

DEVELOPMENT OF PERMANENT CAMPUS (PHASE-I) FOR NALANDA UNIVERSITY

PACKAGE- 3B

TENDER FOR BIO GAS BASED CO-GENERATION ENGINE AND BIOMETHANATION PLANT FOR OUTREACH BUILDING AT PROPOSED PERMANENT CAMPUS (PHASE I)

OF

NALANDA UNIVERSITY, AT RAJGIR, BIHAR.



TECHNICAL SPECIFICATIONS

NALANDA UNIVERSITY, RAJGIR, BIHAR.

Every care has been taken while preparing this document to cover all necessary information, matters, specifications, general conditions, special conditions & provisions for smooth and complete execution of works. However, in case of any omission in the tender/ contract document, the most recent version of correction slips (as on 31st January 2018) of Electrical Specifications for CPWD Works shall be the reference manual.

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1.0 AMBIENT CONDITION FOR DESIGN OF THIS PACKAGE

All the components in the package shall be designed considering the ambient condition of the site as follows.

- a. Ambient temperature : 50 degree Celsius
- b. Lowest Ambient Temperature for heating requirement; 5 Degree Celsius
- c. Relative humidity (avg.) : 60
- d. Isokeraunic level : 33
- e. Seismic Zone : Zone-4
- f. Climate type : hot and humid
- g. The system, Biogas Plant & CHP should run with 100% efficiency in the ambient condition of Nalanda/site.

All the components which comes under the design scope of the contractor shall be designed considering the above conditions. The Vetting of the system design including detailed design of all the components shall be done before commencement of work by the contractor.

2.0 CHP WITH SYNCHRONIZING PANEL

A. GENERAL:

- a. This general specification defines the minimum requirements the design, supply, installation, testing and commissioning of CHP engines for educational institute purposes. The rating of Engine is majorly as per the site requirement, however, the supplier may offer higher rating of the CHP Engine and there will be no price advantage.
- b. The construction, design and rating of the CHP engine shall meet fully, the requirements of the specified driven machine and the Vendor shall select and provide the requisite ancillaries and controls with the gas engine for its safe and satisfactory operation.
- c. No deviations or exceptions from this specification shall be permitted without the written approval of the purchaser. Intended deviations supported by reasons, there of shall be separately listed by the vendor and submitted with the bid for the consideration of the Purchaser.
- d. Compliance with this specification shall not relieve the vendor of the responsibility of furnishing equipment and accessories of proper design, materials and workmanship to meet the specified operating conditions.
- e. This general specification supplements the specific requirements contained in the attached equipment data sheets. In the event of any contradiction between the two, more stringent shall govern.
- f. Other attachments of the Material Requisition from an apart of this specification.
- g. The CHP operation in Island mode as well as in synchronization with grid power is considered in this offer. Facility for synchronization i.e. parallel operation of CHP supply with grid supply shall be provided / available. CHP shall be suitable for running in synchronization with grid supply. Voltage signal before and after grid circuit breaker. Grid circuit breaker shall have shunt trip coil, under voltage coil / release (and not operated through under voltage relay), closing coil, service / test position, over load short circuit protection, potential free contact for breaker on / off position etc. Grid monitoring relay and check / auto synchronizing relay is covered under contractor's scope of supply. The synchronization panel should be capable to sync with 4 input supply. The contractor shall design the logic accordingly. The panel shall be provided with breakers of requisite rating.
- h. **Terms and definitions:**
 - The Net Calorific value of bio-gas is defined as the heat resulting from the complete combustion of a unit quantity of bio-gas. A net calorific value of 5000 Kcal/m³ (to be confirmed at site) shall be considered while declaring the bio-gas consumption and for testing purposes.

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- required

Component	% Volume
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Methane Approx. CHP should run with 100% efficiency on 40 % to 65% of methane content in biogas

Carbon Dioxide Approx.	40% to 45%
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Hydrogen Sulphide	Less than 1%
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Bio-gas gas availability	On continuous basis
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- The unit of horse power as defined in this specification is the metric horse power equivalent to 4,500 n-Kg/Min. The horse power in F.P.S. system is equal to 1.014 metric horse power.
- Other terms used in this specification or in the equipment data sheets are as defined in the latest edition of British Standard-5514.
- Generating electrical output of 330 kW, at 415 V, unity power factor, 50 Hz, and at the **Alternator** terminals. Electric efficiency should be greater than 38% at 100% load.

B. Technical parameters

All data in the technical specification are based on engine full load (unless stated otherwise) at specified temperatures and the methane number and subject to technical development and modifications. All pressure indications are to be measured and read with pressure gauges (psi.g.).

- a. **Mechanical output** is at nominal speed and standard reference conditions ICFN according to DIN-ISO 3046 and DIN 6271, respectively
- b. **Power output given above is** According to DIN-ISO 3046 and DIN 6271, respectively, with a tolerance of +5 %. Efficiency performance is based on a new unit (immediately upon commissioning). Reference Methane percentage of 65% in the Fuel gas.
- c. **Lube oil consumption value to be** average value between oil change intervals according to maintenance schedule, without oil change amount
- d. **Electrical output mentioned above is** at p. f. = 1.0 according to VDE 0530 REM / IEC 34.1 with relative tolerances
- e. Total output with a tolerance of ±5 %.
- f. Exhaust gas temperature with a tolerance of ±2 %.
- g. Ambient Condition: The requirement is indicated above, however the below mentioned is as per running practise

Season	Dry Bulb Temp	Wet Bulb Temp	Relative Humidity
Summer	112.3 °F (44.6 °C)	73.9 °F (23.3 °C)	15.8 %
Monsoon	92.1 °F (33.4 °C)	84.5 °F (29.2 °C)	73.4 %
Winter	40.9 °F (5.0 °C)	39.9 °F (4.4 °C)	92.1 %

h. Intercooler heat on:

- Standard conditions (V_{xx}) - If the turbocharger design is done for air intake temperature > 30°C w/o de-rating, the intercooler heat of the 1st stage need to be increased by 2%/°C starting from 25°C. Deviations between 25 – 30°C will be covered with the standard tolerance.

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- Hot Country application (Vxxx) - If the turbocharger design is done for air intake temperature > 40°C w/o de-rating, the intercooler heat of the 1st stage need to be increased by 2%/°C starting from 35°C. Deviations between 35 – 40°C will be covered with the standard tolerance.

- **Definition of output**

ISO-ICFN continuous rated power:

Net break power that the engine manufacturer declares an engine is capable of delivering continuously, at stated speed, between the normal maintenance intervals and overhauls as required by the manufacturer. Power determined under the operating conditions of the manufacturer's test bench and adjusted to the standard reference conditions.

Performance gas Standard reference conditions:

- a. Barometric pressure: 1000 mbar (14.5 psi) or 100 m (328 ft) above sea level
- b. Air temperature: 25°C (77°F) or 298 K
- c. Relative humidity: 30 %
- d. Volume values at standard conditions (bio-gas gas, combustion air, exhaust gas)
- e. Pressure: 1013 mbar (14.7 psi)
- f. Temperature: 0°C (32°F) or 273 K

C. Performance Guarantee:

a. Performance Guarantee:

Biogas based Genset have been designed for operating performance parameters specified herein. The details as per NIT terms and condition and fulfilment of this TS.

b. Performance guarantee figures:

Specific Fuel Consumption (SFC) : **To calculate with NCV 5000 kCal/m³**

Power Output : 330 kW electrical

Hot water Output : 90 Deg C (Supply Water) & 85 deg C (return water), zero loss

Closed loop jacket water to be supplied in both water circuit, there would be zero water loss in closed loop circuit

The above performance is based on following parameters

- Power output at 100% steady load, 415V, p f 1.0 and 50 Hz.
 - The above SFC is subject to tolerance of +5% According to DIN-ISO 3046 and DIN 6271. Reference Methane percentage of 65% in the Fuel gas.
 - Subject to Technical Parameters of this offer.
 - Tolerance of gas flow meter not considered.
- c. Performance trial of Genset will be conducted for 4 hours for electrical power output on 100% steady load and SFC shall be established based on the average of 4 readings taken at an interval of 15 minutes every hour during trial.

D. RATED POWER OUTPUT AND SPEED:

- a. The gas engine rating shall be the net output in **Kilowatt**, which the engine is capable of delivering continuously at the stated crank shaft speed under the conditions specified, provided the engine is maintained in good operating condition and is service/ overhauled regularly as per the schedules laid down by the Manufacturer.
- b. No negative tolerance shall be allowed on the gas engine rating specified by the Vendor in the equipment data sheets.

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- c. The gas gensets shall not be overloaded more than 100%, since gas gensets are meant for base load operation and cannot be overloaded. The CHP will have automatic over load protective unit. Here over load means –load more than 100%
- d. The normal power requirement of the engine driven radiator fan or the coolant pump and the battery charging dynamo shall be clearly stated for the engine which is so equipped.
- e. Unless otherwise specified in the equipment data sheets, the site rating of the engine shall be worked out considering the duration's specified under the latest edition of B.S.-5514 and the power absorbed by all the engine driven ancillaries shall also be deducted.

E. Design & Construction:

a. General:

- The Gas engine offered shall be of the regular production models of the manufacturer for industrial applications and already type tested either at the manufacturer's works or outside. The type test report shall be furnished to the purchaser for his review if so desired.
- Unless otherwise specified in the equipment data sheets, the gas engine shall be provided with class A2 governing as per the latest edition of B.S. 5514.
- The "Cyclic irregularity" of the gas engine for direct coupling to an electric CHP, "angular deviation of p73 A.C. CHPs" driven by gas engine for parallel operation, and the "engine governor speed droop characteristics", shall be restricted to the values specified under the latest edition of B.S.-5514.
- The vendor shall be responsible for carrying out torsion analysis of the dynamic system as specified in the latest edition of British Standard-5514. The results in the form of a report shall be submitted to the purchaser for scrutiny and reference, if desired.
- Vendor shall provide the flexible exhaust connection /s to connect the engine exhaust to the exhaust piping. The required size of the exhaust piping should be clearly specified by the Vendor.
- If specified, the common base plate for mounting the gas engine and the driven equipment as well as the flexible coupling, shall be supplied by the vendor.
- Vendor shall indicate in the bid, the ISO Noise Level rating i.e. 83 dB at 3-meter distance **from the surface of Acoustic Enclosure**, of the gas engine with the offered exhaust silencer/s.

b. Engine starting:

- Gas engines shall be capable of starting without the use of cold starting aids so long the ambient temperature at the site is not below 4°C. The vendor shall provide suitable cold starting aids with gas engine for quick starting below 4°C of ambient and such aids shall be clearly detailed out along with the offer.
- The battery charger if specified in the equipment data sheet, shall be capable of delivering a current equal to 100 percent of the 20-hour discharge rate of the battery and also equipped with charging rate selector device.
- Where the gas engine is specified / offered with compressed air starting, the Vendor shall also provide the air compressor driven by a gas engine / electric motor and equipped with necessary instruments and controls as specified in the equipment data sheets.
- The air receiver supplied by the vendor shall provide batteries and battery charging equipment for operating the electrical controls of the gas engine.
- If as specified in the data sheets, the gas engine is required to start / stop automatically, the vendor shall provide the necessary controls (automatic-cum-manual) in the engine panel and the interconnecting wiring and piping from the panel to the engine and starting equipment. A pilot lamp shall be provided in the line side of the starting equipment circuit to indicate that the controller is in the automatic position. In the event the engine does not start after three attempts have been made, the controller shall stop all further cranking and operate the audio-visual alarm. A D.C. motor driven per lubrication pump with timer suitably interlocked with the starting system shall be provided by the vendor. Whenever the unit is arranging for automatic shutdown, a running period time set for a specific

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time interval, shall be provided.

c. **Engine cooling:**

- Where the engine cooling is achieved by closed circuit cooling water system, the vendor shall provide the complete jacket water (primary water) circuit, heat exchanger circuit including but not limited to the following:
- Raw water pump with driver, unless the raw water is required to be obtained from the discharge of the pump driven by the gas engine.
- Instruments and controls as specified in the equipment data sheets.

d. **Engine bio-gas system:**

- A bio-gas float (surge) tank if recommended by the manufacturer, shall be supplied with the gas engine along with its interconnecting piping / hoses.
- **Biogas holder of suitable retention time shall be provided.**

F. **Inspection & testing:**

- a. The inspector representing Purchaser shall have entry to the plant while and wherever work for the equipment is being performed. The University representative must be called in advance for witnessing the testing of the machine/CHP
- b. The vendor shall have the responsibility of providing purchaser's inspector with all requisite facilities / equipment for carrying out satisfactory testing.
- c. The routine load and bio-gas consumption test shall be of the following duration:
- d. The hydrostatic test certificates for the heat exchanger / intercooler, bio-gas tanks and other pressure vessels shall be furnished to the purchaser's inspector for his review and approval at the time of load testing of the gas engine.
- e. The engine control panel/s after assembly and wiring, shall be functionally tested in the presence of the purchaser's inspector.

G. **Preparation for shipment:**

- a. Immediately upon completion of all tests and inspections, all exposed machined surfaces shall be cleaned and coated with a suitable rust preventive by the vendor and the un-machined surface shall be painted by at least two coats of red oxide primer.
- b. Gas engines shall be transported assembled as far as possible.
- c. All untapped opening shall be provided with 4mm thick metal closures with full rubber gaskets and bolted by not less than 4 bolts. All connections including those for instruments, instrument leads, lubricating oil and the like shall be identified with securely attached tags indicating the type of connection, the instrument or the line description as applicable.
- d. The equipment shall be crated for domestic / export shipment as specified in the data sheets considering for storage at job site for at least 6 months. Lifting load-out, and handling instructions shall be securely attached to the exterior of the largest packing in a well-marked weather proof container. Upright position lifting points, weight (including packing and dimensions shall be clearly identified with item no., serial no., package no., and the names of the equipment.)

H. **Proposal:**

- a. The proposals must include either a specified statement that all equipment is in accordance with the purchaser's specifications or exceptions, if any, to this general specification including attachments shall be clearly brought out by the vendor on separate sheets, supported with suitable reasons thereof for the consideration of the purchaser.
- b. Additions or exclusions from the scope of supply shall be clearly brought out on separate sheets giving reasons

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for such deviations for the purchaser's approval.

- c. Rating (HP) curves for the gas engine for different duties and their interpretation as per the applicable standard, shall accompany the proposal.
- d. The drawings and data as listed under "prints with Quote" on the vendor data requirement sheet attached with this specification, shall be provided.

I. Synchronisation panel

The Synchronising Panel as a System shall be provided with Synchronizing Relay & all required accessories including digital meters etc which shall facilitate Synchronizing of Power between Local Source & the Power Grid at 415V level initially (and it will be synchronised with 11KV network on later for which contractor has to support and modify accordingly) . This panel is to control the motorised electrical switchgears in the separately provided electrical panels as per requirement of synchronizing for the system. This Panel shall be completely SCADA compatible and shall be Automatic control module, microprocessor based and fully programmable with event logging and communications. Minimum Features shall as follows

Controls:

- Start
- Stop/reset
- Auto
- Manual

Monitoring & Display:

- Voltage
- Amperage
- Frequency
- kW
- kVA
- Power factor

Functions and protections:

- Reverse power
- Dead bus sensing
- Voltage matching
- Frequency matching
- Phase angle matching
- Ramp control
- Blend control
- Circuit breaker closing contact
- Engine speed control

The synchronization panel should be capable to sync with 4 input supply. The contractor shall design the logic accordingly. The panel shall be provided with breakers of requisite rating.

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Indicative Control Logic

CONTROL LOGIC OF REQUIREMENT OF ORC & ORCE BLOCKS POWER SUPPLY WITH DG SET TEMPORARILY

Sr. No	Case	Criteria			Description	Status of Various Breakers												Remarks if any
		Availability of Grid Power via TR	Requirement of Load	Availability/ Accessibility to Temp Back up Power via DG		MLTP-01 (After TR)							Synch Panel (After DG)					
						B1	B2	B3	B4	B5	B6	B7	B8	B9	B10	B11	B12	
1	1	Yes	100%	Yes	Default System	C	O	C	O	O	C	C	O	O	O	C	C	Both TR will run on 50% of the required load independently
2	2	Yes	Less than 50% for a longer days span	Yes	Manual Function Availability	C	O	O	O	C	C	C	O	O	O	C	C	Only one TR will run on required load and Bus will be common here
3	3	No	100%	Yes	NO Grid Power due to power cutoff, system under maintenance, fault from Grid Side, Etc	O	C	O	C	O	C	C	C	C	C	O	C	Both DGSet will run as per requirement independently
4	4	No	Less than 50%	Yes	NO Grid Power due to power cutoff, system under maintenance, fault from Grid Side, etc + Lower demand due to less occupancy/ comfortable weather	O	C	O	C	O	C	C	C	O	C	C	C	Any one DG set will run as per requirement and Bus will be common here (this is possible in automatic mode only if load sharing relay are made available with temporary DG sets & master slave logics are possible- Otherwise this case will run same as Case 3 above
5	5	No	100% or Less than that	Yes	NO Grid Power due to power cutoff, system under maintenance, fault from Grid Side, etc + One DG under maintenance/ not working etc.	O	C	O	C	O	C	C	C	O	C	C	C	Any one DG set will run at maximum possible rating & Bus will be common here (this is possible in automatic mode only if load sharing relay are made available with temporary DG sets & Master slave Logics as possible
Note:																		
1 Above details is not showing detail/ intermediate changeover scenario as the same needs to be understood and provided by the panel builder based on above.																		
2. DG set with demand load relay (Load Sharing) To be provided																		
3 All the Breakers shall be motorised breakers and provided on SCADA																		

J. Scope:

- a. This specification defines the requirements of design, manufacture, testing and supply of **self-excited CHP** complete with accessories as specified in the material requisition.
 - CHP shall be supplied with **Brush less excitation system complete with AVR.**
 - **Housing of CHP, Common base frame, anti-vibrating isolators, flexible coupling for engine/alternator & painting as per manufactures standard.**
 - **Starting System like starting battery & battery charger.**
 - Automatic voltage regulator, , CHP breaker.
 - Bio-gas storage system (**Gas holders**) & flexible gas pipe.
 - Electric panel including control cubicle and associated auxiliary devices, relay panel and CHP breaker battery and charger (unless otherwise specified).
 - **Jacketing for hot water generation at 90°C via heat transfer at exhaust line & engine jacketing. Zero loss in hot water**

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- Lifting arrangement for the machine.
- **Foundation frame complete with foundation bolts and base frame.**
- Lube oil system integral with clean oil tank with level gauge, pump to transfer clean oil, waste oil tank with pump & associated valves & fittings as per standard layout.
- All control valves & accessories should be BMS compatible.
- Exhaust Silencer, Exhaust piping from CHP to stack / chimney via silencer, Support structure for the piping, Condensate drainage at silencer and system low points, structurally supported 30.5 m high exhaust gas Stack / Chimney with Aviation Light and Lightning arrestor arrangement. Chimney/ Stack shall be with Hot Dip Galvanized MS pipe and with Acoustic Layer to provide sound insulation.
- Spares for commissioning.
- The specification of items falling under the common subhead with other services, CPWD specification shall supersede. Vendor to take the written approval from Client/ consultant before actual procurement
- Scope of cables including laying and terminations from output of CHP engine up to Sync. Panel. Synchronisation Panels as required shall be supplied by the CHP Vendor.
- Spares for two years of operation and maintenance.
- Any other part / accessories not specifically mentioned above but considered necessary for safe and reliable operation.
- Test Certificates government approved and NABL certified labs.
- All the required input/ output for BMS connectivity shall be provided by the tenderer.
- Documents containing description, operation manual, maintenance manual, Spare part catalogue with drawings.

K. Technical data of Alternator

Type rating kVA	:	476
Driving power kW	:	342
Ratings at p.f. = 1,0 kW	:	330
Ratings at p.f. = 0.8 kW	:	327
Rated output at p.f. = 0.8 kVA	:	408
Rated reactive power at p.f. = 0.8 kVar	:	245
Rated current at p.f. = 0.8 A	:	568
Frequency Hz	:	50
Voltage V	:	415
Speed rpm	:	1,500
Permissible over speed rpm	:	1,800
Power factor (lagging - leading)	:	0,8 - 1,0
Efficiency at p.f. = 1,0	:	96.40%
Efficiency at p.f. = 0.8	:	95.50%
Moment of inertia kgm ²	:	8.7
Ik'' Initial symmetrical short-circuit current kA	:	8.03
Is Peak current kA	:	20.43
Insulation class	:	H
Maximum ambient temperature °C	:	45
Reactance and time constants (saturated) at rated output	:	1.79

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xd' direct axis transient reactance p.u	:	0.1
xd'' direct axis sub transient reactance p.u.	:	0.07
x2 negative sequence reactance p.u.	:	0.1
Td'' sub transient reactance time constant ms	:	12
Ta Time constant direct-current ms	:	19
Tdo' open circuit field time constants	:	2.5
The SFC is subject to tolerance of +5% According to DIN-ISO 3046 and DIN 6271. Reference Methane percentage of 65% in the Bio-gas gas.		

L. Codes and Standards:

Unless they are in variance with the clause of this specification the gas engine driven CHP and their components shall comply with the latest edition of the applicable standards listed below / **other applicable International standards:**

- IS: 22534 Designation for type of construction and mounting arrangement of rotating electrical machines.
- IS: 46914 Degree of protection providing by enclosures of rotating electrical machinery.
- IS: 47284 Terminal marking of rotating electrical machines. IS: 71324 Guide for testing 3 Ph. synn. Machines.
- IS: 54224 Turbine type CHPs.
- IS: 48894 Methods of determination of efficiency of rotating electrical machines. IS: 12714 Insulating materials for Electric machinery and apparatus in relation to their thermal stability service, classification of
- IS: 47224 Specification for rotating electrical machines. IS: 25164 A.C. Circuit breakers.
- Other codes shall be: AS2789, BS4999, BS5000, DIN6271, EGSA101P, IEC34/1, IS4722, ISO3046/1, ISO8528, NEMAMG1-22, SAEJ1349.

M. Performance Requirements:

a. Operative Conditions:

CHPs shall be suitable for operating satisfactorily in humid and corrosive atmosphere found in pump house. Service conditions shall be as specified in the data sheet. The CHP shall operate satisfactorily under sudden load application.

b. Transient Voltage performance

The dip or rise in system voltage load variations is dependent on the leakage voltage drop of the machine which shall be kept to the minimum.

In case of sudden application of full load at rated power factor the voltage drop shall not exceed 15% of the rated voltage. The rated voltage shall be restored within **5 to 8** second depending on the size of the machine.

c. Voltage Regulation

The voltage regulation of the machine shall be within **+/-2 %** of the nominal voltage under following conditions:

- Between no load and nominal load with p.f. of 0.8 lag to unity.
- With the machine cold or warm. At a speed drop of approximately 3% of the nominal speed.

d. Voltage setting range:

The CHP terminal voltage shall be adjustable with a continuously variable potentiometer. The adjustment range shall be +/- 5% of the nominal voltage with a possible extension to +/- 10%.

e. Harmonic Content

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The maximum permissible deviation from the sine wave shall be 5%. The harmonic content of the voltage shall be less than 3% measured between phases off load and up to nominal rating for a power factor of 0.8 lag to unity and with symmetrical distortion free consumers in circuit.

f. Frequency limits

The CHP shall be suitable for continuous operation at rated load for frequency variation of +/- 3% of rated value in addition the vendor shall furnish the short time under-frequency operating limits.

g. Overloads: No overloading

N. Short Circuit Conditions:

The CHP shall be capable of withstanding without damage, a three phase, a line to line, line to earth or two line to earth short circuit for a period of **3 seconds** when operating at rated speed and with an excitation corresponding to 5% over voltage at no load.

O. Parallel operation:

CHP sets shall be suitable **for Island operation and parallel operation with Grid supply** at operating voltage and under load conditions up to rated value. The set shall be provided with Electronic governor system.

P. Excitation support system

Excitation system shall be provided with short circuit support equipment (Series compounding) to maintain three times the rated current for three seconds in case of short circuit to ensure proper fault clearance in outgoing feeders.

Q. Design and construction:

- a. The CHP design shall meet the requirement specified in data sheet and shall be suitable for the site conditions specified therein.
- b. The CHP shall be mounted on a common base frame together with the prime mover unless otherwise agreed. The CHP shall be provided with necessary lifting hooks and two earth terminals for connection to main earth grid.
- c. The **Alternator** winding shall be class "H" insulation with temperature limitation for **class "F"** the windings and overhangs shall be braced to withstand the short circuit forces. For machines rated 1000 KW and above shall have six no. RTDs suitably distributed in stators winding.
- d. The stators windings shall be brought out to **four** insulated terminals in two separate terminal boxes.. The terminal box for the line terminals shall have sufficient space for the termination of cable size specified in data sheet. The neutral box shall in addition to space for neutral earthing cable have sufficient room for current transformers used for protection of CHP. The terminal box for control cables shall contain properly marked terminals for all internal equipment e.g. embedded temperature detectors etc. All terminals shall be stud type. The terminal boxes shall be complete with lugs and double compression cable glands. Current transformers shall be as specified in data sheet.
- e. All parts and accessories shall be suitable to withstand stresses due to over speed / overload / short circuit conditions specified & should be compatible to BMS.
- f. Bearings shall be double shielded and re-lubricated. Grease in the bearing enclosure shall provide additional lubrication to bearing as well as provide sealing against dust and moisture.
- g. The CHP shall be water cooled unless otherwise agreed CHP enclosure shall be as specified in data sheet.
- h. The direction of rotation of the rotor of the machine shall be compatible with that of the prime mover. A clear indication of the direction of rotation shall be given on either end of the machine.
- i. Space heaters shall be installed within the enclosure, location and max. surface temperature of the heaters shall be such that no damage can be caused to any insulation. Heaters shall suitable for operation on a single phase 240V AC supply unless otherwise specified.

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- j. A suitable double pole switch shall be mounted on or adjacent to the stators frame or enclosure for the manual switching off of the heaters.
- k. Field winding shall have **class "H"** insulation with excellent electrical and mechanical properties. The field winding shall be capable of operating at a field voltage of 125% of rated load field voltage for at least one minute starting from stabilized temperatures at rated conditions.
- l. All cabling on the CHP set skid shall be in GI cable trays / conduits. All cables shall be identified close to their termination point. Double compression type cable glands shall be used for cable termination.
- m. The CHP shall be designed to run for 24 hours continuously without any stoppage.
- n. The CHP shall have the exhaust gas confirming to CPCP emission norms for Bio-Gas engines.
- o. A rating plate of corrosion resistant material shall be fixed on the CHP frame and shall give the following information:
 - Manufacturer's name.
 - Serial Number, Type and frame reference
 - Rated output in MVA & MW
 - Rated power factor, frequency and voltage
 - Rated stators current and speed in Rev. / Min.
 - Class of insulation
 - Phase rotation (CW or CCW)
 - Customer's indent no.
 - Year of manufacture
 - Weight rotor and stators in KG.

R. Excitation system:

The CHP shall be provided with brush less type solid state excitation system with automatic voltage regulator. The excitation system shall include the automatic voltage regulator, **Construction shall be as per manufacturer's standard.**

The exciter capacity shall be at least 20% more than the maximum requirement at any time. The exciter winding shall be insulated with class "F" insulation.

Automatic solid-state voltage shall be provided with the following features as a minimum.

- Under frequency protection.
- short circuit protection.
- annual voltage control switch with adjuster.
- Cross current compensation for parallel operation.
- Voltage build up circuitry.
- Stators current limited.
- Field current limited.

The Current and potential transformers required to feed the AVR from the CHP terminal shall be adequately rated.

S. System operation

The CHP set shall normally be in an unattended area. The Control system shall operate in fail safe mode and shall include all controls and protection necessary for the safe operation of the package. The CHP set shall function as

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per one of the following schemes:

- Auto main failure scheme (AMF).
- Manual start in service mode.

T. CHP control panel:

- a. The Local CHP control panel for the CHP set shall comprise of the following unless otherwise specified in the attached data sheet.
 - Automatic Voltage Regulator.
 - Protection and metering equipment's.
 - Indicating instruments.
 - Control gear for CHP set auxiliaries.
- a. Any other accessories require to make the CHP set operational as a package shall be included in scope of supply. If required the CHP control panel shall be split into various functional sections viz. protection, metering and control, regulation etc.
- b. The breaker rating shall be as specified in the drawing. The protective relays in the Gen. Control panel shall act to trip this breaker on fault conditions unless otherwise specified. This breaker also serves the purpose of local isolation.
- c. All motor starters for CHP set auxiliaries shall be DOL type.
- d. Unless otherwise specified, the DC control supply required for relays, controls, closing / tripping of CHP breaker, annunciation circuit and for any other purpose shall be met by a DC system consisting of battery and battery charger of suitable capacity to be supplied by the CHP set manufacturer. **Battery & battery charger shall be as per manufacturer's standard design.**
- e. The panel shall be free standing, metal enclosed, dust and vermin proof type with a hinged door and having a degree of protection IP 54 as per IS:51 as per IS:2147 unless otherwise specified. Power and control equipment shall be segregated inside the panel as far as practicable. The maximum height of the operation handle/switches shall not exceed 1000 mm. and the minimum height not below 300 mm. All hardware shall be corrosion resistant and bolts, nuts and washers shall be made of galvanized zinc passivated of cadmium plated high quality steel. Unless otherwise specified the panel shall be suitable for bottom cable entry. Necessary glands shall be provided with the panel.

All auxiliary devices for control, indication, measurement and alarm such as push buttons control / selector switches, indicating lamps, metering instruments, annunciation's etc. shall be mounted on the front door of the panel. Adequate number of potential free contacts shall be provided in the control panel for any remote control, monitoring of the CHP set.
- f. All switches shall be load - break, heavy duty type. All fuses shall be non-deteriorating HRC cartridge pressure filled, link type. The contactor shall be air-break type having AC-3 duty rating. Thermal overload relays shall be three elements, positive acting, ambient temperature compensated type with adjustable setting range and built in protection feature against single phasing. All indicating instruments shall be moving iron, flush mounting type and of 96 mm x 96 mm square pattern. All control / selector switches shall be rotary back connected type having a cam-operated contact mechanism with knob type handle. "STOP" push buttons shall be stay put type.
- g. Wiring for power, control and signalling circuits shall be done with PVC insulated copper conductors having 660 / 1100 V grade insulation. Minimum size of control wires shall be 2.5 mm "ELEMEX" type terminals shall be acceptable for wires up to 10 mm² size and for conductors larger than 10 mm² bolted type terminals with crimping lugs shall be provided. A minimum of 10% spare terminals shall be provided on each terminal block.
- h. An adequately sized earth bus shall be provided in the panel for connection to the main earth grid. All noncurrent carrying metallic parts of the mounted equipment's shall be earthed. Doors and movable parts shall be earthed using flexible copper connections.

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- i. Engraved nameplates shall be provided for all devices mounted on the front of the panel. Nameplate or polyester adhesive stickers shall be provided for each equipment mounted inside the panel.

U. Painting, Packing and Transport:

- a. All metal surfaces shall be thoroughly cleaned of scale, rust and grease etc. prior to painting. Cleaned surfaces shall be given two coats of primer and prepared for final painting. Final finish shall be free from all sorts of blemishes.
- b. The equipment shall be shipped to site suitably packed to prevent any damage. Each package shall have labels to show purchaser's name, purchase order and equipment no. suitable lifting lugs etc. shall be provided and lifting points shall be clearly marked on the package. Packing shall be suitable for storage at site for a minimum period of 6 months.

V. Tests and Inspection:

- a. The owner or his authorized representative may visit the works during manufacture of equipment to assess the progress of work as well as to ascertain that only quality raw materials are used for the same. He shall be given all assistance to carry out the inspection.
- b. Detailed test procedure along with the facilities available at vendors works shall be furnished along with the bid. Owner's representative shall be given minimum four weeks advance notice for witnessing the final testing. Test certificates including test records and performances curves etc. shall be furnished by the vendor.
- c. Tests Equipment shall be tested to conform to the appropriate standards and the following tests shall be conducted in the presence of purchaser's:
- d. Functional tests, continuity tests and high voltage test on control panel to establish the performance called for in the specification.
- e. Power frequency voltage test on switch gear and mechanical / electrical operational check. Routine tests for alternator as per IS: 4722.
- f. Over speed test (1.2 times the rated speed for 2 minutes)
- g. Wave form test (type test results are acceptable)
- h. Phase sequence test.
- i. Vibration test
- j. Noise level test.
- k. Dimensional and alignment test.
- l. String test.

W. General Requirements

a. Material quality:

All the materials used for the manufacturing of equipment shall conform to the specifications and shall be supported with tests certificates. Materials used shall be of the very best quality of their respective kinds as specified or described, and all materials to be used in and about every part of the work may from time to time be subjected to tests as per requirements viz: chemicals, mechanical, instruments and appliances as the case may be, as directed by CLIENT AND/OR ITS CONSULTANTS at the expenses of the Vendor / Contractor. Samples subjected to any tests, will not be returned or paid for.

b. Rates:

Rate for any one description of work in the schedule of quantities shall include the rates of main components and the associated accessories, consumables, necessary for completing the work and, for these, no separate or specific charge will be accepted.

c. Material Measurement:

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Material shall be measured as described in the BOQ as per established applicable codes / or established industrial practices as deemed right in the opinion of Client / or project consultant.

d. **Supervising:**

The Vendor / Contractor supervisors shall always carry with them the required tool box together with measuring tape and pad to note any and all the instructions given during the visit of client and or project consultants.

e. **Measurements:**

The Vendor / Contractors or their representative shall accompany the CLIENT AND/OR ITS CONSULTANTS or his representative or the clerk-of-works when required to do so and assist in taking the measurements and shall agree to the measurements recorded on the spot.

f. If the Contractors / Vendors fail to accompany the clerk-of-works or any other person that has been duly authorized by the CLIENT AND/OR ITS CONSULTANT to take measurements, they shall be bound by the measurements recorded by the CLIENT AND/OR ITS CONSULTANT or his representatives.

X. **Protection:**

The **Contractors** / Vendors must cover up and protect from damage due to any cause all material. Any sort of insurances required shall be borne by Contractor / Vendor and the Client shall not pay vendor any additional charges on these accounts.

Y. **Materials and Workmanship:**

a. **General:**

All materials brought on the site of works and meant to be used in the same, shall be of the best quality meeting specifications of their respective kinds and shall be subject to the approval of the CLIENT AND/OR ITS CONSULTANT.

b. **Samples:**

Samples of all materials shall be got approved by the CLIENT AND/OR ITS CONSULTANT and shall be deposited with him before the order for the materials is placed with the supplier. The materials brought on the work shall confirm in every respect to the respective approved samples.

c. **Check:**

The Contractors shall check each fresh consignment of materials, as it is brought on to the site of the works, to see that they conform in all respects to the specification and/or the samples approved by the CLIENT AND/OR ITS CONSULTANT.

d. **Testing:**

The CLIENT AND/OR ITS CONSULTANT will have the option to have any of the materials tested to find whether they are in accordance with the specification and the Contractors will bear all expenses incurred for testing of such materials. Contractor / Vendor shall provide all the supporting bills and documents, test certificates which, in the opinion of the CLIENT AND/OR ITS CONSULTANT or his representatives are necessary to establish the quality of the materials or their suitability shall be produced for his inspection on requisition.

e. **Rejection:**

Any materials that have not been found to conform to the specifications will be rejected forthwith and shall be removed from the site by the Contractors at their own cost.

f. **Storing:**

The materials shall be stored or stocked on the site as directed by the CLIENT AND/OR ITS CONSULTANT and if any additional space is to be hired for this purpose, the Contractors will do so at their own expenses.

g. **Purchase:**

The CLIENT AND/OR ITS CONSULTANT shall have the discretion to ask / instruct Contractor to purchase and use such materials from any particular source as may in his opinion be necessary for the proper execution of the work.

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h. Special Materials:

Any special materials that may be required on the works which are supplied by any other person or firm selected by the CLIENT or by the CLIENT AND/OR ITS CONSULTANT on their behalf shall be taken over in writing by the Contractors for safe custody until they are required on the works when called upon to do so by the CLIENT AND/OR ITS CONSULTANT.

Z. Technical data for Equipments: -

i. Prime mover for CHP

- Prime mover rating 1 nos. capable of generating 330 KWe Electricity
- Service Prime power.
- Horse power - Vendor to specify.
- Rated RPM - 1500 RPM.
- Type Radiator cooled set.
- Make- GAS ENGINE (Fuel- Biogas)

Model / ISS reference Vendor to specify.

Nos. Of cylinder Vendor to specify.

Method of starting Vendor to specify.

Prime Mover for Air Compressor(If starting method is with Air Compressor) Vendor to specify

Aspiration Method Vendor to specify.

Specific bio-gas oil consumption (gm/BHP/hr) Vendor to specify.

Bio-gas Consumption at full load At 75% / 50% / 25% in Ltrs / Hr. including bio-gas required Vendor to specify.

for radiator fan Vendor to specify.

Lub. Oil Recommended Vendor to specify.

Lub. Oil Pressure Vendor to specify.

Qty of Lub. Oil required Vendor to specify.

Time required for starting Vendor to specify.

Lub. Oil sump capacity Vendor to specify.

Nos. of exhaust pipes required Vendor to specify.

Dia. of exhaust pipe Vendor to specify.

Whether meets CPCB norms for emission.

Note:

1. The engine HP. should be selected so as to achieve required KW rating to be generated considering derating of engine due to altitude, temp. humidity etc.
2. The engine test shall be witnessed by the client's representative.

AA. Alternator data sheet

a. Rating : 1 nos. capable of generating 330 KWe electrical power at unity p.f.

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b. Power factor	: 0.8
c. Rated voltage	: 415 V
d. Voltage regulation	: + / - 1%
e. Rated current	: Vendor to Specify
f. Speed	: 1500 RPM.
g. Frequency	: 50 Hz.
h. Enclosure detail	: Vendor to Specify.
i. Full load Output in KVA	: Vendor to Specify.
j. Full load Output in KW at 0.8 PF	: Vendor to Specify.
k. 12.Design overload cap. at max ambient temp	: Vendor to Specify.
l. at max ambient temp :	: Vendor to Specify.
m. Efficiency at full load :	: Vendor to Specify.
n. Field current at rated output and power factor	: Vendor to Specify.
p. Field voltage at rated output and power factor	: Vendor to Specify.
r. Method of excitation and regulation	: Self
t. Class of insulation	: A) Starter – F : B) Rotor - F
u. Degree of protection	: Screen protected, drip proof.
v. Base plate	: The Engine & alternator shall be mounted and aligned on a common base plate fabricated from steel.

BB. GENERAL

a. Overall Dim (LxWxH)	: Vendor to Specify.
b. Overall weight	: Vendor to Specify.
c. Noise level of D.G set at three meter with acoustic enclosure: Vendor to Specify	: 83dB.

CC.Synchronizing / AMF Panels

a. Make	: As per vendor
b. Finish	: Powder Coat.
c. Type (Floor / Wall Mounted)	: Floor Mounted. OUT DOOR TYPE IP 65
d. Instruments / Switchgear	: Consist of On/off indicator.
e. Auxiliary switch.	
f. Ammeter & Voltmeter with assessors	
g. KWH meters with CTs.	
h. Over voltage relay	
i. Under Voltage relay	
j. Reverse & Forward Power relay.	
k. Over & Under frequency Relay	
l. KVA meter	
m. Frequency meter.	
n. Annunciation windows.	
o. LED Lamp indicator.	
p. AMF relay	

Separate box for sealing of ct. & kwh meter as per supply electricity board / electrical inspector requirement.

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DD. Factory acceptance test:

The Seller will permit Client's Inspectors, Consultant and their authorized representatives free access during normal working hours to his works, go down, storage or loading spot etc. and will give them all necessary assistance to perform their task including free use of all accessories, testing and control instruments. The seller shall ensure that the same facilities are granted by his sub-suppliers.

Unless specifically stated to the contrary in the order, all expenses relevant to the preparation and performance of testing, inspection and preparation of any test reports or certificates shall be borne by the Seller EXCEPT for the salaries, fees, traveling, lodging and boarding expense of the Consultant's/ Client's representatives. **However, if the visit duration of Client's or his representatives is extended for the reasons not attributable to CLIENT, the cost of the extended period of visit shall be borne by the seller.**

The sellers shall carry out tests related to performance tests as described in the specifications and specified in the order. All such performance tests shall be at supplier costs. Supplier shall also provide all the tests certificates and documents as demanded by the Inspector for his satisfaction that the order has been executed as per PO specifications. All such certificates, documents in original shall be submitted to the Client before dispatch of material. The goods shall be dispatched from suppliers shop only after written confirmation from clients / or its authorized representative.

EE. Statutory Approval:

The unit supplied shall be duly approved by the statutory / regulatory approval as per prevailing laws and regulations. The supplier shall submit all the documents along with all the dispatch documents.

FF. VENDORS DATA: To be submitted with offer on APPROVED MAKE LIST

Vendor shall provide information on the offered make and Cat nos. of items offered for respective items.

GG. Statutory Approval:

The unit supplied shall be duly approved by the statutory / regulatory approval as per prevailing laws and regulations. The supplier shall submit all the documents along with all the dispatch documents.

HH. Schedule of Quantity: - In case of discrepancy in Drawings and BOQ, Drawings shall be final

II. Price Schedule

Price shall be quoted for Design, Engineering, Fabrication, Supply at Site, unloading at site at one location for BOQ items as per specifications of this tender and details given in their respective SLDs. Cost shall be inclusive of all taxes, transportation and supervision required for installation. In case of discrepancy between drawings and BOQ above, drawings shall be considered final and the same should be brought to notice of client / consultant. The price in the BOQ shall be the total price including supply, installation, testing and commissioning of the CHP engine as per design intent at site and handing over to the client including all the cost of transportation, handling at site, Installation, Testing, Commissioning, related taxes, labour etc.

JJ. Terms of Payment

Payment terms shall be as detailed in the Notice Inviting tender document.

KK. Delivery

The Delivery of the CHP engine and all related equipment's shall be done to the site at Permanent Campus of Nalanda University at Rajgir Bihar.

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LL. Guarantee

If any trouble or defect originating with the design, material, workmanship, or operating characteristic of any materials arises at any time prior to Twenty Four (24) months from the date of the first commercial operation of the plant for which the materials supplied under the order from a part thereof, or Thirty Six(36) months from the date of last dispatch whichever period shall first expire, and the Sellers is notified thereof, Seller shall within a day or as per SLA of such intimation at his own expense and as promptly as possible make such alterations, repairs and replacements as may be necessary to permit the materials to function in accordance with the specifications and to fulfill the foregoing guarantees. Purchaser may, at its option, remove such defective materials, at Seller's expense in which event seller shall, without cost to Client and as promptly as possible rectify the defect. Repaired or replaced materials shall be similar guaranteed for a period of not less than 12 months from the date of replacement.

MM. Guarantee of Complete System:

All the PANELS supplied under this enquiry shall be subject to for a guarantee of 24 months from the date of commissioning or 36 months from the date of supply whichever is earlier towards defective design, material of construction, poor performance.

In the event of poor performance for not achieving the intended performance stated in the specifications the complete unit shall be subject to be rejected and shall be replaced by supplier. If on test any portion of the plant, equipment or components is found to be defective or not fulfilling the intent or the meaning of the specifications, the defective parts shall be replaced with new parts. The defective parts after repair shall not be accepted. Final performance of the Panel and associate accessories shall be performed and validated at site as part of the complete system.

NN. Dispatch:

The entire unit from the factory cleared after inspection shall be dispatched to site dully packed and in assembled conditions with all the documents. The Test certificates, drawings, documents etc. for the complete unit and for all the accessories shall be submitted to the Purchaser before dispatch of unit.

If the unit during transit or during erection under the supervision of supplier representative is damaged due to any reason whatsoever, the supplier shall carryout the repair of unit or replaces the damaged components at site free of cost to Purchaser.

The leak test of the unit at site shall be carried by the supplier after unit erection is completed at site by Purchaser.

OO. Statutory Approval:

The unit supplied shall be duly approved by the statutory / regulatory approval as per prevailing laws and regulations. The supplier shall submit all the documents along with all the dispatch documents.

PP. PERFORMANCE GUARANTEE:

Contractor has to submit a performance guarantee for the entire installation of CHP system on letter head stating that the system will not fail during the functioning of the campus. If there is a downtime in the system then the contractor shall be liable to pay a penalty of Rs 1500 per hour for every hour of downtime other than for regular maintenance after 5000 hrs. The contractor need to submit the guarantee to NU on completion of the work including testing, commission and stabilisation period while submitting the final bill. In the absence of such performance guarantee, the final bill shall not be release.

The performance guarantee submitted above shall be released to the bidder at the end of successful completion of the operation and management period of 5 years /60 months from the date of successful commissioning of the plant after stabilisation period.

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3.0 GAS CASCADE SYSTEM.

The Gas cascade system shall comprise of Gas cylinders, interconnecting pipes, Cascade Frame, Base Support, Lifting arrangement for Cascade, Necessary pressure gauges, Valves, inlet and outlet manifold in SS 316 / Brass material, etc.

The Cylinder shall be made out of High Pressure seamless steel and the cylinder shall confirm to IS: 7285 Part II-Latest revision. All the tests mentioned in the IS code shall be done during manufacturing and shall be submitted along with the invoice. The Cylinder shall be coated with epoxy paint of approved quality to safeguard the cylinder from rusting.

All the connecting pipes between the cylinders shall be in SS 316 / Brass of approved grade and shall confirm to relevant Indian Standard codes.

The Support frame for the cascade shall be made out of Hot-Dip galvanized MS. Hot dip galvanizing shall be as per IS: 2629. The Frame shall be provided with Hooks on all the four corners at the top of the cascade for lifting with crane. Necessary arrangements shall also be done in the bottom for lifting the cascade with a fork lift.

All the Fitting used in the cascade shall be of SS 316 Grade.

The Entire assembly shall be capable of withstanding gas pressure upto 250 bar.

The Rate shall be for per number of cascade supplied to the satisfaction of the Engineer in charge.

The contractor shall submit the shop drawing for the proposed cascade with all the piping and fixture details for approval to Engineer in charge and on approval of the same, the procurement of cascade shall be done.

4.0 BIO METHANATION PLANT

The Biomethanation plant shall be a civil construction structure and all the items used in construction shall be as per relevant CPWD specifications for Excavation, Concrete, Reinforced concrete, Steel works, Door Window Works, Flooring works, and Finishing works. All the Plant structure like digester, slurry mixer etc which are to be constructed (Civil Structures) shall be in RCC of suitable grade and the design for all the structures shall be submitted by the vendor to client for vetting before starting of work.

A. SCOPE OF WORK

The minimum Scope of work for the tender includes the following:

- a. Design of the Biomethanation plant capable of generating 190 cum per hour of Bio gas continuously for 24 hours and 365 days.
- b. Design of all related accessories, electrical Equipment's, Pumps, Blowers and any other work required for the efficient and effective working of the BIOMETHANATION plant
- c. Construction, testing and commissioning of the Biomethanation plant as per the design after getting the design vetted by third part expert from client side.
- d. Collection of required fuel for the Biomethanation plant like cow dung, Poultry waste, kitchen waste, Agriculture waste or any other waste capable of generating the required quality of Bio Gas, to be collected from the nearby villages, vegetable markets, agricultural lands, dairy's, etc in the radius of 150 Kms around the campus for a period of 60 months.
- e. Complete operation and maintenance of the plant including provision of required manpower, vehicle maintenance, Feed Transportation to site, safety equipment's for plant and for workers, project staff etc complete as required.
- f. The Design of the entire bio-methanation plant shall be done considering the ambient condition for the site as mentioned in the start of this document. Necessary heating equipment required for the entire setup to keep the Plant operations during Peak winter also to be considered by the bidder in the plant design. The technical specifications provided below are for guidance only and the vendor has to provide complete design for the Bio-Methanation plant of the capacity as mentioned in the BOQ.
- g. The methane component must be minimum 55% which will be billed for the University.
- h. The biogas or mechanization plant must be designed to perform in all-weather condition, therefore the temperature maintenance unit around the plant will designed and developed.

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B. TECHNICAL SPECIFICATIONS

Section	Name	Specification	Quantity	Unit
Collection and Transportation				
Electro-mechanical Equipment	Collection Vehicle	45 HP Tractor with 2 Ton capacity Trolleys	5	Nos.
Electro-mechanical Equipment		Tempo (TATA 709/ Eicher) - min. 5 Tons capacity	5	Nos.
Civil	Vehicle Maintenance and Parking Shed	Parking / Maintenance Shed - 400 Sq.M area	1	No.
Electro-mechanical Equipment	Daily Maintenance equipment	Maintenance equipment - Compressor, Hydraulic m/c, Lubes,oil pumps	1	Set

Section	Name	Specification	Quantity	Unit
Feed Handling Section				
Electro-mechanical Equipment & Civil	Weigh Bridge with Civil Foundation	Capacity up to 40 MT including Data Logging, Type – pit less Civil foundation included	1	Set
Civil	Press Mud Storage Shed (if pressmud is available)	Press Mud storage for 15days on-site, remaining inventory at the sugar factory, Shed of min 30 m x 40 m, with 6 m truss bottom; with 2m side walls	1	No.
Electro-mechanical Equipment	Receiving Hopper	Fabricated in MS Capacity - About 10 MT organic waste, with tractor loader, with attached screw conveyor at bottom, mounted on weighing platform of 20 T capacity (included)	1	No.
Electro-mechanical Equipment	Batch Weighing Bridge	Included in receiver hopper (above)	1	No.
Electro-mechanical Equipment	Screw Conveyor	Capacity to feed about 20 TPH of organic waste	1	No.
Civil	Shed for feed preparation	Shed to cover the organic waste storage and feed preparation area from rains, Shed to cover about 25 m x 20 m with ht suitable to the Vehicle unloading	1	No.
Electro-mechanical Equipment	Conveying and Shredding system for organic waste (if food & vegetable waste available)	Conveyor and Shredder of suitable capacity depending upon the food waste feed qty	1	Set

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Electro-mechanical Equipment	Substrate feeding	Tractor with front end loader	1	Set
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Section	Name	Specification	Quantity	Unit
Feed Preparation Section				
Civil	Mixing Tank	Volume approx. 60cum, RCC	2	Nos.
Electro-mechanical Equipment	Strainer Grill on top of Mixing tank with additional safety railing	Safety grill in fabricated MS on top and around the Mixing tank	2	Set
Electro-mechanical Equipment	Mixers / Agitators in Mixing Tank	Submersible Mixer, 3-phase-motor 400 V, 50 Hz, 1450 rpm, protection class IP68	2	Set
Electro-mechanical Equipment	Feed Pump	Solid Handling Capacity, Submersible feed pump - Flowrate min. 30cum/hr with min 20m head	3	Nos.
Electro-mechanical Equipment	Fresh Water Pumps	Pump with flow rate of 30 m ³ /h, NPSH of about 15~20 m	2	Nos.
Civil	Water storage tank	RCC or other appropriate material, to store about 100 m ³ fresh water with about 10% extra space	1	No.
Electro-mechanical Equipment	Water Flow Meter	Measure up to 30 m ³ / h with interface for data logging	1	No.
Electro-mechanical Equipment	Scum removal in Mixing tank	Hand held equipment	2	Nos.
Electro-mechanical Equipment	Sedimentation removal in Mixing tank	Mechanized winch type bucket with swivel arm/wheels for manually removing sediments from Mixing tank	1	Set

Section	Name	Specification	Quantity	Unit
CSTR Anaerobic Digester Section				
Civil	CSTR Digester	Volume approx. 6800 cum, RCC	1	No.
Electro-mechanical Equipment	Agitators in Digester	Submersible Mixer, 3-phase-motor 400 V, 50 Hz, 1450 rpm, protection class IP68 with mast / david arm for vertical movement of mixer	4	Nos.
Electro-mechanical Equipment	Slurry level Sensor with indicator	Level control & indicator devices for digester slurry	2	Set
Electro-mechanical Equipment	Bulleye 300	sideview window with safety glass, wallseal & wiper	4	Nos.

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Electro-mechanical Equipment	EX-Light	Explosion Proof LED light for fixing in front of bulleye 300, with resetting time-delay switch to be installed outside of EX-zone. The EX-Light can be combined with EX-CAM in same bulleye.	1	No.
Electro-mechanical Equipment	EX-CAM	Explosion Proof Fixed Lens Camera for fixing outside of bulleye 300. For inspection and remote observation the EX-CAM can be combined with EX-Light in same bulleye	1	No.
Electro-mechanical Equipment	Double-Membrane Gas-Roof for tank, 33 m	Double-Membrane Gas-Storage Roof for CSTR Digester, shell PVC coated Polyester fabric, inner shell Polyethylen, belts structure & safety net for inner support, gas-tight wall fitting syteme with railing, airblower for form fitting roof support, deflation flap, over-/underpressure valve, mechanical gaslevel indicator	1	Set
Electro-mechanical Equipment	Monitoring Island	connection plate with installation sockets for O/U pressure, & foam /liquid max level sensors	1	No.
Electro-mechanical Equipment	Under-/ Over-PressureSensor for DoubleMembrane Gas-Roof	Pressure Sensor for Under-/ Over-Pressure control with calibrated Monitor/screen, and cable connection for 4-20 mAmp signal	1	No.
Electro-mechanical Equipment	CAP-sensor for Double-Membrane GasRoof	Cable actuated position(CAP) sensor for filling level indication of DoubleMembrane Gas-Roof with cable connection clamp for 4-20 mAmp signal	1	No.
Electro-mechanical Equipment	Max Level Watchdog	Level Electrode Sensor for limit level violation , EX-protected, with cable connection clamp for 4-20 mAmp signal	1	No.
Electro-mechanical Equipment	pH measurement	Measurement of digester slurry pH, can be done for the extracted slurry, meter to have data logger connectivity	1	No.
Electro-mechanical Equipment	Temperature measurement	Measurement of digester slurry temperature at outlet, meter to have data logger connectivity	1	No.
Electro-mechanical Equipment	Slurry heating circuit	Heat exchanger that uses hot water from waste heat recovery of the genset or from other source to maintain digester temperature close to 38 °C	1	Set
Electro-mechanical Equipment	Digestate withdrawal pump	Mud pump with flow rate of 30 m ³ /h, NPSH of about 15~20 m	2	Nos.
Electro-mechanical Equipment	Compressor for Bottling Bio Gas	For compressing Bio gas for Efficient storage in Cylinders for future usage with minimum capacity of 25 m ³ /hr	1	Nos.
Civil	Digestate Slurry Tank	Volume approx. 60cum, RCC	1	No.

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Section	Name	Specification	Quantity	Unit
Solid Liquid Separation and Manure Section				
Electro-mechanical Equipment	Solid Liquid Separator (SLS) Feed pump	Mud pump with flow rate of 30 m ³ /h, NPSH of about 15~20 m	2	Nos.
Electro-mechanical Equipment	Solid Liquid Separator (SLS)	Screw Press type solid liquid separator of 30 to 40 m ³ /h capacity	2	Nos.
Electro-mechanical Equipment	Liquid Recycling Pump (Filtrate tank to Mixing tank/ Feed Hopper)	Mud pump with flow rate of 30 m ³ /h, NPSH of about 15~20 m	2	Nos.
Civil	Digestate Liquid Storage - Output of Solid Liquid Separator (Filtrate)	Volume approx. 60cum, RCC	1	No.
Electro-mechanical Equipment	Extracted Solid Trolleys	Trolley on wheels, with self-tilting mechanism, to be taken from SLS to storage / manure handling area	2	Nos.
Civil	Shed over SLS section	Area to accommodate the SLS and handling area for manure of about 10 m x 15 m	1	No.
Electro-mechanical Equipment	Hoppers with screw feeders	System for feeding additives for manure enrichment	1	No.
Electro-mechanical Equipment	Manure mixers and sieves	continuous mixer with screw to move the mixed material out	1	No.

Section	Name	Specification	Quantity	Unit
Scrubbing and Clean Biogas Storage				
Electro-mechanical Equipment	Biogas Blower for Scrubber	Roots type twin lobe blower, capacity - 200cum/hr @ 0.5 bar	2	Nos.
Electro-mechanical Equipment	Desulfurization scrubber	Scrubber suitable for H ₂ S removal. H ₂ S less than 100ppm at the outlet	1	Set
Electro-mechanical Equipment	Biogas Flare	Flare with capacity to completely burn biogas at a flow rate of up to 200 m ³ / h at atmospheric pressure	1	No.
Civil	Scrubber Shed	Shed to cover the scrubber and Blower 5mx10m	1	No.
Civil	Clean Biogas Balloon Foundation	Suitable Foundation for the clean Balloon, approx. 10m dia	1	No.

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Electro-mechanical Equipment	Clean Biogas Balloon with necessary instrumentation & accessories	Double-Membrane Clean Gas-Storage Roof outer shell PVC coated Polyester fabric, inner shell Polyethylene, belts structure & safety net for inner support, gas-tight wall fitting system with railing, air blower for form fitting roof support, deflation flap, over-/under pressure valve, mechanical gas level indicator. Min. 12 hrs storage	1	Set
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Section	Name	Specification	Quantity	Unit
Electrical, Piping and Instrumentation				
Electro-mechanical Equipment	Feed Piping	Piping of suitable material having about 4 inch diameter, with valves, instrumentation, etc., with saddle supports and other structural supports, from mixing tanks and from outlet of CSTR digester	1	Set
Electro-mechanical Equipment	Digestate Slurry Piping	Piping of suitable material having about 4 inch diameter, with valves, instrumentation, etc., with saddle supports and other structural supports, from CSTR digester to slurry tank, to SLS, to recycling liquid tank	1	Set
Electro-mechanical Equipment	Biogas Piping	Piping of suitable material about 6 inch diameter, with valves, instrumentation, etc., with saddle supports and other structural supports, from digester to scrubbers and a bypass from there to the flare	1	Set
Electro-mechanical Equipment	Piping for SLS	From Digestate tank to SLS feed pump and from SLS separated liquid to recycled liquid storage tank	1	Set
Electro-mechanical Equipment	Online Gas Analyser	Measure Methane, carbon dioxide, H ₂ S, meter with digital display, data logger interface capability, properly calibrated with certification	1	Set
Electro-mechanical Equipment	Handheld Gas Analyser	Measure Methane, carbon dioxide, H ₂ S (100ppm), meter with digital display, data logger interface capability, properly calibrated with certification	1	Set
Electro-mechanical Equipment	Raw Biogas Flow Meter	Meter capable of measuring biogas, flow rates of up to 200 m ³ / h at atmospheric pressure	1	No.

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Electro-mechanical Equipment	Clean Biogas Flow Meter	Meter capable of measuring biogas, flow rates of up to 200 m ³ / h at atmospheric pressure	1	No.
Electro-mechanical Equipment	Control Panel & Electrical Cabling	Control Panel (CP) & Programmable Logic Controller (PLC) for the biogas generation plant, standardized & modularized design, integrating consumers / actuators / sensors / auto-switches as per requirement, installed inside control panel room. Electrical cabling for the biogas plant equipment	1	Set
Civil	Control Room	For control panel and PLC of suitable size	1	No.

Section	Name	Specification	Quantity	Unit
Fire Safety Section				
Electro-mechanical Equipment	Fire Extinguishers	As per Standards		
Electro-mechanical Equipment	Fire Hydrant System	As per Standards		
Electro-mechanical Equipment	Fire Alarm System	As per Standards		
Other Civil Units				
Civil	Office Room	As required		
Civil	Labour Changing / Locker Room	As required		
Civil	Toilet block	As required		
Civil	Misc. Foundations	As required		
Civil	Fencing around the plant	As required		
Electrical	All areas	Electrical installation including wiring, cabling, DB, Lighting, Switches, power sockets etc as required for operation of the facility and the office spaces including illuminating the same.		

C. Indian Standards Cited for the Biogas Plant

The standards listed herein shall not be deemed as all inclusive. The Bidder shall furnish a comprehensive list of standards he would be following in the works. These shall be furnished along with the tender. In case of discrepancy between the specifications and the standards, the specifications shall govern.

Biogas Plant

IS: 16087 – Biogas (Biomethane)- specifications

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IS: 7285 (Part 2) : Refillable seamless steel gas 2004 cylinders: Part 2 Quenched and tempered steel cylinders with tensile strength less than 1 100 MPa (112 kgf/mm²)

Materials

- IS : 226 - Specification for structural steel (Standard Quality)
- IS : 269 - Specification for ordinary and low-heat Portland cement.
- IS : 299 - Specifications for Sulphate of Alumina
- IS : 383 - Specification for coarse and fine aggregates from natural sources for concrete.
- IS : 428 - Specification for distemper, oil emulsion, colour as required
- IS : 455 - Specification for Portland slag cement
- IS : 458 - Specification for concrete pipes.
- IS : 459 - Specification for unreinforced corrugated & semi corrugated asbestos cement sheets.
- IS : 650 - Specification for standard sand used for testing of cement.
- IS : 651 - Specification for salt glazed stoneware pipes and fittings.
- IS : 777 - Specification for glazed earthenware tiles.
- IS : 808 - Specification for dimensions for hot rolled steel sections. [Parts-I to VI]
- IS : 814 - Specification for covered electrodes (Part I metal arc welding of struct. Steel I & II
- IS : 961 - Specification for structural steel (High Tensile)
- IS : 1003 - Specification for timber panelled and glazed shutters. (Parts I & II)
- IS : 1038 - Specification for steel doors, windows and ventilators.
- IS : 1077 - Specification for common burnt clay building bricks.
- IS : 1148 - Specification for hot rolled steel rivet bars (upto40mm) for structural purpose
- IS : 1149 - Specification for high tensile steel rivet bars for structural purposes.
- IS : 1230 - Specification for cast iron rainwater pipes and fittings.
- IS : 1363 - Specification for black hexagonal bolts, screws, nuts and black hexagonal screws
- IS : 1364 - Specification for hexagon bolts, screws and nuts
- IS : 1367 - Technical steel supply conditions for (Parts I threaded fasteners To x VIII)
- IS : 1398 - Specification for packing paper water proof bitumen laminated.
- IS : 1489 - Specification for portland puzzolana cement.
- IS : 1540 - Specifications for Quicklime
- IS : 1566 - Specification for hard drawn steel wire fabric for concrete reinforcement.
- IS : 1580 - Specification for bituminous compounds for water proofing & caulking purposes.
- IS : 1786 - Specification for high strength deformed bars & wires for concrete reinforcement.
- IS : 1852 - Specification for rolling and cutting tolerances for hot ventilators.
- IS : 1948 - Specification for aluminum doors, windows and ventilators.
- IS : 1977 - Specification for structured steel (ordinary quality)
- IS : 2016 - Specification for plain washers.
- IS : 2062 - Specification for weldable structural steel
- IS : 2074 - Specification for ready mixed paint, air drying, red oxide zinc chrome & priming.
- IS : 2116 - Sand for masonry works
- IS : 2185 - (Part I) Specification for concrete masonry units, hollow and solid concrete blocks.
- IS : 2202 - Specification for wooden flush door shutters (Parts I & II]
- IS : 2645 - Specification for integral cement water proofing compounds.
- IS : 2750 - Specification for steel scaffoldings.
- IS : 2835 - Specification for flat transparent sheet glass.
- IS : 3102 - Classification of burnt clay solid bricks
- IS : 3384 - Specification for bitumen primer for use in waterproofing and damp proofing.
- IS : 3502 - Specification for steel checkered plates.
- IS : 3757- Specification for high strength structured bolts.
- IS : 4021 - Specification for concrete porous and ventilator frames.
- IS : 4351 - Specification for steel door frames
- IS : 4984 - High Density Polyethylene pipes

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- IS : 4990 - Specification for plywood for concrete shuttering work.
- IS : 5369- General requirements for plain washers and lock washers.
- IS : 5372- Specification for taper washers for channels.
- IS : 5374 - Specification for taper washers for I beams.
- IS : 7215 - Specification for tolerances for fabrication of steel structures.
- IS : 7280 - Specification for bar wire electrodes for submerged arc welding of struct. steel.
- IS : 7634 - Laying and jointing of Polyethylene pipes
- IS : 8008 - Specifications for HDPE fittings
- IS : 8360 - Fabricated HDPE fittings
- IS : 8217 - HDPE run outs and undercuts
- IS: 10262 - Recommended guidelines for concrete mix design
- IS: 14333 - High Density Polyethylene pipes for sewerage

Tests

- IS : 516 - Methods of test for strength of concrete.
- IS : 1182 - Recommended practice for radiographic examination of fusion-welded butt joints
- IS : 1199 - Methods of sampling and analysis of concrete.
- IS : 1542 - Sand for Plastering
- IS : 2386 - [I to VIII] Methods of test for aggregates for concrete
- IS : 2720 - (Parts I to XLI) Methods of test for soils.
- IS : 3025 - Methods for sampling and test (physical and chemical) for water and wastewater.
- IS : 3495 - Methods of tests of burnt clay building bricks.
- IS : 3613 - Acceptance tests for wire flux combinations for submerged arc welding
- IS : 4020 - Methods of tests for wooden flush doors: Type tests.
- IS : 4031 - Methods of physical tests for hydraulic cement.
- IS : 5807 - Method of test for clear finishes for wooden [Parts I to VI] furniture
- IS : 7318 - Approval tests for welders when welding procedure approval is not required.

Codes of Practice

- IS : 456 - Code of practice for plain and reinforced concrete.
- IS : 783 - Code of practice for laying of concrete pipes.
- IS : 800 - Code of practice for general construction in steel.
- IS : 806 - Code of practice for use of steel tubes in general building construction.
- IS : 816 - Code of practice for use of metal arc welding for general construction in mild steel.
- IS : 817 - Code of practice for training and testing of metal arc welders.
- IS : 875 - (Parts 1 to V) Code of practice for design loads/other than earthquake safety
- IS : 919 - Recommendations for limits and fits for Engineering.
- IS : 1081 - Code of practice for fixing & glazing of metal doors, windows and ventilators.
- IS : 1172 - Code of basic requirements for water supply, drainage and sanitation.
- IS : 1477 - (Parts I & II) Code of practice for painting of ferrous metals in buildings.
- IS : 1597 - (Parts I & II) Code of practice for construction of stone masonry.
- IS : 1742 - Code of practice for building drainage
- IS : 1893 - Criteria for earthquake resistant design of structures.
- IS : 2065 - Code of practice for water supply in buildings.
- IS : 2212 - Code of practice for brickwork.
- IS : 2338 - (Parts I & II) Code of practice for finishing of wood and wood based materials.
- IS : 2394 - Code of practice for application of lime plaster finish.
- IS : 2395 - (Parts I & II) Code of practice for painting Concrete, masonry & plaster surfaces.
- IS : 2470 - (Part I) Code of practice for installation of septic tanks - Design & construction.
- IS : 2470 - (Part II) Code of practice for installation & disposal of septic tanks
- IS : 2502 - Code of practice for bending and fixing of bars for concrete reinforcement.
- IS : 2571 - Code of practice for laying insitu cement concrete flooring.
- IS : 2595 - Code of practice for radiographic testing.

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IS : 2751 - Code of practice for welding of mild steel plain and deformed bars used for RCC
IS: 2974 - (Parts II to V) Code of practice for design and construction of machine foundations.
IS : 3007 - (Parts I & II) Code of practice for laying of asbestos cement sheets.
IS : 3114 - Code of practice for laying of Cast Iron pipes.
IS : 3370 - (Parts I & IV) Code of practice for concrete structures for the storage of liquids
IS : 3414 - Code of practice for design and installation of joints in buildings.
IS : 3558 - Code of practice for use of immersion vibrators for consolidating concrete.
IS : 3658 - Code of practice for liquid penetrant flow detection.
IS : 3935 - Code of practice for composite construction.
IS : 4000 - Code of practice for assembly of struct. joints using high tensile friction fasteners.
IS : 4014 - (Parts I & II) Code of practice for steel tubular scaffolding.
IS : 4111 - Code of practice for ancillary structures in sewerage system
IS : 4127 - Code of practice for laying of glazed stoneware pipes.
IS : 4353 - Recommendations for submerged arc welding of mild steel and low alloy steels.
IS : 5329 - Code of practice for sanitary pipe work above ground for buildings.
IS : 5334 - Code of practice for magnetic particle flaw detection of wells.
IS : 5822 - Code of practice for laying of welded steel pipes for water supply.
IS : 7215 - Tolerances for fabrication of steel structures.
IS : 9595 - Recommendations for metal arc welding of carbon & carbon manganese steels.
IS:10005 - SI units and recommendations for the use of their multiples & certain other units.

Safety Codes

IS : 3696 - (Parts I & II) Safety code for scaffolds and ladders.
IS : 3764 - Safety code for excavation work.
IS : 7205 - Safety code for erection of structural steel work.
I.S. 456 - Code of Practice for Plain and reinforced concrete.
I.S. 875 - Code of Practice for design load (other than earthquake) for building structures.
I.S. 3370 - (Part I to IV) Code of practice for concrete structures for the storage of liquids.
I.S. 1893 - Criteria for earthquake resistant design of structures
I.S. 2974 - (Parts I to V) Code of practice for design & construction of machine foundations.
IRC : 6 - Standard specs. & Code of Practice for road bridges - loads & stresses
I.S. 800 - Code of Practice for general construction in steel.
I.S: 806 - Code of Practice for use of steel tubes in general building construction.
NFPA 850 – Recommended practice for fire protection for electrical generating plants and High voltage DC converter stations.
NFPA 54 – National Fuel Gas Code
NFPA 55- Compressed Gases and Cryogenic Fluids Code.

Electrical

Standard Specifications Except where otherwise specified, all electrical machines and accessories shall comply with current national standards CPWD standards and specifications. For the purpose of inspection or testing, the Contractor shall make available to the “Employer/Technical Agency” or his representative copies of relevant standards if requested.

Mechanical

Except where otherwise specified, all equipment and accessories shall comply with current national standards and CPWD standards and specifications. For the purpose of inspection or testing, the Contractor shall make available to the “Employer/Technical Agency” or his representative copies of relevant standards if requested.

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D. OUTPUT PARAMETERS

The Bio Gas generated from the plant shall have the following minimum parameters

Description	Minimum/Maximum Value required
Methane Content	Minimum 55% by Volume
Carbon Dioxide	Maximum 45% by Volume
Hydrogen Sulphide	Less than 1% by Volume
Net Calorific Value	Minimum 5000 KCAL/Cum
Gas Pressure	As required for Operation of CHP engine
Fuel Gas Availability	On continuous Basis

E. TESTING

All testing of the materials, equipment's and works shall be as per relevant standards as put in the Indian standard codes and CPWD specifications.

F. Payment Terms:

Payment terms shall be as mentioned in Notice inviting tender document.

The complete work of SITC has to be done at the permanent campus of Nalanda University at Rajgir Bihar.

G. PERFORMANCE GUARANTEE:

Contractor has to submit a performance guarantee for the entire installation of Bio Gas system amounting to **10%** of the total cost of the Plant or total forecasted cost of the O&M period whichever will be maximum in the form of FDR/TDR/DD/BC/BG – issued from scheduled bank in favour of Nalanda University Payable at Rajgir Bihar. The format of the Guarantee agreement shall be as per NIT document or as per the CPWD format. The contractor need to submit the guarantee to NU on completion of the work including testing, commission and stabilisation period while submitting the final bill. In the absence of such performance guarantee, the final bill shall not be released.

The performance guarantee submitted above shall be released to the bidder at the end of successful completion of the operation and management period of 5 years /60 months plus 60 days from the date of successful commissioning of the plant after stabilisation period.

5.0 ELECTRICAL WORKS SPECIFICATIONS

5.1. Battery charger cum DCDB

5.1.1. Scope

The scope of work shall include:

1. Supplying, installation testing and commissioning of battery charger cum DCDB.
2. Handling, loading unloading and storage.

3. Associated wiring and internal cabling works.

5.1.2. Definitions

The definitions shall be as per relevant IEC/IEEE standards.

5.1.3. Codes & Standards

The contractor is required to follow all relevant IS and IEC codes as per latest amendments, following codes shall be followed in particular:

1. IEC- 60335-2-29 - Particular requirement for battery charger.
2. NEC- 2008 - National electrical code.
3. NBC-2016 - National building code.
4. IER-1956 : Indian electricity rules.
5. IEA-2007: Indian electricity act 2007.
6. Any other local bye-law or supply company norm as applicable.

5.1.4. Service conditions

System particulars

- a. Nominal system voltage - 110V bipolar DC
- b. Rated system voltage - 1.8kV
- c. Frequency - 50Hz \pm 3%
- d. No. of phases – 2pole + earth
- e. System neutral - Solidly earthed

Tropical conditions

- a. Ambient temperature : 50 degree celsius
- b. Relative humidity (avg.) : 60
- c. Isokeraunic level : 33
- d. Seismic Zone : Zone-4
- e. Climate type : hot and humid

The climatic conditions are prone to wide variations in ambient conditions and hence the equipment shall be of suitable design to work satisfactorily under these conditions.

Tolerances and creepage distance

Tolerances (on all the dimensions) and creepage distances shall be in accordance with provisions made in the relevant Indian/IEC/BIS standards and in these specifications. Otherwise the same will be governed by good engineering practice in conformity with required quality of the product.

5.1.5. Specifications

- The Sealed Maintenance Free Batteries or Lead Batteries are placed outside the

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- Charger. The Batteries are supplied in Modular Form, suitable for Floor standing.
- The Battery Charger & DC Distribution Board shall be a composite unit.
 - The Battery Charger shall be Float cum Boost type, Thyristor controlled .The charger shall have selector switch for Auto Float - Boost / Manual Float / Manual Boost Mode of Operation. During Auto Float – Boost Mode, Automatic Changeover shall takes place from Float Mode to Boost Mode and vice – versa. This mean that when the Batteries are fully charged the charging shall automatically change from Boost charge to Trickle charge.
 - The Float cum Boost Charger and DC Distribution Board shall be housed in Sheet Steel Cubicle Sheet Steel Panels of 1.6 mm thickness. Louvers shall be provided in the cabinet for the ventilation. The Cubicle shall be painted in Siemens Grey shade. Channels shall be provided at the base.
 - The D.C Output voltage of Float / Boost Charger shall be stabilized within +/- 2% for A.C. Input variation of 230V +/- 10%, Frequency variation of 50 Hz +/- 50% and D.C load variation of 0-100%. The voltage & regulation shall be achieved by a constant voltage regulator having fast response SCR Controlled. The ripple content in output will be within 3% of D.C. Output Nominal Voltage.
 - There shall be provision to select Auto Float / Manual Float / Manual Boost Modes. During Auto Float mode the Battery charging shall automatically changeover from Boost Mode to Float Mode and vice – versa. During Manual Float / Boost modes it shall be possible to set the Output Volts by separate potentiometers.
 - The Battery Charger shall have automatic output current limiting feature.
 - Battery charger shall constitute of following :
 - a. 1 No. Double Pole ON / OFF MCB at A.C. Input.
 - b. 1 No. Pilot lamp to indicate Charger Mains ON.
 - c. 1 No. MAIN TRANSFORMER: Double wound, naturally air-cooled, having copper winding.
 - d. 1 Set single phase full wave bridge rectifier consisting of 2 nos. Diodes and 2 nos. SCRs, liberally rated, mounted on heat sinks and complete with resistor / condenser network for surge suppression.
 - e. 1 No. Rotary Switch to selected AUTO FLOAT / MANUAL FLOAT / MANUAL BOOST. During Auto Float Mode Automatic Changeover shall take place from Float Mode to Boost Mode and vice-versa.
 - f. 1 Set solid state constant potential controller to stabilize the DC output voltage of the Float cum Boost Charger at +/- 2% of the set value for AC Input Voltage variation of 230V +/- 10%, Frequency variation of +/- 5% from 50 Hz and simultaneous load variation of 0-100% .
 - g. 1 No. Electronic controller to Automatically Changeover Battery charging from Boost to Float and vice – versa.
 - h. 1 No. DC Ammeter and Toggle switch to read charger output current and Battery Charge / Discharge Current.
 - i. 1 No. Moving coil DC Voltmeter with selector switch to read the Charger Output / Load Volts.
 - j. 2 Set Potentiometer to adjust the output voltage during Manual / Auto Float and Boost Modes.
 - k. 1 No. Double Pole ON / OFF M.C.B at Charger Output.
 - l. 1 set Dropper Diode to Automatically maintain Load Voltage constant within 110-125V (Relays) with electronic controller.
 - m. 1 set D.C. Overvoltage Trip circuit with Indication.
 - n. 1 no. Series Diode to prevent reverse current flow Battery to Charger.
 - The Battery Charger shall have following alarm and annunciation feature.

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- a. A.C Mains Fail.
 - b. DC Output/ Battery Under Volt.
 - c. Charger Fail.
 - e. Battery on Boost Charge.
 - f. D.C. Output Over volt.
 - g. Battery on Boost Charge.
- DCDB shall be as per SLD
 - The Battery Charger shall have following ratings :
 - a.AC INPUT - 230V +/- 10% AC 50 Hz Single Phase.
 - b.DC OUTPUT - To Float / Boost Charge 110V – 100AH Batteries and also supply a continuous Load.
 - c. CURRENT RATING - As per schedule : Battery – 10.0A
 - d. FLOAT MODE - Nominal 122.5V (Adj between 110.0V- 125.0V)
 - e. BOOST MODE - Nominal 126.5V (Adj between 110.0 V - 135.0V)
 - f. VOLTAGE REGULATION: +/- 2% of the set value.
 - g. RIPPLE - Less than 3%.

5.1.6. Installation, Testing & Commissioning

- Installation of Inverter shall be carried out as per manufacturer's instructions and installation shall be verified by the manufacturer before energizing.
- Type testing shall be conducted from accredited Lab. Copies of the test certificates for same rating shall be submitted at the time of vendor approval. These shall not be more than **5 years old from the date of approval of drawing.**
- Testing at manufacturers' works shall be conducted before dispatch as per routine verification requirements.
- Physical check including checking damage/crack in any components, etc shall be done at site.
- Following test shall be performed, as a minimum, at site prior to handing over, to confirm the functional and the performance specification of the inverter as specified. All required test equipment like Digital Oscilloscope, Voltage Regulator and Measurement Meters etc. shall be the responsibility of the concerning vendor without any additional cost.
- Full load testing of battery charger with both float and boost charge testing shall be done at site as per the approved QAP. All testing expenses shall be under the scope of vendor.

5.2. UPS

5.2.1. Scope

The scope of work shall include:

1. Supplying, installation testing and commissioning of UPS.
2. UPS and battery handling, loading unloading and storage.
3. Associated racks and other works to install the UPS.

5.2.2. Definitions

The definitions shall be as per relevant IEC/IEEE standards.

5.2.3. Codes & Standards

The contractor is required to follow all relevant IS and IEC codes as per latest amendments, following codes shall be followed in particular:

1. IEEE Standard 446-1987: Emergency and standby power systems.
2. IEC 146 : Performance testing of UPS.
3. ANSI C 37.90a, IEEE Standard 472 : Surge withstand capability test.
4. ANSI C 34.2 : Practices and requirements for semiconductor power rectifiers.
5. ANSI C 34.2 : Practices and requirements for semiconductor power rectifiers.
6. ANSI C 37.90 : Relays and relay system associated with electrical power apparatus.
7. IS 2208 & IS 9224 : Cartridge fuses for voltages up to and including (Part 1&2) (IEC 269) 650 V.
8. IS 9224 (Part - 4) : Fuses for protection of semiconductors.
9. BS 2709 (I.E.C 119) : The Electrical Performance of Semiconductor Rectifiers. (Metal Rectifiers)
10. BS 4417 (I.E.C 146) : Semi-conductor Rectifier Equipments.
11. IS 1652 & IS 1652 : Lead-acid stationary cells and batteries.
12. NEC- 2008 - National electrical code.
13. NBC-2016 - National building code.
14. IER-1956 : Indian electricity rules.
15. IEA-2007: Indian electricity act 2007.
16. Any other local bye-law or supply company norm as applicable.

5.2.4. Service conditions

System particulars

- a. Nominal system voltage - 415V
- b. Rated system voltage - 1.1kV
- c. Frequency- 50Hz \pm 3%
- d. No. of phases- 3P + neutral + Integrated earth
- e. System neutral- Solidly earthed
- f. Short circuit rating - 50kA for 1sec on LV side.

Tropical conditions

- a. Ambient temperature : 50 degree celsius
- b. Relative humidity (avg.) : 60

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- c. Isokeraunic level : 33
- d. Seismic Zone : Zone-4
- e. Climate type : hot and humid

The climatic conditions are prone to wide variations in ambient conditions and hence the equipment shall be of suitable design to work satisfactorily under these conditions.

Tolerances and creepage distance

Tolerances (on all the dimensions) and creepage distances shall be in accordance with provisions made in the relevant Indian/IEC/BIS standards and in these specifications. Otherwise the same will be governed by good engineering practice in conformity with required quality of the product.

5.2.5. Specifications

- The UPS system shall be of microprocessor based and so carefully designed to maximize the availability of power for critical loads and to ensure that equipment's is protected to the extent possible against power failure and quality problems.
- UPS system shall constitute of (but not limited to) following
 - a. Transient Voltage surge suppression (TVSS)
 - b. Rectifier
 - c. Inverter
 - d. Static bypass switch
 - e. Manual / Maintenance by-pass switch
 - f. Display Panel
 - g. Control Logic
 - h. Isolation Transformer
 - i. Battery Monitoring system
 - j. Temperature compensating battery charging
 - k. Audible Alarm
 - l. SMF Battery Bank
- All components of the UPS equipment shall have surge withstand capability (SWC) to meet the requirements of ANSI C 37.90a, IEEE Standard 472-1974.
- All components of UPS system shall withstand short circuit current without any damage.
- Fuses shall not be larger than 125% of the transformer primary circuit current where the secondary circuit fuse protection has not been provided. where the secondary fuses are sized not greater than 125% of the secondary current of the transformer, fuses shall not be required in the primary circuit, provided the primary feeder fuses are not larger than 250% of the transformer primary current.
- All the neutral conductors in three phase UPS systems shall be sized equal to at least 200% of the maximum phase current. In addition, all the isolators and circuit breakers used in three phase UPS system shall also to be rated such that the neutral poles shall take at least 200% of the maximum phase current.
- All control shall be designed and positioned such that possibilities of inadvertent or accidental operations are eliminated.
- All UPS system cabinets, frames and power equipment shall be double earthed.
- The various overload capacities of inverters, static switch, step down transformer/voltage stabilizer as specified herein are the minimum requirements. However, if the firm's offered system has better overload capacities for the above

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- devices, the same shall be highlighted by the bidder in his bid.
- Maximum humming noise level of UPS shall be 75 dB one meter away from the UPS cabinets.
 -
 - The system shall be fully microprocessor based and monitored through SCADA.
 - The system shall be on line double conversion i.e. load independent from both main's voltage and frequency. Ensure server-grade high quality of power.
 - The system shall have IGBT based PWM inverter resulting perfect sine wave voltage.
 - The system should be wide input voltage tolerance (+10/-10%).
 - The system should be wide input frequency tolerance (+ / - 6%)
 - The system shall be advance battery management system with programmable automatic battery testing, constantly monitors the health of the battery pack keeping the battery ready to work for emergency situations.
 - The system shall be high overload capacity of static bypass (10 times for 100ms.)
 - The system shall be built in maintenance bypass.
 - Front access shall be provided for easy replacement and maintenance.
 - The system shall have overload capacity :
 - a. Below 105% rated output current, continuous operation
 - b. 105% ~ 125% UPS output current, 5 minutes
 - c. 125% ~ 150% UPS output current, 1 minute
 - The system shall have selectable timer.
 - The system shall have adjustable frequency synchronization window upto +/-1% in the static bypass.
 - The system shall have hardware for fault diagnostic unit, data logger and power monitoring system.
 - The system shall have comprehensive display panel having three functional sections such as
 - a. Mimic :LED Display indicates the status of UPS.
 - b. Control :Touch membrane switches for ON, OFF, RESET, audible alarm and STOP functions.
 - c. Display :LCD display indicates operating parameters and alarm conditions.
 - Each UPS shall give regulated filtered & uninterruptible power supply as described in the specifications.
 - In case the calculated /specified UPS capacity is not the same as one of the standard KVA ratings of the UPS manufacturer, the next higher standard KVA rating shall be selected. UPS of non standard rating shall not be acceptable.
 - UPS system supplied shall be the latest state of the art technology system fully digitalized using microprocessor controlled, IGBT based full wave rectification and IGBT inverter.
 - Batteries shall be valve regulated lead acid specially meant for UPS application.
 - Monitoring and control system shall also be state of the art technology LCD touch panel type providing all relevant data described in this document.
 - The monitoring and control system shall be capable of RS485 input software for connecting to customer's computer system for data display and monitoring.
 - All necessary components required for protecting UPS equipment and connected inputs and outputs shall be furnished as an integral part of the UPS system.
 - The UPS systems shall include but not be limited to the following equipment:
 - a. UPS system including 100% capacity float-cum-boost charger with 100% sealed valve regulated lead acid batteries with guaranteed battery life of 5 years.
 - b. Suitable factory built battery cabinet for housing the batteries, including terminal isolator / breaker and power disconnect device.

c. All cables, connectors, accessories like trunking, cable trays, conduits etc. required for connection between battery and the UPS unit.

5.2.6. Rectifier

- The static converter (rectifier) shall be a multi-functional converter providing functions of power conversion, battery charging and shall have the additional functions of input power factor improvement and current harmonics reduction.
- The rectifier shall be a solid state, IGBT based, static PWM converter utilizing Intelligent Power Module (IPM) and shall include intelligent features like the drive circuitry, over current protection, over temperature protection, control power failure protection and short circuit protection. The IPM transistors shall enable high speed switching at 6 KHz thus reducing the heat dissipation in the UPS and thereby providing high efficiency. The PWM converter shall utilize the above and achieve unity power factor and reduce input current harmonics as given earlier and thus improve the overall power factor of the converter achieving input KVA savings. During any step inverter load change (0-100%) the converter shall only supply 100% current to the inverter.
- The rectifier equipment shall include all necessary control circuitry and device to conform requirements like voltage regulation, current limiting, wave shaping, transient recovery, automatic synchronization etc.
- The rectifier logic shall provide input current limiting by limiting the DC output current. Two (2) line side current transformers shall be employed as a means of sensing the current amplitude. The rectifier shall be capable of supplying overload current in excess to the full load rating. The DC output current limit values shall be as follows:
 - a. Rectifier output current (maximum) 100%
 - b. Rectifier output current (aux.) 25% - 100% variable.Note : 100% current shall be under the battery recharging mode.
- The rectifier logic shall provide current limiting function of battery charging to prevent the battery from damage. The following battery current limit and protection shall be provided.
 - a. Battery charge current limit 10% of battery Ah rate.
 - b. Over-current protection at 120% of above item.
- The rectifier / charger output voltage shall not deviate by more than +/- 1% of the nominal output voltage, due to the following conditions:
 - a. From 0 to 100% loading.
 - b. Rectifier input variations of voltage and frequency within the limitations
 - c. Environmental condition variations
- The rectifier logic shall employ circuitry to allow a delayed and timed ramping of input current. Subsequent to energizing the rectifier input, the ramping of current shall be delayed by a maximum of 3 seconds. Upon starting the walk-in process, the ramping of current is timed to assume the load gradually within 1 through 60 seconds (every 1 second selectable).
- The A/C input fuses shall be provided at the rectifier input as a means of overload protection. The AC maximum current shall be controlled by the rectifier.
- During any step inverter load change (0-100%), only the rectifier shall supply 100% current to the inverter.
- The rectifiers shall be suitable to be fed from the normal power supply source.
- Basic parameters of rectifier shall be as follows :
 - a. Nominal Voltage: 415V, 3 Phase, 3 Wire

- b. Voltage Range.: + 10 % / - 10% AC
- c. Frequency Range : + 6 % / - 6% AC
- d. Input Power Factor : 0.98 lagging or more at full load(PF improvement)
- e. Input Harmonic Current THD: 7% typical at 100% load 6% maximum at 50% load
- f. Duty : Continuous
- g. Cooling : Forced cooling using fans with thermal relays using a latched cut out for re-setting as protection for cooling fans. Each individual fan shall have its own thermal relay. Ambient operating temperature range: 0 to 45 deg.C maximum.

5.2.7. Inverter

- The static inverter shall be of solid state type using proven pulse width modulation (PWM) technique. The inverter equipment shall include all necessary control circuitry and devices to conform requirements like voltage regulation, current limiting, wave shaping, transient recovery, automatic synchronization etc. as given below.
- The inverter shall utilize IGBT which shall provide intelligent features like the drive circuitry, over-current protection, over temperature protection, control power failure protection and short circuit protection.
- The IGBT / IPM transistors shall enable high speed switching of 6 Khz thus reducing the heat dissipation in the UPS and thereby providing high efficiency.
- The UPS shall utilize both voltage and current feedback control circuits so that the inverter shall act notonly as a constant voltage source but also as a load required current source. This shall enable the inverter to quickly adapt to the changing load current value and wave shape.
- The inverter output voltage shall not deviate by more than + 2% RMS due to the following steady state conditions :
 - a. From 0 to 100% loading
 - b. Inverter DC input voltage varies from maximum to minimum.
- The inverter output frequency shall be controlled by an oscillator internal to the UPS module logic. The inverter output frequency shall not vary during steady state or transient operation due to the following conditions:
 - a. From 0 to 100% loading.
 - b. Inverter DC input varies from maximum to minimum.
- The inverter output shall limit the amount of harmonic content to the values stated in section. The use of excessive or additional filtering shall not be required to limit the harmonic content thus maintaining a high level of efficiency, reliability and original equipment footprint.
- The inverter output shall be capable of providing an overload current while maintaining rated output voltage to the values stated. An LED indicator shall be located on the control panel to identify this condition. If the time limit associated with the overload condition expires or the overload is in excess of the set current amplitude, the load shall be transferred to the bypass source without interruption.
- The inverter output shall be limited to 150% of rated load current.
- The AC output from the inverter shall utilize fuses for overload protection. The inverter shall utilize a contactor to isolate the inverter output from the critical bus. The inverter fuses shall be the fast acting semiconductor type. The inverter output isolation contactor shall be located in the UPS module and shall be controlled by the internal UPS module system logic.
- The inverter shall meet the following specifications in addition to other requirements stated herein:
Voltage Input : Three Phase UPS

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- Nominal DC (Range 300 V to 420 V DC to maximum DC bus voltage during charging the batteries).
- Nominal Voltage Output : 415 V + 1% AC 3 Phase, 4 Wire
- Voltage Regulation :
 - a. For 0 to 100% loading: $<+ 1\%$
- Transient Voltage Regulation :
 - a. At 100% step load change : $<+ 3\%$
 - b. At loss or return of AC input : $<+ 1\%$
 - c. At load transfer from bypass to inverter : $<+ 3\%$
 - d. Total voltage harmonic distortion : $< 5\%$ THD for 100% linear load $< 7\%$ THD for 100% non-linear load
 - e. Output power factor > 0.9
 - f. Duty : Continuous
 - g. Cooling : Forced cooling using fans.
 - h. Ambient operating temperature range : 0 to 40 deg.C maximum continuous.
 - i. Output : Suitable terminals are provided for termination of cables for connecting inverter output to AC distribution board.

5.2.8. Isolation transformer and bypass switches

- This shall provide neutral separation which shall mean that output neutral will be independent of incoming neutral, hence critical load shall be isolated from the problems like incoming neutral open or, short or, variations in neutral to earth voltage due to sudden loading in neighboring installation. The isolation transformer shall be connect so as to protect any unwanted voltage fluctuations in neutral to protect the UPS
- In the event of Phase sequence reversal at the input, UPS system shall continue to work and shall not trip the UPS system.
- A bypass circuit shall be provided as an alternate source of power other than the inverter. A high speed switch and wrap-around contactor shall be used for the critical load during automatic transfers to the bypass circuit. The static switch and wrap-around contactor shall drive power from an upstream bypass feed circuit breaker internal to the UPS module provided for overload protection. The wrap-around contactor shall be electrically connected in parallel to the static switch and shall at the same time as the static switch, energize and upon closure, maintain the bypass source. The static switch shall only be utilized for the time needed to energize the wrap-around contactor thus increasing reliability. The bypass circuit shall be capable of supplying the UPS rated load current and also provide fault clearing current.
- The UPS system logic shall employ sensing which shall cause the static switch to energize within 150 microseconds thus providing an uninterrupted transfer to the bypass source when any of the following limitations shall exceed:
 - a. Inverter output under voltage or over voltage.
 - b. Overload beyond the capability of the inverter
 - c. DC circuit under voltage or over voltage
 - d. Final end voltage of system battery is reached.
 - e. Bypass source present and available
 - f. System failure (eg.Logicfail, fuse blown, etc.)
- Keeping the above requirements in view, the static switch shall have the following minimum rating.
 - a. Capacity continuous equal to 100% of continuous rating of the inverter.
 - b. Capacity overload equivalent to overload characteristics specified for UPS.
 - c. Nominal bypass input voltage: 415 V, 3 phase, 4 wire

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- d. Voltage Range : +/- 10% of nominal
- e. Nominal Frequency : 50 Hz
- f. Frequency range :+ 6%
- g. Output Fault Clearing : Current : 1000%, Duration : 20 milli seconds
- h. Duty : Continuous

- In the event that the critical load must be transferred to the bypass source due to an overload, the UPS system logic monitors the overload condition and, upon the overload being cleared, performs an automatic re-transfer back to the inverter output.
- The UPS shall be capable of transferring the critical load to / from the bypass source via LCD touch panel. When performing manual transfer to inverter or automatic re-transfers, the UPS system logic shall force the inverter output voltage to match the bypass input voltage and then parallel the inverter and bypass source providing a make-before-break transition allowing a controlled walk-in of load current to the inverter.
- The UPS shall include as standard equipment, a zero energy maintenance bypass switch. Full UPS wraparound enables personnel to do work inside the UPS module or maintenance bypass switchboard without danger for high voltage conditions.
- The UPS shall have built-in protection against: surges, sags, and over-current from the AC rectifier input source, over-voltage and voltage surges from output terminals of paralleled sources, and load switching and circuit breaker operation in the distribution system.
- The UPS shall be protected against sudden changes in output load and short circuits at the output terminals. The UPS shall have built-in protection against permanent damage to itself and the connected load for all predictable types of malfunctions. Fast-acting current limiting devices shall be used to protect against cascading failure of solid-state devices. Internal UPS malfunctions shall cause the module to trip off-line with minimum damage to the module and provide maximum information to maintenance personnel regarding the reason for tripping off line. The load shall be automatically transferred to the bypass line uninterrupted, should the connected critical load exceed the capacity of the available on-line modules. The status of protective devices shall be indicated on a graphic display screen on the front of the unit.

5.2.9. Battery system

- The battery system shall be sized to provide 30 minutes backup time when the UPS is supplying 100% rated load at 0.9 load power factor.
- The battery system design shall be provided with necessary devices to prevent deep discharge beyond recommended limits to prevent the batteries discharging beyond end cell voltage specified by the battery maker. The connections from battery to battery shall be by using copper cable and BCB (Battery circuit breaker).
- All batteries shall be clearly identified and identification numbers marked on the batteries and a schematic diagram along with the complete calculations, including manufacturers supporting curves, shall be submitted with the tender.
- Batteries shall be VRLA (Maintenance-Free) type. Constant current boost charging, constant voltage boost charging, float charging (float charging compensation) and EOD protection are available for different kinds of batteries.
Charging: In addition to supplying power to the load, the battery converter shall be capable of producing a battery charging current sufficient to replace 95% of the

battery discharge power within ten (10) times the discharge time. Ripple voltage at the battery terminal (RMS) should be less than 1%, and ripple current must not exceed 5% (of C-10 Ah rating) nominal discharging current. (Number of battery is 25 - 40 blocks, nominal voltage is 12V per block).

- Discharging: The battery converter will supply power to the inverter when the rectifier is shut down or in joint mode, and also the rectifier is current limiting.

5.2.10. Operation

- Under normal operation, the UPS load will be fed from the Inverter with the bypass switch inhibited. The rectifier, apart from providing DC power to the Inverter, also charges the battery under the float charge mode. The battery charge system shall have float charge, equalizing charge and recovery charge modes, to replenish the batteries self-discharging part while the battery is fully charged, equalizing the battery cell voltage to a constant value forcibly, and recharging the battery system to the required values when the batteries have been used, respectively.
- The Inverter shall constantly monitor the AC source frequency and shall be in synchronization with the AC input source till the frequency of the AC input source is within synchronizing limit and if the frequency of the standby source exceeds the synchronizing limit the Inverter will work on its own internal oscillator maintaining an output frequency of 50 Hz +/- 0.01% under all conditions of load. When the Inverter operates on its internal oscillator, it shall continuously monitor the frequency of the input source and when the input source frequency returns to within synchronization limit, the Inverter shall automatically synchronize itself with the input A/C source frequency and use it as a signal for Inverter output frequency control.
- When the A/C input voltage drops below specified limits or in case of a power failure the Inverter continues to supply AC power of constant voltage and constant frequency utilizing the battery system as a power source until the input voltage returns to normal requirement. When the power supply is resumed or the input voltage returns to limits, the Converter shall automatically start and the load fed for normal operation status.
- If the power failure continues beyond battery backup time or the battery voltage drops to the final discharge voltage, the Inverter should automatically stop and at the same time transferring the load to the bypass circuit. On resumption of power supply, the Converter shall automatically re-start the operations and charge the batteries whereas the Inverter should inhibit automatic start and should be started manually.
- When power is supplied from the Inverter in synchronization with the bypass, it shall accomplish the following:
 - a. When the UPS output current reaches overload status it shall automatically transfer the load to bypass circuit with no interruption and when the overload status is cleared it automatically re-transfers the load to Inverter.
 - b. When the battery final discharge condition is reached, the load shall automatically be transferred to the bypass circuit without interruption.
 - c. In case of failure of the UPS, the load shall be automatically transferred to the bypass circuit with no interruption and when the failure is cleared, re-transfer the load to the Inverter shall be done manually.
 - d. There should be provision made in the system to prevent, when necessary, asynchronous transfer.
 - e. When the UPS goes on bypass mode in any of the conditions described above and if at that time there is no bypass power supply available due to power failure, the UPS shall remain in standby mode and as soon as the bypass power supply is available will

transfer the load to bypass.

f. A maintenance bypass transfer switch shall be provided with lock and key arrangement and should be manually done by authorized personnel only.

- The entire UPS system, including all components like inverter, static switch, maintenance bypass, shall be housed in free-standing steel type factory-finished enclosures complying with the protection standards of IP20. The enclosure shall be open able using a special tool for internal access. The color shall be light grey.
- Forced air-cooling shall be provided to allow components to operate within their rated temperature specified. The cooling fans shall have thermal relays protection using a latched cut fire re-setting, as a protection for the cooling fans.

5.2.11. Control and monitoring

- The UPS shall have Simple Network Management Protocol (SNMP) card with system (RS485 compatibility port) for interfacing to IBMS system or client's centralized computer network for Control and Monitoring System.
- It shall be provided with LED displays. The display system shall have, as minimum individual
- LEDs with different colors for the following:
 - a. Load on Inverter
 - b. Battery operation
 - c. Load on Bypass
 - d. UPS failure
 - e. LCD failure
 - f. Overload
- Statistical data Providing all statistical data like no. of days of UPS operation, no. of mains failures up to 1min, 2min etc., no. of overloads up to 110%, 125% etc, no. of hours operation on battery & on bypass etc., no. of hours battery temp exceeded 25 degree C.
- LCD touch panel
- The UPS shall be provided with a operator friendly large scale LCD touch panel.
- The LCD touch panel shall also include graphic measurement display, operational procedures of each activity, fault status display and also have capability to record at least 50 faults.
- The touch screen panel shall clearly define specified areas for operational function, execution and message display.
- It should be possible to operate the entire UPS system and its components and obtain all measurements and data through the touch screen operation. The measurement software should provide capability to measure phase voltage, current in each phase, frequency, power factor, available battery time etc.
- Under all operating conditions, the system software should have capability for displaying fault alarm automatically. The Firm should describe in detail the faults that would be displayed under this mode.

5.2.12. Installation, Testing & Commissioning

- Installation of UPS shall be carried out as per manufacturer's instructions and installation shall be verified by the manufacturer before energizing.
- Type testing shall be conducted from accredited Lab. Copies of the test certificates for same rating shall be submitted at the time of vendor approval. These shall not be more than **5 years old from the date of approval of drawing.**

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- Testing at manufacturers' works shall be conducted before dispatch as per routine verification requirements.
- Physical check including checking damage/crack in any components, etc shall be done at site.
- Following test shall be performed, as a minimum, at site prior to handing over, to confirm the functional and the performance specification of the UPS as specified. All required test equipment like Digital Oscilloscope, Voltage Regulator and Measurement Meters etc. shall be the responsibility of the concerning vendor without any additional cost.
- Full load testing of UPS with required size load bank shall be done at site as per the approved QAP. All testing expenses including load bank and its arrangements shall be under the scope of vendor.

The vendor shall demonstrate as a minimum the following features on site by providing all required test equipment, such as power factor improvement, input current THD, output voltage THD, output frequency and all other performance monitoring requirements detailed before as required by the Owner.

5.3. LT PANEL

5.3.1. Scope

The scope of work shall include:

1. Supplying, installation testing and commissioning of LT Panels for substation
2. Panel handling, loading unloading and storage.
3. Associated inter panel and intra panel wirings including both ac and dc wirings as well as control cabling, from panel to panel and from panel to DB.

5.3.2. Definitions

The definitions shall be as per IEC-61439 and other relevant IEC standards.

5.3.3. Codes & Standards

The contractor is required to follow all relevant IS and IEC codes as per latest amendments, however in particular following codes may be applied in addition.

1. IEC-61439 - Standard for low voltage switchgear and assemblies.
2. IEC-60044 - Standard for instrument transformer.
3. IEC-60099- Standard for surge arrester.
4. IEC: 60255- Measuring relays and protection equipment.
5. IEC -60947 - Low voltage switchgear and controlgear.
6. IS 2147 - Degrees of protection provided and enclosures for low voltage switchgear and control gear
7. IS 375 - Marking and arrangement of bus bars.
8. IS 13703-1993- HRC Fuse Links

9. IS 2705- Current Transformer
10. IS 3231- Relay
11. IS 1248- Indicating Instruments
12. IS 722- Integrating Instruments
13. IS 6875- Control Switches & Push Buttons.
14. NEC- 2008 - National electrical code.
15. NBC-2016 - National building code.
16. IER-1956 : Indian electricity rules.
17. IEA-2007 : Indian electricity act 2007
18. Any other local bye-law or supply company norm as applicable.

5.3.4. Service conditions

System particulars

- a. Nominal system voltage - 415V
- b. Rated system voltage - 1.1kV
- c. Frequency- 50Hz \pm 3%
- d. No. of phases- 3
- e. System neutral- Solidly earthed
- f. Short circuit rating - 50kA for 1 sec
- g. Automation compatibility : SCADA compatible

Tropical conditions

- a. Ambient temperature : 50 degree celsius
- b. Relative humidity (avg.) : 60
- c. Isokeraunic level : 33
- d. Seismic Zone : Zone-4
- e. Climate type : hot and humid

The climatic conditions are prone to wide variations in ambient conditions and hence the equipment shall be of suitable design to work satisfactorily under these conditions.

Tolerances and creepage distance

Tolerances (on all the dimensions) and creepage distances shall be in accordance with provisions made in the relevant Indian/IEC/BIS standards and in these specifications. Otherwise the same will be governed by good engineering practice in conformity with required quality of the product.

5.3.5. Specifications

Panel Cubical Construction

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- The complete panel assembly shall be a design verified assembly with design verification done as per IEC-61439.
- Panel fabricated out of 2mm CRCA sheet steel throughout and shall have undergone 7 tank process or better.
- Undrilled gland plates shall be 3mm thick. The gland plates shall have knock able type holes of suitable diameter of cable glands. Minimum 30% extra knock able holes shall be provided on each gland plate. Non-magnetic gland plates shall be used where single core cables are used for three-phase supply.
- The panel shall be self-supporting, free standing or wall mounted.
- The enclosure shall confirm to IP55 protection for outdoor panels and IP42 for indoor panels.
- The Panel shall be dust, vermin, corrosion proof and shall be mechanically stable to take the mechanical load of complete assembly with all fixed and moving components.
- The panel shall have appropriate protection against mechanical impact.
- The panel shall be extendable from both sides.
- The terminal blocks shall be provided at convenient location for cable termination. The distance between the terminal strip and gland plate shall be kept in such away that the cables can be properly dressed & no cable tension is transferred on the terminal strip/or equipment.
- Proper grouting arrangement shall be made in panel for installation of panel in accordance with seismic requirement.
- Complete panel assembly shall be fixed on ISMC-100.
- The design shall ensure generous availability of space for ease of installation and maintenance of cabling, and adequate safety for working in one vertical section without coming into accidental contact with live parts.
- Front and rear doors should be fitted with synthetic rubber or neoprene gaskets with fasteners designed to ensure proper compression of gaskets.
- All sheet steel work forming the exterior of switch boards shall be smoothly finished, leveled and free from flaws. The corners should be rounded. The apparatus and circuits in the panels shall be so arranged as to facilitate their operation and maintenance and at the same time to ensure the necessary degree of safety.
- Panel shall be constructed in form-3b methodology.
- All sheet steel work used in construction of panels shall be given for proper shot blasting/surface finish to make it free from all rusts/impurities/deposits.
- It shall be then provided with two primer coat and then/powder coated (electrostatically) with final paint shade RAL7032 as per IS – 5.
- It shall be the process of Powder Coating with suitable primer and having total coating thickness of 85-100 micron. The M.S Sheet Steel shall be given for proper shot blasting / surface finish to make it free from all impurities.
- All sheet steel work used in construction of panels should have undergone a rigorous metal treatment 7 tank process or better as mentioned below.
 - a. All sheet steel work shall be phosphate in accordance with the procedure in accordance with relevant standards for phosphatizing iron and steel. Oil, grease and dirt shall be thoroughly removed by emulsion cleaning.
 - b. Rust and scale shall be removed by pickling with dilute acid followed by washing with running water, rinsing with slightly alkaline hot water and drying.
 - c. A recognized phosphate process to facilitate durable coating of the paint on the metal surface and also to prevent the spread of rusting in the event of the paint film being mechanically damaged. This again, shall be followed by hot water rinsing to remove traces of phosphate solution.
 - d. After phosphatizing through rinsing shall be carried out with clean water followed

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by final rinsing with dilute dichromate solution and oven drying.

e. Passivation in deoxalate solution to retain and augment the effects of phosphatizing.

Busbars and internal connections

- The selection, design and construction of bus bars shall conform to IS/IEC specifications and the latest amendments.
- Busbars shall be designed to carry rated currents during both steady state and transient conditions.
- The bus bars shall be air insulated and made of high conductivity, high strength electrolytic grade aluminium.
- Bus bars shall be located in air-insulated enclosures and segregated from all other compartments of the cubicle.
- Direct access or accidental contact with bus bars and primary connections shall not be possible.
- Bus bars shall be rated in accordance with service conditions and the rated for continuous and short time current ratings specified in SLD / data sheets.
- Busbars shall be design for a temperature rise of 40 degree celsius above the ambient temperature, while for all bolted connections of bus it shall be 45 degree celsius.
- The busbar shall be designed for a temperature of 190 degree during transient conditions.
- Bus bars shall be adequately supported on SMC/DMC insulator supports to withstand electro dynamic stresses due to short circuit currents.
- Bus bar support insulators shall be of non-hygroscopic material and shall conform to relevant IS standards.
- The current density of the bus bars shall not be less than 0.8 Amp / sq mm.
- Bus bars should be color coded for easy identification of individual phases and neutral.
- All the bus bars should be provided with color coded heat shrink sleeves.
- A main horizontal aluminum grounding bus, rated to carry maximum fault current, extending along the entire of the panel shall be provided.
- The ground bus shall be provided with two-bolt drilling with GI bolts and nuts at each end to receive the main Earthing grid.
- The size of the earth bus shall be as mentioned in drawings and schedules
- Important parameters for complete panel assembly shall be as follows :
 - a. Voltage - $415V \pm 6\%$
 - b. Frequency - $50\text{hz} \pm 3\%$
 - c. No. of Phases - 3 + 100% Neutral + Earth bus
 - d. Peak Impulse Voltage - 12KV
 - e. Power frequency withstand capability – 2.5KV (power circuit) and 2KV (control circuit)
 - f. Short circuit withstand capacity - 50kA for 1 second
 - g. Type of discrimination required among switchgears - Total discrimination
 - h. Min clearance and creepage distance - As per IEC-61439
 - i. Dimensions : As per approved type tested design.
- Control wiring for all control circuit shall be done as follows :
 - a. Each control circuit shall be protected with the help of DP MCB .
 - b. Control wiring shall be done with 1.1kV grade FRLS type control cables tested for power frequency withstand of 2kV.
 - c. All voltage circuits shall be wired with 1.5sqmm cu control cables.
 - d. All current circuits shall be wired with 2.5sqmm cu control cables.

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- e. Control wiring shall be done neatly with proper dressing and ferruling done.
 - f. Control wiring shall be color coded appropriately.
 - g. Terminal links used for control wiring shall be of good quality and shall withstand the temperature.
 - h. All connections must be be tight.
- Power wiring for main circuit shall be done as follows :
 - a. Switchgears of 100A rating and above shall be connected by the means of suitable busbars only.
 - b. Cable terminal blocks used for power cable termination shall be suitable to withstand the temperature rise due to steady state and transient currents.
 - c. All connections must be be tight.

Safety features and Interlocks

- The safety shutter shall be provided in breaker panels, which shall prevent in advertent contact with isolating contacts when breaker is withdrawn from the Cradle.
- Door interlocking shall be provided in each switchgear compartment with a provision of defeat interlock .
- All panel doors shall have provision of padlocking.
- Insulating barriers shall be provided in all live sections of the panel.
- There shall be provision of positive earth connection between fixed and moving portion of the ACB either through connector plug or sliding solid earth mechanism.
- Earthing bolts shall be provided on the cradle or body of fixed ACB.
- Arc chute covers shall be provided wherever necessary.
- In case of drawout type switchgears safety shutters shall be provided to fully cover the live section automatically once the switchgear is being draw out
- It shall be possible to bolt the draw-out frame not only in connected position but also in TEST and DISCONNECTED position to prevent dislocation due to vibration.
- There shall be provision for locking the breaker in all three positions.
- The breaker shall be provided with interlock to prevent the breaker from being withdrawn or replaced except in the fully isolated position.
- Interlock shall also be provided to prevent the breaker from closing without in service position.
- Space heaters triggered by thermostat shall be provided in cable compartments to avoid moisture.
- Lamp operated with a door limit switch and a toggle switch shall also be provided in panel compartments along with 6/16A witch socket for ease of maintenance

Air Circuit Breaker (ACB)

- ACB shall be mechanically rugged and shall be designed to carry steady state current and also transient current up to the time arc gets quenched.
- The moving parts of 4 pole circuit breaker shall have operating mechanism, primary and secondary isolating devices, auxiliary switches, mechanical position indicators, all mounted on a rigid sturdy steel frame work.
- Primary and secondary disconnecting devices shall be self-aligning type of fully isolating.
- On/Off push buttons shall be provided in ACB in such a way that ACB can be switched ON or OFF without opening the switchgear compartment. Breaker shall also trip without opening switchgear compartment.
- ACB shall be mounted on a cradle and shall be withdrawable type.

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- The cradle shall be so designed and constructed as to permit the smooth withdrawal and insertion of the breaker into it.
- The movement shall be free from jerks, easy to operate and shall be on steel balls/rollers and not on flat surfaces.
- There shall be 3 distinct and separate positions of the circuit breaker on the cradle.
 - a. Service : Both main and secondary isolating contacts in service.
 - b. Test : Main isolating contacts separate and secondary isolating contacts in service.
 - c. Isolated : Both main and secondary isolating contacts in isolated.
- Both mechanical and electrical indications shall be provided for TEST and SERVICE position.
- ACB maintenance trolley shall be provided by the contractor to rack out ACB
- ACB shall have following parameters / features :
 - a. Rated voltage – 415 +/-6% V
 - b. Rated frequency - 50Hz
 - c. P.I.V - 12kV
 - d. Rated short circuit capacity - 50kA for 1 sec.
 - e. Poles - Four pole
 - f. Temperature deration : No deration upto 50 degree celsius (In case deration is applicable, higher rating switchgear shall be provided)
 - g. Self watt loss : As per IEC-60947
 - h. Total breaking time : less than 70ms
 - i. Closing coil : suitable for 230V AC
 - j. Shunt coil : suitable for 230V AC
 - k. Drawout type : Electrical
 - l. Spring charge operation : Through 230V AC motor as well as through handle.
 - m. Antipumping feature : Required and shall be inbuilt.
 - n. $I_{cs} = I_{cu} = I_{cw} = 100\%$
 - o. Spare contacts required : 4NO + 4NC
 - p. Indications : On, Off, Trip, Spring Charge, Ready to close
 - q. Undervoltage coil : As per design requirement.
 - r. Time delay (td) - 0-400 m sec
 - s. Inbuilt thermal memory

- Release of ACB shall have following parameters / features :
 - a. Protections : L,S,I,G
 - b. Setting options : L - 40%-100% I_n (nominal current rating) = I_r
 - S - 2 x I_r to 10 x I_r
 - I - 6 x I_n to 12 x I_n
 - G - 10% ,20% , 50% , 100%
 - c. Release type : microprocessor based.
 - d. Zone selective interlocking - required.
 - e. Communication : Fully communicable and shall be equipped with RS-485 port.
 - f. Memory : Non volatile memory to record 10 trip histories and 10 alarm history.
 - g. Alarm and indications : Visual indications for % loading in each phase, L,S,I,G fault, release failure
 - h. Release shall be capable to generate remote alarm in case of any internal fault and Spare contacts shall be provided with release to do so.

Moulded Case Circuit Breaker (MCCB)

- MCCB shall be mechanically rugged and shall be designed to carry steady state current

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- and also transient current up to the time arc gets quenched.
- MCCB shall be provided with door operating mechanism having interlock, defeat and padlocking facility.
 - MCCB should trip free, quick make and quick break type and should be equipped with a current limiting feature.
 - MCCB shall have spreader links and terminal shroud as a feature for safety and proper heat dissipation.
 - MCCBs shall have double break mechanism.
 - MCCB shall have following parameters / features :
 - a. Rated voltage - 690V
 - b. Rated frequency - 50Hz
 - c. P.I.V - 12kV
 - d. Rated short circuit capacity - **50kA (minimum)**
 - e. Poles - Four pole
 - f. Temperature deration : No deration upto 50 degree celsius (In case deration is applicable, higher rating switchgear shall be provided)
 - g. Self watt loss : As per IEC-60947
 - h. Total breaking time : less than 40ms
 - i. Shunt coil : suitable for 230V AC
 - j. Drawout type : Non withdrawable (fixed type)
 - k. $I_{cs} = I_{cu} = 100\%$
 - o. Spare contacts required : 2NO + 2NC
 - p. Indications : On, Off, Trip
 - q. Undervoltage coil : As per design requirement
 - Release of MCCB shall have following parameters / features :
 - a. Overload setting (L) $0.4-1 \times I_n$
 - b. Short circuit setting (with time delay)(S) $2 -10 \times I_r$
 - c. Time delay (td) 0-400 m sec
 - d. Short circuit setting (Instantaneous) (I) $11 \times I_n$
(Where I_n = nominal current of MCCB & I_r = rated current to which it is set.)
 - e. Ground Fault Setting with time delay (0-300ms) (G) : $0.1-1 \times I_n$
 - f. Neutral setting (N) (where ever required): $0.5-1 \times I_n$
 - g. Release type : microprocessor based
 - h. Communication : Fully communicable and shall be equipped with RS-485 port.
 - i. Memory : Inbuilt thermal memory.
 - g. Alarm and indications : Visual indications for L,S,I,G fault
 - h. Release shall be capable to generate remote alarm in case of any internal fault and Spare contacts shall be provided with release to do so.

Contactors

- All contactors and bi-metal relays should conform to IS - 13947 - 4/IEC - 947-4 standards.
- Contactors should be suitable for requisite duty and the contactor shall be designed to operate even in severe operating conditions.
- The Contactors shall be suitable for switching and controlling squirrel cage and slipping motors as well as other AC loads such as solenoids, capacitors, lighting loads, heating loads and transformer loads.
- The contactors shall be suitable for operation in service temperature up to 50 degree C without derating.
- The contactors and bimetal relays shall have been tested for type-2 co-ordination at

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50KA, 415 V 50 Hz as per IS 13947 for both fuse protected as well as fuse-less motor feeders.

- The contactor shall have coil of 220/240 V AC or as may be specifically asked for.
- The design of the current carrying parts, contact system and the magnet system should be such that it should increase reliability of electrical and mechanical endurance.
- Auxiliary contact should have double break parallel bridge contact mechanism. For operator safety the contactors above 45 Amp should have arc-chamber. The construction of the arc chamber should be such that there is no emission of arc by-products on the surrounding equipment.
- The contactor shall have funnel shaped cable entries, cable end stops and predetermined insertion depths.
- Contactor below 63 Amp shall have captive screws preventing the screws from falling.
- Main contacts should be of silver alloy to have long contact life; it should withstand to keep the contact bounce to minimum and should be shrouded with an arc chute.
- Both moving and fix contacts should be accessible for inspection or replacement without disturbing terminal wiring.
- The magnet system should have laminated, construction to minimize the losses.
- Coils should withstand high temperature and ensure low power consumption. Coil should be resin cast/encapsulated. It should have inter layer insulation.
- Contactor should have facility to mount add-on auxiliary contact block. Mechanical interlocks should be provided for sequential operations if required.
- Contactor should be comfortably mounted in any position on a vertical plane. Contactor should be capable of handling high transient currents.
- It's Insulation voltage level should be – 1000 v. Contactor shall be designed to have mechanical endurance of the order of minimum 15 million operations or better.
- Contactor should operate without deration from - 30° C to +50°C

Current Transformer

- Current transformers shall comply with the requirements of IS. 2705.
- The current transformers shall be core type with castresin/encapsulated secondary winding.
- CTs shall be mounted on the switchboard stationary part.
- The secondary CT leads from all panels should be terminated on the front of the board on easily accessible shorting type terminal connectors so that operation and maintenance can be carried out when the panels are in service.
- CT's shall be given heat run test.
- CT shall have following parameters / features :
 - a. Rated voltage - 415V
 - b. Rated frequency - 50Hz
 - c. Class : 0.5 (for metering) / 5P10 for protection / PS for unit protection
 - d. Rated short circuit capacity - As per fault level
 - e. Construction - Ring / wound type
 - f. Burden - As per SLD
 - g. Rated secondary current : 5A

Control switches

- Control Switches shall be of the heavy-duty rotary type with escutcheon plates clearly marked to show the operating position.
- They shall be semi-flush mounting with only the front plate and operating handle projecting.

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- Circuit breaker control switches shall be of the spring return to neutral type, while instrument selector switches shall be of the stay-put type.

Push Buttons

- Push buttons should be of the momentary contact, push to actuate type.
- Push Buttons should be panel mounted, flush type having 22.5 mm Ø.
- Push Buttons should be spring returns type.
- Lock and key head with Push turn facility.
- Modular blocks should contain NO-NC contact.
- It should be snap-fit type for easy assembly.
- Double break self-cleaning contacts for prolong life.
- NO-NC contact block should be colour coded for easy identification.
- Push Buttons should have transparent shroud and rubber shroud to enhance protection against ingress as per IP- 67.
- It should withstand operating voltage as well as frequent operation.
- It should have finger proof shrouded terminals.

Terminal Blocks

- Insulating barriers shall be provided between adjacent terminals. CT Terminal blocks shall be shorting type.
- Terminal blocks shall have a minimum current rating of 10 Amps & 650 volt grade rating complete with insulated barriers. Provisions shall be made for label inscriptions.
- It should have snap fit action.
- It should have captive-screws and self-lifting washers.
- Withstand temp range from -30° C to 100° C.
- Terminal Connectors should have flame retardant property confirming to UL-94, V-2.
- Terminal Block should be suitable for commonly used DIN Rail – 35 X7.5 mm and mounting channel 'C' shaped Std.32 mm.
- Terminal Block should be suitable for commonly used DIN Rail – 35 X7.5 mm and mounting channel 'C' shaped Std.32 mm.
- The construction material should be of high quality like polyamide 6/6 and contacts of Nickel plated brass. Labels shall be of anodized aluminum, with white engraving on black background.
- They shall be properly secured with fasteners.

Digital Energy Meter

- The load manager shall be micro-controller based unit capable to measure a host of electrical parameters and display them on a 128 x 64 backlit LCD.
- It shall have load management feature and shall have six numbers of output relay contacts apart from CT/PT contacts.
- These outputs shall be individually field programmable for both the parameter on which to generate alarm as well as the values on which to activate alarm and deactivate it.
- In addition to this flexibility in terms of load management, the load manager shall also have RS485 port. RS485 supports MODBUS RTU protocol for connections to EMS/SCADA.
- The unit shall be made for three phase four wire system. The installation type, CT ratios and PT ratios shall be site selectable.
- The Load Manager with its six relay contacts shall be capable to be used as a Demand

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Controller. The method of Demand calculation i.e. sliding window, fixed window shall be selected at site. The device shall have all the features needed to implement a robust electrical load management system.

- It shall be programmable / configurable to suit most control and communication needs. The load manager shall be capable to measure following parameters:
 1. Voltage (Volts L-N & L-L) VL-N Accuracy: 0.5% of Reading VL-L Accuracy: 1.0% of Reading.
 2. Current (Amps IR, IY, IB) Accuracy: 0.25% of Reading.
 3. Line Frequency 45 to 55 Hz, Accuracy: 0.3% of Reading.
 4. Active Power (P) Accuracy: 0.5% of Reading (For IPFI>0.5).
 5. Reactive Power (Q) Accuracy: 1.5% of Reading (Between 0.5 Lag to 0.8 Lead).
 6. Apparent Power (S) Accuracy: 0.5% of Reading.
 7. Power Factor For Individual phases and System. Accuracy: 0.5% of Reading (IPFI≥0.5) Range of Reading: 0.05 to 1.000 Lag/Lead.
 8. Total Active Energy (KWh) Range of Reading: 0 to 9999999.9 KWh Accuracy: Class 0.5 as per IS14697.
 9. Total Apparent Energy (KVAh) Range of Reading: 0 to 9999999.9 KVAh Accuracy: Class 0.5 as per IS14697.
 10. Total Reactive Energy (KVARh) Range of Reading: 0 to 9999999.9 KVARh Accuracy: Class 0.5
 11. 3 rd to 15 th Harmonics(Odd) for all Voltages with THD.
 12. 3 rd to 15 th Harmonics(Odd) for all Currents with THD.
 13. Active Power (KW) Demand - Sliding & Fixed, Selectable.
 14. Apparent Power (KVA) Demand - Sliding & Fixed, Selectable
- The device shall also have following features:
 1. Display 128 X 64 Graphical LCD with Operating temp 10°C to 50°C.
 2. Data Logging Buffer 2 MB, Non-volatile memory, capable of holding 19691 records LoggingDuration Site selectable.
 3. RS485 Modbus-RTU protocol
 4. Communication USB 8.0 Pen-drive For downloading logged data

5.3.6. Installation, Testing and Commissioning

- The complete Panel assembly shall be installed in accordance with the manufacturer's installation drawing duly approved by "The consultant "
- The panels needs to be grouted considering the seismic zone requirement.
- Panels shall be properly aligned and the leveled within tolerance of +/- 2mm and shall be ensured with a water level indicator or a laser gun whichever available. No shim shall be allowed to make a panel level suitably.
- All live sections and compartments shall be covered with insulation barriers.
- All the components of the panel shall be easily accessible.
- The location of installation shall be cleaned and co-ordination shall be made with other disciplines.
- Grouting holes shall be provided from inside and the panel shall be suitably and tightly bolted. No tuck welding with base channel is allowed.
- Panels shall have peel-able poly layer on the cover for protection from cement, plaster, painted. during the construction period.
- The holes made in enclosure for cable termination or anything else shall be made only through drill machine or approved cutting tool with marking of dia done prior to cutting or drilling. Extra left out holes shall be filled neatly with fire retardant sealant.

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- The Panel shall be tightly grouted. No spare nuts-bolts shall be left out un-tightened / open inside the DB enclosure in any case.
- Gland plates where ever used for cable termination shall be tightly fixed and shall be earthed.
- Size of Horizontal and vertical bus bars shall be equal.
- Switchgears above 63A shall be mounted on bus bars tightly and accurately.
- Termination lugs shall be tightly fixed and connected and there shall not be any bare wire strand jetting out of the lugs. Suitable crimping tool shall be used and terminal wires shall beloved with heat shrinkable sleeves whose color coding has to match with the color of the wire used.
- Color coding shall be followed for internal wiring also in a similar pattern as described. Bus bar shall be tagged for phase indication.
- Panel compartments shall be provided with space heaters and lights operated by door limit switches.
- The door of panel shall be aligned properly and there shall be no air gap left after closing the DB door. Gaskets shall be used to make DB free from moisture.
- Panel shall have Padlocking arrangement and shall be pad locked after complete installation.
- Panel board shall be fully tested (both type and routine test) for its components as per the specification laid under Indian standards. In particular following test shall be done :
 - (a) Continuity test (both earth continuity and loop continuity)
 - (b) Insulation resistance test.
 - (c) Contact resistance test.
 - (d) Primary injection test.
 - (e) Trip test and trip unit reset test with Test knob of breaker.
 - (f) CT testing (Polarity, Knee voltage)
 - (g) Phase rotation test.
 - (h) HV test on bus bar
 - (i) Space heater Testing
 - (j) Control wiring check

5.4. LT CABLE AND TERMINATION (AC and DC cables)

5.4.1. Scope

The scope of work shall include:

1. Supplying, laying, testing and commissioning of 1.1kV grade power cables and control cables suitable for 415V, 3Phase , 50Hz AC supply and also for 230V, 1Phase , 50Hz AC supply.
2. Supplying, laying, testing and commissioning of 1.8kV grade, DC power cables suitable for 325V, bipolar DC supply.
2. Handling, loading, unloading and storage of both AC and DC cables.
3. Civil works, piping works and ducting works required for cable laying as per tender document.
4. Cable termination using double compression brass glands and lugs (cu lugs for cu cables and Al lugs for Al cables) as specified

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5. The Cables shall be Copper cables. Power/ Control cables shall be multicore cable with number of cores as per requirement and with 20% spare cores but shall be minimum 6 core cable. Procurement of cables shall be done only after getting approval from Engineer-In-Charge and Design Consultant.

5.4.2. Definitions

The definitions shall be as per IS 7098-Part 1, IEC 60050-461 and IEC 60502-2

Abbreviation used to define the following are stated in front of the entity

Aluminium Conductor - A

XLPE Insulation - 2X

Steel round wire armor - W

Steel strip armor - F

Steel Double round wire armor - WW

Steel Double strip armor - FF

Non-magnetic (A1.) round wire armor - Wa

Non-magnetic (A1.) strip armor - Fa

PVC outer sheath - Y

5.4.3. Codes & Standards

The contractor is required to follow all relevant IS and IEC codes as per latest amendments, however in particular following codes may be applied in addition.

1. IS 7098-Part 1- Specifications for XLPE insulated thermoplastic sheathed cables, for working voltage up to 1.1kV (including 1.1kV)
2. IS-1255 - Code of practice for installation and maintenance of power cable up to 33KV rating
3. IEC 60502-1- Standard for cables for rated voltage from 1KV up to 6kV ($U_m=1.2kV$)
4. IEC-60050-461- Definitions for cables.
5. IEC-60811 - Common test methods for cable insulation.
6. IS : 3961- Part 2: Recommended current ratings for cables.
7. IS : 8130 Conductors for insulated cables.
8. IS : 5831 XLPE Insulation and outer sheath of electric cables.
9. IS : 10418 Specification for drums for electric cables.
10. NEC- 2008 - National electrical code.
11. NBC-2016 - National building code.
12. IER-1956: Indian electricity rules.
13. IEA-2007: Indian electricity act 2007

14. Any other local bye-law or supply company norm as applicable.

5.4.4. Service conditions

System particulars

- a. System voltage - 415/230 V for AC cables and $\pm 325V$ for DC cables
- b. Frequency- 50Hz $\pm 3\%$ for AC cables
- c. No. of phases- 3 for AC / 2 (poles) for DC
- d. System neutral- Solidly earthed
- e. Short circuit rating - As per system fault level

Tropical conditions

- a. Ambient temperature: 50 degree celsius
- b. Relative humidity (avg.) : 60
- c. Isokeraunic level: 33
- d. Seismic Zone: Zone-4
- e. Climate type : hot and humid

The climatic conditions are prone to wide variations in ambient conditions and hence the equipment shall be of suitable design to work satisfactorily under these conditions.

Tolerances and creepage distance

Tolerances (on all the dimensions) and creepage distances shall be in accordance with provisions made in the relevant Indian/IEC/BIS standards and in these specifications. Otherwise the same will be governed by good engineering practice in conformity with required quality of the product.

5.4.5. Specifications

LT Cables (AC & DC):

- Cables shall be XLPE insulated PVC sheathed, Al or Copper conductor as specified.
- Cable shall be heavy duty type.
- Stranded Aluminum/Copper conductor shall be used.
- All Aluminum/Copper XLPE cables insulation shall be of high grade Cross- linked Polyethylene for insulation for extrusion process. Cores laid up.
- The inner sheath shall be bonded over with thermoplastic material for protection against mechanical and electrical damage.
- Armoring should be provided over the inner sheath to guard against mechanical damage.
- Armoring should be Galvanized steel wires or galvanized steel strips as specified.
- In single core cables used in A.C. wires/strips, round steel wires should be used; where diameter over the inner sheath does not exceed 13 mm, flat steel armor should be used.
- Insulation shall be of XLPE types per latest IS general-purpose insulation for maximum rated conductor temp 90 degree C.
- The Conductor shall be stranded Aluminum/Copper circular/sector shaped and compacted.
- In multi core cables the core shall be identified by red, yellow, blue and black coloring

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- of insulation.
- Conductor shall be of electrolytic Aluminum/Copper conforming to IS: 8130 and are compact circular or compact shaped.
 - In Inner sheath laid up cores shall be bonded over with thermo-plastic material for protection against mechanical and electrical damage.
 - Insulation, inner sheath and outer sheath shall be applied by extrusion and lapping up process only. The outer sheath shall have FRLS properties.
 - Repaired cables or cables made up of re-used copper / aluminium shall not be used.
 - The cables shall be suitable for laying in racks, ducts, trenches, conduits and underground buried installations with uncontrolled back fill and chances of flooding by water.
 - Progressive automatic in line sequential marking of the length of cables in meters at every one meter shall be provided on the outer sheath of all cables.
 - Both ends of the cables shall be properly sealed with PVC/Rubber caps so as to eliminate ingress of water during transportation, storage and erection.
 - Embossing of outer sheath: the following details on the other sheet of cable at a regular interval of 1(one) meter:
 - a. Name of customer : Nalanda University
 - b. Conductor size, type of insulation and voltage grade.
 - c. Manufacturer's name along with ISI mark
 - Typical parameters for AC cables shall be as follows :
 - a. Rated Maximum Voltage: 1.1 kV (rms)
 - b. Rated Frequency: 50 Hz
 - c. Rated Power Frequency Withstand Voltage (5 min): 3 kV (rms)
 - d. Rated short time withstand current for 1 sec: as per fault level
 - e. Conductor material: Aluminium / Cu. as per cable schedule.
 - Typical parameters for DC cables shall be as follows :
 - a. Rated Maximum Voltage: 1.5 kV
 - b. Maximum permissible DC voltage : 1.8 kV
 - c. Voltage withstand for 5 minutes : 6.5kV
 - d. Rated short time withstand current for 1 sec: as per fault level
 - e. Conductor material: Aluminium / Cu. as per cable schedule.

LT cable termination:

- All cable glands shall be made out of brass and of good quality as approved.
- All cable glands shall be of double compressions type.
- Termination/ Joining of power and control cables shall be done by means of compression methods using solder less tinned copper or Aluminum terminal lugs.
- For control cables terminations, ring tongue or reducer pin type lugs shall be used to suit the purpose.
- Proper crimping tools with crimping paste shall be used to maintain proper conductivity and avoid any air gap.

Cable Tags:

- Cable tag shall be made out of stainless steel minimum 1.2 mm thick and 25 mm x 100 mm size with holes provided to tag the cable.
- Following information shall be engraved in the cable with good quality material and the lettering height shall be 4.5mm

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- a. Source of the Cable from where it is supplied power.
- b. Destination where the cable is terminated.
- c. No of cores of cables.
- d. Cross sectional area of the cable
- e. Complete notation as described under definition part of cable specification.

5.4.6. Installation, Testing & Commissioning

- Cables shall be stored in a dry covered place to prevent exposure to climate conditions and wear and tear of wooden drums and it should be preferably concrete surface.
- All drums should be stored in such a manner as to leave sufficient space between them for air circulation. It is desirable for drums to stand on battens directly placed under the flange.
- In no case should the drums be stored “on the flat” i.e. flange horizontal.
- Both ends of the cables shall be properly sealed with PVC/Rubber caps so as to prevent ingress of water, miniaturization of cores and armors during transportation, storage and erection.
- On receipt of cable drums visual inspection of drums should be carried out for any damages to these cables.
- While unloading the cables certain precautions are to be taken to ensure the safety of cables. The cable end to be opened on one side and tested for its insulation and continuity.
- The cable drums should not be dropped or thrown from the trucks/railway wagons etc. during unloading operations as shock may cause serious damage to cable layers.
- A crane may be used for unloading cable drums. While lifting the cable drums with crane, it is recommended that the lagging should be left in place to prevent the flanges from crushing on the cables.
- If crane is not available a ramp should be prepared with approximate inclination of 1: 3 or 1: 4.
- The cable drums should be rolled over the ramp by means of ropes and winches. Additionally a sand bed at the foot of the ramp may be prepared to brake the rolling of the cable drum.
- Cable should not be dragged along the earth surface. Drums should be rolled in the direction of arrow only.
- For laying of cables special care is to be taken to prevent sharp bending, kinking, twisting.
- Cable should be unwound from drum by proper mounting the cable drum on a cable wheelmaking sure the spindle is strong enough to carry the weight without bending and that it is lying horizontally in the bearings, so as to prevent the drum creeping to one side or the other, while it is rotating.
- The maximum safe pulling force (when pulled by pulling eye) proper and safe method of pulling of cable should be used depending upon the site conditions to avoid any kind of damage to the cables. Following pulling forces to be noted.
 - a. Aluminum Conductor cables: 3.0 Kg/mm²
 - b. Copper conductor cables: 5 Kg/mm²
- Special care is to be taken while laying cable at bends. Following are the recommended bending radius for power and control cables.

Sr. No.	Voltage rating (kV)	PVC / XLPE cables
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		Multi core	Single core
1	Up to 1.1 kV	12D	15D
2	Above 1.1 kV to 33 kV	15D	15D

D = D is over all diameter of cable.

- Armored cables are to be laid on cable trays/ underground as per relevant design drawing and specifications.
- All flexible cables shall be laid inside exposed / canceled conduits (rigid / flexible)/ raceways or as per relevant design drawing and specifications.
- After the cable trench has been properly excavated and straightened, it shall be covered with 100 mm thick layer of sand, the cable shall then be lifted and placed over the sand cushion.
- It may be planned to lay down the cables in stacks under the trench and under such circumstances, cables shall be laid with the help of angular supports or cable trays suitable to take the load of the cable.
- In case the cable is laid with the help of angular supports inside the trench, such supports shall be provided at a regular intervals so that the cable does not sag due to its weight.
- After laying the cable the complete trench shall be filled with sand / earth up to 200 mm depth from the ground level.
- A layer of silver sand along with a good quality caution tape with warning written in Hindi and regional language shall be laid throughout along the length of the trench at this level to indicate that electrical cables are running below and the area shall not be further excavated without suitable precautions and permissions.
- The complete trench may then be backfilled with earth up to ground level.
- Riggers shall ensure that while laying, the cable should not be subjected to any form of damage. Cables shall be laid by skilled and experienced workmen using adequate rollers to minimize stretching of the cable.
- The cables shall not be laid in such a fashion that one cable crosses over the other. Proper spacing shall be left between two cables as mentioned in the GFC or as specified or directed by engineer-in-charge.
- Drain points shall be ensured inside these trenches so that in case of water logging, the water ejects out through these drain points as a result of natural gradient provided.
- Man-holes shall be provided at strategic locations so as to ease the pulling of cables and maintenance. The manhole shall be covered with suitable covers of mentioned material and dimensions as per GFC.
- When laid in cable trays above ground, power cables to be placed at the bottom most layer and control cables at the top most layer. In case of multi core power cables, cables shall be laid side by side with spacing not less than half the diameter of larger cable.
- Multi-core cables shall be clamped by means of mild steel galvanized saddles. All cables below 1.1 KV single core cables if any should be clamped by means of non-magnetic saddles.
- The saddles / clamps shall not be placed at the intervals more than 1500 mm for horizontal and 1200 mm for vertical runs.
- Multi core control cables can be laid touching each other in cable racks and wherever required may be taken in two layers. These cables should be clamped by means of PVC straps for horizontal and vertical runs. Fabricated aluminum clamps may be used at regular intervals.

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- All the cable shall be properly identified at regular intervals and care shall be exercised in laying cables to avoid forming kinks.
- The relative position of the cables, laid on the cable tray shall be preserved and the cables shall not cross each other.
- At all changes in direction in horizontal and vertical planes, the cable shall be bent smooth with a radius as recommended by the manufacturers.
- All cables shall be laid with minimum half diameter gap and shall be clamped at every meter to the cable tray and shall be tagged for identification with cable tag and clamped properly.
- Tags shall be provided at both ends and all changes in directions both sides of wall and floor crossings.
- All cable shall be identified by embossing on the tag the information as laid down under this specification.
- If there is a need to joint the cable due to finishing of cable in cable drum such joints shall be made through the approved straight through joints and jointing kits as directed by and approved by engineer-in-charge at site.
- Cables shall be fully tested (both type and routine test) as per the specification laid under Indian standards. In particular following test shall be done at site.
 - a. Insulation resistance test.
 - b. Continuity test.

5.5. Cable trays

5.5.1. Scope

The scope of work shall include:

1. Supplying, laying, testing and commissioning of cable trays and its allied accessories.
2. Handling, loading, unloading and storage of cable trays
3. Civil works associated with the said job.

5.5.2. A.6.2 Definitions

The definitions shall be as per NEMA-VE-2

Accessory: Components used to supplement the function of a straight section or fitting. Examples include, but are not limited to, dropout, cover, conduit adapter, hold-down device, and divider cable tray support.

Span: The distance between the centrelines of supports.

Cable tray system: A section or assembly of sections, and associated fittings, forming a mechanical system used to support cables and raceways.

Channel cable tray: A fabricated structure consisting of a one-piece ventilated- or solid-bottom channel section.

Connector: A component that joins any combination of cable tray straight sections and fittings.

5.5.3. Codes & Standards

The contractor is required to follow all relevant IS and IEC codes as per latest amendments,

however in particular following codes may be applied in addition.

1. NEMA VE-2 -2013
2. IS 1079 - Cable trays and their accessories
3. NEC- 2008 - National electrical code.
4. NBC-2016 - National building code.
5. IER-1956: Indian electricity rules.
6. IEA-2007: Indian electricity act 2007
8. Any other local bye-law or supply company norm as applicable.

5.5.4. Service conditions

System particulars

- a. System voltage - 415/230 V for AC
- b. Frequency- 50Hz \pm 3% for AC cables
- c. No. of phases- 3 for AC
- d. System neutral- Solidly earthed
- e. Short circuit rating - As per system fault level

Tropical conditions

- a. Ambient temperature: 50 degree celsius
- b. Relative humidity (avg.) : 60
- c. Isokeraunic level: 33
- d. Seismic Zone: Zone-4
- e. Climate type : hot and humid

The climatic conditions are prone to wide variations in ambient conditions and hence the equipment shall be of suitable design to work satisfactorily under these conditions.

Tolerances and creepage distance

Tolerances (on all the dimensions) and creepage distances shall be in accordance with provisions made in the relevant Indian/IEC/BIS standards and in these specifications. Otherwise the same will be governed by good engineering practice in conformity with required quality of the product.

5.5.5. Specifications

- Cable tray system shall comprise of hot dip galvanized G.I cable trays, with galvanizing thickness of 65 micron and standard length of 2.5 meters made out of 2 mm thick perforated sheet metal for cable trays which are 600mm wide and above and 1.6mm thick for cable trays whose width is below 600mm.
- The construction of the cable trays shall be as per the approved GA drawing from Vendor.

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- The construction of cable tray shall follow NEMA standards.
- The cable trays shall be hot dip galvanized with perforations not more than 17.5% and factory fabricated out of G.I., angle iron, tee, bends, sections, flats and perforated sheet for different loads.
- All accessories shall follow NEMA VE-2 standards

5.5.6. Installation, testing and commissioning

- The Complete installation of cable trays shall be in accordance with NEMA VE-2 standards.
- Before installing cable in the cable tray, examine cable paths to ensure all areas are free of debris that may interfere with cable installation.
- Cable tray should never be used as a walkway.
- Most cable installations require the use of cable pulling tools On horizontal straight runs, cables generally ride on rollers mounted in or on cable trays.
- These rollers should be properly spaced, depending on the size and weight of the cable, to prevent the cable from sagging and dragging in the cable tray during the pull.
- Cable manufacturer shall be contacted for information regarding proper roller spacing. Cables may be fastened to the cable tray by means of cable clamps or cable ties. Generally, cables shall be fastened every 450 mm (18 in) on vertical runs.
- Although not required by the NEC, single conductor cables can be fastened on horizontal runs to maintain spacing and ensure that the cable is confined within the cable fill area.
- When using cable clamps, the clamps should be sized correctly and tightened only enough to secure the cable without indenting the jacket.
- The same precaution should be observed with cable ties, and they should be applied with a pressure limiting device.
- Extremely long vertical drops introduce a new set of issues requiring special consideration.
- The weight per meter (foot) of the cable multiplied by the number of meters (feet) in the vertical drop, in many cases, exceeds the load carrying capacity of the cable tray component. The one or two rungs supporting this weight are likely to be damaged, and the vertical load could exceed the allowable cable tension.
- The cable weight should be supported in such a manner as to prevent damage to the cable tray or cable during this type of installation.
- As the cable is installed, intermediate supports should be installed on the vertical drop to break the cable load into segments supported at multiple places.
- Once the cable is installed in an open cable tray system, care must be taken to protect the exposed cables from falling objects or debris that could cause damage to the cable.
- In areas where the cable tray is to be covered, covers should be installed as soon as possible. Temporary protection for the cables and cable tray can be constructed of available wood or metal materials until the risk of damage has passed.
- Complete installation shall be in accordance with seismic requirements.

5.6. Relay

- Relays shall be numeric type, microprocessor based for feeder protection and shall have following required programmable protections:
 - a. Instantaneous (overcurrent and earth fault.)
 - b. Overcurrent

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- c. Earth fault
- d. Overvoltage
- e. Undervoltage
- f. Frequency
- g. CT / PT supervision
- h. Phase sequence
- i. Broken conductor protection based on negative sequence current to positive sequence current.
- Relays shall be numeric type, microprocessor based for transformer protection and shall have following required programmable protections:
 - a. Differential
 - b. Restricted earth fault
 - c. High oil temperature
 - d. High winding temperature
 - e. Sudden pressure.
- Relays shall be hinged armature type, electromechanical, for following required protections:
 - a. DC failure
 - b. Trip circuit supervision
 - c. Lockout
- Relays and circuit breakers shall be fully co-ordinated to achieve total discrimination up to main LT panel inside each distribution substation.
- Separate numeric relay shall be provided for feeder and transformer protection.
- **Relay shall confirm to IEC-61850 and shall be provided with Ethernet IP communication port. Relay shall have dual port for PR to PR communication. All protection relays shall be connected in ring topology with Ethernet switch.**
- Relay used for transformer protection shall have a feature to bypass the harmonic switching current at the time of transformer switching so as to prevent the breaker trip during switching of transformer. Circuit breaker shall be capable to handle the current at the same time.
- Numeric relays shall have self-supervision function and shall be able to communicate and provide indication in case of internal fault in relay.
- Relays shall have inbuilt volatile and non-volatile memories and shall be capable to record and store at least 100 events with date and time, with last five faults stored in non-volatile memory.
- Relays shall be completely SCADA compatible and shall have **Ethernet IP** port available for communication.
- 4 spare binary inputs and 4 spare binary outputs shall be provided in addition to those required.
- The operation of the relay shall be practically free from errors due to normal variations in frequency, waveforms & from ambient temperature effects range between - 20 degree to +55 degree C.
- The relay shall have 3 independent time delayed O/C stages. The first stage should be programmable to have either a DT characteristics or IDMT characteristics described as follows and shall have a current
 - setting range of 10% to 2500% and time setting range of 0 ms to 150 sec. The second and third settings shall have a current setting range of 50% to 4000%.
- The relay should have 3 independent time delayed E/F stages. Should have a current setting range 1% to 800% and time setting range of 0 ms to 100 sec. The lower setting is critical to take care of system which have low earth fault currents.
- The relay shall have reverse blocking or bus bar blocking feature.

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- The relay shall have 8 Indication LEDs out of which minimum 4 should be freely programmable.
- Relay shall be able to record at least 5 oscillographic disturbance records each of minimum 3 seconds.
- Relay shall have independent setting groups.
- Relay shall have at least 4 shots of auto-reclose function, switch on to Fault function, circuit breaker failure function, cold load pick up function. and inbuilt output relay latching function
- Relay shall have keypad buttons at front of the relay to configure the relay and shall be easily programmable and maintainable.
- Aux Supply input voltage shall be 110VDC however relay shall be capable to operate at 24-250VDC / 240VAC.
- Relay shall have its LCD display and any other control feature required in the relay shall be provided by the contractor at the time of product data approval at no extra time and cost.

5.7. Multifunction meter

- Multifunction meter shall be electronic, digital type with inbuilt selector switches suitable to show parameters on 11kV
- Multifunction meter shall be suitable for panel mounting, flushed type of size min 96 x 96 mm and shall be fully communicable with provision of Ethernet IP port and shall be SCADA compatible.
- Meter shall have distinct indication upon front LCD screen for following (but not limited to) data and values :
 - a. Current (for all three phases)
 - b. Voltage (for lines and phases)
 - c. Power factor (Avg. and individual phases)
 - d. Active power kW (Avg. and individual phases)
 - e. Reactive power kVAr(Avg. and individual phases)
 - f. True power KVA
 - g. Frequency
 - h. Energy kWh (Avg., current , max in a day along with date and time, min in a day along with date and time)
 - i. Reactive kVArh(Avg, current)
 - j. Energy kVAh
 - k. Total harmonic distortion THD %
 - l. Current harmonics THDi (for harmonics up to 15th order)
 - m. Voltage harmonics THDv (for harmonics up to 15th order)
- Multifunction meter shall have accuracy class of 0.5 and shall have 2 DI/DO ports.
- Multifunction meter shall be fully programmed from factory along with its CT ratio settings.

5.8. Analog voltmeter

- Voltmeter shall be analog type suitable with external selector switch.
- Voltmeter selector switches shall be four position type. Selector switch shall be suitable for semi flush mounting with only switch front plate and operating handle projecting out.

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- Range of voltmeter shall be 0-12000V for 11kV
- Voltmeter shall be PT operated with accuracy class 0.5
- Deflection needle shall be self-adjustable type.
- Front fascia shall have glass/polycarbonate cover.
- Range shall be properly engraved in the front fascia and shall be easily identifiable.

5.9. **The control cable of multiple core of copper with 20% extra should be designed and provided.**

5.10. The Area lighting and plant illumination must be provided inline of the standard industry practise.

6.0 CIVIL WORKS SPECIFICATIONS

All the civil structure designed by the bidder shall confirm to latest Indian standard codes, CPWD Specifications, NBC 2016 and other relevant standards. The Bidder shall provide at-least the following minimum design specifications for the campus as per the final design to be done by the bidder. Due to Site Condition, the Structures have to be designed on **PILE FOUNDATION**. Contractor to take a note of the same.

Sr. No	Item Description	Minimum Specification Required	Specification Document to be followed
1	All PCC Components	Minimum M10 to be used	CPWD Specifications & Relevant IS Codes
2	All RCC Components	Minimum M25 to be used	CPWD Specifications & Relevant IS Codes
3	All Reinforcement steel	Minimum FE 500D	CPWD Specifications & Relevant IS Codes
4	All Brick Work	Bricks of Minimum 7.5 MPA Strength to be used. All single brick masonry to be in CM 1:4 and remaining Brick Masonry in CM 1:6.	CPWD Specifications & Relevant IS Codes
5	All Structural steel	Minimum shall be of YST 240 Grade	CPWD Specifications & Relevant IS Codes
6	Storage sheds for feed	Shall be RCC Framed Structure with Brick masonry infill walls and roofing shall be with MS Structural frames for Epoxy Painted GI/MS Sheet or Galvalume Sheet. Flooring shall be IPS Flooring.	CPWD Specifications & Relevant IS Codes
7	Cement	OPC/ PPC 43 Grade	CPWD Specifications & Relevant IS Codes
8	Door Frames	Wooden Frames or Pressed Steel Frames with Epoxy Paint	CPWD Specifications & Relevant IS Codes
9	Door Shutters	Flush Door Shutters with Solid Cores and SS Hardware's	CPWD Specifications & Relevant IS Codes
10	Window	Wooden Windows with Glass Infill and SS Hardware or UPVC Windows with Frame and Shutter and UPVC hardware's.	CPWD Specifications & Relevant IS Codes