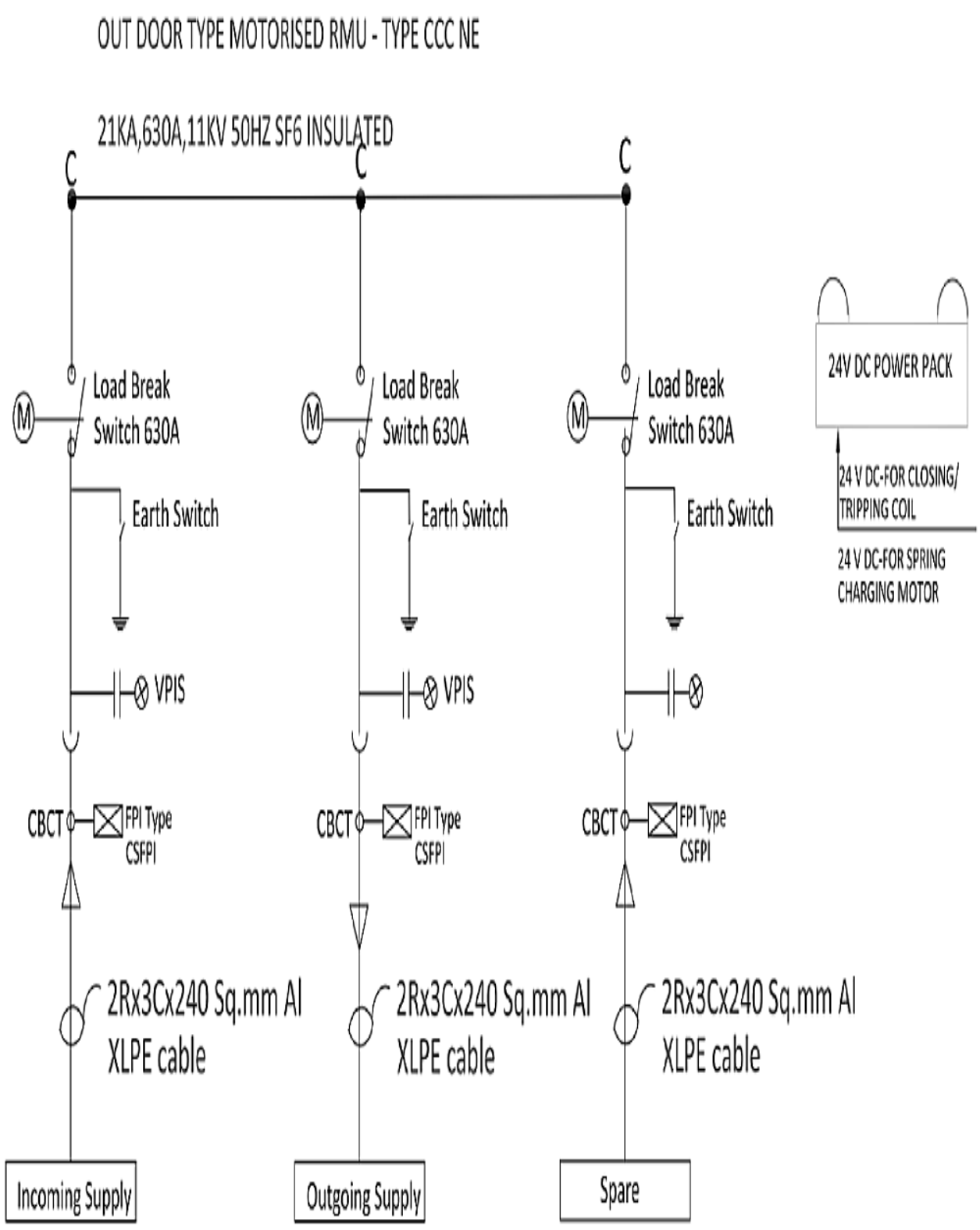
10. Material Codes (BHEL use)

S.No	Material Description	Material Code
1	500KVA Compact Substation/Packages Substation	
2	11KV RMU with FRTU	
3	Commissioning Spares	
4	Supervision of Erection & Commissioning of CSS,RMU & FRTU	

11.Typical SLD's

(A) Typical SLD of 500KVA CSS::




OUT DOOR TYPE MOTORISED RMU - TYPE CCC NE
21KA,630A,11KV 50HZ SF6 INSULATED
C
C
C
Load Break Switch 630A
Load Break Switch 630A
Load Break Switch 630A
M
M
M
Earth Switch
Earth Switch
Earth Switch
VPIS
VPIS
CBCT
FPI Type CSFPI
CBCT
FPI Type CSFPI
CBCT
FPI Type CSFPI
2Rx3Cx240 Sq.mm Al XLPE cable
2Rx3Cx240 Sq.mm Al XLPE cable
2Rx3Cx240 Sq.mm Al XLPE cable
Incoming Supply
Outgoing Supply
Spare
24V DC POWER PACK
24 V DC-FOR CLOSING/ TRIPPING COIL
24 V DC-FOR SPRING CHARGING MOTOR

12.00.00 DATA SHEET

Sr.No.	Description Unit	Unit	Particulars	To be confirmed by Bidder
1.0	**Rated voltage**	kV	12	
1.1	Designation		1.11kV CSS 2. 11kV RMU	
1.2	Make		As per approved Make list	
1.3	Applicable Standards		As per Tender Specification	
1.4	Type		SF6 Type	
1.5	Power frequency withstand voltage	kV	28	
1.6	Impulse withstand voltage	kV	75	
1.7	Rated frequency	Hz	50	
1.8	Rated current busbars		630	
1.9	Rated current (cable switch)		630	
1.10	Rated current (T-off)		630	
2.0	**Breaking Capacities**			
2.1	Active load	A	630	
2.2	Closed loop (cable switch)	A	630	
2.3	Off load cable charging (cable switch)	A	630	
2.4	earth fault (cable switch)	A	135	
2.5	earth fault cable charging (cable switch)	A	200	
2.6	short circuit breaking current (T-off circuit breaker)	kA	115	
2.7	Rated making capacity	kA	20	
2.8	Rated short time current 3 sec.	kA	52	
3.0	Ambient temperature			
3.1	Maximum value	°C	20	
3.2	Maximum value of 24 hour mean	°C	50	
3.3	Minimum value	°C	35	
3.4	Altitude for erection above sea level4	m	0	
3.5	Relative humidity		1000	
4.0	General data, enclosure and dimensions		Max 95%	

4.1	Type of Ring Main Unit & 11kV RMU		Metal Enclosed, Panel type, Compact Module.	
4.2	Number of phases		3	
4.3	Whether CSS & RMU is type tested		Yes	
4.4	Whether facility is provided with pressure relief		Yes	

4.5	Insulating gas		SF6	
4.6	Nominal operating gas pressure		1.4 bar abs. 20° C	
4.7	Gas leakage rate / annum	%	0.075	
4.8	Expected operating lifetime		30 years	
4.9	Whether facilities are provided for gas monitoring		Yes, temperature Compensated manometer can be delivered	
4.10	Material used in tank construction		Stainless steel sheet,3mm/ metallised cast resin	
5.0	**Operations**			
5.1	Means of switch operation i) 11kV CSS ii) 11kV RMU		i) Separate handleManual operated ii) Motorized	
5.2	Means circuit breaker operation for 11kV CSS		Separate handle and push buttons	
5.3	Rated operating sequence of Circuit Breaker for 11kV CSS		O –3min-CO-3min-CO	
5.4	Total opening time of Circuit Breaker for 11kV CSS		approx. 45ms	
5.5	Closing time of Circuit Breaker for 11kV CSS		approx. 40ms	
5.6	Mechanical operations of switch		1000	
5.7	Mechanical operations of earthing switch		1000	
5.8	Mechanical operations of circuit breaker		2000	

5.9	Principle switch / earth switch		3 position combined Switch /earth switch	
6.0	**Degree of protection:**			
6.1	High Voltage live parts, SF6 /VCB tank		IP 67	
6.2	Front cover mechanism		IP 2X	
6.3	Cable covers		IP 3X	
6.4	Outdoor Enclosure		IP 55	

2.0 DISTRIBUTION TRANSFORMER:

Sr. No.	Description	Unit	Particulars	To be confirmed by Bidder
1	Manufacturer's Name And Country Of Manufacture		Make Shall be same as CSS Make	
2	Applicable Standards		As Per Specifications	
3	Quantity	Nos.	As Per BOQ	
4	Application / Designation		PowerDistribution Oil type /Dry Type	
5	System Voltage - Nominal - Highest	kV kV	11 12	
6	Method of Connection HV Winding /LV Winding		Delta Star	
7	Rated Frequency	Hz	50	
8	Type Of Winding / Material		Two Winding / Copper	
9	3 Phase / Single Phase Unit		3 Ph Unit	
10	Rating Of Each Unit	kVA	500KVA	
11	Voltage Rating	kV/ kV	11 / 0.433	
12	Cooling		ONAN	
13	Percentage Impedance at Principal Tap & Without Negative Tolerance	%	As Per IS 1180:2014 & its latest amendment	
14	Over fluxing Withstand Capability		110% Continuous	
15	Vector Group		Dyn11	

16	Winding Insulation (HV & LV)		Uniformly Insulated, Class H	
17	Short Circuit Current	kA	20kA	
18	Maximum Duration of Fault	Sec.	1 Sec	
19	Insulation Withstand Voltage			
a	1 Min Power Frequency Withstand Voltage (Dry & Wet) - HV (11 KV)/ LV (0.433 KV)	kV	28/ 3	
b	Lightning Impulse Withstand Voltage - HV (11 KV)/ LV (0.433 KV)	KV (Peak)	75/ NA	
20	Temperature Rise (H Factor of Max. 1.3 As Per IEC 60354 To Be Considered)			
a	Maximum Ambient Air	°C	50	
b	Yearly Average Air (Minimum)	°C	32	
c	Average winding temperature rise over maximum yearly weighted average ambient temp of 32°C as per IS	°C	90	
21	Weight			
a	Core coil assembly	Kg		
b	Transformer weight	Kg		
22	Max. flux density			
a	At rated voltage	Wb/sq m	1.6	
b	At 110% rated voltage	Wb/sq m	1.76	
23	Current Density		Bidder To Furnish	
a	HV	A/Cm2		
b	LV	A/Cm2		
24	Noise level		As per NEMA TR -1	
25	Guaranteed Total Losses At 100% Rated Voltage And Frequency (Without Is Positive Tolerance)	kW	As per CBIP	
26	Guaranteed No-Load Current: A. When Excited From LV Side At 100% Rated Voltage B When Excited From LV Side At 110% Rated Voltage	A	Bidder To Furnish	
27	Guaranteed Efficiency i) At 75 °c ii) At Unity P.F iii) At Full Load		Bidder To Furnish	

28	Regulation: At Full Load, 0.8 P.F At 75 °C Winding Temperature	%	Bidder To Furnish	
29	**Core:**			
a	Material of Core Lamination		CRGO	
b	Insulation of Core Lamination		Bidder To Furnish	
c	Core loss in watt: a) Normal voltage b) Maximum voltage	Watt	Bidder To Furnish	
d	Maximum temperature rise of core by thermometer		Bidder To Furnish	
e	Center to center distance of the core	Mm	Bidder To Furnish	
f	Magnetizing (No load) current at a) Normal Voltage		Bidder To Furnish	
	b) Maximum Voltage			
30	Winding			
a	Class of Insulation		Class H	
b	Material		Copper	
c	Maximum temperature rise of Windings by resistance method		Bidder To Furnish	
31	Tapping			
a	Tapping On Winding	HV/LV	HV	
b	Whether Off-Circuit		OCTC	
c	Tapping Range	%	-5% to +5%	
d	Tapping Step	%	2.5%	
32	Parallel Operation		No	
33	Terminal Bushings		HV / LV	
a	Rated Voltage Class –	KV	11/ 0.433	
b	Rated Current Class –	A	Bidder To Specify	
c	Impulse(1.2/ 50 □ Sec. Wave Withstand) –	kVp	75	
d	One Minute Power Frequency Withstand (Dry & Wet)	k V (Rms)	28	
e	Minimum Clearance In Air (Ph- Ph/Ph-Gnd)	mm/ Kv	25	
f	Minimum Creepage Distance (Total)	Mm	Bidder To Furnish	
g	Protected Creepage Distance	Mm	Bidder To Furnish	

h	Voltage Tap For Use With Potential Device	Reqd./ Not Reqd.	Bidder To Furnish	
34	All The Accessories, Protections, Equipments - Compliance With Specification, SLD & Data Sheet Requirements.		Yes/ No	
35	No Of Units To Be Subjected To Acceptance Tests		Each Unit	
36	Total weight of 11kV CSS	Kg	Bidder To Furnish	
37	Dimensions of CSS (LxWxH)	Mm	Bidder To Furnish	
38	Total weight of 11kV RMU	Kg	Bidder To Furnish	
39	Dimensions of RMU (LxWxH)	Mm	Bidder To Furnish	

3.0 TECHNICAL SPECIFICATIONS OF MAXIMUM DEMAND CONTROLLER

Maximum demand controller with accuracy class :0.5 , LCD display soft touch selector switches ,RS 485 with 4 relays ,TOD options,8MB or more storage for data logging with RS485 to USB converter downloading the stored data.

Features:

1)Basic:

Line to Neutral Voltage –VLn Avg, VR-N, VY-N, VB-N.
Line to Line Voltages: VLL avg,V-RY,V-YB,V-BR.
Line current: I Avg, IR,IY,IB.
Neutral current.
Frequency, RPM.
V&I Phase Angle,
High, Low profiles for V,A,W,PF,VA Parameters.

2) Power:

Active power –W Total,,W-R,W-Y,W-B
Apparent power:VA Total,VA-R,VA-Y,VA-B
Reactive power:VAR total,VAR-R,VAR-Y,VAR-B
Power factor:PF Avg,PF-R,PF-Y,PF-B.

3)Energy:

Active energy-Wh
Apparant Energy:Vah
Reactive energy:VArh-Inductive,VARH-capacitive,
Load hours,run hours,No of interuptions,Old Energy.

4)Demand:

NO contacts SPST 2A/240V AC

Raising Demand
Maximum demand
Forecast Demand
Additional load.

5)RTC:Real time clock ,synchronization with EB meter

6)TOD: Time Of day , 6 slots for energy and demand

7) Data Logging: memory card of >=8MB for data logging to be available in meter to facilitate download the data from meter to Laptop

8)PTR & CTR : Primary& Secondary programmable.

9)Aux supply:80 to 300V AC/DC

10) Size: 96X96 mm flush mount type.

13. Documentation

INSPECTION & TESTS

All equipment shall be completely assembled, wired, adjusted and tested at the factory as per the relevant IS/IEC standards. The following tests shall however be carried out as a minimum. All the tests being conducted shall clearly be brought out in the Quality Assurance Plan (QAP) by Bidder. The category of test i.e whether it is a routine test or type test or both, must also be brought out clearly in the QAP with specific mention of relevant standard Number against each test.

a)	BOM verification	100 % Witness
b)	Dimensional check , Painting thickness , finish quality & workman ship	100 % Witness
c)	One Set of Manufacturer's Test certificates for major bought out equipment shall be made available during inspection	100 % Review
d)	All Routine & acceptance tests in including Load test for 11kV CSS & RMU set as per relevant standards shall be conducted.	100 % Witness
e)	All type tests shall be as per the relevant IS/IEC standard .	100 % Review

13.1 Test certificates for the type tests (as per Latest & relevant standards) of not older than 5years (as on date of enquiry) issued by any recognized laboratory for the similar rating 11kV CSS & 11kV RMU set shall be furnished for BHEL's review along with Technical data sheets. If Type test certificates are not available same shall be conducted by vendor at his own cost in any recognized laboratory.

Units shall be type tested in accordance with the IEC standards. Following type test certificates shall be provided

- Short time and peak withstand current test
- Temperature rise test
- Dielectric test
- Test of apparatus (CB & ES)
- Arc fault test

- Measurement of resistance of main ckt.
- Mechanical endurance test
- Duty cycle test.
- Internal arc test for HT chamber
- Degree of protection.

13.2 Type reports of Transformer and LT switchgear shall furnished as per relevant IEC/IS standards.

13.3 Shop Tests

13.4 All equipment and material shall be subjected to manufacturer's standard shop tests. Tests shall be carried out at the manufacturer's works during and after completion of manufacture of different component parts in accordance with the requirements of relevant codes, and wherever not specified in the said codes/regulations, the tests shall be carried out in accordance with the standards approved by the Purchaser.

14.0 DRAWINGS, DATA AND MANUALS

14.1 To be submitted with the Offer

Sl. No.	Documents to be submitted with the Offer
i.	Electrical single line diagram showing ratings of all equipment
ii.	Layout drawings showing arrangement of the PSS
iii.	Type test certificates on similar equipment

14.2 To be submitted for Approval and Distribution

Sl.no	Document to be submitted for Approval	Approval/ Information
i.	Electrical single line diagram showing rating of all equipment.	Approval
ii.	GA / OGA Drawing and BOM of PSS	Approval
iii	Data Sheets of PSS,HT breaker, Transformer & LT breakers	Approval
iv	Foundation Plan & Loading Details of PSS	Information
v	PSS area Layout and Cross Section considering acoustic enclosure, exhaust piping, cable trenches, cable trays, fuel trenches etc.	Approval
vi	Any other relevant drawings, documents or data necessary for satisfactory installation, operation and maintenance	Information
vii	Type test certificates	Information
viii	O&M, Storage & Erection instruction manual	Information
ix	As built & Commissioned / final document	Information

Note: i)The manuals shall clearly indicate method of installation, check-ups and tests to be carried out before commissioning of the equipment.

ii)The Vendor may note that the drawings, data and manuals listed herein are minimum requirements only.

iii)The Vendor shall ensure that all other necessary write-ups, curves, calculations and information required to fully describe the equipment offered are submitted with his bid.

15.00.00 Make of components:

S.NO.	ITEM	RECOMMENDED ELECTRICAL VENDOR
1	H.T Breaker	Siemens/Schnieder/ABB/L&T/Cromton/Alstom
2	Dry Type Transformer	Same as 11kV RMU
3	LT Breaker	L&T/GEC/Siemens/Schnieder
4	Auxiliary Relays	ABB, Jyoti, Areva
5	Bi-metal Relays	ABB, BCH Electric, C&S Electric, Larsen & Toubro Ltd., SchneiderElectric, Siemens, GE
6	Contactors	ABB, BCH Electric, C&S Electric, GE India, Larsen & Toubro, SchneiderElectric, Siemens
7	Control switches(Breaker)	Areva T&D India Ltd, Reliable Electronic Components, Switron Devices, Alstom, Kaycee
8	Control switches/Selector switches	Areva T&D, Hotline Switchgear & Controls, Kaycee Industries Ltd.,Larsen & Toubro, Reliable Electronic Components Pvt. Ltd., SiemensLimited, Switron Devices.
9	Earth Leakage Circuit Breaker	Datar Switchgear, Indo Asian Fusegear , Legrand, Havell's, ABB,Siemens, Schneider
10	Fuses	GE India Industrial, Indo Asian Fusegear., Larsen & Toubro, Siemens,Cooper Bussman
11	Heavy duty switches	C&S Electric, Indo Asian Fusegear, Larsen & Toubro, Siemens
12	MCBs	Datar Switchgear, Havell's, Indiana Current Control, Indo Asian Fusegear, Legrand , Standard Electricals, Schneider, ABB, Siemens
13	MCCBs	GE India, Siemens, Larsen & Toubro, Schneider Electric
14	Meters	Automatic Electric, MECO Instruments, Nippen Electrical InstrumentsCo., Rishabh Instruments.

15	Protection Relays (Conventional & Numerical)	ABB, Areva, Easun Reyrolle, Larsen & Toubro (P&B), Schneider Electric , Siemens, Schweitzer Engg.
16	Push buttons & Indicating lamps	BCH Electric, C& S Electric, Hotline Switchgear & Controls, Larsen &Toubro, Precifine Products, Schneider Electric India, Shri Tulsi Switchgears., Siemens, Teknic Controls, Essen Deinki
17	Fuse-switch combination	ABB, C&S Electric, Havell's, Indo Asian Fusegear, Larsen & Toubro, Schneider Electric India, Siemens, Standard Electricals, GE
18	Timers	BCH Electric., Electronic Automation Pvt. Ltd., Larsen & Toubro Ltd.,Siemens Limited
19	CT & PTs (MV)	Gilbert & Maxwell Electricals Kalpa Electrikal., Kappa Electricals,Narayan Powertech, Pragati Electricals Precise Electricals, Silkaans Electricals.

NOTES:

1. Vendor shall strictly follow the list of makes for equipment's as specified above.
2. For components other than the above, vendor shall submit past track record for the proposed sub-vendors and obtain written approval from BHEL before placing order.

16.00.00 PRICE FORMAT

Project : Enquiry no :

Sl. No	Description	Unit Price	Qty	Total Value	Quoted Yes/No	Remarks
1	500kVA Packaged Substation /Compact Substation package as described in specification		1 Set			
2	11KV,630A RMU along with FRTU		1 Set			
3	Lump sum Price for supervision of installation, testing & commissioning of CSS & RMU including FRTU for each visit (**each Set visit constitutes of 5Mandays @ field**)		2 Set			Refer Note-2 1Set=1Vist
4.	Commissioning spares & Tools and Tackles as per Cl.9		1 Set			

Notes:-

1. The evaluation shall be done considering Sl. No 1, 2, 3 & 4 above.
2. Lump sum prices for each visit for Supervision of Installation, testing & commissioning of Equipment at site shall include Travel expenses, Incidental charges, Man-day charges and any other charges if applicable.
3. Vendor shall submit the prices in the above format only. No other format is acceptable. Vendor shall submit above format duly signed & indicating each item as quoted or not quoted (without prices) along with technical offer.

When the no. of Visits mentioned above exceeds unit prices quoted above will be applicable

ANNEXURE-1

DEVIATION SCHEDULE

ENQUIRY No. _____ NAME OF BIDDER _____

ITEM _____ OFFER REF NUMBER _____

Sl.No.	Clause.no. & Spec.no	Description as per specification	Deviation taken	Nature of Deviation	Remarks

NOTES

1. Technical offer of the bidder will be evaluated only on the basis of Deviation Schedule. Deviation Schedule constitutes this sheet (with these Notes) duly signed and stamped.
2. Deviations, if any, shall be clearly brought out only in this format. Deviations mentioned / taken elsewhere or in any other format will be ignored.
3. Additional sheets in the same format can be attached by the vendor, if necessary.
4. Nature of Deviations shall only be of Design / Manufacturing constraints and non-availability of items / components / makes in market.
5. No price implications shall be entertained for deviations withdrawn during the technical scrutiny. If any deviations are accepted by BHEL during technical scrutiny, then also there will be no price implication. Hence, in no case there will be consideration of Price implications.
6. Reasons for the deviations shall be specified in the Remarks column.
7. If there are no deviations from the specifications, bidder still has to submit the Deviation Schedule by writing “NO Deviations” in this format.
8. If the “Deviation Schedule” is not submitted along with the offer, the bidder’s offer is likely to be rejected without any further interaction with the bidder.
9. Only the accepted deviations in conjunction with the original tender shall constitute the contract document for the award of job to the bidder.

SIGNATURE OF BIDDER _____

NAME _____

DESIGNATION _____

DATE _____

Company Seal

ANNEXURE-2

PACKAGE EXECUTION MILESTONES/SCHEDULE:

Sl. No.	Event	Schedule	
		For GA & Layouts	For Scheme Drawings , BOM,SLD
1	Drawings submission	Within 1 week from P.O. date	Within 1 week from P.O. date
2	BHEL Comments (along with Final/Firm inputs and revisions)	Within 1 week from receipt of the "Drawings in line with Inputs" (Note-2)	Within 1 week from receipt of the "Drawings in line with Inputs" (Note-2)
3	Revised Drawings submission	Within 1 week from BHEL's comments date	Within 1 week from BHEL's comments date
4	BHEL Comments / Approval for Manufacture Clearance	Within 1 week from receipt of the revised Drawings	Within 1 week from receipt of the revised Drawings
5	Revised Drawings submission	Within 1 week from BHEL's comments / Manufacture Clearance date	Within 1 week from BHEL's comments / Manufacture Clearance date
6	BHEL Approval on Revised Drawings	Within 1 week from receipt of the revised Drawings	Within 1 week from receipt of the revised Drawings
7	As-Manufactured Drawings + Commissioning Manuals	Note-3	

Notes:

1. Kick off Meeting will be held after order placement at BHEL-Visakhapatnam. It is Vendor's responsibility to call and fix up date for the meeting. It is intended to provide revised inputs (if any) and clarifications on the inputs during the Kick off meeting. It is vendor's responsibility to collect the above within 2 weeks from P.O. / L.O.I. beyond which delays will be to the vendor's account.
2. It is Vendor's responsibility to submit the Drawings in line with the latest inputs else the drawings will be rejected. Delays on account of this will be attributed to the Vendor.
3. Six sets of all As-Manufactured drawings and Commissioning Manuals shall be dispatched along with the first consignment.
4. The total delivery time from P.O. date is 10 weeks progressively. For package execution schedule and accounting of delays, the schedule for GA & SLD drawings shall be taken as reference.

TECHNICAL SPECIFICATION OF 500KVA COMPACT SUBSTATION &RMU

Ref no: WE-29082020-01

ANNEXURE-3

CHECK LIST FOR 11kV CSS & RMU.

TO BE FILLED BY BIDDER AND SUBMITTED ALONG WITH TECHNICAL OFFER)

Sl. No.	Check point description	Supplier Confirmation
1.	Completely filled-in Technical Datasheet of CSS(Cl.12) as per specification enclosed.	YES/NO
2.	Duly signed Deviation Schedule(Technical) enclosed	YES/NO
3.	Relevant Type Test Certificates enclosed	YES/NO
4.	Unpriced Schedule enclosed as per BHEL specification complying to following: 1. Signed & Stamped 2. In BHEL format. 3. All items are quoted	YES/NO
5.	Clause wise confirmation to BHEL specification included in technical offer except the deviations listed in deviation schedule.	YES/NO
6.	Bidder Credentials attached	YES/NO

Along with the offer, bidder to furnish **this checklist** duly filled and signed. No deviation is acceptable in this regard. Without duly signed & stamped checklist offer shall not be considered for evaluation.

BIDDER'S STAMP & SIGNATURE

Annexure-4

QAP GUIDELINES

The QAP guidelines shall be used by vendor for preparation and submission of QAP after order placement.

1. QAP shall be made in landscape mode on A4 size paper as per the format enclosed. Font size shall be minimum 10.
2. Each page of QAP shall contain the following information.
   a) Vendor's name & address.
   b) Customer: BHEL, Hyderabad.
   c) Project.
   d) BHEL Product Standard Number/revision number as referred in P.O.
   e) BHEL Purchase Order Number & Date.
   f) Product as per P.O. description.
   g) QAP Number (unique and shall not repeat)/revision number/date.
   h) Page number and number of pages
3. QAP shall contain four parts / stages as follows.
   a) Raw materials and bought out items.
   b) In process Control / Inspection.
   c) Final assembly, Inspection & Testing.
   d) Painting, preservation & packing.
4. Under 'Component', indicate name of the component (say casing, rotor, pressure gauge, etc).
5. Under 'Characteristics', indicate appropriately (say chemical analysis, mechanical properties, NDT (UT,DP etc.), hydrostatic test, calibration check etc.)
6. Under 'Class', indicate minor, major or critical depending on the importance of characteristic.
7. Under 'Type of check', indicate appropriately (say chemical, mechanical, UT, DP etc.)
8. Under 'Quantum of check', indicate appropriately (say 100%, 10%, sample, per melt, per heat, all pieces etc.)
9. Under 'Reference document' and 'Acceptance norms', appropriate National & International standards, BHEL standards, approved drawing references etc. should be indicated. It is not correct to mention as "Vendor's internal standards or Vendor's standard practice etc.". If vendors' internal standards are referred, same shall be in line with BHEL Spec. indicated in the P.O. These may require review & approval by our Engineering dept.
10. Under 'Format of record', indicate appropriately supplier's test certificate, calibration certificate, lab report, inspection report etc.
11. Please refer 'Agency' in QAP format.
    Under P: Perform, W: Witness, V: Verify