HSCC (India) Limited
as Executing Agency on behalf of
MINISTRY OF HEALTH & FAMILY WELFARE, NEW DELHI

TENDER

FOR

External Electrical Works for All India Institute of Medical Sciences (AIIMS) at Nagpur (Maharashtra)

Under

Pradhan Mantri Swasthya Suraksha Yojana (PMSSY)

VOLUME – IV

Technical Specification

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Executing Agency

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TECHNICAL SPECIFICATIONS

1.00 GENERAL SCOPE OF WORK

The scope of work shall cover internal and external electrical works for **AIIMS Nagpur.** The scope of work covers electrical equipments as per BOQ. Also, supply, installation, testing and commissioning of electrical works of the project including the following main items/systems:

i. H.T. Sub-station including VCB panel, Transformers, bus ducts, HT cables etc
ii. Main LT , Capacitor panels (APFC), Active harmonic Filters, MV Panels
iii. DG set
iv. UPS
v. LT Cabling.
vi. Earthling, safety equipments and misc items required for electrical installation complete in all respect.
vii. Outdoor lighting
viii. EPBAX
ix. Grid interactive Solar Photovoltaic System: If there is any incentive/ subsidy from state Govt. / Center Govt. then contractor has to arrange that subsidy including all incidental charges. However, fee etc. if any is required will be reimbursed to the contractor after submission of proof of deposit.
x. Building Management System.
xi. External PA and CCTV
xii. Boom Barrier System
xiii. Specialized services for Auditorium
xiv. Testing and commissioning of all electrical installations.
xv. Any other items/ works required for the completion of electrical work.
xvi. Enhancement/Sanctioning Electrical Load from State Electricity Board.
xvii. Submission of GA drawings of electrical equipments and getting approvals from Client/HSCC/Owner before manufacturing/fabrication.
xviii. Obtaining approvals from Chief Electrical Inspectors, Local Electricity Supply Authority, Telecom Department, and any other statutory authorities for the complete scope.
xix. Contractor shall submit equipment drawing from manufacturer along with the layout etc. and working drawings for approval from HSCC Electrical Engineer before manufacture / commencement of work at site.
xx. Contractor has to submit the working drawing of internal & external electrification based on our tender drawings for the approval of HSCC Electrical Engineer before commencement of work.
xxi. Contractor has to take the approval of DB schedule/drawing of each DB from HSCC.
xxii. If, details of any electrical item/ system are left out, then kindly refer the CPWD specifications & approval from Engineer.

2.0 REGULATIONS AND STANDARDS

2.1 All equipments their installation, testing and commissioning shall conform latest CPWD/ IS specifications in all respects. Indian Standard Code of Practice for Electrical Wiring Installation IS:732-1989. It shall also be in conformity with Indian electricity Rules and the Regulations, National Electric Code, National Building Code, latest CPWD specifications amended up to date and requirements of the Local Electric Supply Authority. In general, all materials equipment and workmanship shall conform to the Indian Standards specifications and code. Mode of all measurement will be as per latest CPWD norms/ specifications Some of the applicable codes/standards are as under:

a)	CPWD General specifications for electrical works	Part-I (Internal)- 2013
b)	CPWD General specifications for electrical works	Part-II (External)-1995
c)	CPWD General specifications for electrical works	Part-III (Lifts & Escalators)-2003
d)	CPWD General specifications for electrical works	Part-IV (Substation)-2007
e)	CPWD General specifications for electrical works	Part VII (DG Sets) 2006
f)	CPWD Specification/norms for measurement	Latest revision
g)	Guide for marking of insulated conductors	IS 5578
h)	Guide for uniform system of marking and identification of conductor and apparatus terminals.	IS 11353
i)	Low voltage switchgear and control gear assemblies	S 8623 Part-1 to 3
j)	Specification for low voltage switchgear and control gear	IS 13947
k)	Enclosed distribution fuse boards and cutouts for voltages not exceeding 1000V AC and 1200 V DC	IS 2675
l)	Code of practice for selection, Installation and maintenance of switchgear and control gear.	ISI 10118 Part – 1 - 4
m)	Low-voltage fuses for voltages not exceeding 1000V AC or 1500V DC	ISI13703 Part-1&2
n)	PVC insulated (heavy duty) electric cables	IS 1554
o)	PVC insulated cables for working voltages upto and including 1100V.	IS 694
p)	Conduit for electrical installations	IS 9537

q)	Accessories for rigid steel conduits for electrical wiring	IS 3837
r)	Boxes for the enclosure of electrical accessories	IS 14772
s)	General and safety requirements for luminaries	IS 1913
t)	Code of practice for earthing	IS 3043
u)	Electrical accessories – circuit breakers for over current protection for household and similar installations.	IS 8828
v)	Low voltage switchgear and control gear	IS 13947 part 1 – 5
w)	Residual current operated circuit beakers	IS 12640
x)	Current Transformers	IS 2705
y)	Voltage Transformers	IS 3156
z)	Direct acting indicating analogue electrical measuring instruments and their accessories	IS 1248 part – 1 to 9
A1)	Control Switches (switching device for control and auxiliary circuits including contactor relays) for voltages upto and including 1000V ac and 1200V DC.	IS 13947 & IS 1336
B1)	ONAN Transformer Dry Type Transformer	IS 1180 IS 2026
C1)	Energy Conservation Building code	(Latest)

In case of contradiction in specification the priority of the documents shall be as follows:

CPWD/ IS specification, BOQ, drawings, Technical specifications

AIIMS – NAGPUR

SPECIFICATIONS – EXTERNAL ELECTRICAL INDEX

SECTION: 2.3

TRANSFORMERS (Oil Cooled)

1.0 Scope

1.1 The scope of work shall cover the supply of transformers suitable for indoor and/or outdoor installation meeting the requirements specified in the Data Sheets. Associated minor building works required for the erection of the transformer are excluded from the scope of this contract.

1.2 Erection, testing and commissioning of the transformers shall be as specified in the section "Substation Auxiliaries And Installation".

2.0 Standard

2.1 The following standards shall be applicable.

1) IS 2026	1977	Power Transformers
2) IS 6600	1972	Guide for loading of oil immersed transformers
3) IS 10028	1985	Code of Practice for selection, installation and maintenance of transformers.
4) IS 335	1993	New Insulating Oils
5) IS:8468	1977	On-load tap changers
6) IS: 1180		

All standards shall be the latest

2.2 Tenderers should submit guaranteed performance data as per Appendix B to IS:2026 for proper evaluation of their equipment.

3.0 Construction

3.1 Transformer core shall be built up of low loss non-ageing grain oriented silicon steel insulated laminations and designed to ensure low core losses. Adequate cooling ducts shall be provided to achieve low temperature rise and hot spot temperature. Transformer tanks shall be of robust construction fabricated out of M.S plates. All welded joints and valves shall be tested after fabrication of the tank to withstand a pressure of 1.0 bar in excess of the static head of oil. Bolted joints shall carry non-deteriorating gaskets.

3.2 Transformer cooling shall be as specified in the data sheets with fixed or removable radiator tubes of seamless construction and adequately braced to the tank.

3.3 All fittings shall be provided as stipulated in the data sheets.

3.4 Winding shall have Class `A' or better insulation graded uniformly to earth. Interturn insulation of tapped windings shall be reinforced to obtain uniform stress distribution. The winding assembly shall be preshrunk by vacuum drying and impregnated with an approved insulation. Adequate ventilating ducts shall be provided in the winding.

3.5 Tappings shall be OFF-load or ON-load as shown in the data sheet and brought out from the HV winding and terminated in an external tap switch, Manual switches shall have position indicator and pad locking arrangement. Automatic ON-load tape changers shall be proven units. Transformer output shall remain unaffected for any tap position.

3.6 The Transformer shall be supplied under oil conforming to IS:335. The transformer shall be delivered after filtering and drying out to a moisture content of less than 5ppm and the content shall be tested and confirmed before dispatch. The transformer should be ready to be put into commission without further drying out at site. Should however, the precommissioning tests require drying, necessary drying with a stream line filter shall be carried out free of cost. Any other filter process is not acceptable.

3.7 RTCC panel colour shall be matched with the LT panels in in electrical room & the same will be confirmed at the time of shop drawing approval.

4.0 **Factory Testing**

4.1 Transformers shall undergo following routine tests as per IS 2026:1997 and shall form part of the test report to be submitted along with the transformer.

Ratio & Polarity tests	Winding resistance
Phase angle error	Tap contact resistance
IR Valves	Open circuit,
B D V of oil	Short circuit & Impedance tests
Polarisation Index	Separate source voltage test
Dielectric discharge	Induced over voltage test
	Vector group test
	Zero sequence voltage test

4.2 Vendor should quote for a heat run test as an optional item.

5.0 **Installation, testing and commissioning**

5.1 Installation, testing and commissioning shall be carried out as specified under the section "Substation & Auxiliaries and Installation".

6.0 **Mode of measurement**

6.1 Supply of the transformer including transport to site loading and unloading etc. as specified will be treated as one unit for measurement & payment. Installation and commissioning shall be paid separately.

6.2 It heat-run test is to be done, it shall be paid for separately.

SECTION: 2.4

HV SWITCHGEAR

1.0 Scope

1.1 The scope of work shall cover supply of high voltage switchgear incorporating Vaccum breakers.

1.2 Equipment should conform to the specifications and the data sheet.

1.3 Installation, testing and commissioning shall be carried out as specified under the section "Substation Auxiliaries".

2.0 Standards

2.1 The switchgear should meet the requirements of the following standards and rules:

i)	IS 3427 – 1997	AC Metal enclosed switchgear & control gear for 1KV and above.
ii)	IS 13118 – 1991	HV alternating Current Circuit Breakers.
iii)	IS 2705 – 1992 Pts 1 to 4	Current transformers
iv)	IS 3156 – 1992 Pts 1 to 4	Voltage Transformers
vi)	Any other applicable standard	

All standards shall be the latest

3.0 Type & Construction

3.1 The breaker panel shall be a fully factory built assembly to IS 3427 and pressure tested to ensure maximum safety for operating personnel. The panel shall be type tested and all test certificates furnished before inspection. Panels shall be subject to inspection at the factory.

3.2 The panel shall be extensible and shall have following insulated compartments:

i) Breaker compartment
ii) Bus bar compartment
iii) CT & cable compartment
iv) Relay / Instruments compartment

3.3 The breaker compartment shall house the vacuum circuit breaker mounted on a drawout truck. The drawout truck shall have three (Test / service / Isolated) distinct positions. The truck front panel shall house:

i) Mechanical ON-OFF indication
ii) Spring charge status
iii) Manual & motorised mechanisms
iv) Breaker control switch
v) Operation counter
vi) Any other elements considered necessary for the safe operation of the panel.

3.4 The bus bars shall be air insulated Aluminium bars supported on cast epoxy insulators, capable of withstanding the forces due to short circuit current as specified in datasheets. The bus bars shall be rated for a normal temperature rise of 30°C over the maximum ambient temperature 45°C.

3.5 The CT compartment shall house all instruments and relays with a multiple pin plug socket arrangements duly interlocked with the truck position.

3.6 P.T's shall be resin-cast rack-out type mounted on the panel with necessary protective fuses.

4.0 **Safety Systems**

4.1 The following safety arrangement shall be provided for the safety personnel and to prevent mall operation of the breakers.

a) Inter-lock to prevent the circuit breaker from being raised or lowered or moved unless the breaker is open.

b) Inter-lock to prevent the truck from being withdrawn or replaced in the fully isolated position.

c) Interlock to prevent the breaker from being closed unless it is fully home.

d) Interlock to prevent earth connection from being made by the earthing device except when the circuit breaker is open.

e) The earthing switch cannot be switched on when the truck is inside the panel and the truck cannot be inserted when the earthing switch is ON.

f) Interlock to prevent the local and remote control apparatus from being operative at the same time and the low voltage plug socket cannot be disconnected except in isolated position.

g) Automatic insulated dust-proof safety shutters to cover all live sockets with facility for pad locking them in the shut position.

h) Pad-locking arrangements may also be provided to lock the with-drawable gear when the breaker carriage is in the 'fully withdrawn' ('Earthing' or Fully Home Position)

4.2 The following safety devices shall also be provided :

1) Individual explosion vents for breaker / bus bar and cable chambers.

2) Cubicle with the front plate is to be pressure tested for internal single phase to ground fault. (vendor should submit type test certificate)

3) Entire panel including all the conduction components shall be fully earthed.

5.0 **Fittings and Accessories**

5.1 Fittings and accessories required are listed below :

a) Earth device for earthing either the feeder or bus bar.

b) Foundation bolts.

c) Cable boxes with glands suitable for the specified cable and entry positions i.e. upturn or down turn.

6.0 **Instrument Transformers**

6.1 CT's shall be air or epoxy resin insulated with wound or bar primary as required and of the rated burden within the error limits for the specified class of accuracy of meters. The CT design and construction shall withstand system thermal and dynamic overloads. Where CTs are used for both metering and protection they must fulfil the duties specified, for both purposes. Two core CTs are acceptable.

6.2 Voltage transformers shall be two winding epoxy resin insulated and shall conform to the general requirements of IS 3156 and be suitable for measuring purposes as per part II of IS 3156. Voltage transformers shall be of specified accuracy class.

7.0 **Meters and Relays**

7.1 All relays, meters and instruments shall be flush mounted and be easily removable for testing and shall be operable from 5A CT secondaries. All relays should conform to IS : 3842.

7.2 The voltmeter and ammeter shall be of square or rectangle with digital read out. Meters shall be electronic/solid state with class 0.5 accuracy or multi-parameter digital meters where specified.

7.3 Overcurrent relays shall be of numerical type multifunction relays with specified definite minimum time complete with indicator. Relays shall be suitable for a current setting range from 50-200 %. Earth fault element shall also be similar with settings from 10-40 % or 20-80 % as specified in the equipment schedule.

7.4 The following general principles may be adopted. Unless otherwise stated in the data sheet.

1)	Radial incomer breaker (33KV Panel)	Numerical IDMT	Type	O/C	50 – 200%
				EF	20 – 80%
		Standby		EF	10 – 40%
2)	Transformer breaker	Numerical IDMT	Type	O/C	50 – 200%
				EF	20 - 80%
		Inter trip			From LT breaker (Restricted earth fault)

7.5 All relay settings shall be established for the entire system and get approved by the consultants.

8.0 Testing

8.1 The switchgear shall be subjected to the type and routine tests as listed herein and all the tests shall be in accordance with the IS 9920-4/1985.

8.2 Following type tests shall have been conducted on a prototype and test certificates furnished in proof of such testing. (Test certificates shall not be more than 5 years old)

1) Tests to verify the insulation level, including withstand tests at power frequency voltages on auxiliary equipment.
2) Temperature rise test.
3) Making and breaking tests.
4) Tests to prove the capability of the switch to carry the rated peak withstand current and rated short-time current.
5) Tests to prove satisfactory operation and mechanical endurance.

8.3 All routine tests shall be conducted as per IS 3427 and shall be witnessed by the consultants and owners.

9.0 Installation, Testing & Commissioning

9.1 The panel shall be installed, tested and commissioned as specified under "Substation Auxiliaries".

10.0 Mode of Measurement

10.1 Supply of HT switchgear panel, loading and unloading at site including all accessories and transport shall be treated as one unit of measurement and installation, testing and commissioning of the same will be treated as another unit of payment.

SECTION: 2.5

H V CABLING

1.0 Scope

1.1 The scope of work shall cover supply, laying and termination of HV cables

2.0 Standards

2.2 The following standards

IS : 7098 - 1985	XLPE insulated cables for voltage 3.3 to 33KV
IS : 1255 (Part -2) - 1983	Code of practice for installation & maintenance of cables Upto 33KV.

All standards shall be the latest

3.0 Cables

3.1 Cables shall be XLPE insulated earthed or unearthed systems conforming to IS 7078. Cable cores shall be of copper or aluminum as specified in the schedule of work with XLPE insulated & wrapping, flat strip armouring and a PVC outer sheath.

3.2 Cable terminations shall be heat shrinkable type & standard products of approved manufacturers.

4.0 Installations

4.1 HV cabling shall be laid in accordance with IS:1255. All high tension cables shall be XLPE as specified in the schedule of work. Cables shall be laid and joined in accordance with IS:1255.

4.2 No joints are permitted upto 500m length of cable, for higher length, cables shall be jointed in accordance with IS : 1255.

4.3 Cables shall be laid in the route marked in the drawings. Where the route is not indicated, the contractor shall mark out the cable route on the site and obtain the approval of the Engineer-in-charge before laying the cables.

4.3 Cables in ground shall be laid at a depth of 1.5m from finished ground. Excavation trench shall be carried out neatly with sides at 30° to the verticals. Trenches shall be back filled with clean dry river sand upto 300mm thick over the cables and covered with cement tiles extending to 150mm on either side of the cables. Remaining trench shall be backfilled with sifted earth. Cable markers set in a 300 x 300 cement concrete block shall be provided at every 30m C.C.

4.4 Cables laid above ground shall be suitably protected to meet the approval of the Electrical Inspectorate and other statutory regulations. Cables shall be run on MS cable trays with necessary MS frame work supports at every 1m distance including anchor fastners, insert plates etc. for completeness of installation or ready-made masonry trenches with necessary supports of galvanised steel. Plastic identification tags shall be provided at the ends and along the length of cable @ 20m centres.

4.5 HV cables shall be tested upon installation with a 1000V DC meggar and the following readings established.

1) Continuity on all phases

2) Insulation resistance
   a) between conductors
   b) all conductors and earth

3) High potential testing, if required, by the local electrical inspectorate.

4.6 For each lot of cables the contractor shall supply a certificate issued by the manufacturer stating its original date of manufacture, constitution and standard to which it complies and the test certificate.

4.5 Cable terminations shall be Heat shrinkable.

SECTION: 2.6

BATTERY CHARGER

1.0 Scope

1.1 The scope of work shall cover the supply, installation, testing & commissioning of battery and battery charger.

2.0 Battery Chargers

2.1 One (1) set of thyristor controlled battery charging set shall be provided for each battery bank complete with two identical charging units, each capable of functioning as a float charger or boost charger as well as supplying the DC loads. Each charger shall have provision for auto/manual changeover from float to boost mode and vice versa. Suitable DC contactors shall be provided for this purpose. One common manual selector switch shall be provided to pre-select any charger to operate in boost mode.2.2.

2.2 Separate charge bus and load bus shall be formed. Normally, both chargers, the battery and the load shall be connected to the load bus, the chargers being on float charging mode. During boost charging of battery, the charger selected for boost mode shall be connected to the charge bus with battery also connected to the same bus through contactor changeover arrangement. During this period, it shall be ensured that the other charger is healthy and connected to the load bus to supply the specified DC loads. In case, one charger fails, audio-visual alarm as called for subsequently shall be available and the healthy charger shall feed the total load.

2.3 In case of main AC power failure with the battery on float charge mode, the battery shall be automatically connected to the load bus for feeding of all loads. When power supply is resumed, then the charger, pre-selected as boost charger, shall start boost charging the battery until the desired battery voltage is reached. During this period, the load bus shall be isolated from the charge bus and the other charger shall feed the load.

2.4 In case of main AC power failure during boost charging of the battery, the battery shall be automatically connected to the load bus by a DC contactor. During the time of closure of the auto changeover contactor, the continuity of power supply shall be maintained from the tap cell of the battery through suitable diodes.

2.5 During the period of boost charging, if the float charger fails, then the boost charger shall get connected to the load bus automatically though the dropper diodes to feed the load. Normally, the dropper diodes shall remain by passed by suitable normally closed DC dropper diode by pass contactor. During the time of opening /closing of the auto changeover contactors, the continuity of power supply shall be maintained from the tap cell of the battery through suitable diode. Boost charger shall be designed to cater DC continuous load as well as desired constant current for charging the battery simultaneously. The voltage at the load terminals shall be kept within specified limit through proper selection of dropper diodes.

2.6 During the period of boost charging, if the boost charger fails, then the mode of operation of the float charger shall automatically change from float to boost and charger shall start boost charging the battery as well as go on feeding the load through dropper diodes.

2.7 Facility shall be provided to manually connect the battery to the charge bus and switch on the selected boost charger when the battery voltage falls below a preset level and charge the battery at a constant recommended starting current upto recommended cell voltage level. After this the charging current shall be automatically reduced to a constant recommended finishing rate and the charging shall be continued and an alarm shall be operative after a preset time as set by a synchronous timer for manual changeover from boost charge mode of operation to trickle charge mode

2.8 In trickle/float charging mode, the selected charger shall be connected to the load bus and shall be cable of floating each cell at the specified voltage and supplying rated Dc load continuously under normal system operation.

2.9 The battery charging set shall be housed in floor mounted cubicle made of CRCA sheet steel having minimum thickness of 2mm. The enclosure shall generally conform to IP54 degree of protection. All lamps, meters, switches and push-buttons shall be located within 400 to 1900 mm from the floor level.

2.10 415 V, 3-phase, 4-wire, 50 Hz power supply over duplicate feeders shall be taken from the AC distribution board. Suitable changeover arrangement over contactors shall be provided inside the charger panel for automatic changeover to the healthy incoming feeder in case of sudden outage of the running feeder. For momentary voltage dip, the chargers shall not trip.

2.11 Each charger shall be self contained with dry type air-cooled transformer suitable for operating from 415 V, 3-phase, 4-wire, 50 Hz supply, full wave, half controlled, thyristor diode units with necessary automatic regulation circuits to deliver stabilized DC output voltage of +2.5% as well as all necessary protection, metering, interlocking, indicating and other devices as required for smooth and reliable operation.

2.12 The transformers shall be of self-cooled dry type (AN) generally conforming to IS:11171 as applicable and suitably mounted on vibration dampers to prevent transmission of vibration to adjoining cubicles. It shall be suitable for operation at rated load, with minimum class B insulation. The ratings of the transformers shall be finalised during engineering stage based on calculations to be furnished by the successful tenderer.

2.13 Rectifier units

2.13.1 The rectifier unit for boost and trickle operation shall conform to IS:4540 and IEC publication 146, 1973 wherever applicable

2.13.2 The assembly shall consist of required number of adequately rated diodes/thyristors mounted on heat sinks, and connected in three-phase full wave bridge circuits. The rectifier shall have adequate peak inverse voltage (PIV) rating and the safety factor for the diodes / thyristors shall be more than 2.5

2.13.3 The power circuit devices shall comprise incoming MCCB on the 415 V AC side, contactors, thermal overload relay, DC side filter chokes, blocking diodes, DC shunt and DC side MCCBMCB of adequate rating to meet the full load requirements of the charger unit

2.13.4 The diode/thyristor units shall be adequately protected against all abnormal over-voltage, short-circuits, overloads, etc for which necessary devices and relays shall be provided including the following :

1) Surge absorbers on the AC side of the rectifier bridges. The surge absorber shall be provided with monitoring system so that in the event of failure, alarm can be initiated.

2) Snubber circuit comprising resistor and capacitor across each thyristor cell.

3) HRC semi – conductor fuses in series with each rectifier cell complete with trip indicating devices.

2.13.5 The salient features to be provided for the battery charging set and its interconnection with the battery bank shall include but not be limited to the following:

i) The ripple content in the output DC voltage shall be less than 2%.

ii) Stabilized DC output voltage for variation of AC supply voltage and DC load by means of suitable control equipment.

iii) Automatic changeover from boost charging state to trickle charging state and vice versa.

iv) Automatic and manual control of voltage regulations.

v) Measurement of AC input and DC output voltage and current.

vi) Visual indication for "AC supply ON" "Float ON" and "Boost ON".

vii) Visual indication for the following abnormal conditions.

a) AC supply fail
b) Float charger trip
c) Boost charger trip
d) Float device fuse fail
e) Float filter fuse fail
f) Boost device fuse fail
g) Boost filter fuse fail
h) Load over-voltage
i) Load under-voltage
j) Boost over-voltage
k) Battery under-voltage
l) Battery earth fault

viii) The DC system shall be unearthed with battery earth –fault alarm by battery earth- fault monitoring relay of reputed make.

2.13.6 Provision shall be made for transmitting the signals specified in item 2.13.5(vii) above, grouped together to the audio –visual annunciation system in control panel provided for high voltage switchgear and also to BMS system.

SECTION: 2.7

SUBSTATION AUXILIARIES INSTALLATION

1.0 Scope

1.1 The scope of work shall cover the following:

1) Supply, Installation, testing & commissioning of 33KV HT panel Transformer.

2) Supply, laying, termination, testing of HV 33KV cables & LV cables

3) Substation earthing, interlocks, safety pads etc.

4) Wiring for temperature alarm and tripping.

5) Supply & Installation of Switch tripping battery, associated control cables etc.

2.0 Codes & Standards

2.1 The following codes and Standards shall be followed:

IS : 10028

Code for practice for selection, installation and maintenance of transformers –
IS : 3043 Code of practice for earthing.

2.2 All codes and standards mean the latest.

3.0 Transformers

3.1 Transformer installation shall be carried out in accordance with IS: 10028 –Pts 1 & 2.

3.1.1 Indoor Installation

3.1.1.1 The most important thing to be ensured with transformer installed indoors is proper ventilation, that is, free moment of air round all the four sides. The level of the transformer base should be higher than the highest flood and storm water level of that area.

3.1.1.2 The transformers should be kept well away from the wall. The minimum recommended spacing between the walls of the transformer periphery from the point of proper ventilation should be as per IS : 10028 (Part II).

3.1.1.3 The site should be so chosen that it is not normally damp because the dampness may find its way to the bushings and may cause them to flash over. There shall be no chance of water dripping either on the transformer or anywhere in the transformer room itself. Chemical fumes, particularly acid fumes, should not be allowed in the transformer room as they corrode the body.

3.1.1.4 For indoor installations the air inlets and outlets shall be of adequate sizes and so placed as to ensure proper air circulation for the efficient cooling of the transformers. The inlet should preferably be as near the floor as possible and the outlets as high as the building allows to enable the heated air to escape readily and be replaced by cool air.

3.1.1.5 The transformer should be so installed that severe vibrations are not transmitted to its body.

3.1.2 Outdoor Installation

3.1.2.1 Only transformers designed for outdoor use should be installed outdoors. In case of locations where the atmosphere is polluted, it is desirable that the transformer is located in suitable covered shelter to minimize adverse effects of polluted atmosphere.

3.1.2.2 The transformer should be so installed that the breather, thermometer, oil level indicator and the top position indicator may be safely examined with the transformer energized.

3.1.2.3 Sampling valve or drain valve should be conveniently arranged for drawing oil samples.

The transformers shall be mounted on a concrete plinth. After installation, the rollers shall be locked by wedges or any other means to prevent accidental movement of transformers. Foundation shall be as per details provided by transformer, panel etc. manufacturers.

3.2 The following pre-commissioning tests shall be carried out:

3.2.1 Power Transformer

1) Measurement of winding resistance
2) Measurement of voltage ratio and check of voltage vector relationship.
3) Measurement of impedance voltage / short – circuit impedance (principal tapping) and load loss.
4) Measurement of no-load loss and current
5) Measurement of insulation resistance
6) Dielectric tests
7) Tests on on-load tap-changers, where appropriate.
8) Visual inspection for broken parts & cracks.
9) The insulation resistance shall be tested with a 1000VDC meggar to establish the following values:

(a) Between HV 3 phases and between each phase winding and earth.

(b) Between LV 3 phases and between each phase winding and earth.

(c) Between HV and LV windings
(d) Oil BDU

10) All transformer mountings and accessories such as the Buchholts protector, breather, gauges, thermometer should thoroughly be checked and adjusted. All such checks and adjustments shall be recorded in the presence of the Engineer.

3.2.2 Distribution Transformers

1) Measurement of winding resistance
2) Measurement of voltage ratio and check of voltage vector relationship.
3) Measurement of impedance voltage (principal tapping), short – circuit impedance and load loss.
4) Measurement of no-load loss and current
5) Separate –source voltage withstand test
6) Induced over voltage withstand test
7) Visual inspection for broken parts & cracks.
8) The insulation resistance shall be tested with a 1000VDC meggar to establish the following values:

(a) Between HV 3 phases and between each phase winding and earth.

(b) Between LV 3 phases and between each phase winding and earth.

(c) Between HV and LV windings

9) All transformer mountings & accessories should thoroughly be checked and adjusted. All such checks and adjustments shall be recorded in presence of the engineer.

3.3 After satisfactory testing as above, the transformer shall be energised on no-load and maintained on no-load for a period of 8 hours. Thereafter, the full load shall be built-up progressively over a period of another 8 hours.
Transformer shall be commissioned under supervision of manufacturers service engineer

4.0 HV switchgear

4.1 The installation shall be carried out in accordance with IS:3072.

4.2 The following pre-commissioning tests shall be carried out on the breakers & panels.

1) Inspection of breaker parts for breakages and mechanical performance.
2) Check and confirm all mechanisms and safety interlocks, alignment of contacts, lowering and racking gear.

3) The insulation of main breakers shall be tested with a 2500V DC meggar and readings shall correspond to the factory test readings.

5.0 HV Cabling

5.1 HV Cable laying shall follow the section 2.6 “HV CABLING”.

6.0 Switch Tripping Battery

6.1 The switch tripping battery shall be of the rating indicated in the data sheet. Battery shall have high discharge performance cells. The battery should have its own charger for and trickle charging.

6.2 The battery shall meet with the duty of atleast 3 breakers consecutively tripping and closing.

6.3 Batteries shall conform to following IS Standards

a) IS 8320 – General Requirements & method of testing for Lead Acid Batteries

b) IS 10918 – Vented type Ni – cd batteries

7.0 **Earthing**

7.1 System earthing shall follow TN – S form of earthing.

7.2 Copper plate earth stations shall consist of 600 x 600 x 3mm buried in ground to a minimum depth of 3.0 meters. The plate shall be surrounded with a mixture bentonite and earth all round as shown on drawings. The earthing stations shall be complete with cement concrete manhole, CI cover etc. as per IS code 3043 / 1987. Soil resistivity should be maintained at 3 ohm meter through chemical mixing.

7.3 All earthing conductors shall be either bolted with spring washers or riveted. Dissimilar metal joints shall have suitable bimetallic connectors. Entire earthing installation shall conform to IS 3043 . All earth leads connecting the earthing stations shall be provided with testing links.

7.4 All equipment in the substation shall be earthed as shown below:

1. Power Transformer

(a) Neutral	Two separate earth connections to as specified in IS : 3043 . (If NGR is provided then transformer neutral will be connected to NGR and NGR neutral will be connected to earth pits)
(b) Tank & core	Two distinct connection to an earth bar.

2. Distribution Transformer

(a) Neutral — Two separate earth connections to as specified in IS : 3043 .

(b) core — Two distinct connection to an earth bar.

3. HT Switchgear — Two distinct connection to an earth bar.

Sizes of earth conductors shall be as shown on drgs. and schedule of work.

7.5 The following resistance values shall be measured with an approved earth meggar and recorded:

1) Each earthing station
2) Earthing system as a whole

8.0 Control Cabling / Power Cabling

8.1 All cabling shall be 1100V grade (for AC) or 600V (for DC) XLPE insulated sheathed with or without armouring as specified with outer protective sheath. All cables shall have Flame Retardant, Low Smoke sheath (FRLS). Cables shall have high conductivity stranded copper conductors and cores colour coded to the Indian Standards.

8.2 All cables running indoor shall be supported with necessary MS cable trays. Cable trays shall be minimum 1.8 mm thick. All cable trays shall be suspended but supported on MS frame work with supports at every 1.5 m distance including necessary anchor fasteners, insert plates etc. for completeness of installation. Cables laid in built up trenches shall be on steel supports.

9.0 Mode of measurement

9.1 Transformer

1) Installation, testing, commissioning of the transformer including the supply & wiring for temperature alarms will be treated as one unit for measurement and payment.

2) Each earthing station shall be paid as a unit.

3) Earthing strip shall be measured per unit length.

9.2 HV switchgear

1) Installation, testing, commissioning of the HV switchgear complete with the various components specified will be treated as one unit for the purpose of measurement and payment.

2) Earthing of the panel and control cabling will be paid for at unit rates separately.

9.3 HV cabling

1) All HV cabling shall be measured on the basis of unit length and the cost per unit length shall cover cost of cable, cost of supports, clamps, labour, excavation and back filling, with cable markers, testing and commissioning.

2) Cable terminations shall be measured per unit and the cost shall include lugs, gland, all jointing materials, bolts and nuts, earthing etc. and labour.

3) Cable trays shall be measured per unit length for each of the specified widths. This should include necessary supports or suspenders, anchor fastners, insert plates etc. for completeness of installation for the trays.

9.4 Switch Tripping Battery

Switch tripping battery (STB) with first charge of electrolyte, one set hydrometer, cell testing ammeter, battery charger with rectifier, ammeters, voltmeters, output circuits, sheet steel enclosure shall be considered as one unit of measurement. All cabling to and from the STB will be paid per unit length.

9.5 Earthing

1) Providing an earthing station complete with excavation backfilling, electrode watering pipe, soil treatment, masonry etc. shall be paid per unit.

2) The following items of work shall be measured and paid at unit rates covering the cost of the earth wires/strips, clamps, labour etc.

   a) Main equipment earthing grid and connections to the earthing stations.

   b) Connections to transformers, power panels, distribution boards etc.

9.6 Control cabling/ Power cabling

All cabling shall be measured and paid at unit rates. The rate shall include for cable (armoured XLPE with Al conductor multi-core) supports and terminations. Cable tray shall be paid extra including necessary supports, anchor fastners, insert plates etc.

SECTION: 2.8

POWER FACTOR CORRECTION SYSTEM

1.0 Scope

1.1 The scope of work shall cover supply, installation, testing and commissioning of power factor improvement capacitors, PF relay, contactors etc.

2.0 Standards

2.1 The following standards shall be applicable;

i) IS 2834 : 1986 Power Capacitors

3.0 Capacitors

3.1 Capacitors shall be Heavy duty MPP type long life (minimum 100,000 operating hours) without degradation or loss of capacitance. Capacitors shall have low energy loss (less than 0.5W/KVAr) and totally tropicalised. Each capacitor shall have a discharge resister to bring down the residual voltage to 50V within 60 secs.

3.2 The capacitance output shall be guaranteed for a period of 2 years @ +10% & -5% of the rated value. All capacitors shall be type tested for dielectric strength, IR value (min. 50 megohms), losses, surge protection etc. in accordance with the IS standards. Capacitor elements shall be canned in a galvanised steel enclosure and sealed to meet IP 52 class. All capacitors shall operate at 135% overload (over voltage or harmonics) without deterioration. Temperature rise shall be as per IS 2834.

4.0 Control Panel

4.1 The control panel shall consist of three sections:

i) Capacitor section
ii) Switch section
iii) Monitor and control section

4.2 The capacitor section shall house the capacitors with proper and adequate ventilation using exhaust fans so that the capacitors will not be overheated. The enclosure shall also provide easy access to each capacitor unit for maintenance.

4.3 The switch section shall consist of Thyrister switch- fuses/breakers, contactors, voltmeter, PF meter, ammeter selector switch, push button for opening & closing power circuit, On-Off indication lamps.

4.4 The control section shall contain a microprocessor based control unit with requisite relays to switch the capacitors ON or OFF. The system PF shall be monitored constantly and the switching sequence regulated. The switching sequence shall be capable of being changed or modified so as to ensure that all the capacitor units will have equated run hours. Provision shall be available for manual override through multiple push buttons. Control unit shall have communication port / potential free contacts or necessary provision to start / stop from IBMS.

4.5 The panel and individual capacitors shall be earthed as required under "PROTECTIVE EARTHING".

4.6 The control panel shall have no voltage, unbalance protection & short circuit protection. Each section shall have ON-OFF indication.

4.7 Following protections shall be provided for the capacitor panel:
i) No voltage protection
ii) Unbalance protection
iii) Short circuit protection

5.0 **Testing**

5.1 Capacitors units shall be tested to withstand 2500V AC for one minute and shall yield an IR value of 50 megohms after one minute charge with 500V DC meggar. The sequence switching shall be functionally tested.

5.2 All test readings shall be duly recorded and presented.

6.0 **Mode of measurement**

6.1 Each capacitor panel will be considered as one unit for the purpose of measurement and payment and shall include the following:

i) incoming and outgoing feeder, fuses etc.

ii) contactors, PF relay wherever specified

iii) capacitors in multiple units duly supported and enclosed.

iii) PF meter, indicating lamps, push buttons, control microprocessor

v) supporting frame & painting

vi) necessary CT's in the main panel, control wiring therefrom.

vii) installation, testing and commissioning

SECTION : 2.9

DIESEL ENGINE

1.0 Construction

1.1 The Diesel Engine shall be 4 cycle, multi cylinder, turbo charged heavy-duty industrial type with rated electrical output. Engine shall be rated generally in accordance with data sheet & ISO 8528-1

1.2 Cylinder housing and crank case shall be of high grade cast iron with overhead valves. Housing and heads shall be provided with necessary cooling fins.

1.3 Crank shaft shall be manufactured from solid forging with hardened crank pin and main bearing journals. The entire shaft shall be truely balanced.

1.4 Pistons shall be of close grained cast iron of aluminium alloy and provided with necessary compression and scrapper rings and a fully floating gudgeon pin.

1.5 Connecting rods shall be H-section steel stampings. Camshaft shall be gear driven (fly-wheel end) and easily removable. Fly wheel shall be accurately balanced meeting the requirements of cycle variation as set down in BS: 649.

1.6 Lubrication system shall be complete with necessary gear pump, piping and drilled oil passage strainer, oil cooler etc. and relief valve.

2.0 Cooling

2.1 The engine shall be radiator cooled or through a heat exchanger as specified in the equipment schedule. A thermostatic valve should by-pass the coolant in the primary circuit until a pre-set operating temperature is reached.

2.2 The heat exchanger shall be cleanable shell and tube with prime surfaced copper tubes of minimum 15mm dia. The cooling side of the exchanger shall be designed for the system pressures encountered.

3.0 **Fuel System**

3.1 Fuel injection equipment shall be driven by the timing gear train and complete with oil strainers, injectors etc. Fuel is to be supplied from the day tank with necessary piping.

3.2 A tank of specified capacity shall be provided for lasting atleast for 10 hour period or 900 ltrs whichever is lower. The tank should be complete with filter breather unit and drain plug.

4.0 **Filtration**

4.1 The engine shall have cleanable fuel oil filters. Lub oil filtration shall be through strainers which are capable of being cleaned when the engine is running. Air filtration shall be through oil bath or cleanable dry type filters.

5.0 **Engine Exhaust**

5.1 The engine exhaust piping shall be amply sized for minimum back pressure and connected to the engine manifold through flexible connection on one side and to a silencer on them other side. The silencer shall be packed type with adequate attenuation for urban use (Residential type), constructed from heavy guage galvanised steel. The sound absorbent infil shall be nonhygroscopic, verman proof, non-combustible material. The silencer should be adequately sized to impose minimal additional aerodynamic loading on rotor fans.

5.2 The exhaust piping from the silencer on wards shall be led upto the top most level and discharged through a rain cowl as shown on drawings. Entire exhaust piping and silencer shall be insulated with 75 th 48Kg/cum density fibreglass white wool. The insulation shall be held in position with galvanised steel wire mesh 0.63 dia 20 mesh and finished neatly with 26 SWG Aluminium cladding.

5.3 The exhaust piping shall be fabricated with mild steel as shown in the equipment schedule and all flanged joints shall have spiraget high temperature gasket. The piping shall be installed with necessary thermal expansion facility as required and shown on drawings.

6.0 **Safety Systems**

6.1 The Governor is to be driven by bavel gears from the engine camshaft with manual adjustment of engine speed between +5% and -10% of rated speed. The Governor shall control the engine speed with atleast class 'A2' limits permissible under B.S 649/1958. A governor shall trip the engine at the pre-set over-speed and shut-off the fuel supply.

6.1.1 The governor shall be electronically controlled with provision for paralleling of DG sets and for load sharing. Steady state frequency regulation shall be +0.25% and load sharing shall be with in ± 5%.

6.2 The engine cooling water temperature shall be monitored by a two point thermostat which should acuate an audible cum visible alarm at one point and trip the engine at the second point. Likewise the low oil pressure cut-out shall trip the engine with visible indication.

Other safety controls and indicating instruments shall be as shown in Equipment Schedule ES 04.

7.0 **Engine Starting**

7.1 The engine shall be electrically started and the battery shall be 24V lead acid high discharge tubular or plante type and rated for 4 (four) consecutive starting kicks and the continous drain for signals and controls. All batteries shall be complete with associated charger incorporated in the generator panel. The starting system shall be complete with necessary relays solenoid valves for fuel, control and indicating panels as specified and required.

8.0 **Mounting and installation**

8.1 A common rigid bed plate shall be provided for the engine and alternator which shall be flexibly coupled. The coupling must be done after ensuring proper alignment of generator and engine shafts.

8.2 The entire engine set shall be mounted on suitable vibration mounts as specified in the datasheet. A nominal base concrete pad (if required) shall be provided by clients, over which the engine set with its own base frame and vibration mounts shall be mounted. The base concrete pad in turn shall be mounted on multiple cork pads of 300 x 300 x 50mm wrapped in polythelene faced hessian.

SECTION : 2.10

ALTERNATOR

1.0 Type & Rating

1.1 Alternator shall be 3 phase, 4 wire 50 cycles 415 volt, brushless screen protected drip proof with self contained excitation systemed and self regulating and conforming to BS 4999/5000 & continuously rated in accordance with BS 2613. The alternator should have the rated capacity at 0.9 PF. The alternator shall be designed to suppress radio interference in conformity with BS 800.

1.2 The alternator shall be of fabricated steel construction conforming to IP class specified dynamically balanced rotor with two bearings and damper windings. The unit shall be with a large terminal box for outgoing cable connections specified. Necessary adaptor box shall be provided wherever required.

1.3 Alternator rotor shall be salient pole type with a damper cage and dynamically balanced. Insulation shall be to class 'F' or 'H' (BS 2757/1957). Insulation on other windings of minimum class 'F'. All winding shall be fully impregnated for tropical climates with high quality oil resistant varnish.

1.4 Ventilation to the alternators shall be by means of fans fitted on the rotor.

2.0 Excitation system

2.1 The main exciter shall receive power from a permanent magnet generator via Automatic Voltage regulator. The AVR shall be of solid state circuitary and shall provide regulated voltage to the exciter compensating for all normal variations. The main exit or output is fed to the main motor windings via a rotating 3 phase bridge rectifier assembly which shall be protected from voltage surges, short circuit, overload and diode failures. The AVR and control gear shall be mounted in a component box on the side of the machine. Electrical connections to the AVR shall be taken through a multiway plug and socket.

2.2 Voltage regulation shall be within +/- 2.5 (two and half percent) under all conditions of load, power factor and temperature including cold to hot variation. Voltage drift shall be negligible. There shall be no radio or television interference. Line voltage wave form shall be as true as possible with a total harmonic distortion not exceeding 3% on 3 Ph load. The response to transient load should be rapid as specified.

2.3 The excitation system and engine governor should be such that the alternator is capable of starting up induction motors having a starting KVA of not less than 1.8 times the alternator rated KVA.

Manufacturer should indicate the voltage dip and duration under such conditions as required under equipment data.

2.4 The neutral of each generating set shall be earthed solidly to ground with facility for isolation through a fully rated contactor or manual switch as shown on drawings.

3.0 **Automatic Mains Failure (AMF) operation**

3.1 The mains and DG set contactor or breakers shall be mechanically and electrically interlocked. Neutrals shall be grounded through neutral contactors and only one of multiple sets shall be earthed during operation.

3.2 The AMF logic shall start the set automatically only in the event of:

i) mains failure
ii) phase failure
iii) voltage, drop to 85% of rated voltage

The set shall be capable of starting and taking up the load within the time stipulated in equipment schedule.

3.3 The sequence of AMF operation shall be as follows:

i) Upon main power failure, the generator shall receive 4 kick starts and the generator breaker shall close only after building up of voltage.

ii) Hold the Mains Breaker (MC) open.

On restoration of power, AMF logic should provide the following commands.

i) Trip the engine

4.0 **Auto Synchronization**

4.1 An auto-synchronizer and load control system shall be provided wherever two or more sets are required to be operated in parallel. The system shall be microprocessor based using a wood ward speed control for synchronization, parallel operation, loading, unloading and load-sharing of the generators in parallel. The control system shall be suitable for similar or dissimilar generators, if necessary

4.2 The system shall perform the following functions:

- Automatic synchronization based on slip frequency with voltage matching
- Automatic generator loading and unloading with smooth load transfer.
- Isochronous load sharing based on fixed frequency regardless of the load and provide load and unload ramp for smooth transition.
- Base loading of a generator in the event of trouble on the other
- Equal sharing of VAR load of the generators in parallel operation
- Reverse power flow monitoring and control
- Digital communications network between the various generator controls
- Self – diagnostic and hi/Lo limit alarms.

4.3 The synchronizer shall be a fully tested product having been used in at least 5 installations and operative for more than 3 years. Vendor to furnish the data with his offer.

5.0 **Testing & Commissioning**

5.1 After installation, each shall be run for a minimum period of 30 minutes continuously on no load. On satisfactory completion of the no-load run the set shall be run for a period of 12 hours at 100% full load. All consumables including fuel and lub oil required for commissioning the set shall be supplied by the contractor. Test readings as per Annexure 2.1.6 together with a log of the running test shall be furnished. Load banks shall be provided by the clients.

5.0 **Mode of measurement**
(for sections 2.2 & 2.3)

1) The diesel generating set complete with:

i) Engine and alternator with flexible coupling.

ii) Mounting frame with vibration isolation mounts.

iii) 24V battery with leads, stand, acid etc.

iv) Expansion tank, heat exchanger and piping to and heat exchanger, exp. tank. (Not Applicable)

v) Flexible connection and exhaust piping upto and including Exhaust Silencer insulation of the same.

vi) Erection, testing and commissioning

shall be considered as one unit of measurement.

2) The AMF panel comprising:

i) Panel with an AMF section as specified complete with battery charger.

ii) Indication and alarms

iii) Auto synchronization control system

iv) BMS Port to be provided as per drawing.

Shall be treated as one unit of measurement.

3) Cooling tower along with starter panels shall be treated as one unit. (Not applicable)

4) Cooling tower pumps along with starter panel shall be treated as one unit. (Not applicable)

5) All control wiring from D.G Power Panel to generating sets shall be through 1.5 or 2.5 sqmm copper PVC insulated armoured and sheathed multi-core cables and this will be paid per unit length including the elemental cost of terminations, glands, lugs, cable supports etc. No separate payment shall be made for cable supports, terminations, glands etc.

6) All power cabling shall be paid for per unit length and all cable joints shall be measure per unit.

7) Bus duct, wherever used shall be paid per unit as specified in the schedule of work.

SECTION: 2.11

ACOUSTIC ENCLOSURE – FOR DIESEL GENERATING

1.0 Scope

1.1 The scope of work covers providing Acoustic Enclosure to reduce the noise from Diesel Generating Sets as required in the schedule of work.

2.0 Design Criteria

2.1 The design criteria shall be that the insertion loss across the enclosure shall not be less than 20dB, while the sound pressure level at 1m from any part of the enclosure shall be less than 75dBA.

2.2 The enclosure shall provide for an air intake, engine exhaust outlet, cable and fuel pipe entries. A control & monitoring panel shall be accessible from outside with toughened glass cover. An emergency trip device shall be provided in the control panel.

2.3 The enclosure should also accommodate a breaker panel appropriate for the set capacity. Access door shall be suitably gasketted so that the opening does not degrade the integrity of the acoustic enclosure.

2.4 In the case of sets larger than 1000 KVA, the DG room should be acoustically insulated meeting the above noise criteria.

3.0 Acoustic Enclosure

3.1 The enclosure shall be fabricated from MS sheets of 16G thickness sandwich insulated with suitable sound absorbing material. With the enclosure in place, it should be possible to operate the DG set with out any deration.

3.2 The enclosure should be such that the Diesel Generating set can be directly mounted inside the MS fabricated container with proper clamping, mounting and supporting arrangement. The enclosure should have hinged doors.

3.3 Provision should be made for air intake and exhaust silencers.

3.4 Openable doors should be provided allowing easy access to all parts of the DG Set. The doors shall be double wall insulated.

3.5 The sound barrier shall consist of the following.

a) Layer of HDPE / Vinyl sheet for anti – droning.
b) Non ferrous sheet sound barrier
c) Rock wool or equivalent sound absorbing material 48kg/ m^3 and 100mm thick.

3.6 It should be possible to dismantle the enclosure completely to make the engine accessible from all the sides.

3.7 Acoustic property of the insulation material used shall be as under.

Sound Absorption Coefficient at Octave Mid band frequency HZ				
250	500	1000	2000	4000
0.32	0.82	0.95	0.96	0.94

3.8 The glass wool shall be specially selected shot – free non corrosive non setting variety.

4.0 **Acoustic Insulation of DG Rooms SETS (Not Applicable)**

4.1 **Wall & Ceiling Acoustic**

4.1.1 Walls and ceilings shall be acoustically insulated wherever shown on drawings or as required by the Engineer-in-charge. The wall/ceiling surface shall be cleaned and a grid work of 600 x 600 shall be made using 50 x 50 x 0.8 G.I pressed steel forms. 50mm resin bonded fibre glass shall be cut to size and positioned within the grid work and held with 1.0 mm galvanised steel wire at 300 mm intervals. Entire insulation shall be covered with 0.8 mm thick aluminium sheets having 3 mm perforations at 5 mm staggered centres. The sheet shall be neatly cut and the edges reinforced with a 20 mm sheet fold and made into neat looking panels. The panels shall be fixed on the frame work using cheese headed No. 8-20 mm sheet metal CP brass screws at 300 mm centres.

4.1.2 Where the insulation thickness is 100 mm the channels shall be 50 x 100 and the remaining work shall be as specified above.

4.2 The materials for acoustic insulation shall be as follows:

Application	Material	Sound Absorption Coefficient at Octave Mid band frequency HZ				
		250	500	1000	2000	4000
Walls & Ceiling	Resin bonded Fibre glass 32 Kg/Cum 50mm thick	0.76	1.04	0.75	1.15	0.83

5.0 **Mode of measurement**

5.1 The acoustic enclosure with all its attachments complete shall be measured as one unit.

SECTION : 2.12

TESTING OF DG SETS

1.0 Type Test Certificates

1.1 The Tenderer shall enclose copies of type test certificates, wherever applicable, for all the equipments and materials, quoted by him, along with the bid for Employer's reference as per the relevant standards specified.

2.0 Testing of DG Sets

2.1 All the type tests, if not conducted earlier on similar type of equipments, covered under the relevant standards, shall be conducted, wherever required, by the suppliers for all the equipment and materials at manufacturer's works in the presence of the Employer's representative. The test certificates of all the equipments / materials shall be approved by the Employer's representative before dispatch / acceptance of the equipment and materials. Routine tests for all equipment will be witnessed by Engineer's Representative.

2.2 The following tests shall be done at works before dispatch

2.2.1 Tests on Alternator:

1 DC Resistance Measurement

1.1 Stator
1.2 Rotor
1.3 Exciter Stator
1.4 Exciter Rotor
1.5 PMG Stator(if applicable)

2 Insulation Resistance Measurement, before and after High Voltage Test

2.1 Stator
2.2 Rotor
2.3 Exciter Stator
2.4 Exciter Rotor
2.5 PMG Stator

3 High Voltage Test

3.1 Stator
3.2 Rotor
3.3 Exciter Stator
3.4 Exciter Rotor
3.5 PMG Stator

4 Functioning Tests on RTDs

4.1 DC Resistance Measurement

5 Characteristics

5.1 **No Load Saturation Tests**

5.1.1 Open Circuit Magnetization Characteristics

5.1.2 Voltage Measurement

5.1.3 Symmetry of generated voltage

5.1.4 Phase Sequence (Phase Rotation) check

5.1.5 Direction of Shaft Rotation check

5.1.6 Sustained 3Phase Short Circuit Magnetization Characteristics

5.2 **Vibration Measurement**

5.2.1 During No Load Mechanical Run

5.2.2 During No Load Open Circuit Magnetization Test

5.2.3 During Sustained 3Phase Short Circuit Magnetization Test

5.3 Over speed test (120% of rated speed for 2 minutes).

5.4 Regulation Tests

5.4.1 Voltage & current

5.6 Temperature Rise Test

5.7 No Load losses

5.8 Determination of efficiency

The following tests shall be carried out on Generator and Excitation system:

a) Insulation Resistance Tests

b) Winding Resistance Test

c) Phase sequence Test

d) Open and Short Circuit Characteristic Test

e) AVR response / Regulation Test.

f) Load test on Generator at both unity and 0.8 PF.

g) Excitation at full load and under specified variation of voltage and speed

h) Measurement of voltage dips at the generator terminals while feeding the base load 75% and on simultaneous starting of the largest motor.

i) EMPLOYER reserves the right to reject the equipment if the guaranteed performance is not met with.

j) All instruments required for performance testing of the equipment covered in this specification shall be provided by the TENDERER at no extra cost to the purchaser for entire duration of the performance test.

k) The TENDERER shall ensure that instruments and gauges to be used for testing and inspection of critical parameters as identified in the specification shall have valid calibration and the accuracy can be traceable to National Standards.

l) In addition to the above guarantees, TENDERER shall also guarantee the period for completing supply, erection, testing and commissioning as six (6) months for DG set and accessories from the date of Letter of Award.

2.2.2 **Load Test**

The load tests will be witnessed by consultant & client at works. The supplier shall provide advance information for pre dispatch tests conducted at works.

These tests shall form part of this contract. Above tests shall be conducted for all DG sets. The test results shall match with the technical requirements specified in the technical data sheet.

The Consultant / Employer shall have the right to accept or reject the modules if it does not meet the technical requirements.

The load test shall be conducted through resistive load bank at unity power factor. Before conducting test, following shall be recorded on test report :

a) Engine serial No.
b) Engine model & make No.
c) Alternator serial No.
d) Engine & alternator rating
e) Date of testing
f) Rated speed, voltage & kW

Loads & duration:

Idle run	: 05 mins
25% load	: 30 mins
50% load	: 30 mins
75% load	: 30 mins
100% load	: 30 mins
110% load	: 60 mins

The following parameters shall be noted on the test report :

a) Load in kW
b) Power factor
c) Voltage
d) Current
e) Frequency
f) Alternator winding temperature
g) Alternator bearing temperature
h) Lube oil pressure
i) Water temperature
j) Lube oil temperature
k) Fuel consumption though flow meter

Impact test:

A block load of at least 50% shall be put on the DG from no load condition & similarly when DG is 100% loaded, the load is removed & the parameters like voltage, frequency & RPM is noted. The readings should be with in acceptable limits.

2.2.3 Rejection & Penalty

The purchaser may reject any DG Sets during tests or service any of the following conditions arise and the provision under the relevant clause of the general conditions of contract shall immediately become applicable:
If it is not adhere to:-

a) GUARANTEED TECHNICAL PARTICULARS- Diesel Engine

b) GUARANTEED TECHNICAL PARTICULARS- Generator

c) DG Sets fails on performance guarantee test at works.

d) DG Sets fails on performance guarantee test at site.

e) Proven performance in number of running hours for the type / Model of the DG set

f) DG Sets is proved to have been manufactured not in accordance with the agreed specification.

g) The purchaser reserves the right to retain the rejected DG Sets and take it into service until the tenderer replaces the defective DG Sets by a new acceptable DG Sets at no extra cost. The tenderer shall repair or replace the DG Sets within a reasonable period mutually agreed time to the satisfaction of the purchaser at no extra cost.

2.3 Performance Test

- The following items of performance shall be guaranteed during site performance tests in respect of the DG and the auxiliaries for the specified site conditions:
- Net electrical output (continuous)
- Fuel oil consumption at ¼, ½ , ¾, 85% and full load
- Lubricating oil temperature to and from engine
- 10% overload for one (1) hour out of a total of twelve (12) consecutive hours of operation without over-heating or showing signs of undue stress and within specified frequency variation
- Freedom from vibration and noise
- Governor response, over-speed trip and speeder gear capability

- Voltage regulator response

- Excitation at full load and under specified variation of voltage and speed.

- 12 hrs continuous performance test to prove the reliability of the machine. In case at any point of the test a trip should occur the test shall be conducted again. The necessary fuel oil, lube oil & consumables required for the test shall be included in the scope of supply.

Penalties for non-performance:

- Reduced net output Power. (Rs 50,000/- for every 1% reduction from the rated power)

- Increased fuel oil consumption.

- Increased lube oil consumption.

- Noise level

- Stack emission SOX, NOX, Particulates, CO.

- In addition the following items of performance shall be guaranteed during site performance tests at site by the TENDERER and the auxiliaries for the specified site conditions. All instruments and accessories for performance testing shall be provided by the TENDERER.

- Noise level over the full range of load up to 110% MCR load

- Vibration level over the full range of load up to 110% MCR load.

2.4 Start-up & testing at site

A equipment manufacturer's representative approved by the Consultant / Client shall be engaged to perform start-up and load test upon completion of installation with the Consultant / Client in attendance. A certified test record shall be provided.

Tests shall include, but are not be limited to, the following:

a) Check fuel, lubricating oil, and antifreeze in liquid cooled models for conformity to the manufacturer's recommendations under environmental conditions present.

b) Test, prior to cranking of engine, for proper operation of accessories that normally function while the set is in a standby mode.

c) Check, during start-up test mode, for exhaust gas leaks outside the building, cooling air flow, movement during starting and stopping, vibration during running, line-to-line voltage and phase rotation.

d) Test by means of simulated power outage, automatic start-up by remote-automatic starting, transfer of load, and automatic shutdown. Engine generator sets are to be synchronized and paralleled during tests. Monitor throughout the test, engine temperature, oil pressure, battery charge level, generator voltage, amperes, and frequency.

e) Tests shall demonstrate capability and compliance of system with operating requirements. Where possible, correct malfunctioning units at site then retest to demonstrate compliance; otherwise remove and replace with new units, and proceed with retesting. Retesting to be at no cost to the Consultant / Client.

f) This section includes a very basic outline of the start-up sequence. The actual sequence will be determined after the final design is completed. The commissioning of the new generators will occur on weekends and after-hours depending upon the scheduling requirements of the business.

SECTION: 2.13

PIPING & INSULATION

1.0 **Scope**

1.1 The scope of work covers supply, installation, testing & commissioning of all piping.

2.0 **Standards**

2.1 Following codes and standards shall be applicable.

IS . 1239 – 2004 (Parts1 & 2)	-	Mild steel tubes and tubulars & wrought steel fittings.
IS . 3589 – 2001	-	Steel pipes for water & sewage.
IS . 6392 – 71	-	Steel pipe flanges

2.2 All standards mean the latest

3.0 **Application**

3.1 This specification shall be applicable to pipes covering the following fluids:

i) cooling water not exceeding 50° C
ii) chilled water not less than 6° C
iii) hot water not exceeding 60° C

4.0 **Pipes & Fittings**

4.1 Pipes shall conform to the following schedule:

Pipe (mm) NB	Min.OD	Thickness	Material
25	33.3	4.05	ERW Heavy class mild steel tube to IS-1239-90 Part I
40	47.9	4.05	
50	59.7	4.50	
65	75.3	4.50	
80	88.0	4.85	
100	113.1	5.40	
150	163.9	5.40	

200	219.1	6.00	
250	273.0	6.00	ERW pipes to IS 3589-1991
300	323.9	6.00	
350	355.6	7.00	
450	406.4	7.00	

All pipes shall be factory fabricated.

4.2 All pipes shall be new and from standard manufacturers.

4.3 All bends upto 65 mm NB shall be hydraulically formed with a minimum R/D of three unless space restrictions inhibit, in which case long radius elbows may be used with the approval of the Engineer-in-charge. For sizes upto 40 mm NB, socket weld fittings shall be used. For larger sizes upto 150-mm dia butt welding wrought steel fittings to BS 1965 and matching with the straight pipe wall thickness shall be used. In the case of larger sizes, the bends shall be fabricated from the same stock of pipe and in at least 4 sections with a radius equal to + / - 1.5 times the diameter.

4.4 Flanges shall be slip-on carbon steel with plain faces conforming to IS 6392-1971. Flange shall be rated for 1000 kPa or twice the system working pressure whichever is higher and drilled to suit the equipment or valve flange if already drilled. All bolts & nuts shall be carbon steel and gasket 3-mm fiber reinforced PTFE.

5.0 **Valves**

5.1 All valves and the flanges shall be suitable for 1000 kPa cold non-shock working pressures or twice system pressure whichever is high.

5.2 Valves upto 50 mm NB shall be full bore ball valves with forged body and polished hard chrome plated ball with PTFE seal.

5.3 Higher size valves shall be butterfly type. Butterfly valves shall have a fine grain cast iron body with mirror smooth finished cast steel disc and spindle of stainless steel AISI 410. The valve shall be of wafer-type and should be fitted with two slip on type pipe flanges. The valve shall have an easily replaceable molded EPDM sleeve which shall bring about 100 % tight shut off at the design working pressure. Shaft bottom shall have an axial bearing Where valves are to be insulated they should have on extended neck.

5.4 Non-return valves upto 50 mm NB shall be swing-type of gun metal construction with flanged ends. Larger sizes shall be of cast iron construction with gun mental internals and flanged ends.

5.5 Water strainers shall be either 'Y' or pot type with cast iron bodies for specified test pressure. Strainers shall be complete with brass basket with 3 mm perforations, a dirt blowout plug and a permanent magnet. Strainers shall be designed for easy removal of strainer basket without dismantling the pipe and shall have flanged end connections.

5.6 Manual air vents shall be provided at all high points in the piping systems for air purging. Vent sizes shall be as follows and suitable for specified test pressure.

Up to 152 mm : 12 mm size ball type gun metal valves with hose connections.

Over 152 mm : 20 mm size globe type gun metal valves with hose connections.

Air vents associated with equipment or cooling coils shall be 12mm automatic venting type with a shut off ball cock and a plastic pipe discharging into the condensate drain. Such air vents should form part of the coil or equipment.

5.7 Drains shall be provided at all low points and all drain valves shall be gunmetal globe type with hose connectivity. Drain sizes shall be 25 dia or as shown on drawings.

5.8 Pressure gauges shall be "Bourdon' type with minimum 100 mm dial and required range. All gauges shall be provided with gun metal plug type gauge cocks and copper or S.S capillary connection to prevent system fluctuations affecting the gauge. Gauges shall be provided wherever shown.

5.9 Thermometers shall be industrial direct reading stem type of the required range. Thermometers shall be provided in separable wells.

6.0 **Pipe Installation**

6.1 Pipe installation shall be carried out in a workman-like manner in accordance with approved drawings. Pipes shall be aligned parallel to walls and ceiling and not across a room. Change of direction shall be through hydraulically formed or wrought iron welding fittings as specified. Alignment shall follow the approved drawings and wherever necessary pipe shall be rerouted under the instructions of the Engineer-in-charge in order to meet the site conditions and or interference from services.

6.2 Pipes passing through walls & floors shall be provided with sleeves as follows:

Space	Sleeve dia (mm)	Sleeve Projection (mm)	Sleeve Material	Sleeve packing and Closure
Floors	D + 50	50 AFF	1.25 mm GSS OR Light duty galvanised tube	32 Kg/cum Resin bonded fibre glass with 8 mm thick polysulphide or Silicon sealant
Walls				
i) Internal	D + 50	Flush with Finish	- do -	32 Kg/cum Resin bonded fibre glass closed on both sides with 1.0 mm GSS split flange
ii) External	D + 50	- do -	- do -	Caulked with lead wool and oakum & closed on both sides with 1.25mm GSS split flanges with brass screws

D = Outside diameter of pipe with insulation
GSS = Galvanised sheet steel
AFF = Above finished floor

6.3 Pipe supports shall be standard factory made galvanised systems or fabricated from steel structurals galvanised after fabrication. Supports shall be spaced as follows:

Size	Horizontal	Vertical
Upto 15 mm	1.25 m	1.8 m
20 to 25 mm	2.00 m	2.5 m
32 to 125 mm	2.50 m	3.0 m
150 & over	3.00 m	3.0 m

6.4 Additional supports shall be provided at the bends, at heavy fittings like valves, near equipment and as directed by the Engineer-in-charge. Pipe hangers shall be from galvanised structural steel, steel inserts in concrete or anchor fasteners, wall brackets or floor supports as decided by the Engineer-in-charge depending upon the location of the support. Hangers shall not be secured to light weight roof, wall, false ceiling or any other member which is not structurally meant for such loading. Hangers from structural steel shall be from suitably designed clamps or attachments and in no case should drilling or punching of such steel members be allowed. All pipe supports shall be capable of being adjusted in height to the tune of 50mm. All supports suspenders and hangers shall be galvanised after fabrication.

5.5 Pipe clamps shall be specially fabricated fittings for pipes. All clamps shall be of galvanised mild steel. Clamps shall take into account pipe movement owing to temperature variations & anchors, and in no case shall the clamp- ing arrangement induce stresses beyond the safe load limits of the pipe under fully filled conditions. Where pipes are insulated, the clamping shall interpose a hard insulation material or shall be designed so that the insulation is not compressed for more than 60% of its compression strength.

6.6 Vertical pipe risers shall be supported at each floor and in addition, the riser shall have a duck-foot support at the lowest point.

6.7 All pipe joints shall be welded except where flange joints are specified. Pipes upto 40 mm NB shall use socket-weld fittings with fillet welding and larger sizes use butt-welding type single V 35 deg weld preparation. Flange joints shall be provided at the following positions:

i) Pair of flanges for isolation of equipment
ii) Mating flanges for equipment flange connections
iii) Mating flanges for valves, strainers as the case may be
iv) Pair of flanges at every 30 m continuous run of piping

Galvanised pipes when welded, the joints shall be painted with zinc – rich paint as approved by the Engineer.

6.8 Where valves, strainers, NR valves adjoin, there is no need for additional mating flanges and valve flanges may be used to mate with the other valves, strainers etc.

6.9 Entire piping shall be self-draining, using only eccentric reducers at all change of sections. 25mm NB drain points with a dirt leg and a shut off valve shall be provided at all low points of the piping and the piping system shall be pitched 1% towards such low points. All air handling unit drains shall be pitched 2% with a 75-mm water seal trap. Fan coil unit drains also shall be pitched likewise but the water seal could be 40 mm. All traps shall be built-up or prefabricated. In the case of the multiple risers of supply and return water lines, isolating valves with a strainer and drain valve shall be provided wherever required. All isolating valves shall be gate/ball/ butterfly valves suitable for tight shut-off. Valves shall not have their spindles downwards.

6.10 A vent shall be provided at high points. All vents shall have a shut off ball valve with hose connectivity.

6.11 Where pipes are directly buried in ground, the pipes shall be coated 2.0mm "Sealfas' or equivalent coating.

6.12 Pipes shall be buried at a depth of 750 mm to top of pipe. The excavated trench be filled with soft earth/sand for atleast 150 mm over the top of pipe before being refilled with the excavated soil.

6.13 Where pipes are buried at less than 750 mm, the pipes shall be duly protected as directed by the Engineer-in-charge.

6.14 All piping shall be laid and tack welded in position with flanges, valves etc. After inspection and approval by the Engineer as to the alignment and height, the piping shall be full welded. Slip-on flanges shall be demounted for welding. Piping may be presented to the Engineer for such approval in sections. Random samples of valves shall be tested for leaks and seating. Necessary hand pump and blank flange facilities with pressure gauge, valves etc. should be provided at site.

7.0 **Testing**

7.1 Hydraulic testing of piping shall be carried out before equipment connections are made. No insulation shall be carried out unless and until the piping, in section, is tested and tests approved. Piping may be tested in sections, with the approval of the Engineer and in such cases all open ends shall be blanked off with necessary flanges.

7.2 All piping shall be tested for pressure equivalent to the following:

2 x dynamic head of the pump plus the gravity head due to expansion tank or cooling tower.

In such a pressure test, the system shall hold for a minimum period of 3 hours. All pipe testing shall be witnessed and certified by the Engineer-in- charge and leaks or defects found in the joints shall be rectified.

7.3 The contractor shall make all arrangements for testing & removal after testing of all water connections, if any, without causing any damage to the property of the employer or any other contractor.

7.4 After the entire piping has been tested and equipment connected, the system of water piping shall be filled and drained till all the dirt, milscale and any other foreign matter is flushed out to the satisfaction of the Engineer-in- charge. At any rate, the system shall be flushed atleast 3 times before commissioning. All strainers shall be cleaned of all accumulated dirt before the system is charged.

8.0 Mode of measurement

8.1 All pipes shall be in unit length rounded off to the nearest centimeter and measured along the center line of the pipe and all fittings, flanges etc. excluding the flange to flange distance of valves, strainers or any other equipment. The rate shall include all clamps, bolts etc. cutting holes in ceiling, floor or wall and making good the same including scaffolding, staging supports, flexible etc. and painting of piping as per the painting specifications or as directed by the Engineer – in – charge.

8.2 All valves, strainers etc. shall be measured per unit in each size and paid for.

8.3 All pressure gauges complete with socket, gauge cock and pressure gauge and CP brass capillary shall be measured per unit.

8.4 Thermometers together with thermowell, conducting fluid etc. shall be measured as one unit.

8.5 Air vents and drains shall each be measured per unit and paid for. Auto air vents with cooling coils / equipment shall form part of the coil or equipment.

9.0 Insulation

9.1 Boiler Flues, Engine Exhaust pipes shall be insulated with 48 kg/cum unbonded fibre glass with galvanised wire netting on one side. The flue/ pipe shall be thoroughly cleaned with wire brush to remove all milscale and painted with one coat of bitumastic paint. The wool blankets 100mm thick shall be applied with the wire netting on the out side. The insulation shall be held in position by lacing with 1.0mm dia galvanised steel wire and covered with fibre glass tissue with 75mm overlapping. The finished surface shall be clad with 0.50mm thick aluminium sheets with 50mm overlap and fixed with self-tapping M8 sheet metal screws.

SECTION: 2.14

PROTECTIVE EARTHING

1.0 Scope

1.1 The scope of work shall cover earthing stations, laying aluminum/ copper earth strips and connecting the power panels, DBs and switch boards.

2.0 Standards

2.1 The following standards and roles shall be applicable:

1) IS:3043 - 1966 Code of Practice for earthing.
2) Indian Electricity Act and Rules

2.2 All codes and standards mean the latest.

3.0 Plate Earthing Station

3.1 The substation earthing shall be with copper plate earthing station unless otherwise specified.

3.2 The earthing station shall be as shown on the drawing. The earth electrodes shall be 600 x 600 x 3mm copper plate. The earth resistance shall be maintained with a suitable soil treatment and watering arrangement as shown on drawings. Excavated soft soil shall be thoroughly mixed with specialized chemical material and the earth pit is back-filled 300 x 300 earth chamber with cast iron cover shall be provided to house the earth terminal and water pipe & funnel.

3.3 The resistance of each earth station should not exceed 3 ohms.

3.4 The earth lead shall be connected to the earth plate through copper/brass bolts as shown on the drawing.

4.0 Pipe Earthing Station

4.1 The pipe earth station shall be as shown on the drawing and shall be used for equipment protective earth grid. The earth electrode shall be 2.5/3m long 19/25mm dia galvanised steel pipe. The earth resistance shall be maintained with a suitable soil treatment as shown on drawings and as for plate electrodes. An earth chamber shall be provided as for plate earth station.

4.2 The resistance of each earth station should not exceed 5 ohms.

4.3 The earth lead shall be fixed to the pipe with a clamp and safety set screws. The clamps shall be permanently assessable.

5.0 Earth leads and connections

5.1 Earth lead shall be bare copper or aluminium or galvanised steel as specified with sizes shown on drawings. Copper lead shall have a phosphor content of not over 0.15 percent. Aluminium and galvanised steel buried in ground shall be protected with bitumen and Hessian wrap or polythene faced hessian and bitumen coating. At road crossings necessary hume pipes shall be laid. Earth lead run on surface of wall or ceiling shall be fixed on saddles on wall so that the strip is atleast 6mm away from the wall surface.

5.2 All earth strip shall be jointed as follows:

Copper	:	Copper riveting with 80mm fish plate and brazing
Aluminium	:	Riveting with 2Nos 100mm long bimetal fish plates using copper rivets
Galvanised Steel	:	Lap welding with 50mm minimum lap

5.3 All strips shall be run on walls/beams with 6mm thick galvanised steel earth saddles at 500mm centre to centre as shown on drawings.

6.0 Equipment earthing

6.1 All apparatus and equipment transmitting or utilising power shall be earthed in the following manner:

Size of phase conductor	*Copper*	*Aluminium*	*Galvanised steel*
Upto 16	<	Same >	1.55
Over 16 to 35	<	16 >	32
Over 35	<	As shown on drgs.	>
Minimum (base)	2.5	4.0	6
Minimum (enclosed)	2.5	2.5	-

The protective earth continuity conductor may be drawn inside the conduit in which case, it should be insulated.

Copper earth wires shall be used where copper wires are specified. Aluminium wires may be used where aluminium phase wires are specified unless otherwise indicated in the schedule of work and drawings.

6.2 Metallic conduit shall not be accepted as an earth continuity conductor. A separate insulated/bare earth continuity conductor of size related to phase conductor shall be provided. Non-metallic conduit shall have an insulated earth continuity conductor of the same size as above. All metal junction and switch boxes shall have an inside earth stud to which the earth conductor shall be connected. The earth conductor shall be distinctly coloured (green) for easy identification.

6.3 Armoured cables shall be bonded to the earth by 2 distinct earth connections to the armouring at both the ends and the size of connection being as above. In multiple cables entering a panel/DB, the cable joints shall be bonded together using a bonding wire selected on the basis of the largest size of cable in the group. In the case of unarmoured cable, an earth continuity conductor shall either be run outside along the cable or should form a separate insulated core of the cable. 3 Ph. power panels and distribution boards shall have 2 distinct earth connections of the size correlated to the incoming cable size. In case of 1 Ph. DB's a single earth connection is adequate. Similarly for 3 Ph and 1 Ph. isolating switches there shall be 2 and 1 earth connections respectively, sizes being correlated to the incoming cable.

6.4 3 Ph. motors and other 3 Ph. apparatus shall have 2 distinct earth connections of size equal to incoming feeder size. For 1 Ph motor and 1 Ph apparatus, the single earth connections shall be provided of the above size.

7.0 **Earthing Installation**

7.1 All work shall be carried out in accordance with local Electrical Inspectorate, and IS Code of Practice 732. Reference to above codes, specifications and regulations shall mean the latest.

7.2 All materials used on the installation shall be new and of approved make. Tenderer should indicate makes of materials proposed to be used on the job.

8.0 **Testing**

8.1 The following earth resistance values shall be measured with an approved earth meggar and recorded.

1) Each earthing station
2) System as a whole
3) Earth continuity

9.0 **Mode of measurements**

9.1 Providing earthing station complete with excavation, electrode, watering pipe, soil treatment, masonry chamber with cast iron cover etc. shall be treated as one unit of measurement.

9.2 The following items of work shall be measured and paid per unit length covering the cost of the earth wires/strips clamps, labour etc.

(a) Main protective earth terminal and connections to the earthing stations

(b) Connections to the switchboard, power panels, distribution boards etc.

9.3 The cost of earthing the following items shall become part of the cost of the item itself and no separate payment for earthing shall be made.

a) Motors - earthing forming part of the cabling/wiring for the motors.

b) Isolating switches and starters should form part of mounting frame, switch starter etc.

c) Light fittings - form part of installation of the light fittings.

d) Conduit wiring - should form part of the wiring

e) Cable armouring - should form part of the cable termination.

f) Street lighting - should form part of the external cable which shall incorporate a protective earth-conductor which shall be used for earthing of the pole etc.

SECTION: 2.15

UNINTERRUPTED POWER SYSTEM

1.0 The Scope

1.1 The scope of work shall cover supply, packing, forwarding to site, unloading at site, erection, testing and commissioning of a static Uninterrupted Power Systems meeting the performance criteria listed in the Data sheets and the specifications. Units may be single or multiple modules as defined in the Data sheets.

2.0 Code & Standards

2.1 UPS shall be standard products of established manufacturers and shall meet international standards with UL or CSA or CE listing. Safety & EMC standards should conform to EN 50091 – 1 & 2

3.0 Environment

3.1 Design ambient operating conditions shall be

Dry bulb	0 to 40°C
RH	0 to 95% (non-condensing)
Altitude	1000m above mean sea level (Derate for higher levels)

3.2 Transport & storage conditions shall be

Dry bulb	0 to 70°C
RH	0 to 95% (non-condensing)
Altitude	12000m above mean sea level

3.3 Acoustic performance of the units shall meet DIN 45630.

4.0 System Content & Configuration

4.1 General

4.1.1 UPS may have single module or may consist of multiple modules. Each module shall be supported by a back up battery. In multimodule parallel redundant systems, only one of the modules needs to be redundant in a n + 1 configuration. Each module shall be rated for continuous operation at 100% load with over load capability as specified and shown in the data sheets. By pass section both for static and maintenance, shall be integral with each module. UPS shall be supported by necessary paralleling cards and software in case of multi module redundant systems

4.1.2 Each module essentially shall consist of A.C input section, AC output section, Bypass section and a back-up battery section and a control and monitoring panel.

UPS shall be supported with EPO (emergency power off) facility and soft start facility.

4.2 AC Input section

4.2.1 The AC input power supply is from the utility and the characteristic is defined in the Data sheets. Rectifier shall be IGBT based and shall meet the full load + the quick charging current of the battery. Input current limit shall be adjustable to maximum of 125% of normal full load current. The input circuit breaker shall therefore have trip rating to supply full rated load and recharge the battery at the same time. The breakers shall have an under voltage release to open automatically when the supply voltage is lost.

4.2.2 Input Current distortions shall be limited to the values set in the data sheets. Likewise the input power factor shall be as high as possible and not less than what is stated in the data sheets. In addition, the section shall sustain input surges without damage and in this connection it is desirable to follow the criteria listed in ANSI C62.41 – 1980.

4.3 AC Output section

4.3.1 The inverter shall be solid state, pulse width modulated utilizing insulated gate bipolar transistors. Each power IGBT shall be individually fused with a fast acting fuse. Fuse failure shall be displayed in the monitor.

4.3.2 Inverter shall be rated for 100% continuous load at 40°C ambient temperature, for any combination of linear or non-linear loads and 10 times continuous load for 3 cycles without causing the bypass breaker to close. For parallel operation, all inverter modules shall automatically share the load within ±5% unbalance. Parallel load sharing function shall be resident and redundant in each unit without requiring master controllers.

Paralleling of UPS shall allow to switch off inverter of UPS in bank for lower loads but it shall be hot standby.

4.3.3 AC output from the inverter shall be better than what is specified in the data sheets. Voltage distortion, voltage transients, over load performance shall all be good for any load characteristic, linear / nonlinear or any load power factor between 0.8 lagging to 0.9 leading. Provide necessary filters to achieve THD specified in data sheets. There should be no de-rating from point 0.9 lag to 0.9lead power factor.

4.3.4 A dry type isolation transformer (wherever applicable as per datasheets) with double shielded copper windings with input and output surge suppression network shall be provided for true galvanic isolation. The transformer shall employ class H 220°C insulation but the maximum temperature rise shall not exceed 150°C. The rating of the transformer shall match with inverter rating and shall have six full-capacity primary taps (+2 ½ ,+ 5, – 2 ½ , - 5, 7 ½ , 10) Noise / transient suppression shall be not less than 140dB for common mode and 90dB for normal mode. Acoustic noise should not exceed 50 dB at 1.5m and also meet DIN 45630. Efficiency of dry type transformer shall be more than 96%.

4.3.5 An automatic output circuit breaker shall be provided to isolate the malfunctioning module from the critical load. The module should sustain sub cycle current of 300 to 500% and in the case of a sustained short circuit, the inverter shall disconnect automatically from the load bus. An uninterrupted load transfer to by pass shall be initiated should connected critical load exceed the capacity of the available on-line modules.

4.3.6 UPS should have low ripple & temperature compensated charging facility.

4.4 **Bypass Section**

4.4.1 A static transfer switch and bypass circuit shall be as far as possible, an integral part of the UPS. The static switch is a naturally commutated high speed static device rated to conduct 125% of full load current continuously, 200% for 30 seconds and 2000% for two cycles. The static switch may be provided with a wrap-around contactor as necessary.

4.4.2 The inverter shall track the bypass continuously so that the bypass source maintains a frequency of 50± 0.5 Hz. The inverter will change its frequency at 0.1 Hz per second to maintain synchronous operation with the bypass to enable make before break transfer manually or automatically. If the bypass fails to maintain the frequency, the inverter shall revert to a temperature compensated internal oscillator and hold the inverter output frequency 0.1% from the rated frequency for steady state and transient conditions. Total frequency deviation, including short time fluctuations and drift shall not exceed 0.1% from rated frequency.

4.4.3 A manually operated maintenance bypass switch shall be incorporated to each module.

4.4.4 Neutrals of all isolation transformers shall be connected to a common earth bus which in turn shall be connected to the earth stations

4.5 **Back-up Battery**

4.5.1 Each UPS module shall have a matching battery power pack housing batteries for quick discharge. AH rating of the battery pack shall be such as to sustain full load of the UPS for the specified discharge period till 1.7V cell voltage.

4.5.2 Recharge time to 95% capacity shall be within 10 times the discharge time. A 2-step battery charge current shall be limited to 10% (1 – 25% adjustable) and 1% (1 – 25% adjustable).Batteries shall have minimum 5 yrs life.

4.5.3 Battery charging circuit shall be intelligent to consider battery charging curves as per battery manufacturers specifications, temperature rise and % charge remaining.

4.5.4 Battery charger should support to battery banks to provide flexibility in battery configuration so that in case of failure of one battery bank other bank is available.

4.5. 5 Insulation of inter-cell connectors for batteries shall be of FRLS type, also battery terminals shall have FRLS shrouds (anti static type).

4.5. 6 Batteries to be installed in earthquake prone areas should include seismic tests on batteries & stands.

4.5.6 Vendor should submit data for hydrogen gas evolution under float and boost conditions.

4.5.7 Batteries shall be with flame retardant container material.

4.6 **Control, Monitoring and Display**

4.6.1 The UPS, single or multimodule, shall monitor and control through the use of menu-driven commands. System logic and control programming shall be resident in Application Specific Integrated Circuits and shall be solid state using switches, contacts and relays only to signal status of mechanical devices or to signal user control inputs. Redundant control voltage shall be available for all functional blocks.

4.6.2 A microprocessor shall control the display and memory functions of the monitoring system. All voltage and current parameters shall be monitored using true RMS measurements (±1% accuracy) displaying all three phases of three phase parameters. Display shall show, but not limited to the following:

Input

- Voltage (L-L & L – N)
- Current
- Frequency

Battery

- Voltage
- Charging Current
- Discharging Current
- Time left during Battery operation by pass

Output

- Voltage (L-L & L – N)
- Current
- Frequency
- KVA
- KW
- % rated KVA

4.6.3 Alarms listed below shall be displayed in text and audio formats.

- Ambient over temperature
- Equipment over temp.
- Over temp. time out
- Input
  Under Voltage
  Over Voltage
  Under frequency
  Over frequency
  Input fail
  Input current imbalanced
  Rectifier fuse blown
  Blower failed
  Reverse power
  Over load shut down
  Hardware shut down
  Inverter fault
  Inverter non-synchronized
  DC over Voltage shutdown
  DC ground fault
  DC capacitor fuse blown
  Battery circuit breakers open
  Batter discharging
  Low battery shut down
- Output
  Load on by pass
  Auto transfer to By pass
  Bypass not available
  Bypass – wrong phase sequence
  Control power failure
  Communication failure

The alarm displays shall not be limited to the above.

4.6.4 The system shall provide a connection for a remote terminal in RS485 format through a compatible modem and also a local terminal. All system features and alarms shall be capable of being remotely monitored leading to remote maintenance. In addition the following I/O points shall be provided 6 universal points, 8 potential free contacts.

4.6.5 Battery monitoring system

4.6.5.1 The Battery Monitoring System shall provide for the automatic acquisition, trending, alarming and storage of information from battery bank. It will have the interactive ability to first identify and then provide an isolated equalizing charge current to any individual cell or jar that deviates below a user-specified set point, from the cell average, within the same string or bank.

4.6.5.2 The Battery Monitoring System shall test the relative charge state and health of each individual cell or jar by injecting a DC current, recording the magnitude of this current & comparing it to previous benchmark values. Systems that require battery discharge for testing are not acceptable. The system shall provide estimated backup time remaining during an actual discharge.

4.6.5.3 The Battery Monitoring System shall monitor and maintain historical files for:

a) individual cell or jar voltage
b) total bank voltage
c) discharge current
d) ambient and pilot cell temperature
e) relative current response value

4.6.5.4 Display shall be via local LCD display, with capacity for viewing at a remote terminal. All files shall be written to a fixed solid state disk within the enclosure. All functions shall be accessible via modem using common communications software.

4.6.5.5 Cell voltage measurements must be made to within plus or minus 5 millivolts over the entire operating and temperature range.

4.6.5.6 Documentation, Manuals and installation documentation for the equipment shall be provided which lists block diagrams, schematics parts list and theory of operating for each unique component of the system. Installation drawings and documentation shall be site specific for each string at this facility.

4.6.5.7 The system shall be factory tested fully and completely before shipment.

4.6.5.8 Site testing: Each measurement shall be tested and to assure that is properly corresponds to the correct cell location and that the measured value corresponds to a separate measurement taken within a four (4) digit laboratory accuracy Digital Voltmeter which has been calibrated to NBS standards within the past six (6) months. Manufacturer shall submit test procedures for approval

4.6.5.9 Support shall be provided as follows:

a) At least 2 – 4 hour on site training sessions shall be provided after installation and start up is complete with the operation of the battery monitoring system.

b) Factory trained field service engineers shall be available for maintenance and repair of the battery monitoring system within 4 hours of the service call.

5.0 **Testing, Training and Service**

5.1 Unit Start-up and Testing

5.1.1 Factory testing shall be provided by the manufacturer before to dispatching UPS system. Factory acceptance testing shall consist of a complete test of the UPS system and the associated accessories supplied by the manufacturer. A full 100% load, 24 hour burn in load power test including a 50% battery discharge test shall be provided as part of the standard start-up procedure. Overload test for 10 min. at 125% load and 30 sec. at 150% load. The test results shall be documented, signed, and dated for future reference. Test to be performed at factory.

i) Power failure test
ii) Communication test
iii) Power continuity test
iv) Load on mains
v) Load on inverter
vi) Uncoupling
vii) Coupling
viii) Module exclusion test W/O using manual by pass.
ix) Remote alarm operation
x) UPS parameter check on display
xi) UPS function check
xii) Battery discharge test

5.1.2 Dedicated engineers shall be engaged on site for testing & commissioning of complete UPS system & for training of UPS system maintenance.

5.2 UPS Maintenance Training

5.2.1 Maintenance training shall be provided for a minimum of 8 hours for maintenance staff. This training will be in addition to the basic operator training conducted as part of the system start-up.

5.3 Manufacturer's Field Service

5.3.1 The manufacturer shall provide a fully automated national dispatch center to co-ordinate field service personnel schedules. One toll-free number shall reach a qualified support person 24 hours/day, 7 days/week, 365 days/year. Emergency telephone service response time shall be 20 minutes or less, and on site service response time within 4 hours.

5.3.2 Battery manufactures service engineers shall supervise the battery bank installations. Also service engineers shall inspect battery inspection at regular intervals and submit inspection report to facility engineer.

5.4 Replacement Parts Stacking

5.4.1 Parts must be available for guaranteed delivery with 12 hours.

6.0 **Warranties**

6.1 Provide 3year warranty for full battery replacement (material and labor).

6.2 UPS shall be warranted to be free from defects for a period of 2 years from the date of acceptance of equipment. Warranty and preventive maintenance service shall be performed by factory-trained personnel.

SECTION: 2.16

M V SWITCHGEAR

1.0 Scope

1.1 The scope of work shall cover the supply, installation, testing and commissioning of all power panels, incorporating circuit breakers, switch fuses, busbars, interconnections, earthing etc.

2.0 Standards

2.1 The following standards and rules shall be applicable:

1) IS:13947:1993 Switchgear & Control gear specification

2) IS:8623:1993 Parts 1 & 3 Low Voltage Switchgear and Control gear assemblies.

3) Indian Electricity Act and Rules

All codes and standards mean the latest. Where not specified otherwise the installation shall generally follow the applicable Codes of Practices of the Bureau of Indian Standards.

3.0 Air Circuit Breakers

3.1 Air circuit breakers shall be heavyduty air break horizontal draw out fully interlocked and meeting the requirements of Indian Standards. Breakers shall be rated for a medium voltage of 500V and rated full load amperes as indicated on drawings. Breakers shall be capable of making and breaking system short circuits specified.

3.1.1.1 Breakers shall be, motorised or manually operated as specified, complete with front-of-the-panel operating handle, isolating plugs with safety shutters, mechanical ON/OFF indicator, silver plated arching and main contacts, arc chutes and trip free operation. Breakers shall be capable of being racked out into 'testing', 'Isolator' and 'Maintenance' position and kept locked in any position. Breakers for remote and automatic operation shall be motor operated spring charged with closing and trip coils. Breakers shall have minimum 3 NO-NC contacts. Breaker terminals shall be shrouded.

3.3 **Construction**:

1) ACB should be with safety shutter, Anti-pumping and rating error preventer.
2) Cradle: Should be service, test, isolate & maintenance positions Racking handle should be stored in cradle.
   Electrical breaker should not close during travel from service and test position and vice versa.
3) Inter-phase clearance should be more than 25 mm after termination of bus bar.
4) Neutral pole rating should be equal to phase rating unless specified otherwise

5) Electrical /Mechanical life: 15000 Cycles up to 2500A and 5000 cycle above 3200A.

3.4 **Release:**

1) All releases in ACB should be communicable microprocessor Based and having over load, short circuit and earth fault protection.
2) Release should be operated through magnetic fluxing device direct on trip rod.
3) Release should be True RMS, self powered using CT.
4) Release should have zone selectivity facility.

3.5 **Breaking:**

1) As per SLD ICU=100%ICS=ICW for 1 sec
2) Breaking capacity should be tested by CPRI/ERDA and reputed international authority. (Type test certificates not older than 3 year shall be provided when asked.)

4.0 **MCCB's**

4.1.1 Construction

1) MCCB should be current limiting type, and of trip free mechanism.
2) MCCB operated with rotary handle having door interlock facility.
3) All accessories like Shunt release, UV release, Aux & trip contacts should be site fittable.
4) Phase to phase barrier should be provided with MCCB.
5)

4.2 **Breaking:**

1) As per SLD ICU=100% ICS.
2) Breaking capacity should be tested by CPRI/ERDA and reputed international authority. (Type test certificates not older than 3 year shall be provided when asked.)

4.3 **Release:**

1) Ratings above 250Amp. should be Microprocessor based with over load ,short circuit ,earth fault protections
2) Ratings equal & less then 250A should be adjustable thermal and magnetic type.

5.0 **Switch Fuse Units & Disconnectes**

5.1 Switch fuse units shall have quick-make, quick-break silver plated preferably double break contacts with operating mechanism suitable for rotary operation in the case of cubicle mounting.
All switches shall be rated according to the equipment schedule or drawings and shall withstand the system prospective fault current let through.

Cam operated rotary switches with adequate terminal adaptors upto 25A are acceptable but for all higher rating switch fuse units shall be heavy duty type. All switch fuse unit should be AC23A.

5.2 Fuses shall be HRC cartridge type conforming to IS:2208 with a breaking capacity corresponding to system fault level. Fuses shall be link type with visible indication. Screw type diazed fuses are not acceptable for any ratings.

5.3 All disconnecting isolators shall consist of switch units quick-make, quick-break type with silver plated contacts. The switches shall preferably have double breaks. The switches shall have sheet steel enclosure, which in turn is mounted on suitable angle iron frame work. In wet locations switches shall have cast iron enclosures. Disconnects shall have a minimum breaking capacity of 5KA at 415 Volts.

6.0 **Isolators**

6.1 Isolators shall be fixed on wall on self-supported angle iron frame work as required and mounted as near to the motor as possible. Where several motors are installed, isolators if required shall be provided at a central location on a common frame work.

6.2 Painting, earthing and labels shall be provided as generally indicating for MV Switchgear and shown on drawings.

7.0 **Instrument Transformers, Meters & Relays**.

7.1 Ammeters and voltmeters shall be electronic digital type. Meters shall conform to BS:89 and have grade 'A' accuracy.

7.2 Energy meters shall be electronic two element switch board mounting type suitable for unbalanced loads. In case of two incoming feeders, a summating C.T shall be provided with the meter. Meters shall conform to IS: 37.

7.3 The energy meters for grid supply and DG supply shall be calibrated and got certified by the respective Electricity Authority wherever required.

7.4 CTS shall be cast resin type and conform to IS:2705 in all respects. Rated secondary current shall be 5A unless otherwise stated. Accuracy class of metering CT's shall be 1.0 & for protection 5P20 or as specified in the datasheets.

Test links to be provided in secondary connection to facilitate testing of instruments, meters & protection device. CT burden shall be minimum of 10VA but appropriate to the instruments, relays connected or as specified in the datasheets.

7.5 Relays and trip devices shall be any one of the following as specified:

i) Adjustable Thermal – Magnetic trips – direct acting
ii) Solid state relays with shunt tripping.
iii) Microprocessor controlled relays numerical type with shunt Tripping.

All trips shall be 400/230V AC series type unless shunt tripping is specified for.

7.6 LED indicating lamps to be provided for phase indication & breaker position as required.

7.7 All wiring for relays shall be of stranded copper with colour coding and labelled with appropriate plastic tags for identification.

Minimum size of control wiring shall be 2.5 sqmm stranded copper. All control circuits to be provided with protective MCB's or fuses consistent with short circuit levels.

8.0 **Cubicle Boards**

8.1 All boards shall be combination of 14 SWG (Main Body) & 16 SWG (Doors & partitions) sheet steel, 3mm thick gland plates, free standing, extensible, totally enclosed, dust tight, vermin-proof cubicle as per IP 43, flush dead front and of modular construction suitable for 3 phase 415V 4 wire 50 Hertz system TN-S neutrals grounding. All boards shall be accessible from the front or as shown on Drgs, for the maintenance of breakers, switch fuses, busbars, cable terminations, meters etc. Cables shall be capable of entering the board both from top as well as bottom as specified in drawings. All panels shall be machine pressed with punched openings for meters etc. mounted on a 75mm high base channel frame. All sheet steel shall be rust inhibited through a process of degreasing, acid pickling, phosphating etc. The panels shall be finished with powder coating of approved colour applied over a primer. Aluminium anodized Engraved labels having white letters on black background shall be provided indicating the feeder details and capacity. All panels shall be provided with danger boards on bus bar & cable chamber.

8.2 The boards shall accommodate air insulated bus bars, air circuit breakers, mccb's switch fuse units with HRC fuses, starters, necessary meters, relays, contactors etc. as required and arranged in suitable tiers. All breakers and switch fuses shall be suitably derated taking into account specified ambient temperature and ruling temperature inside the cubicle.

8.3 The switch board shall be fully compartmentalised in vertical tiers housing the feeder switches in totally enclosed independent compartments. Each compartment shall be self sufficient with switch unit, fuses, contactors, relays, indicating lamps and an inter-locked door with facility for padlocking. Each switch or MCCB or ACB shall have provision for locking in the OFF position for life safety. Each feeder must terminate in an independent labelled terminal block. Strip type terminal block accommodating several feeders together is not acceptable. Pressure clamp type terminals suitable for aluminium wires may be used upto switches of 25A and cable lugs for higher ratings. Glands shall be of heavy duty brass casting, machine finished & complete with check nut, washers etc. The lugs shall be tinned Cu /Al depending upon cable conductor & of solderless crimping type. All terminations shall be shrouded in an approved manner. The entire enclosure shall meet with IS: 13947. Feeder connections shall be of solid insulated copper/aluminium wires or strips with bimetallic clamps wherever required and if insulated, the insulation shall be able to withstand the high temp at the terminals. Internal wiring, bus bar markings etc. shall conform to IS:375/1963. Internal wiring shall have terminal ferrules.

Panels shall be supplied with necessary fastners.

Main switch should be at an easily accessible height and the highest switch operating handle should not be over 1.75M from floor level. Cable glands shall form part of the switch board.

8.4 Space heaters of adequate capacity shall be provided inside each panel. They shall be suitable for 240V, 1ph 50 Hz supply. They shall be complete with MCB or HRC fuses, isolating switches & adjustable thermostat.

8.5 Each panel shall be provided with 240V 1ph 50Hz , 5A 3pin receptacle with switch located at a convenient position.

9.0 Bus bars shall be three phase and neutral and of copper or aluminium or aluminium alloy (E91E) as specified and shown on drawings and rated for a temperature rise of 30 deg C over the ambient temperature specified, (IS:8084-1976). Neutral bars may be of one half the size of the phase bars or as shown on drawings. The main horizontal bus bars shall be of uniform cross section and rated for the incoming switch. The vertical bus bars for the feeder columns should be equal to size of horizontal busbar and shall be uniform in size. Bus bars

interconnections shall be taped with heat shrinkable PVC colour coded tape to prevent bar-to bar accidental shorts. Each bus bar shall be directly and easily accessible on removal of the front cover. Bus bars shall be totally enclosed, shrouded, with heat shrinkable colour coded sleeves and supported on non-hydroscopic insulator blocks to withstand thermal and dynamic overloads during system short circuits.

Feeder connections shall be solid copper bus bars duly insulated with bimetallic damps where we required. Bus bars shall be designed for easy extension in future on either side. All feeder connections shall be rated for 25ºC temperature rise over the ambient.

10.0 Earthing

10.1 An earthing bus shall be provided at the bottom & extended throughout the length of panel. It shall be be bolted / welded to the frame of each unit & each breaker earthing bar.

10.2 Protective earthing shall be provided as shown on drawings or as follows:

Phase conductor	Protective conductor
upto 16 sqmm	equal size
16 to 35 sqmm	16 sqmm
over 35 sqmm	50% of phase conductor

In case of dissimilar materials the Protective Earth Conductor shall be suitably sized for equal conductance.

10.3 Protective earthing of each switch shall be connected to the earth bar.

10.4 All non current carrying metal work of the switchboard shall be effectively bonded to the earth bus.

11.0 Installation

11.1 All panels shall be supported on MS channels incorporated in the panel during the fabrication. All such supports shall have two finish coats over a prime coat after completion of the work. All panels shall be touched up for damaged painting.

11.2 All panels shall be meggared phase to phase and phase to neutral using a 1000V meggar with all outgoing feeders in closed position. The meggar value should not be less than 2.5 megohms between phases and 1.5 megohms between phases and neutral.

11.3 Fabrication drawings of all panels shall be approved by the Consulting Engineers before fabrication.

12.0 Testing & Inspection

12.1 All switchboards shall be factory inspected before finishing and dispatch unless waived. Type test reports for all switchgear shall be furnished.

12.2 Certificate for all routine and type tests for circuit breakers in accordance with the IS:2516-1963 shall be furnished. In addition, all panels shall be meggared phase to phase and phase to phase neutral, using a 1000V meggar with all switchgear in closed position. The meggar value should not be less than 2.5 megohms between phases and 1.5 megohms between phase and neutral.

12.3 All meters shall be calibrated and tested through secondary injection tests.

12.4 All field tests shall be witnessed by Consultants and recorded unless waived.

13.0 Mode of measurement

13.1 Each panel will be considered as one unit for the purpose of measurement and shall include the following:

i) Incoming and Outgoing feeders.
ii) Interconnections and controls and instrument wiring with necessary protective fuses.
iii) Meters, Relays, Indicating lamps, CT's control fuses etc.
iv) Supporting structure, sheet steel enclosure
v) Installation, commissioning and testing

13.2 Isolators shall each be measured as one unit complete with:

i) mounting frame
ii) switch/fuse

13.3 Protective earthing of the panel/Isolator from the equipment earthing system will be measured separately and paid at unit rates.

13.4 Outgoing and incoming feeder terminations will be paid at the unit rates separately as specified under cabling.

SECTION: 2.17

MEDIUM VOLTAGE CABLING

1.0 Scope

1.1 The scope of work shall cover supply, laying, connecting, testing and commissioning of low and medium voltage power and control cabling.

2.0 Standards

2.1 The following standards and rules shall be applicable:

1) IS: 1554 Parts I & II PVC Insulated Heavy duty cable
2) IS: 3961 Recommended current Rating of cable
3) IS: 7098 XLPE Insulated cables

All codes and standards mean the latest.

3.0 Cables

3.1 All cables shall be 1100 Volt grade PVC insulated, sheathed with or without steel armouring as specified and with an outer PVC protective sheath. All cables shall have Flame Retardant, Low Smoke Sheath (FRLS) and meet, ASTM norms for the smoke density and Oxygen Index norms. Cables shall have high conductivity stranded aluminium or copper conductors and cores colour coded to the Indian Standards.

3.2 XLPE cables shall be same as PVC with an FRLS outer sheath.

3.3 All cables shall be new without any kinks or visible damage. The manufacturers name, insulating material, conductor size and voltage class shall be marked on the surface of the cable at every 600mm spacing.

4.0 Installation

4.1 Cables shall be laid in the routes marked in the drawings. Contractor shall install all conduits/Pipes required for the cable work as per drawings. Where the route is not marked, the contractor shall mark it out on the drawings and also on the site and obtain the approval of the Architect/Consultant before laying the cable. Procurement of cables shall be on the basis of actual site measurements and the quantities shown in the schedule of work shall be regarded as a guide only.

4.2 All cables running indoor shall be supported with necessary GI cable trays. Cable trays shall be hot dip galvanized. All cable trays shall be suspended but supported on MS frame work with supports at every 1.5 m distance (for Rod supports every 1.0m distance) including necessary anchor fasteners, insert plates etc. for completeness of installation. Cables laid in built up trenches shall be on steel supports.

Cable support dimensions shall be as per table 1.1.

Sr. no.	Size	Cable Support
1	1500MM wide	2nos x 50 x 50 x 5MM GI Angle
2	1200MM wide	2nos x 50 x 50 x 5MM GI Angle
3	1000MM wide	2nos x 40 x 40 x 5MM GI Angle
4	750MM wide	2nos x 40 x 40 x 5MM GI Angle
5	600MM wide	2nos x 32 x 32 x 5MM GI Angle
6	For 2 Tier	2nos x 32 x 32 x 5MM GI Angle
7	450MM wide	2nos 8MM DIA GI RODS
8	300MM wide	2nos 8MM DIA GI RODS
9	150MM wide	2nos 8MM DIA GI RODS

4.3 Cables shall be bent to a radius not less than 12 (twelve) times the overall diameter of the cable or in accordance with the manufacturer's recommendations whichever is higher.

4.4 In the case of cables buried directly in ground, the cable route shall be parallel or perpendicular to roadways, walls etc. Cables shall be laid on an excavated, graded trench, over a sand or soft earth cushion to provide protection against abrasion. Cables shall be protected with brick or cement tiles as shown on drgs. Width of excavated trenches shall be as per drawings. Backfill over buried cables shall be with a minimum earth cover of 600mm. The cables shall be provided with cable markers at every 50 meters and at all loop points.

4.5 The general arrangement of cable laying is shown on drawings. All cables shall be full runs from panel to panel without any joints or splices. Cables shall be identified at end terminations indicating the feeder number and the Panel/Distribution board from where it is being laid, on aluminium tag. All cable terminations for conductors upto 4 sqmm may be insertion type and all higher sizes shall have tinned copper compression lugs. Cable terminations shall have necessary brass glands and all lugs shall be double compression type whether so specified or not. The end terminations shall be insulated with a minimum of six half-lapped layers of PVC tape. Cable armouring shall be earthed at both ends.

4.6 Each cable shall be tagged with number that appears in cable schedule & Panel/Distribution board from where it is being laid., tag shall be of aluminium.

5.0 **Testing**

5.1 MV cables shall be tested upon installation with a 500V Meggar and the following readings established:

1) Continuity on all phases

2) Insulation Resistance
   (a) between conductors
   (b) all conductors and ground

All test readings shall be recorded and shall form part of the completion documentation.

6.0 **Mode of measurement**

6.1 Cable will be measured on the basis of a common rate per unit length indoor or outdoor and shall include the following:

For cables laid indoors:

i) Cables and clamps

ii) Installation, commissioning and testing

iii) Cable marking

OR

For cable buried underground:

i) Cables and protective bricks & tiles

ii) Installation, commissioning & testing

iii) Cable markers

6.2 Cable trays/racks will be measured on the basis of unit length for individual sizes and shall include

i) Galvanised steel tray with necessary suspenders and frame supporting the tray, anchor fastners, insert plates & necessary support arrangement for completeness of the installation.

ii) Installation and painting in 2 coats of black bituminous paint on one coat of red oxide primer.

6.3 Each cable termination will be measured as one unit for payment. Certain cable sizes are grouped together and rates shall be furnished against each group. The item shall include the following:

i) Lugs, glands, bolts, nuts

ii) All jointing materials

iii) Installations, testing and commissioning

iv) Earthing the glands

6.4 For cables buried under ground excavation shall be paid for additionally for the following per unit volume:

i) Excavation and back filling

ii) 6" Soft Earth Cushioning below and above cable

The cost of laying protective tiles shall be part of cable cost as stated above.

SECTION: 2.18

EXTERNAL LIGHTING

1.0 Scope

1.1 The scope of work covers the supply, installation and testing of lighting poles, weather proof light fixtures, wiring to the fixtures, Junction boxes, cable laying & termination, earthing as specified and shown on drawings including necessary minor civil work like excavation & backfilling, foundation for poles etc. for completeness of installation.

1.2 Wherever fixtures and poles are supplied by the client, the installation shall include erection of poles, excavation, coping & necessary foundations etc for completeness of installation.

2.0 Standards

2.1 The following standards and rules shall be applicable:

1) IS: 1913 - 1969 General and safety requirements for light fittings.
2) IS: 2944 - 1981 Code of Practice for lighting public thoroughfares
3) IS: 3528 - 1966 Water proof electric lighting fitting
4) IS: 1239 - 1966 Water tight electric lighting fitting
5) IS: 1239 - 1958 Mild steel tubulars and other wrought steel pipe fittings
6) IS: 2149 - 1978
7) IS: 2149 - 1970 Luminaries for street lighting
8) Indian Electricity Act and Rules

2.2 All codes and standards mean the latest. Where not specified otherwise the installation shall generally follow the Indian Standard Codes of Practice or the British Standard Codes of Practice in the absence of Indian Standards.

3.0 Light Fixtures (Weather proof & Water proof)

3.1 The light fixture construction shall be of die cast aluminium with a separate compartment for integral ballast equipment. The reflector shall be anodized polished aluminium. The glass refractor shall be heat-resistant.

3.2 Lamp holder shall be of porcelain and shall comprise a terminal block of non-hygroscopic material. The luminaries shall have integral ballasts as specified housed in water tight and dust tight metal cases. Ballasts shall be prewired to the lamp socket and terminal block, requiring only power supply leads to the ballast primary terminals.

3.3 The lamp & Luminaire shall be as specified in BOQ.

4.0 Lighting Poles

4.1 The lighting poles shall be fabricated from heavy duty cold-rolled steel tubes to IS:1239-1958 and hot dip galvanised or painted as specified. The pole shall have a base plate, a large access panel, and necessary fixture mounting bracket at top. The access panel shall provide easy access to a multiway porcelain connector and fuse board, to be mounted inside the pole. The access shall be specially fabricated with adequate reinforcement and weather gasket to prevent ingress of moisture and vandal proofed. Poles shall have large diameter entries for incoming and outgoing cable and two earth studs. The pole fabrication shall conform to the drawings and , the contractor shall make drawing and have it approved before fabrication.

4.2 The pole shall house a multiway porcelain junction box with MCB and rewirable fuse as shown on the drawings. Pole shall have a concrete coping.

5.0 Feeder Pillar

5.1 Feeder Pillars shall be factory fabricated distribution centres housing necessary

a) Fuses, MCB's with holders
b) Copper busbars and a separate earth bar
c) 15A weather proof socket outlet and switch
d) Atleast 2Nos 9W bulkhead CFL fittings with weather proof switches.

5.2 The feeder pillar shall be fabricated out of 14SWG mild steel with 12 SWG hinged lockable door panel . Hinges shall be heavy duty minimum 100mm long and of CP brass or S.S 304. Mild steel panel shall undergo a rigorous treatment of 7 bath anti-corrosion process and powder coated. The Feeder pillar shall be rendered dust proof, vermin proof and weather proof conforming to IP 65. Feeder pillar shall be mounted on concrete pedestal (400mm above ground) with suitable provision for entry and engress of cables. Feeder pillar shall be amply sized to accommodate all the internals and at the same time achieve an internal temperature of not more than 40 ^{o}C, 2Nos earth studs shall be brought out. All hard-ware such as door handles, hinges, locks etc. Shall be chromium plated brass or stainless steel.

5.3 Feed pillars shall house necessary fuses, mcb's , tag blocks etc. as shown on drawings and as specified.

6.0 **Cable laying**

6.1 Cabling shall be generally as specified in the section 'M V CABLING.'

6.2 Cables shall be terminated in a junction box inside the pole or attached therewith as shown on drawings.

6.3 Cable route shall be as shown on the drawings or the contractor shall mark out the route and lay the cables only upon approval of the route.

6.4 If Flexible wires are used, then they have to be laid in FR RIGID PVC conduits buried in soil. It shall be terminated in terminal block inside the pole. Route shall be as shown on drawings or the contractor shall mark out the route & lay the conduits with wires only upon approval of the route.

7.0 **Earthing**

7.1 All street lights fixtures and poles shall be earthed as specified.

8.0 **Mode of measurement**

8.1 Each light fitting with lamp, control gear, earthing etc. shall be considered as one unit for measurement and payment.

8.2 Each lighting pole, concrete coping, base plate, earthing etc. shall be considered as one unit for measurement and payment.

8.3 Wiring from the junction box to the light fitting shall be considered as one unit for measurement and payment.

8.4 All cabling work shall be measured on the basis of unit length and the cost shall include, cost of cable, minor civil work required for laying cables, laying tiles etc.

8.5 All cable terminations shall be measured as one unit complete with necessary glands, lugs, nuts, bolts, jointing material, earthing of glands etc. for completeness of installation.

8.5 Feeder pillars shall be measured per unit complete with all components as specified.

8.6 Wherever light poles and fixtures are supplied by client, the installation shall be paid per unit and the unit cost shall include excavation, erection, concrete coping, earthing etc.

SECTION: 2.19

BUS DUCTING (SANDWICHED CONSTRUCTION)

1.0 Scope

1.1 The scope of work shall cover the design, supply, installation, testing and commissioning of sandwich type Bus Ducting

2.0 Standards

2.1 The following standards and rules shall be applicable

i) IEC 60439-2 Particular requirement for bus bar trunking system.
ii) IEC 60529 Degree of protection
iii) IS 2147 Degree of protection
iv) IS 8623 – 1 & 2 For LV Distribution

3.0 Construction

3.1 The busbars shall be of sandwich construction. It shall be possible to mount the busbar system in any orientation, without affecting the current rating.

3.2 The bus duct system shall be a light weight, low impedance, non ventilated naturally cooled and totally enclosed for protection against mechanical damages, vermin protection and dust accumulation with compact and sandwich type.

For each busduct length and fitting shall be included as an integral part while on both internal and external surface, metal trunking shall be made of 1.6mm Electrogalvanized sheet steel with Epoxy Powder Coated by an automated electrostatic process and 50% integral housing ground is standard (UL listed 50% ground path).

The busbars and their connections shall be capable of withstanding without damage, the thermal & mechanical effects of a through fault current equivalent to the short time rating of the switchgear. Busbars shall be of uniform cross sectional area throughout their length with connections as short and straight as possible

4.0 Bus Bars

4.1 Busbars shall be of high conductivity electrolytic grade single or multiple Aluminum bars with conductivity >61% or of Copper as specified.

The busbars shall be amply sized to carry the rated continuous current under the ambient temp of 40° without exceeding the total temp specified Access to busbars & the connections directly thereto shall be gained only by the removal of covers secured by bolts or screws.

4.2 Copper & aluminium bus bar conductors shall be of tin electroplated. Its entire length shall be insulated over with epoxy resin coated by the machine. This is to prevent it from water and moisture that can cause reduction in dielectric resistance. And in case of fire, the flame retardant will ensure the safety.

On the tin electroplate for the jointing part of Aluminum Bus Conductor, it will be coated by silver for the better conductivity.

5.0 Insulation

5.1 The busbars shall be insulated throughout their length by epoxy / Mylar. The insulation material used shall be of class F (155°C). The insulation shall be fire retardant, non toxic, chemically inert, stable material.

6.0 Joints

6.1 Shall be checked for tightness without de-energizing the busbar trunking runs, the joints shall be of maintenance free system of one bolt (M14) type with through bolts with at least 80mm overlap. The high strength bolt shall be insulated by an insulation, resistant for heat and impact forces.

For the uniformed distribution of the clamping force over the joints, all the bolted connections must be equipped with Two Belleville washers. The joints design shall permit safe practical testing of joints for tightness without de-energizing the busbars and it is possible to remove any one section in a run without disturbing the two adjacent busbars sections. Joints shall preferably have an adjustability of ± 14mm for the precise alignment and to facilitate an easy field installation.

The joints are provided with torque bolts and maintenance free nuts where the outer head will be twisted off once the specified tightening torque of 12 kg-m is reached and it will then acts as a lock nut.

7.0 Plug in Hole

7.1 Each plug in unit that rated 400Amp and below shall be mechanically interlocked with the busduct housing to prevent installation or removal of plug in units while the switch is in the ‘ON’ positions. It is equipped with an operating handle which always remains in control of the switching mechanism.

Before the jaws make contact with the busbar, the plug in unit enclosure shall make positive ground connection to the busduct housing. The grounding method is that it shall not be damaged by future painting of the busduct housing. The plug in units are also equipped with internal insulation barriers due to prevent accidental contact of housing plate and conductors with live parts which are on the line side of the protective device during time of wire pulling.

To prevent the cover from being opened while the switch is in the 'ON' position, the covers of all plug in units shall have 'releasable' type of interlocks. The plugs shall be provided with means of padlocking the switch in the 'OFF' position.

For IP65 bus truncking the tap off unit arrangement also must achieve IP65 without requiring any additional sealing at site.

8.0 Expansion Joints

8.1 Expansion joints shall be provided when necessary and it shall be capable of taking up all thermal expansion, assuming fully loaded conditions.

9.0 Support of Busduct

9.1 Supporting space of horizontal runs shall not exceed 2.0 meters. Vertical riser runs of bus duct shall be supported adequately with rigid and / or spring hangers at each floor. Immediate supports shall be provided if the floor to floor distance exceeds 5 meters.

10.0 Temperature Rise

10.1 The temperature rise at any point in the busduct / rising mains shall not exceed 55°C rise above the ambient temperature of 40°C when operating at load current.

11.0 Short Time Current Capacity

11.1 The short-time current capacity of the busduct shall be not less than the value specified.

12.0 Impedance Value

12.1 The impedance of the busduct shall not exceed the value specified.

13.0 Testsing

13.1 Vender shall furnish following type test certificates of bus duct from CPRI, not older than 3 years.

i) Short circuit withstand capacity for 1 sec.

ii) Temperature rise test.

iii) Fire retardant test.

13.2 Following routine tests shall be carried out in the presence of owner & 3 sets of test certificates shall be submitted.

i) Visual Inspection.

ii) One minute power frequency voltage withstand test

iii) Insulation resistance test

13.3 Bus duct shall be tested upon installation with a 500V megger and the following readings must be taken:
i) Continuity of all phases
ii) Insulation resistance
a) between conductors &
b) all conductors & ground

All test readings shall be recorded.

14.0 Application Data

14.1 Busduct voltage grading: 1100 Volts
Withstanding Voltage: 10000 Volts

14.2 Class of insulation and insulation materials : Class F, 155°C with epoxy / mylar / cast resin.

14.3 System configuration : 3 phase 4 wire or as specified.

14.4 Degree of protection : For Indoor minimum IP 54 and Outdoor minimum IP65 / IP68.

14.5 Busbar Conductor : Tin coated for anit-corrosion and better conducitivity. Extendable at both ends, Phase colours – R, Y, B.

15.0 Earthing

15.1 All metal parts, other than these forming part of an electrical circuit shall be connected to a hard drawn, high conductivity earth conductors on each unit.

15.2 It shall be bolted to the main frame and located so as to provide convenient facilities for earthing cable sheaths and for use with earthing devices.

16.0 Installation

16.1 Bus ducts shall be installed in the positions shown. The contractor should survey the route and ensure that there is no obstructions for fixing the busducts.

16.2 Rating of busducts, voltage & danger sign shall be stenciled in bright yellow at every floor.

17.0 Mode of Measurement

17.1 Bus duct shall be measured on the basis of unit length & the cost shall include bends, all supporting system, Jointing, end supports, testing & commissioning.

18.0 Painting

The busduct & supporting frames shall be epoxy painted to the following colour code.

i) Supporting frame : Black
ii) Busduct : Siemens Gray

Bus bars shall have following colour code:

i) R phase : Red
ii) Y phase : Yellow
iii) B phase : Blue
iv) Neutral : Black

SECTION: 2.20

ERECTION, COMMISSIONING & TESTING

1.0 Scope

1.1 Scope of work shall cover erection, commissioning and testing of all the elevators.

2.0 Erection

2.1 The elevator contractor should furnish detailed drawings showing their requirements of cutouts, holes and beams, before the machine room floor is cast. In case no such details become available, the machine room floor will be cast and all such openings shall be made by the Elevator contractor at his own cost.

2.2 All structural steel required for mounting the machinery, controllers etc. should form part of elevator suppliers scope of work. This includes all supporting beams, hoisting beam etc. All minor builder's work shall also be included in the scope of work and this shall include chasing of floors, walls, fixing of hoistway brackets etc. Safe scaffolding shall be provided by the elevator vendor as required for the erection and for providing necessary lighting in the hoistway.

2.3 Elevator machine shall be mounted on suitable vibration isolation pads to prevent machine vibration being transmitted to the structure.

2.4 All wiring inside the machine room shall be neatly done in conduit or wire race. The elevator machine, motor alternator, controller and the car shall be double earthed will be brought to the main panel. Suitable guards for counter weights and deflectors shall be provided.

2.5 Entire installation shall conform to the requirements of Local Lift Inspectorate and necessary approvals shall be obtained from the statutory authorities for the use of the elevator.

2.6 All exposed elevator metal work shall be given one shop coat of paint and one field coat after installation, testing and commissioning.

3.0 **Commissioning and Testing**

3.1 The pre-commissioning checks shall among others consist of the following:

1) Insulation resistance testing of drive motors and alternator with 1000 V meggar.

2) Insulation resistance testing of cabling and wiring.

3) Proving tests on various interlocks and safety devices.

All results of the pre-commissioning checks shall be recorded and four copies submitted to the consultants.

3.2 A contract load test under the supervision of the local authority and in the presence of Architect/Consultant shall be carried out before each elevator is put in regular service. During the test, the brakes, limit switches buffers, car safety devices shall be caused to function with the contract load in the elevator and the operation of various safety devices shall be recorded.

3.3 The levelling gear shall be tested on-load and off-load to ensure car levelling within limits.

3.4 The elevator must be tested for contract speed with the full contract load.

3.5 The emergency landing facility shall be tested for all the elevators and test results recorded.

3.6 The elevator shall be accepted upon satisfactory completion of the above tests.

SECTION: 2.21

MAINTENANCE

1.0 Scope

1.1 The scope of work covers the maintenance chores to be attended to by the elevator contractor during the Defects liability period as well as under the Annual Maintenance Contract.

2.0 Defects Liability Period

2.1 During the defects liability period the contractor shall furnish services of inspection and maintenance for the equipment installed under this contract for period stated in para 18 section 1.4, reckoned from the date of handing and taking over of the complete installation. The maintenance during the above period shall be free of cost and shall cover inspection of equipment, carrying out necessary adjustments, oiling, greasing except replacement of parts due to misuse or accidents or negligence of others. The periodicity of such inspection maintenance service shall be not less than once a month. The above maintenance schedule is over and above break-down calls. A record of such maintenance shall be maintained.

3.0 Annual Maintenance Contract

3.1 At the end of the above defects liability period, an annual maintenance service for the equipment furnished shall be provided. This service shall include regular examination of the installation during regular working hours by trained employees and shall include all necessary adjustments, greasing, oiling, cleaning, supplies of genuine standard parts to keep the equipment in proper operation, except any parts made necessary by misuse accidents or neglect caused by others. Alternatively, an ALL-IN maintenance service shall be provided. The contract for this additional maintenance will be effective after expiry of the defects liability period.

2.22 BULDING AUTOMATION SYSTEM

1.0 OPEN, INTEROPERABLE, INTEGRATED ARCHITECTURES:

1.1 SPECIFICATION NOMENCLATURE

A. Acronyms used in this specification are as follows:

BMS Building Management System
GUI Graphical User Interface
POT Portable Operator's Terminal
DDC Direct Digital Controls
LAN Local Area Network
PICS Product Interoperability Compliance Statement

1.2 ARCHITECTURE:

A. The intent of this specification is to provide a peer-to-peer networked, stand-alone, distributed control system with the capability to integrate both the ANSI/ASHRAE Standard 135-1995 BACnet, and Modbus technology communication protocols in an interoperable system.

B. The supplied computer software shall employ object-oriented technology (OOT) for representation of all data and control devices within the system. In addition, adherence to industry standards including ANSI / ASHRAE™ Standard 135-1995, BACnet TCP to assure interoperability between all system components is required. For each BACnet device, the device supplier must provide a PICS document showing the installed device's compliance level. Minimum compliance is Level 3; with the ability to support data read and write functionality. Physical connection of BACnet devices shall be via Ethernet at all levels.

C. All components and controllers supplied under this contract shall be true "peer-to-peer" communicating devices. **Components or controllers requiring "polling" by a Master / Global / Host to pass data shall not be acceptable**.

D. Structured Query Language (SQL) or Java Database Connectivity (JDBC) or ORACLE compliant server database is required for all system database parameter storage. This data shall reside on a server for all database access. **Systems requiring proprietary database and user interface programs shall not be acceptable**.

E. Two (2) level hierarchical topology is required to assure fast system response times and to manage the flow and sharing of data. Systems Requiring Router, Gateways are not acceptable.

1.3 WEB BROWSER CLIENTS

The system shall be capable of supporting an unlimited number of users using a standard Web browser such as Internet Explorer™ or Netscape Navigator™. **Systems requiring additional software (to enable a standard Web browser) to be resident on the DDC / client machine,**

or manufacture-specific browsers shall not be acceptable. The Web browser software shall run on any operating system and system configuration that is supported by the Web browser.

The Web browser shall provide the same view of the system, in terms of graphics, schedules, calendars, logs, etc., and provide the same interface methodology as is provided by the Graphical User Interface. Systems that require different views or that require different means of interacting with objects such as schedules, or logs, shall not be permitted.

The Web browser client shall support at a minimum, the following functions:

User log-on identification and password shall be required. If an unauthorized user attempts access, a blank web page shall be displayed. Security using Java authentication and encryption techniques to prevent unauthorized access shall be implemented.

Graphical screens developed for the GUI shall be the same screens used for the Web browser client.

HTML programming shall not be required to display system graphics or data on a Web page. HTML editing of the Web page shall be allowed if the user desires a specific look or format.

Storage of the graphical screens (Static) shall be stored in DDC directly and should not depend on any other hardware.

The Web page shall get automatically refreshed without any user intervention.

Users shall have administrator-defined access privileges. Depending on the access privileges assigned, the user shall be able to perform the following:

Modify common application objects, such as schedules, calendars, and set points in a graphical manner. Schedule times will be adjusted using a graphical slider, without requiring any keyboard entry from the operator and set holidays

View logs and charts

View and acknowledge alarms

The system shall provide the capability to specify a user's (as determined by the log-on user identification) home page. Provide the ability to limit a specific user to adjust their defined home page. From the home page, links to other views, or pages in the system shall be possible, if allowed by the system administrator.

Graphic screens on the Web Browser client shall support hypertext links to other locations on the Internet or on Intranet sites, by specifying the Uniform Resource Locator (URL) for the desired link.

1.4 SYSTEM DESCRIPTION & INPUT OUTPUT SUMMARY

The proposed system shall be a Direct Distributed Digital Control (DDC) system. It shall be a PC based system and shall combine latest state of the art technology with simple operating techniques. The entire Monitoring of Building Management System (BMS) shall be comprise of a network of interoperable, stand-alone digital controllers communicating on an open protocol communication network to a host computer within the facility and communicating via the Internet to a host computer in a remote location. The BMS shall communicate to third party systems such as Chillers, VAVs, Energy meters, UPS, DG, Lifts, VFDs & HT/LT circuit breakers, access control systems, fire-life safety systems and other building management related devices with open, interoperable communication capabilities.

The BMS framework shall utilize built-in Internet connectivity to a broad range of distribution partners in the building automation, energy services, power/utility, and industrial sectors. The Framework shall bring together the ongoing computerization of control applications under single integrated system architecture.
The features shall be distributed both physically and functionally over the field controllers. Microprocessor based Direct Digital Distributed Controllers (DDC) shall interface with sensors, actuators and environmental control systems (i.e. HVAC units, chillers, pumps, fans, lighting etc.) and carry out followings functions:

a. Individual input/output point scanning, processing and control.
b. Centralize operation of the plant (remote control).
c. Static / Dynamic graphic details of plant and building.
d. Energy Management through optimization of all connected electrical and mechanical plants.
e. Alarm Detection and early recognition of faults.
f. Time, event and holiday scheduling as well as temporary scheduling.
g. Prevention of unauthorized or unwanted access.
h. Communication interface and control.
i. Suggestive preventive maintenance for all equipment as well as own error diagnosis.
j. Report generation.
k. Optimum support of personnel.
l. Data Visualization Tool

These Controllers shall be capable of functioning on a stand-alone mode i.e. in case of loss of communication with the central control station / Server, these shall function independently. DDC shall have microprocessors built-in as standard, which control the respective operation centers based on the required logic and also offer fast communication of data via the network communication system. The local access to these shall be either through an in-built display with keypad for each outstation or through a portable operator's terminal. The controllers shall be capable of executing advanced control algorithms like Optimum Start stop, PID control, auto PID tuning and schedule management. They shall also execute logic functions based on time and/or event. Totalization and averaging functions shall be an inherent feature of the controller.
Each stand-alone intelligent DDC Controller shall have a **single 32 bit processor**, on board Ethernet connectivity. These shall also control any other operations on the floor and shall be sized to suit the operation centres or system requirement. This shall help in reducing the site electrical installation.

The number of controllers for central plant room equipments shall be decided by the contractor. Overall, the system shall be provided with 15% spare capacity, with spare of at least 15% points on each controller.

There shall be one BMS control station located in Control Room. The Operator Station should use a simple Web Browser in conjunction with the BMS Server software. The Computer shall be sized to cover the graphic display memory, planning information, software & data storage requirement. The display shall be in the form of dynamic color graphics and text format with menu driven pop-up windows and help facility.

The following software packages shall be loaded into the system as minimum standard:-

a. Complete system operational software

b. Site specific data manipulation software

c. Graphics software

d. Alarm indication software

e. Internet Enabled Remote Monitoring Package.

DI=DIGITAL INPUT; AI=ANALOG INPUT; DO=DIGITAL OUTPUT; AO=ANALOG OUTPUT

2.0 CENTRAL STATIONS SOFTWARE AND HARDWARE

2.1 CENTRAL STATION SOFTWARE

A. A central server, located at Control Room, shall be provided. The server shall support all DDC's connected to the customer's network whether local or remote.
B. Local connections shall be via an Ethernet LAN. Remote connections can be via ISDN, PSTN or dial-up connection.
C. It shall be possible to provide access to all DDC & 3rd party integration units via a single connection to the server. In this configuration, each DDC can be accessed from the Graphical User Interface (GUI) or from a standard Web browser (WBI) by connecting to the Local Area network.
D. The server software shall provide the following functions, at a minimum:

- Complete control and monitoring of IBMS system from colour graphics pages on the machine, or from a remote web browser.
- Full client-server operation.
- SQL / JDBC / ORACLE Database.
- Comprehensive alarm handling with alarm retransmission and logging.
- Scheduled recording of logged data from DDC.
- Management of multiple controller occupation times.
- Multilevel security system.
- International language support
- Display of HTML pages from company Intranet, or Internet.
- Display of live, logged, or recorded data in multi-trace graphs.
- Simple engineering path using drag and drop operations.
- Self-learning of all local networks.
- Help file in PDF format for viewing or printing.
- Access to the configuration mode of devices.
- Display all devices on the system connected via LANs, internet works, autodialed links and Ethernet Network connections.
- Customised program creation environment.

The BMS software shall be simple, flexible and convenient to use such that an operator with minimal programming knowledge can use it to perform control / monitoring and to build programs for control applications, graphics to generate management information systems (MIS) reports. As well, on higher end it shall be possible to create customized programs to suite the site requirement by a software programmer. All necessary documents required to make customization possible should be available along with the software without any additional charge.

The operating system shall be the Microsoft Windows XP / Windows 7 / Windows 2008 Server / Enterprise /Professional 32 / 64 bit multitasking environment. The networking software shall use the TCP / IP LAN protocol. The system shall be capable of supporting up to 25 simultaneous operator workstation connections but however presently we need Five User Option.

2.2 Monitoring and control functions

Monitoring:

The system shall support data acquisition using periodic scanning, exception reporting or on operator request. The system shall support a range of scan intervals, ranging from less than 5 second up to several minutes as desired / required. The system shall allow certain selected points to be scanned more often / faster than other points.

The communication techniques shall be optimized to minimize network traffic while providing good system response and reliability. The system shall also provide utilities to compile aggregate statistics on communication link usage.

Control:

Control transactions issued by the operator shall be communicated to control devices using a write followed by read to ensure the integrity of the transaction. If the read following the write to the device indicates that the control action has failed, the operator shall be informed by means of a control failure alarm. The priority of the control failure alarm shall be configurable by the user

2.3 System Database

The system shall provide a real-time database incorporating data from analogue, logical or pulse inputs. The database shall be configurable by the end user without the need for any programming and shall be able to modify on-line without interrupting operation of the system. In addition to point based information, the database shall also provide historization capabilities for analogue, digital, pulse; event based information and calculated values. This information shall be accessible by all facilities of the system such as custom displays, reports, trends, user written application, etc.,

The real-time database shall use suitable data structures to collect and store the following categories of data, as minimum.

- Access points
- Analogue points
- Status points
- Accumulator points
- Historical data

- Event data

The facility shall also exist to accommodate user defined data structures.

Each of the point database structures shall be comprised as a composite point with a number of associated parameters that may be referenced relative to a single tag name. Specifically, each of these parameters shall be accessible by various sub-systems such as the graphical operator interface, report generation system and application program interface in a simple format without the need to know any internal storage mechanism.

The system shall maintain portions of the data base requiring frequent high-speed access as memory resident information and other less frequently accessed data as disk resident data.

Database backup shall be possible with the system on-line including backup of historical based data. The database backup shall be part of GUI software & shall be possible to configure automatic backup at regular interval without any user interference / attention. All other backup such as graphic pages / drawing etc can be windows based where simple copy & paste should be enough for taking backup other than database. Long term storage of this data shall be possible using the zip drive. The system shall have the provisions for importing this data at later date for analysis and long terms MIS reports.

Point data shall be stored in a composite point database structure that provides a wide range of configurable information including but not limited to:

- Point name and description
- Multiple locations for data storage and device scanning addresses.
- Scan period
- Multiple dead-band or hysteresis settings
- Monitoring and control access restriction information.
- Location of operator alarm handling instructions
- Location of ancillary information associated with the point.

2.4 Historical data storage

Collection of historical point data shall be configurable as part of the point definition. Once configured, this data shall be collected automatically. Historical data collection shall be provided for both snapshots and averages with intervals ranging from 5 seconds to several hours.

The system shall provide the necessary means to easily locate the particular value of interest for any of the historical points. The graphical operator interface, trend, report generation and application interfaces shall be able to access historical data.

2.5 Trending

The system shall provide flexible trending allowing real-time, historical or achieved data to be trended in a variety of formats. In addition, trend data types shall be able to combine to allow for comparisons between data e.g. current real-time data versus archived data. The system shall provide trending capability with following functions.

- Real time trending
- Historical trending
- Archived history trending
- Trend scrolling
- Trend zoom
- Export option / Copying of currently displayed trend data to the clipboard for pasting into spreadsheet or document.

The system shall allow the trending of a minimum of 5 points in a single trend display set. For each trend set display it shall be possible for operators to configure the number of historical samples and ranges displayed. Points configured in trend sets shall be changeable on-line.

Operators shall be able to zoom in on information displayed on trend sets for closer inspection by dragging out an area of interest with the mouse or other pointing devices. From such a selection, it shall be possible to copy the underlying data to the windows clipboard for subsequent pasting into spreadsheet application such as Microsoft excel

2.6 Alarm Management

The software shall include a well organized alarm management facility to enable the operator to react quickly and efficiently to alarm conditions. Apart from the specific points identified for alarm annunciation in the I/O points schedule, the alarm types supported shall included:

- Very high value alarm
- Very low value alarm
- Large deviation alarm
- Rate of change alarm
- Unreasonable value alarm
- Delay to avoid nuisance alarm / short time change in value

The system shall permit any of these alarm types to be applied to the analog and accumulated points.

- The software shall permit at least 90 levels of alarm priorities to be assigned to each alarm ranging from the lowest to the highest. These levels shall be easily distinguished by the manner in which they are presented such as the color of the alarm message, blinking of the alarm message, varying audible alarms, etc., All alarm shall be logged in the event / alarm file and / or on the alarm printer. On acknowledgement of an alarm, it shall be possible to automatically issue a reset command to the controller so as to attempt to reset the alarm point.

2.7 Reporting

The system shall support a flexible reporting package to allow easy generation of report data. The reports provided shall include pre-configured standard reports for common requirements such as alarm / event reports and custom report generation facilities that are configurable by the user.

The following pre-formatted reports shall be available on the system:

- Alarm / event report

- Operator trail report
- Point trail report
- Alarm duration report
- All point report
- Point attribute report
- Lockout summary
- Over-ride summary

Configuration of these reports shall only require entry of the schedule information, and other parameters such as point name or wildcard, filter information, time interval for search and destination printer to fully configure the report. No programming shall be required

The requirement of the above mentioned reports shall be as follows:

Alarm/Event Report

This report shall be summary of all events of a specified type for nominated points occurring in a time period. The time period may be specified as an absolute start and end date and time, or as a period to the current time.

Operator trail report

This report shall be a summary of all operator actions relating to a specific operator in a specified period.

Point trail report

This report shall be provided to produce a summary of all events of a specified type occurring in a period on nominated points.

Alarm duration report

This report shall be provided to calculate the total amount of time a nominated point or group of points has been in an alarm condition over a given time period.

All point report

A report shall be provided to produce a list of point information, including point name, description, point type, engineering units, and current values.

Point attributes report

A report shall be provided for summaries of the points selected as per the following criteria:

- Out of service
- Alarm suppressed
- Abnormal input levels
- In manual mode.

Over-ride summary

This report shall be used to provide the summary of all points / commands that have been over-ridden by the operator.

2.8 Time Schedules:

The system shall include the facility for time scheduling activities on both a periodic and one-off basis. All time schedules shall be configurable via the Operator workstation. Each time schedule entry shall consist of:

- Date
- Time
- Point name
- Point Parameter
- Target Value
- Type of scheduling

The available time schedule type shall include:

Daily – to be executed everyday

Workday – to be executed on the week days

Holidays – to be executed on holidays

Individual days – to be executed on a particular day

The system shall also have the provision for programming temporary schedules that over-ride the normal schedule.

2.9 Energy Monitoring & Analysis:

Energy Monitoring & Analysis should be integral part of GUI. It shall support minimum of 50 Energy points for analysis purpose. The software shall provide the following feature but are not limited to,

a) It shall be possible to generate & view detailed Daily, Weekly & monthly graphs of the energy meter / point identified.
b) It shall be possible to see and analyze the total energy usage in a building and also shall be possible to identify by which system is major user of the energy.
c) It shall be possible to compare the energy points week against week, day against day in a month, identify Maximum, Minimum & average daily values & Energy usage for different periods of time of the day.
d) It shall be possible to make cost and consumption analysis or CO2 reports on consumption.
e) Based on the energy consumed it shall be possible to rank the systems or building (in case of multi location buildings)
f) Software shall allow the user to compare the predicted / forecasted energy or based on historic performance with current performance.
g) It shall be possible to create energy signature with respect to ambient / outside temperature of the day

h) Software shall allow the user to identify the exceptions happened in the system due to which energy consumption was increased.
i) It shall be possible to compare the energy consumption after introducing a energy saving strategy for further fine tuning or to visualize the savings achieved.

2.10 Operator Interface:

The operator interface provided by the system shall through an intuitive graphical user interface and shall allow for efficient communication of operational data and abnormal conditions. It shall provide a consistent frame work for viewing of information. Critical areas (such as alarm icons) shall be visible all the times. A predefined area on the screen shall provide operator messaging, and this area shall also be visible at all times.

The operator interface shall be interactive and based on graphics and / or icons. Standard tool bar icons and drop-down menus shall be available on all standard and custom display to allow easy access to common functions.

The system shall provide an operator interface with the following minimum capabilities:

- Window re-size, zoom in, zoom out.
- Dedicated icons and pull down menus to perform the following:
- Associated display
- Alarm summary
- Alarm acknowledgement
- Previous display recall
- Graphic call-up
- Trend call-up
- Point detail
- Current security level
- Alarm annunciation
- Communication fail annunciation
- Operator message zone.

2.11 Area assignment / area profile

Each operator shall be assigned one or more specific areas / functions of the facility with the appropriate monitoring and control responsibility. An area shall be defined in this context as a logical entity comprising of a set of points in the system. This is turn may represent a physical space in the facility or a particular utility or a particular equipment.

The system shall provide the facility to create area profiles, which combine areas and time periods, and which can be assigned to operators with the same area access requirements. By using area profiles in this way, area access can be specified to apply during certain time periods, allowing different areas of access at different times of the day or week.

2.12 Command partitioning

It shall be possible to assign to each operator a set of allowed commands / operating for each assigned area. With this feature, it shall for example be possible to configure an operator to set a digital point to On, but to disallow the same operator from setting the same digital point to OFF.

2.13 Standard system displays

The following displays shall be included as part of the system:

- Alarm summary display
- Event summary display
- Point detail template displays
- Trend set template displays
- Communication status displays
- System status displays
- Operator scratch-pad display.

2.14 System Status Displays

These shall display the following information

- Points in alarm condition pending acknowledgement
- Points which remain in an alarm condition state but which have been acknowledged.
- Communication failure
- Printer Status
- Operator workstation status
- Controller status

2.15 Administrative Displays

The system shall provide the following full screen display

- Master system menu
- Report summary
- Alarm summary
- Event summary
- Display summary.
- Area assignment
- Holiday assignment
- History assignment
- Push-button assignment
- Operator definition
- Operator message board
- Events archive and retrieval
- Time period summary

2.16 Other requirements

It shall be possible to launch any windows based applications, such as Microsoft word or Microsoft excel, from within the operator interface.

2.17 Help Facility

Software shall be provided to facilitate programming and storage of the system operation manuals in the hard-disk. The operation manual shall be retrieved by On Line Help mode so as to enable the operator to self learn the system operation, command, or function as and when needed.

This `help' facility shall be made available to the operator by use of a dedicated key or a single key click on the mouse. A minimum help shall be available for every menu item and dialogue box.

The facility shall contain both text and graphics to provide information about the selected function directly.

The information provided shall be in simple clear language and shall be possible to search the help based on typical word included in the process.

When a point is overridden by operator command from an operator workstation or a local workstation, an alarm message shall be output to the appropriate alarm printer and to respective operator workstation. Alarm messages shall require operator acknowledgement.

When a point returns to normal, the event shall be recorded in control stations as 'Return to Normal'.

The Operator workstations shall be capable of displaying a list of all points in alarm for the building in a single summary. Systems which require the operator to make a separate summary for alarms shall not be acceptable. The software shall also provide details of particular alarm occurred on a point.

2.18 21 CFR Part 11

The computer system software and hardware should be 21 CFR part 11 compliant.

Therefore, vendor to carry out system qualifications accordingly

All instruments, software supplied shall be validated, tested and certified complying to 21 CFR Part – 11.
Contractor shall strictly follow the procedures as laid down in the necessary guidelines.

3.0 3rd Party System Integrator Units:

A. The 3rd party Integration unit shall provide the interface between Ethernet LAN and the 3rd party field control devices such as DDC or PLC or any other devices which need to be integrated. These shall also provide supervisory capability of functions over the devices connected to it. **The purpose of using these units should be limited to integrate devices only, not for any DDC interface with GUI, provided by others.**

B. The Unit must provide the following hardware features as a minimum:
   a. One no. on board RS-232 port
   b. One No. on Board RS-485 port
   c. Provision to include / add additional communication card
   d. Battery Backup
   e. Minimum RAM of 128 MB & Flash of 64MB

C. The Unit must communicate over TCP/IP with communication speed of 10/100MBPS.

D. The Integration unit shall have built in drivers for open protocol such as
   a. Bacnet over MSTP
   b. Bacnet over IP
   c. Modbus over MSTP
   d. Modbus over IP
   e. Lon FTT
   f. Lon IP
   g. Mbus over TCP
   h. Mbus Serial
   i. SNMP

   If the above drivers are add-on products, it shall be made available / considered while selecting the unit & the same to be confirmed in writing.

E. The Integration unit shall provide flexibility of adding communication ports (RS485) by adding communication cards, minimum one slot, when required rather than adding additional unit itself.

F. The Integration unit shall have inbuilt JAVA engine and it shall be possible to configure the IO, if required, of the 3rd party devices.

G. The Integration unit should be capable of handling multiple protocol simultaneously and should not be restricted to single protocol.

H. The Integration unit should have inbuilt memory for program storage.

I. The Integration unit should automatically backup its database for the user defined interval.

j. User authentication should be integral part of the unit.

K. All vendors are required to provide the documentation highlighting the capabilities mentioned above.

L. All units shall have LEDs for fault / status identification such as
   a. LAN active (one per port in case of multiport units)
   b. LED to display proper functionality / Status of the unit.
   c. LED to display healthiness of CPU of the unit.

4.0 DIRECT DIGITAL CONTROLLER

4.1 DIRECT DIGITAL CONTROLLER (DDC) HARDWARE REQUIREMENT :

1) DDC controllers shall be capable of fully "stand- alone" operation i.e. In the event of loss of communication with other DDC's or Control Station, they shall be able to function on their own.

2) The controllers shall consist of **single 32 bit microprocessors for reliable throughput**, with EEPROM based operating system on BACNET

3) The memory available to the controller board should serve as working space and there should not be any limitation of using particular function block other than the memory.

4) The controllers shall be UL listed and conforming to CE.

5) The controller shall have support programs built in RAM for minimum of 120 hours in the event of a power failure and it shall be possible to fit any battery thus expanding the time limit to 5 years. An alarm shall be generated on low battery voltage. The battery shall not be required to supply power to actuators, valves, dampers etc.

6) DDC shall have embedded **TCP/IP connectivity** so that it can be hooked into the Local Area Network (LAN) provided by the client / can be on dedicated network created by the vendor. Each DDC can be accessed from the **Graphical User Interface (GUI)** or from a standard Web browser (WBI) by connecting to the server.

7) Controller shall have capability to communicate with other controllers for any interlock or data sharing using peer to peer technology. The Controller which route the messages or data sharing through the system or any intermediate hard ware / controller shall not be acceptable.

   Vendor to demonstrate this capability during the commissioning time and the same shall be verified at the time of handing over.

8) Each controller shall have RS232 port built on to it so that any trouble shooting required at field level can be carried out without removing the controller from the network (LAN).

9) All controllers shall accept **230V, 50Hz** Uninterrupted power supply, provided by end user, directly so that the in between hardware such as transformers and SMPS are avoided.

10) Controller shall support DHCP addressing over Local Area Network (LAN) so that the static IP requirements are reduced however a single static IP shall be provided for system so that it can be hosted on to internet in consultation with end user / consultant.

11) All controllers shall have capability to provide 24V DC auxiliary power supply for the sensor which requires power, however the same shall not be required to high power consuming devices / equipments such as actuators, dampers etc.

Vendors to provide details on the same at the time of offer.

12) The Controllers shall have proportional control, Proportional + Integral (PI) Control, Proportional plus Integral plus Derivative (PID) Control, Two Position Control and Time Proportioning Control and algorithms etc, all in its memory and all available for use by the user, i.e. all the control modes shall be software selectable at any time and in any combination. The analog output of Proportional Control, PI Control, and PID Control shall continuously be updated and output by the program shall be provided. Between cycles the analog output shall retain its last value. Enhanced integral action in lieu of Derivative function shall not be acceptable.
Automatic loop tuning facility should be available to tune the loop at regular interval and adjust the gain or the integral / derivative time.

13) The controllers shall have a resident real time clock for providing time of day, day of week, date, month and year. These shall be capable of being synchronized with system / time master clocks in the network.

Upon power restoration all clocks shall be automatically synchronized to the time master controller which will be set during the commissioning phase.

14) The microprocessor based DDC's shall be provided with power supply, A/D and D/A converters, memory and capacity to accommodate a maximum of 128 input/output (I/O) hardware points (with or without an expansion board).

15) If the controllers provided by the contractor have the configurable plug in function cards, then the following minimum specifications shall have to be met :

i) The cards shall provide for analog or digital, input or output, hardwired connections to the installed plant.

ii) The quantity and combination of these cards shall be determined by the requirements of the plant in that location with the concurrence of the Owner/ Consultant.

16) The DDC's shall have 15% spare capacity for each type of point (digital/analog input/output) to give flexibility for future expansion.

17) All DDC controllers shall have 10 / 12 bit A/D resolution and be capable of handling voltage, milli-ampere, resistance or open and closed contacts inputs in any mix, if required.

Analog inputs/outputs of the following minimum types shall be supported:

a. 4-20 mA.
b. 0-10 volts.
c. 2-10 volts.
d. Resistance Signals (either PTC or NTC such as PT 100, PT 1000, PT 3000, NTC20K)

Digital input/output types to be supported shall be, but not limited to the following:

i) Normally-open contacts.

ii) Normally-closed contacts.

iii) Pulse inputs

Modulating outputs shall be true proportional outputs and not floating control type.

18) It shall be possible to change the analog inputs to accept any of the above depending upon the site condition or system requirement using a jumper. **The DDC which is configured using software trigger / switch shall not be acceptable.**

19) Controller's packaging shall be such that, complete installation and check out of field wiring can be done prior to the installation of electronic boards.=

20) All board terminations shall be made via plug-in connectors to facilitate trouble-shooting, repair and replacement. Soldering of connections shall not be permitted.

21) Controllers shall preferably be equipped with diagnostic LED indicators with at least indication for Power up Test OK, Watch dog and Bus Error. All LED's shall be visible without opening the DDC cover.

22) It shall be possible for the controllers to accept regulated uninterrupted power supply to maintain full operation of the controller functions (control, logging, monitoring and communications) in the event of a localized mains failure.

23) Controllers requiring fan cooling are not acceptable.

24) There shall be the facility for accessing controller data information locally, via a portable plug-in color LCD display which will be common to all controllers and normally removed to prevent unauthorized tampering. In either case, access to the system thus provided shall be restricted by passwords in the same way as at the main operator terminal.

25) In case the Portable operator Terminals (POT) are required to programmed the controllers, sockets shall be provided for same. Attachment of POT shall not interrupt or disable normal panel operation or bus connection in any way.

26) The controllers shall be housed in vandal proof boxes to protect them from tampering by any unauthorized personnel. All DDC controllers used in plant room spaces and external application shall be housed IP66/IP54 rating enclosures.

27) It shall be possible to add new controllers to the system without taking any part of the system off-line.

28) All DDC should have XML web service option which can be enabled in later stage for any higher interface with IT infrastructure or any other service.

29) Individual DDC should be BTL (Bacnet Testing Lab) tested.

4.2 DIRECT DIGITAL CONTROLLERS CAPABILITIES :

1) The Controllers shall have a self analysis feature and shall transmit any malfunction messages to the Control Station. For any failed chip the diagnostic tests, printout shall include identification of each and every chip on the board with the chip number/location and whether the chip "Passed" or "Failed" the diagnostic test. This is a desired requirement as it would facilitate trouble-shooting and ensure the shortest possible down time of any failed controller. Controllers without such safety feature shall be provided with custom software diagnostic resident in the EEPROM. The tenderer shall confirm in writing that all controllers are provided with this diagnostic requirement.

2) Operating system (O.S.) software for controllers shall be EPROM resident.

Controllers shall have resident in its memory and available to the programs, a relevant library of algorithms, intrinsic control operators, arithmetic, logic and relational operators for implementation of control sequences.

3) In the event of failure of communication between the controllers and/or Control Station terminal, alarms, reports and logs shall be stored at the controllers and transmitted to the terminal on restoration of communication.

4) In the event of memory loss of a Controller or the expiration of back-up power, on start-up of the unit the necessary data-base shall be downloaded manually so that the logic built are verified by the user. However, controllers requiring a manual intervention for the re-boot of software are not desired.

5) Where information is required to be transmitted between controllers for the sharing of data such as outside air temperature, it shall be possible for global points to be allocated such that information may be transmitted either on change of incremental value or at specific time intervals.

6) Controllers must be able to perform the following energy management functions as a minimum,

a. Time & Event programs
b. Holiday Scheduling
c. Maximum and Distributed power demand
d. Optimum start and stop program
e. Night purge
f. Load reset
g. Zero energy band
h. Duty cycle
i. Enthalpy analysis and control
j. Run Time Totalization
k. Sequencing and Optimization
l. Exception scheduling

- Detailed description of software features and operating sequence of all available energy management software shall be submitted with the tender for evaluation by the consultant.
-

7) The DDC Controllers shall have Adaptive Control capability whereby the control software measures response time and adjusts control parameters accordingly to provide optimum control. The software shall allow self-tuning of the variable control loops (all or any of P, P+I, P+I+D) of the AHU's and chiller system so as to provide the most efficient and optimized controls at different load conditions. The energy management programs shall update their parameters based on past experience & current operating conditions.

8) Alarm Lockout shall be provided to prevent nuisance alarms. On the initial start up of air handler and other mechanical equipment a "timed lockout" period shall be assigned to analog points to allow them to reach a stable condition before activating an alarm comparison logic. Tenderers shall indicate their proposed system alarm handling capability & features.

9) Run time shall be accumulated based on the status of a digital input point. It shall be possible to total either ON time or OFF time. Run time counts shall be resident in non-volatile memory.

10) It shall be possible to accommodate Holiday and other planned exceptions to the normal time programs. Exception schedules shall be operator programmable up to one year in advance.

11) All DDC shall have trend / log storing capacity in built into it. It shall be possible to have stored the data for at least 40 days @ 1 hour sampling time for all the points of the DDC (used or unused).

12) Minimum communication should be 10MBPS for each of the controller.

13) DDC should be forward compatible type so that any expansion or upgrade of the system required in the future is easily taken care off without scrapping / removing / disturbing the existing working system.

14) DDC Should allow user to include graphics, if required, however it shall be of static in nature.

15) All DDC Should be capable of sending email to specific user in the event of alarm, identified by end user / consultants.

5.0 PORTABLE OPERATORS TERMINAL (POT)

1) POT shall be provided to allow operator readout of system variables, override control and adjustment of control parameters. The POT shall be portable and plug directly into individual controllers for power and data.

2) The minimum functionality of POT shall include :

- Set points to a fixed value or state.
- Display diagnostic results.
- Display sequentially all point summary and sequentially alarm summary.
- Display/change digital point state, analog point value.
- Display/change time and date.
- Display/change analog limits.
- Display/change time schedule.
- Display/change run time counts and run time limits.
- Display/change time and/or event initiation.
- Display/change programmable offset values.
- Access DDC initialization routines and diagnostics.
- Enable/disable points, initiators and programs.
- Display/change minimum ON/OFF and maximum OFF times.

3) The POT shall be complete with command keys, data entry keys, cursor control keys **or** liquid crystal display (LCD). Access shall be via self prompting menu selection with arrow key control of next menu/previous menu and step forward/backward within a given menu.

4) Connection of a POT to a controller shall not interrupt or interfere with normal network operation in any way, prevent alarms from being transmitted, or interfere with Control Station commands and system modifications.

5) Connection of POT at any controller shall provide display access to all controllers on that bus. In case the controller has a fixed LCD display and entry keyboard, then the display access shall be available on each screen.

6) It should be possible to override the commands given through POT by the Operator Control Station.

7) POT shall have touch screen color display and it shall possible to hook this to Local area Network so that the entire system data can be visualized.

8) POT shall have self learning capability so that it can recognize the DDCs on the network and update all points without any manual programming.

6.0 DATA COMMUNICATION

The communication between controllers shall be via a dedicated or customer provided Ethernet communication network as per standards. Controller's microprocessor failures shall not cause loss of communication of the remainder of any network. All networks shall support global application programs, without the presence of a host PC.

Each controller shall have equal rights for data transfer. There shall be no separate device designated as the communication's master. Those systems using dependent controllers shall be pointed out by the contractor and a dual Hot redundant transmission media with automatic switching and reporting in the event of line faults will have to be provided.

The communication network shall be such that:

1) Every DDC must be capable of communicating with all DDC's on its own.

2) Network connected devices shall be capable of sending message after successive retries shall constitute a communication or device failure.

3) Each controller is to be provided with a communication watchdog to assure that the failure is reported to central station.

4) Error recovery and communication initialization routines are to be resident in each network connected device.

5) The communication protocol shall incorporate CRC (Cyclic Redundancy Check) to detect transmission errors.

Single or multiple standalone controller failures shall not cause loss of communication between active DDCs connected on the communication network. Full communication shall be sustained as long as there are at least two operational stand alone control panels active on the communication network.

All the System Integration Units shall be linked together on a Local Area Network.

The communication network shall include provision for automatically reconfiguring itself to allow all operational equipment to perform as efficiently as possible in the event of single or multiple failures.

The BAS supplier shall be required to provide details of standards to which their system conforms.

7.0 FIELD DEVICES

7.1 ELECTRIC AND ELECTRONIC CONTROLS RELATED EQUIPMENT

General Requirements

All controls shall be capable of operating in ambient conditions varying between 0-55 deg. C and 90% R.H. non-condensing.

All Control devices shall have a 20 mm conduit knockout. Alternatively, they shall be supplied with adaptors for 20 mm conduit.

Ancillary Items

When items of equipment are installed in the situations listed below, the BAS contractor shall include the following ancillary items:

(i) Weather Protection

All devices required to be weatherproofed are detailed in the Schedule of Quantities. IP ratings for the equipment are mentioned in the respective section.

(ii) Pipework Immersion

Corrosion resisting pockets of a length suitable for the complete active length of the device, screwed ½" (13 mm) or ¾" (20 mm) NPT suitable for the temperature, pressure and medium.

(iii) Duct Mounting (Metal or Builders Work)

Mounting flanges, clamping bushes, couplings, locknuts, gaskets, brackets, sealing glands and any special fittings necessitated by the device.

7.2 TEMPERATURE SENSOR

Temperature sensors for space, pipes and ducts, shall be of the Resistance Temperature detector (RTD) type or thermistor. These shall be two wire type and shall conform to the following specifications :

1) Immersion sensors shall be high accuracy type with a high resistance versus temperature change. The accuracy shall be at least ± 1.33 deg C.

2) Immersion sensors shall be provided with separate Brass thermo well. These shall be manufactured from bar stock with hydrostatic pressure rating of at least 10 kgf/cm^2.

3) The connection to the pipe shall be screwed type. An aluminum sleeve shall be provided to ensure proper heat transfer from the well to the sensor. Terminations to be provided on the head. Flying leads shall not be acceptable.

4) The sensor housing shall plug into the base so that the same can be easily removed without disturbing the wiring connections.

5) Duct temperature sensors shall be with rigid stem and of averaging type. These shall be suitable for duct installation.

6) Outdoor air temperature sensor shall be provided with a sun shield.

7) The sensors shall not be mounted near any heat source such as windows, electrical appliances etc.

The temperature sensors may be of any of the following types :

1) PT 100, PT 1000, PT 3000
2) Thermistor

7.3 HUMIDITY SENSOR

Space and duct humidity sensors shall be of capacitance type with an effective sensing range of 10% to 90% RH. Accuracy shall be + 3% or better. Duct mounted humidity sensors shall be provided with a sampling chamber. Wall mounted sensors shall be provided with a housing. The sensor housing shall plug into the base so that the same can be easily removed without disturbing the wiring connections. The sensors shall not be mounted near any heat source such as windows, electrical appliances etc.

7.4 FLOW METER

Water flow meters shall be either Electro magnetic or ultra sonic type. For electromagnetic flow meter, teflon lining with 316 SS electrodes must be provided. The housing shall have IP 55 protection. Vendors shall have to get their design/ selection approved by the Consultant, prior to the supply.

The exact ranges to be set shall be determined by the contractor at the time of commissioning. It should be possible to 'zero' the flow meter without any external instruments, with the overall accuracy of at least ± 1% full scale.

7.5 PRESSURE TRANSMITTER FOR WATER

Pressure transmitters shall be piezo-electric type or diaphragm type. (Bourdon Tube type shall not be acceptable). Output shall be 4-20mA or 0-10V DC and the range as specified in the data sheet depending on the line pressure. Power supply shall be either 24 V AC, 24 V DC or 230 V AC. Connection shall be as per manufacturer's standards. The pressure detector shall be capable of withstanding a hydraulic test pressure of twice the working pressure. The set point shall fall within 40%-70% of the sensing range and detector shall have sensitivity such that change of 1.5% from the stabilized condition shall cause modulation of the corrective element. The sensor must be pressure compensated for a medium temperature of -10 ^{o} C to 60^{o} C with ambient ranging between 0 ^{o} C to 55 ^{o} C.

7.6 DIFFERENTIAL PRESSURE SWITCH FOR PIPE WORK

These shall be used to measure pressure differential across suction and discharge of pumps. The range shall be as specified in the data sheet. Switch shall be ON with increase in differential. Housing for these shall be weather proof with IP 55 protection. The pressure switch shall be capable of withstanding a hydraulic test pressure of 1.5 times the working pressure. The set point shall fall in 40-70% of the scale range and shall have differentials adjustable over 10%-30% of the scale range. The switches shall be provided with site adjustable scale and with 1 NO/NC contacts.

7.7 DIFFERENTIAL PRESSURE SWITCH FOR AIR SYSTEMS

These shall be diaphragm operated. Switches shall be supplied with air connections permitting their use as static or differential pressure switches.

The switch shall be of differential pressure type complete with connecting tube and metal bends for connections to the duct. The housing shall be IP 54 rated. The pressure switches shall be available in minimum of 3 ranges suitable for applications like Air flow proving, dirty filter, etc. The set point shall be concealed type. The contact shall be SPDT type with 230 VAC, 1A rating.

The switch shall be supplied suitable for wall mounting on ducts. It should be mounted in such a way that the condensation flow out of the sensing tips. Proper adaptor shall be provided for the cables.

The set point shall fall within 40%-70% of the scale range and l has differentials adjustable over 10%-30% of the scale range.The switches shall be provided with site adjustable scale and with 1 NO/NC contacts.

7.8 AIR FLOW SWITCHES

Air flow switches shall be selected for the correct air velocity, duct size and mounting attitude. If any special atmospheric conditions are detailed in the Schedule of Quantity the parts of the switches shall be suitably coated or made to withstand such conditions. These shall be suitable for mounting in any plane. Output shall be 1 NO/NC potential free. Site adjustable scale shall also be provided.

7.9 AIR PRESSURE SENSOR

The pressure sensor shall be differential type. The construction shall be spring loaded diaphragm type. The movement of the membrane in relation to the pressure should be converted by an inductive electromagnet coupling which would give an output suitable for the controller. The pressure sensor shall be in a housing having IP 54 ratings in accordance with IEC 529. Suitable mounting arrangement shall be available on the sensor. The sensor shall come complete with the PVC tubes & probes.

7.10 WATER FLOW SWITCH

These shall be paddle type and suitable for the type of liquid flowing in the line. Output shall be 1NO/1NC potential free.

7.11 **CO SENSOR**

CO Sensor shall be integrated Surface mounted type on the field. These shall work on 24V AC/DC supply with the output being standard type i.e. 4-20 mA / 0- 10 Volts etc. Response time of the detector shall be <10 minutes

7.12 **AIR VELOCITY SENSOR**

Air Velocity Sensor shall be integrated Surface / Duct mounted type on the field. These shall work on 24V AC/DC supply with +/- 10% variation the output being standard type i.e. 4-20 mA / 0- 10 Volts etc with an accuracy of +/- 3%. It shall be possible to select the different ranges by changing the jumpers on the sensor. At least 3 selection ranges on the sensors are required.

7.13 **CO2 SENSOR – Space Type**

CO2 Sensor shall be wall / Surface mounted type on the field. These shall work on 24V AC/DC supply with the output being standard type i.e. 4-20 mA / 0- 10 Volts etc. The sensing range required shall be 0-2000 PPM with good resolution.
The preferred type of sensing element / method is NDIR type with accuracy of +/-30PPM or +/-5% of measured value. Warm up time of sensor shall be <2 minutes & response time is better than 150 seconds. Sensor shall be suitable to fix & operate at 1500 to 1750mm above the finished floor level.

7.14 *LEVEL SWITCH*

The level switches shall have to meet the following requirement:

Type	:	Float Type/Capacitance type/Conductivity type
Mounting	:	To suit application.
Connection	:	Flanged ANSI 150 lbs RF Carbon steel
Float material	:	316 SS
Stem Material	:	316 SS
Output	:	1 NO, 1 NC potential free
Switch Enclosure	:	IP 55

8.0 ENCLOSURES FOR CONTROLLERS AND ELECTRICAL PANELS

All the controllers shall be housed in Lockable Vandal proof boxes which shall either be floor mounted or wall mounted. These shall be free standing, totally enclosed, dust and vermin proof and suitable for tropical climatic conditions.

The panel shall be metal enclosed 18 SWG CRCA sheet steel cubicle with gaskets between all adjacent units and beneath all covers to render the joints dust proof. All doors and covers shall be hinged and latched and shall be folded and braced as necessary to provide a rigid support. Joints of any kind in sheet metal shall be seam welded with welding slag grounded off and welding pits wiped smooth with plumber metal.

All panels and covers shall be properly fitted and secured with the frame and holes in the panels correctly positioned. Fixing screws shall enter into holes tapped into an adequate thickness of metal or provided

with nuts. Self threading screws shall not be used in the construction of control panels. Knockout holes of approved size and number shall be provided in the panels in conformity with the location of incoming and outgoing conduits/cables. Lamps shall be provided to support the weight of the cables. The dimension of the boxes shall depend on the requirement with the colour decided in consultation with the Architect/Consultant.

Note: All panel enclosures used in plant room spaces and external to building shall be suitable for outdoor application (IP 54 protection).

9.0 CONDUITS AND WIRING

Prior to laying and fixing of conduits, the contractor shall carefully examine the drawings indicating the layout, satisfy himself about the sufficiency of number and sizes of conduits, sizes and location of conduits and other relevant details. Any discrepancy found in the drawings shall be brought to the notice of Architect/Engineers any modifications suggested by the Contractor shall be got approved by the Architect /Engineers before the actual laying of conduits is commenced.

9.1 **CONDUITS/TRUNKER**

Conduits and accessories shall conform to relevant BS Standards. PVC conduits of required dia shall be used as called for in the schedule of quantities. Joints between conduits and accessories shall be securely made, with help of adhesive.

The conduits shall be delivered to the site of construction in original bundles and each length of conduit shall bear the label of the manufacturer.

9.2 **CONNECTIONS**

All jointing methods shall be subject to the approval of the Architect/Engineer. Separate conduits shall run for all power wiring.

The threads and sockets shall be free from grease and oil. Connections between conduit and controller metal boxes shall be by means of brass hexagon smooth bore bush, fixed inside the box and connected through a coupler to the conduit. The joints in conduits shall be smooth to avoid damage to insulation of conductors while pulling them through the conduits.

9.3 **BENDS IN CONDUIT**

Where necessary, bends or diversions may be achieved by means of bends and/or circular inspection boxes with adequate and suitable inlet and outlet screwed joints. In case of recessed system each junction box shall be provided with a cover properly secured and flush with a finished wall surface. No bends shall have radius less than 2-1/2 times the outside diameter of the conduit.

9.4 **FIXING CONDUITS**

The conduits, junction boxes, outlet boxes and controller boxes once installed in position, shall have their outlets properly plugged or covered so that water, mortar, insects or any other foreign matter does not enter into the conduit system. Surface conduits shall be fixed by means of spacer bar saddles at intervals not more than 500 mm.

The saddles shall be 2 mm x 19 mm galvanized steel flat, properly treated, primer coated & painted, securely fixed to supports by means of nuts and bolts/rawl bolts and brass machines screws.

9.5 **DRAWING OF CONDUCTORS**

While drawing insulated wires/cable into the conduits, care shall be taken to avoid scratches and kinks which may cause breakage of conductors. No joint shall be allowed in case of breakage of any conductor. No joint shall be shaved off like length of the conductors. Insulation shall be shaved off like sharpening of a pencil and it shall not be removed by cutting it square to avoid depression/cutting of conducting material.

Strands of wires shall not be cut to accommodate & connect to the terminals. Terminals shall have sufficient cross-sectional area to take all the strands.

No wire shall be drawn into any conduit until all work of any nature that may cause injury to wire is completed. Before the wires are drawn into the conduit, the conduits shall be thoroughly cleaned of moisture, dust, dirt or any other obstruction. Where wires are connected to detectors, or panel, sufficient extra length of wires shall be provided to facilitate easy connections and maintenance.

Only licensed supervisors/wiremen shall be employed for cabling and other connected work. Only approved make of cables shall be used. The cables shall be brought to the site in original packing.

9.6 **MODE OF MEASUREMENT**

Signal Cable

The cabling running between DDC controllers to the field devices shall be termed as signal cabling. This cabling along with conduits shall be payable on per I/O point basis.

LAN Cable

The cable connecting various system integration units to the control station shall be termed as LAN cable. These cable alongwith conduits shall be measurable on unit length basis.

10.0 SIGNAL CABLING & COMMUNICATION CABLING

The signal cable shall be of the following specifications:

a.	Wire	:	Annealed Tinned Copper
b.	Size	:	1.0 sq. mm, stranded type
c.	No. of conductors	:	Two (One pair)
d.	Shielding	:	Overall beld foil Aluminium polyester shield.
e.	Jacket	:	Chrome PVC
f.	Nominal DCR	:	17.6 ohm/km for conductor 57.0 ohm/km for shield
g.	Nominal capacitance at 1 KHz	:	130 pF/m between conductors 180 pF/m between one conductor and other Conductors connected to shield.

11.0 **LOCAL AREA NETWORK CABLE**

Depending on the type of LAN system being used by the contractor, standard, manufacturer's specification shall apply.

12.0 BMS DELIVERABLES-

The deliverables expected from the BMS in broadly defined here under. However it is understood that the I / O summary detailed in this specifications will be reckoned while designing the system.

Ventilation:

1. Timed scheduled operation ventilation fans.
2. Facility to bring into any of the additional fans into operation in the event of maintenance on any of the main in-line fans.
3. Status of fans
4. Status of Generator room, STP room, and toilet ventilation fans
5. Status of staircase pressurization and kitchen exhaust fans
6. Run Time Reports for above equipment
7. Trending of CO concentration levels.

Chillers:

The chiller supplier shall provide software interface by providing linking of all Chiller Microprocessor panel for communication between panels. Additionally, he shall provide single point gateway for high level integration with read/write capability to the BMS system.

1. Data logging of Chillers – operating parameters.

2. Fault history.
3. Cycle operation of Chillers on standby mode whenever applicable during night charge cycle.
4. Chiller sequencing and load sharing.
5. Status.
6. Customized Trends/Schedules etc. pertaining to various Chiller parameters
7. Maintenance Alarm Pop up

Pumps:

Primary and secondary Brine pumps:
1. Control and Status
2. Time totalizing- led/lag for standby operation.
3. Data logging
4. Pump status
5. Run Time of the pumps

Secondary Chilled water pumps with VFD:
1. Loading history
2. Pump Status
3. Run Time of the pumps

Air handling units (Standard AHU's)

1. Space Temperature Set point control
2. Actual space / RA Temperature
3. Filter status
4. Fan status
5. Auto/Manual operation status
6. Fan on/off status
7. Control valve status
8. Run Time for the Fan/Motors
9. PID Control for Valves

Air handling units (AHU's with return air fans, if applicable):

1. Emergency smoke evacuation:
2. Fans and damper control on actuation of smoke sensor.
3. Night purge / Free cooling:
4. Fans, Dampers and control valve control on ambient temperature sensing.
5. Balance deliverables as under iii. Above
6. PID Control for Valves
7. Run Time for Fan/Motors
8. Customized Control Strategy & Switching Logic

Plumbing system:

1. Monitoring of water levels in under ground tanks and overhead tanks
2. Pumps run hours
3. Pump on-off status
4. Run Time

STP:

1. Run hours pumps in the system
2. High water level alarm

Electrical monitoring and data logging:

Parameters relevant to Automatic Transfer Switches (ATS) at the origin of utility supply and standby sources and Multi Data Meters (MDM) in outgoing feeders as per following.
(Through integration as all MDMs shall be provided with communication ports)
Data Points to be monitored & trended for MDMs: kW, kWh, kV Ar.p.f, V, A, Power outages, DG run
Data Points to be monitored & trended for KWH Meters: kW, kWh

2.23 PROCUREMENT, INSPECTION OF EQUIPMENT & APPROVALS

Approved list of makes and vendors are given in the end of technical specifications. The makes of equipment/materials supplied shall be strictly as mentioned therein. For items not specially mentioned, prior approval shall be taken before procurement of the same. All equipments/material supplied shall be brand new and shall be procured directly from the manufacturers, dealers or authorised agents.

HSCC Electrical Engineer shall have access to the manufacturer's premises for stage inspection/final inspection of any item during its design, manufacturing, and assembly and testing. After carrying out the necessary factory tests and routine tests as per IS Standards, a copy of the routine test certificate shall be forwarded along with the call for carrying out the inspection at the manufacturer's works.

Based on the inspection certificate, HSCC Electrical Engineer reserves the right to carry out the inspection at a mutually agreed date and/or give inspection waiver. A minimum of two weeks will be needed after receipt of complete shop inspection report and other details to depute our inspector for inspection.

It is the responsibility of the contractor to ensure that all electrical works are carried out as per the IE Rules & regulations, National Building Code and IS Codes & Standards. All necessary drawings and details as required by Electricity Board, Electrical Inspector, Fire Department and other Local Statutory agencies, shall be prepared by the contractor. The contractor is responsible to submit the drawings and other details as required to the Local Authorities (refer above) and obtain necessary approvals including sanction of load/enhancement of electrical load from SEB before energizing and commissioning. All official fee required for getting the approval will be reimbursed on account of Client on submission of original documents.

S.N.		DESCRIPTION	QTY	IO Listing					
A	Location/ Area			AI	AO	DI	DO	BMS REQUIREMENT	
A		**AHU MANAGEMENT SYSTEM**							
		Air Handling Units							
		Air Handling Units TYPE 1 with VFD	78						
1		AHU ON/OFF Command					1	Hardware Interface	
2		AHU ON/OFF Status				1		Hardware Interface	
3		AHU Auto/Manual Status				1		Hardware Interface	
4		Supply Air Temperature Sensor		1				Room Temp Sensor	
5		Return Air Temperature Sensor		1				Room Temp Sensor	
6		Fresh Air Temerature Sensor		1				Room Temp Sensor	
7		Supply Chilled water Temperature Sensor		1				Temp sensor with Thermowell	
8	**PER AHU-TYPE**	Return Chilled Water Temperature Sensor		1				Temp sensor with Thermowell	
9	**1**	IAQ sensor (or CO2 sensor)		1				Room CO2 Sensor	
10		Supply Air Fire Damper				1	1	Actuator	
11		Return Air Fire Damper				1	1	Actuator	
12		Fresh Air Motorised Damper		1	1			Actuator	
13		Filter Status				2		Filter DP Switch	
14		AHU 2way CHW Valve Control			1			Hardware Interface	
15		Fire Signal				1		Hardware Interface	
16		DPS FOR STATIC PRESSURE		1					
17		VFD STATUS/CONTROL		1	1				
		Total Required		**351**	**117**	**273**	**117**		
		Point Per DDC		**9**	**3**	**7**	**3**		
		Spare 15%		**53**	**18**	**41**	**18**		
		Total IO per DDC		**404**	**135**	**314**	**135**		
				AI	AO	DI	DO		
		Air Handling Units TYPE 2 with VFD	23						
1		AHU ON/OFF Command					1	Hardware Interface	HVAC Contractor to provide hardwired Pot Free Contact
2		AHU ON/OFF Status				1		Hardware Interface	Differential Pressure Switch Across AHU Blower
3		AHU Auto/Manual Status				1		Hardware Interface	HVAC Contractor to provide hardwired Pot Free Contact
4		Supply Air Temperature Sensor		1				Room Temp Sensor	
5		Return Air Temperature Sensor		1				Room Temp Sensor	
6		Fresh Air Temerature Sensor		1				Room Temp Sensor	
7		Supply Chilled water Temperature Sensor		1				Temp sensor with Thern	HVAC Contractor to provide tapping in pipe line with ball valve
8		Return Chilled Water Temperature Sensor		1				Temp sensor with Thern	HVAC Contractor to provide tapping in pipe line with ball valve
9	**PER AHU-TYPE**	IAQ sensor (or CO2 sensor)		1				Room CO2 Sensor	
10	**2**	Supply Air Fire Damper				1	1	Actuator	HVAC Contractor need to provide data of connection with actuator
11		Return Air Fire Damper				1	1	Actuator	HVAC Contractor need to provide data of connection with actuator
12		Fresh Air Motorised Damper		1	1			Actuator	HVAC Contractor need to provide data of connection with actuator
13		Filter Status				3		Filter DP Switch	
14		AHU 2way CHW Valve Control			1			Hardware Interface	HVAC Contractor need to provide data of connection with actuator
15		Fire Signal				1		Hardware Interface	Fire Panel Signal
16		DPS FOR STATIC PRESSURE		1				Hardware Interface	HVAC Contractor need to provide data of connection with actuator
17		VFD STATUS/CONTROL		1	1			Hardware Interface	HVAC Contractor need to provide data of connection with actuator
18		Heating coil			1				

S.N.		DESCRIPTION	QTY	IO Listing					
A	Location/ Area			AI	AO	DI	DO	BMS REQUIREMENT	
19		Exhaust fan ON/OFF Sensor				1	1		
		Total Required		**54**	**24**	**54**	**24**		
		Point Per DDC		**9**	**4**	**9**	**4**		
		Spare 15%		**8**	**4**	**8**	**4**		
		Total IO per DDC		**62**	**28**	**62**	**28**		
				AI	AO	DI	DO		
B		**ELECTRICAL MANAGEMENT SYSTEM**							
		MAIN LT PANEL (IPD)							
1		Incomer Breaker # 3 ON/ OFF / TRIP Status				3		Hardware Interface	LT PANEL Contractor need to provide potential free contact
2		Outgoing Breaker # 28 ON / OFF / TRIP Status				28		Hardware Interface	LT PANEL Contractor need to provide potential free contact
3		Spare Breaker # 28 ON / OFF / TRIP Status				28			
						177			
		Utility LT Panel (IPD BLDG)							
1		Incomer Breaker # 3 ON/ OFF / TRIP Status				2		Hardware Interface	LT PANEL Contractor need to provide potential free contact
2		Outgoing Breaker # 16 ON / OFF / TRIP Status				16		Hardware Interface	LT PANEL Contractor need to provide potential free contact
3		Spare Breaker # 16 ON / OFF / TRIP Status				16		Hardware Interface	LT PANEL Contractor need to provide potential free contact
						102		Hardware Interface	LT PANEL Contractor need to provide potential free contact
		FEP						Hardware Interface	LT PANEL Contractor need to provide potential free contact
1		Incomer Breaker # 2 ON/ OFF / TRIP Status				2		Hardware Interface	LT PANEL Contractor need to provide potential free contact
						6		Hardware Interface	LT PANEL Contractor need to provide potential free contact
		UPS Output Panel						Hardware Interface	LT PANEL Contractor need to provide potential free contact
1		Incomer Breaker # 5 ON/ OFF / TRIP Status				5		Hardware Interface	LT PANEL Contractor need to provide potential free contact
						15		Hardware Interface	LT PANEL Contractor need to provide potential free contact
		HVAC Panel						Hardware Interface	LT PANEL Contractor need to provide potential free contact
1		Incomer Breaker # 2 ON/ OFF / TRIP Status				2			
						6		Hardware Interface	LT PANEL Contractor need to provide potential free contact
								Hardware Interface	LT PANEL Contractor need to provide potential free contact
		Total Required		**0**	**0**	**306**	**0**		
		Spare		**0**	**0**	**31**	**0**		
		Grand Total		**0**	**0**	**337**	**0**		
				UI	AO	DI	DO		
1		Spare Breaker 1 On/Off Status				1		Hardware Interface	DG PANEL Contractor need to provide potential free contact
2		Spare Breaker 2 On/Off Status				1		Hardware Interface	DG PANEL Contractor need to provide potential free contact
3		Breaker 3 On/Off Status				1		Hardware Interface	DG PANEL Contractor need to provide potential free contact
4		DG Set 1 Brekaer On/Off Status				1		Hardware Interface	DG PANEL Contractor need to provide potential free contact
5		DG Set 2 Brekaer On/Off Status				1		Hardware Interface	DG PANEL Contractor need to provide potential free contact
6		DG Set 3 Brekaer On/Off Status				1		Hardware Interface	DG PANEL Contractor need to provide potential free contact
7		Breaker 4 On/Off Status				1		Hardware Interface	DG PANEL Contractor need to provide potential free contact
8		Breaker 5 On/Off Status				1		Hardware Interface	DG PANEL Contractor need to provide potential free contact
9		Spare Breaker 6 On/Off Status				1		Hardware Interface	DG PANEL Contractor need to provide potential free contact
		MAIN LT PANEL - L							
10		Spare Breaker On/Off Status				1		Hardware Interface	LT PANEL Contractor need to provide potential free contact

S.N.		DESCRIPTION	QTY	IO Listing					
A	Location/ Area			AI	AO	DI	DO	BMS REQUIREMENT	
11		Spare Breaker On/Off Status				1		Hardware Interface	LT PANEL Contractor need to provide potential free contact
12		Spare Breaker On/Off Status				1		Hardware Interface	LT PANEL Contractor need to provide potential free contact
13		MSPP-1-L Breaker On/Off Status				1		Hardware Interface	LT PANEL Contractor need to provide potential free contact
14		HVAC PANEL-L Breaker On/Off Status				1		Hardware Interface	LT PANEL Contractor need to provide potential free contact
15		CPP-1 Breaker On/Off Status				1		Hardware Interface	LT PANEL Contractor need to provide potential free contact
16		Auto Change Over Breaker On/Off Status				1		Hardware Interface	LT PANEL Contractor need to provide potential free contact
17		Auto Change Over Breaker On/Off Status				1		Hardware Interface	LT PANEL Contractor need to provide potential free contact
18		Breaker On/Off Status				1		Hardware Interface	LT PANEL Contractor need to provide potential free contact
19		Combination breaker of MLTP-L & MLTP-R On/Off Status				1		Hardware Interface	LT PANEL Contractor need to provide potential free contact
20		Breaker On/Off Status				1		Hardware Interface	LT PANEL Contractor need to provide potential free contact
21		Auto Change Over Breaker On/Off Status				1		Hardware Interface	LT PANEL Contractor need to provide potential free contact
22		Auto Change Over Breaker On/Off Status				1		Hardware Interface	LT PANEL Contractor need to provide potential free contact
23		CPP-2 Breaker On/Off Status				1		Hardware Interface	LT PANEL Contractor need to provide potential free contact
24		HVAC PANEL-R Breaker On/Off Status				1		Hardware Interface	LT PANEL Contractor need to provide potential free contact
25		MSPP-1-R Breaker On/Off Status				1		Hardware Interface	LT PANEL Contractor need to provide potential free contact
26		FEP-L Breaker On/Off Status				1		Hardware Interface	LT PANEL Contractor need to provide potential free contact
27		Spare Breaker On/Off Status				1		Hardware Interface	LT PANEL Contractor need to provide potential free contact
28		Spare Breaker On/Off Status				1		Hardware Interface	LT PANEL Contractor need to provide potential free contact
29		Spare Breaker On/Off Status				1		Hardware Interface	LT PANEL Contractor need to provide potential free contact
		CONSUMER HV PANEL							
30		Breaker On/Off Status				1		Hardware Interface	HV PANEL Contractor need to provide potential free contact
31		Breaker On/Off Status				1		Hardware Interface	HV PANEL Contractor need to provide potential free contact
32		Breaker On/Off Status				1		Hardware Interface	HV PANEL Contractor need to provide potential free contact
		DG Sychronising Panel							
33		Spare Breaker 1 Trip Status				1		Hardware Interface	DG PANEL Contractor need to provide potential free contact
34		Spare Breaker 2 Trip Status				1		Hardware Interface	DG PANEL Contractor need to provide potential free contact
35		Breaker 3 Trip Status				1		Hardware Interface	DG PANEL Contractor need to provide potential free contact
36		DG Set 1 Brekaer Trip Status				1		Hardware Interface	DG PANEL Contractor need to provide potential free contact
37		DG Set 2 Brekaer Trip Status				1		Hardware Interface	DG PANEL Contractor need to provide potential free contact
38		DG Set 3 Brekaer Trip Status				1		Hardware Interface	DG PANEL Contractor need to provide potential free contact
39		Breaker 4 Trip Status				1		Hardware Interface	DG PANEL Contractor need to provide potential free contact
40		Breaker 5 Trip Status				1		Hardware Interface	DG PANEL Contractor need to provide potential free contact
41		Spare Breaker 6 Trip Status				1		Hardware Interface	DG PANEL Contractor need to provide potential free contact
		MAIN LT PANEL - L							
42		Spare Breaker Trip Status				1		Hardware Interface	LT PANEL Contractor need to provide potential free contact
43		Spare Breaker Trip Status				1		Hardware Interface	LT PANEL Contractor need to provide potential free contact
44		Spare Breaker Trip Status				1		Hardware Interface	LT PANEL Contractor need to provide potential free contact
45		MSPP-1-L Breaker Trip Status				1		Hardware Interface	LT PANEL Contractor need to provide potential free contact
46		HVAC PANEL-L Breaker Trip Status				1		Hardware Interface	LT PANEL Contractor need to provide potential free contact
47		CPP-1 Breaker Trip Status				1		Hardware Interface	LT PANEL Contractor need to provide potential free contact
48		Auto Change Over Breaker Trip Status				1		Hardware Interface	LT PANEL Contractor need to provide potential free contact
49		Auto Change Over Breaker Trip Status				1		Hardware Interface	LT PANEL Contractor need to provide potential free contact
50		Breaker Trip Status				1		Hardware Interface	LT PANEL Contractor need to provide potential free contact
51		Combination breaker of MLTP-L & MLTP-R Trip Status				1		Hardware Interface	LT PANEL Contractor need to provide potential free contact
52		Breaker Trip Status				1		Hardware Interface	LT PANEL Contractor need to provide potential free contact
53		Auto Change Over Breaker Trip Status				1		Hardware Interface	LT PANEL Contractor need to provide potential free contact
54		Auto Change Over Breaker Trip Status				1		Hardware Interface	LT PANEL Contractor need to provide potential free contact

S.N.		DESCRIPTION	QTY	IO Listing					
A	Location/ Area			AI	AO	DI	DO	BMS REQUIREMENT	
55		CPP-2 Breaker Trip Status				1		Hardware Interface	LT PANEL Contractor need to provide potential free contact
56		HVAC PANEL-R Breaker Trip Status				1		Hardware Interface	LT PANEL Contractor need to provide potential free contact
57		MSPP-1-R Breaker Trip Status				1		Hardware Interface	LT PANEL Contractor need to provide potential free contact
58		FEP-L Breaker Trip Status				1		Hardware Interface	LT PANEL Contractor need to provide potential free contact
59		Spare Breaker Trip Status				1		Hardware Interface	LT PANEL Contractor need to provide potential free contact
60		Spare Breaker Trip Status				1		Hardware Interface	LT PANEL Contractor need to provide potential free contact
61		Spare Breaker Trip Status				1		Hardware Interface	LT PANEL Contractor need to provide potential free contact
		CONSUMER HV PANEL							
62		Breaker Trip Status				1		Hardware Interface	HV PANEL Contractor need to provide potential free contact
63		Breaker Trip Status				1		Hardware Interface	HV PANEL Contractor need to provide potential free contact
64		Breaker Trip Status				1		Hardware Interface	HV PANEL Contractor need to provide potential free contact
65		Hi/Low Level Indicator for Disel Tank 1				1		level Switch	DG Contractor need to provide data of tank to procure the level switch and also they need to make the provision based on level switch mounting
66		Hi/Low Level Indicator for Disel Tank 2				1		level Switch	DG Contractor need to provide data of tank to procure the level switch and also they need to make the provision based on level switch mounting
		Total Required		**0**	**0**	**66**	**0**		
		Spare		**0**	**0**	**7**	**0**		
		Grand Total		**0**	**0**	**73**	**0**		
				UI	AO	DI	DO		
1		FEEDER PILLER-1 - R1 to R8 Phase On/Off Status				8		Hardware Interface	Lighting Contractor need to provide potential free contact
2		FEEDER PILLER-1 - R1 to R8 Phase On/Off Command					8	Hardware Interface	Lighting Contractor need to provide potential free contact
3		FEEDER PILLER-1 - Y1 to Y8 Phase On/Off Status				8		Hardware Interface	Lighting Contractor need to provide potential free contact
4	**DDC-FP-1**	FEEDER PILLER-1 - Y1 to Y8 Phase On/Off Command					8	Hardware Interface	Lighting Contractor need to provide potential free contact
5		FEEDER PILLER-1 - B1 to B8 Phase On/Off Status				8		Hardware Interface	Lighting Contractor need to provide potential free contact
6		FEEDER PILLER-1 - B1 to B8 Phase On/Off Command					8	Hardware Interface	Lighting Contractor need to provide potential free contact
		Total Required		**0**	**0**	**24**	**24**		
		Spare		**0**	**0**	**4**	**4**		
		Grand Total		**0**	**0**	**28**	**28**		
				UI	AO	DI	DO		
1		FEEDER PILLER-2 - R1 to R8 Phase On/Off Status				8		Hardware Interface	Lighting Contractor need to provide potential free contact
2		FEEDER PILLER-2 - R1 to R8 Phase On/Off Command					8	Hardware Interface	Lighting Contractor need to provide potential free contact
3		FEEDER PILLER-2 - Y1 to Y8 Phase On/Off Status				8		Hardware Interface	Lighting Contractor need to provide potential free contact
4	**DDC-FP-2**	FEEDER PILLER-2 - Y1 to Y8 Phase On/Off Command					8	Hardware Interface	Lighting Contractor need to provide potential free contact
5		FEEDER PILLER-2 - B1 to B8 Phase On/Off Status				8		Hardware Interface	Lighting Contractor need to provide potential free contact
6		FEEDER PILLER-2 - B1 to B8 Phase On/Off Command					8	Hardware Interface	Lighting Contractor need to provide potential free contact
		Total Required		**0**	**0**	**24**	**24**		
		Spare		**0**	**0**	**4**	**4**		
		Grand Total		**0**	**0**	**28**	**28**		
				UI	AO	DI	DO		
1		FEEDER PILLER-3 - R1 to R8 Phase On/Off Status				8		Hardware Interface	Lighting Contractor need to provide potential free contact
2		FEEDER PILLER-3 - R1 to R8 Phase On/Off Command					8	Hardware Interface	Lighting Contractor need to provide potential free contact
3	**DDC-FP-3**	FEEDER PILLER-3 - Y1 to Y8 Phase On/Off Status				8		Hardware Interface	Lighting Contractor need to provide potential free contact

S.N.		DESCRIPTION	QTY	IO Listing					
A	Location/ Area			AI	AO	DI	DO	BMS REQUIREMENT	
4	DDC-FP-3	FEEDER PILLER-3 - Y1 to Y8 Phase On/Off Command					8	Hardware Interface	Lighting Contractor need to provide potential free contact
5		FEEDER PILLER-3 - B1 to B8 Phase On/Off Status				8		Hardware Interface	Lighting Contractor need to provide potential free contact
6		FEEDER PILLER-3 - B1 to B8 Phase On/Off Command					8	Hardware Interface	Lighting Contractor need to provide potential free contact
		Total Required		**0**	**0**	**24**	**24**		
		Spare		**0**	**0**	**4**	**4**		
		Grand Total		**0**	**0**	**28**	**28**		
				UI	AO	DI	DO		
1	DDC-FP-4	FEEDER PILLER-4 - R1 to R8 Phase On/Off Status				8		Hardware Interface	Lighting Contractor need to provide potential free contact
2		FEEDER PILLER-4 - R1 to R8 Phase On/Off Command					8	Hardware Interface	Lighting Contractor need to provide potential free contact
3		FEEDER PILLER-4 - Y1 to Y8 Phase On/Off Status				8		Hardware Interface	Lighting Contractor need to provide potential free contact
4		FEEDER PILLER-4 - Y1 to Y8 Phase On/Off Command					8	Hardware Interface	Lighting Contractor need to provide potential free contact
5		FEEDER PILLER-4 - B1 to B8 Phase On/Off Status				8		Hardware Interface	Lighting Contractor need to provide potential free contact
6		FEEDER PILLER-4 - B1 to B8 Phase On/Off Command					8	Hardware Interface	Lighting Contractor need to provide potential free contact
		Total Required		**0**	**0**	**24**	**24**		
		Spare		**0**	**0**	**4**	**4**		
		Grand Total		**0**	**0**	**28**	**28**		
				UI	AO	DI	DO		
1	DDC-FP-5	**DDC for Façade lighting**						Hardware Interface	Lighting Contractor need to provide potential free contact
2		FEEDER PILLER-5 - R1 to R8 Phase On/Off Status				8		Hardware Interface	Lighting Contractor need to provide potential free contact
3		FEEDER PILLER-5 - R1 to R8 Phase On/Off Command					8	Hardware Interface	Lighting Contractor need to provide potential free contact
4		FEEDER PILLER-5 - Y1 to Y8 Phase On/Off Status				8		Hardware Interface	Lighting Contractor need to provide potential free contact
5		FEEDER PILLER-5 - Y1 to Y8 Phase On/Off Command					8	Hardware Interface	Lighting Contractor need to provide potential free contact
6		FEEDER PILLER-5 - B1 to B8 Phase On/Off Status				8		Hardware Interface	Lighting Contractor need to provide potential free contact
7		FEEDER PILLER-5 - B1 to B8 Phase On/Off Command					8	Hardware Interface	Lighting Contractor need to provide potential free contact
		Total Required		**0**	**0**	**24**	**24**		
		Spare		**0**	**0**	**4**	**4**		
		Grand Total		**0**	**0**	**28**	**28**		
				UI	AO	DI	DO		
H		**Water Management System**							
2		Fire Tank-1 High level indicator				1		Level switch	FF Contractor need to provide data of tank to procure the level switch and also they need to make the provision based on level switch mounting
3		Fire Tank-1 Low level indicator				1		Level switch	FF Contractor need to provide data of tank to procure the level switch and also they need to make the provision based on level switch mounting
4		Raw Water Tank-1 High level indicator				1		Level switch	FF Contractor need to provide data of tank to procure the level switch and also they need to make the provision based on level switch mounting

S.N.		DESCRIPTION	QTY	IO Listing					
A	Location/ Area			AI	AO	DI	DO	BMS REQUIREMENT	
5		Raw Water Tank-1 Low level indicator				1		Level switch	FF Contractor need to provide data of tank to procure the level switch and also they need to make the provision based on level switch mounting
6		Fire Tank-2 High level indicator				1		Level switch	FF Contractor need to provide data of tank to procure the level switch and also they need to make the provision based on level switch mounting
7		Fire Tank-2 Low level indicator				1		Level switch	FF Contractor need to provide data of tank to procure the level switch and also they need to make the provision based on level switch mounting
8		Raw Water Tank-2 High level indicator				1		Level switch	FF Contractor need to provide data of tank to procure the level switch and also they need to make the provision based on level switch mounting
9		Raw Water Tank-2 Low level indicator				1		Level switch	FF Contractor need to provide data of tank to procure the level switch and also they need to make the provision based on level switch mounting
14		Treated Water Tank 1 High Level Indicator				1		Level switch	FF Contractor need to provide data of tank to procure the level switch and also they need to make the provision based on level switch mounting
15		Treated Water Tank 1 Low Level Indicator				1		Level switch	FF Contractor need to provide data of tank to procure the level switch and also they need to make the provision based on level switch mounting
16		Treated Water Tank 2 High Level Indicator				1		Level switch	FF Contractor need to provide data of tank to procure the level switch and also they need to make the provision based on level switch mounting
17		Treated Water Tank 2 Low Level Indicator				1		Level switch	FF Contractor need to provide data of tank to procure the level switch and also they need to make the provision based on level switch mounting
		AC Make up Tank High Level Indicator				1		Level switch	FF Contractor need to provide data of tank to procure the level switch and also they need to make the provision based on level switch mounting
	MEP Building	AC Make up Tank Low Level Indicator				1			
		Raw Water Feed Pump 1 (Working) On/Off Status				1		Hardware Interface	Water Management Contractor need to provide potential free contact
		Raw Water Feed Pump 1 (Working)Trip Status				1		Hardware Interface	Water Management Contractor need to provide potential free contact
		Raw Water Feed Pump 2 (Working) On/Off Status				1		Hardware Interface	Water Management Contractor need to provide potential free contact
		Raw Water Feed Pump 2 (Working)Trip Status				1		Hardware Interface	Water Management Contractor need to provide potential free contact
		Raw Water Feed Pump 3 (Standby) On/Off Status				1		Hardware Interface	Water Management Contractor need to provide potential free contact
		Raw Water Feed Pump 3 (Standby)Trip Status				1		Hardware Interface	Water Management Contractor need to provide potential free contact
		AC Make Up Pump 1 (Working) On/Off Status				1		Hardware Interface	Water Management Contractor need to provide potential free contact
		AC Make Up Pump 1 (Working)Trip Status				1		Hardware Interface	Water Management Contractor need to provide potential free contact

S.N.		DESCRIPTION	QTY	IO Listing					
A	Location/ Area			AI	AO	DI	DO	BMS REQUIREMENT	
		AC Make Up Pump 1 (Standby) On/Off Status				1		Hardware Interface	Water Management Contractor need to provide potential free contact
		AC Make Up Pump 1 (Standby)Trip Status				1		Hardware Interface	Water Management Contractor need to provide potential free contact
		Boiler 1 (Working) On/Off Status				1		Hardware Interface	Water Management Contractor need to provide potential free contact
		Boiler 1 (Working) Trip status				1		Hardware Interface	Water Management Contractor need to provide potential free contact
		Boiler 2 (Standby) On/Off Status				1		Hardware Interface	Water Management Contractor need to provide potential free contact
		Boiler 2 (Sandby) Trip status				1		Hardware Interface	Water Management Contractor need to provide potential free contact
		STP panel On/Off Status				1		Hardware Interface	Water Management Contractor need to provide potential free contact
		STP panel Trip Status				1		Hardware Interface	Water Management Contractor need to provide potential free contact
		WTP panel On/Off Status				1		Hardware Interface	Water Management Contractor need to provide potential free contact
		WTP panel Trip Status				1		Hardware Interface	Water Management Contractor need to provide potential free contact
		Hot Water Panel On/Off Status				1		Hardware Interface	Water Management Contractor need to provide potential free contact
		Hot Water Panel Trip Status				1		Hardware Interface	Water Management Contractor need to provide potential free contact
		Total Required		**0**	**0**	**34**	**0**		
		Spare		**0**	**0**	**5**	**0**		
		Grand Total		**0**	**0**	**39**	**0**		
				UI	AO	DI	DO		

LIST OF APPROVED MAKES FOR ELCTRICAL SYSTEM

Contractor shall use the materials of approved make as indicated below unless specified in BOQ or as approved by the HSCC engineer incharge. The contractor shall ensure the correct selection of the approved make meeting the specifications and application duties. Before placing order for procurement, the sample of approved make shall be got verified for its suitability to the specification and application duty. However, HSCC engineer incharge reserves the right to opt for the best preferred listed make. The contractor shall quote the rates for the material and equipment as per the list of approved makes. In the event of the contractor wants to use alternate makes other than those stipulated for non availability, monopolistic attitude with proof, the contractor can send a proposal after ensuring that what he proposes at the least meets both the quality and safety standard of the stipulated makes, and the financial benefit, if any, that will accur to the client. He shall also stand full guarantee to his alternate proposal. The alternate makes can be used only after an approval accorded by the client/HSCC., whose decision will be final in this matter.

Note- Approved Main LT Panel manufacture can use their Own Manufactured items for fabrication of panels. Authorized panel builders will not be accepted.

S.No.	ITEM	MAKE
1	HT VCB Panel Board/ RMU	Siemens/L&T/ABB/Schneider
2	Transformer	ABB/GE/ Schneider/Alstom
3	Main LT Panel/ APFC panels / Active Harmonic Filter (AHF)	Siemens/ L&T/ABB/Schneider
4	Additional make for APFC Panel/ AHF	EPCOS, Ducati
5	Synchronization Panel/AMF Panel	OEM of the DG set or above panel manufacturer as mentioned against s.no.-3
6	Diesel Engine:	Cummins/ Caterpillar/MTU/ Perkins- Sterling
7	Alternator:	Stamford/AVK/ Leroysomer/ KEC
8	Fastener	Hilti/ Fisher or equivalent as approved by HSCC
9	Anti-vibration mounting:	Dunlop, Gerb, resistoflex
10	Bus Duct/Rising main	L&T/ABB/Siemens/Schneider/GE/ Legrand/C&S

- **Equivalent makes can be added with price adjustment with the prior approval of Engineer-in-charge**

11.	Battery:	Panasonic/Hitachi/Cummins/Exide
11a	Automatic Battery Charger	Max Power/Amara raja Batteries ltd./Chhabi Electrical/Statcon power control ltd.
12.	MV panels/Fire panel/AHU Panel	Tricolite/Adlec./Sterling &Wilson / Control & Switchgear/Nitya Electro Control Pvt. Ltd./SPC Electrotech/Neptune/Risha Control Engineers pvt.ltd
13.	ACB	L &T 'U' Power(Omega)/ Siemens 3WL/ ABB/ Legrand(DMX)/ Schneider (NW- Master Pact)
14.	Moulded Case Circuit Breaker	L &T – (D sine/DL) / Siemens-VA/ ABB-TMA/ Schneider – (NSX/NS/CVS) /Legrand-DPX
15.	Power/auxiliary Contactors, timers, Relay, starters	ABB/ Schneider/ L&T/ Siemens
16.	AMF Relay	wood ward
17.	SFU with HRC	L&T/ Siemens/ ABB/ Schneider/GE
18.	Change over switches/Isolators	Schneider / Siemens/ABB/GE/L&T
19.	Instruments (Analog & Digital)	L&T/ AE/ Siemens/ Schneider/ABB
20.	Timers	Legrand/ L&T/ Siemens/ ABB
21.	Cast resin current Transformers:	AE/L&T
22.	Selector Switches:	L&T /KAYCEE/ Siemens
23.	Push button, Indicating Lamps LED:	L&T /Siemens/Schinder
24.	Auto manual changeover switches (3Way)	Kaycee/L&T/ Schnieder/Siemens

- **Equivalent makes can be added with price adjustment with the prior approval of Engineer-in-charge**

25	MCB distribution Boards	L &T/Hager/Legrand/ Siemens/ Schneider/GE / Philips
26	RCCB/MCB	L & T / Legrand-DX3/ Siemens / Schenider –Acti 9/GE/ Hager/Philips
27	HT/LT- XLPE cables	CCI/Universal/Finolex/Rallison
28	Copper Control cable	CCI/ Universal/Finolex/ Rallison
29	Compression Glands & Lugs	Comet/ Dowells
30	PVC Tape	Steel Grip
31	Cable Jointing kit	Raychem / 3M
32.	Cable Trays/ Raceways	OBO/ Legrand/ Cooper
33	Terminal Strips	Elmex/ Connectwell/ Technoplast
34	LED light fitting & Fixture	Philips / GE/ Crompton Greaves
35	MS conduit	BEC/ AKG/ Steel Kraft

- **Equivalent makes can be added with price adjustment with the prior approval of Engineer-in-charge**

36	PVC conduit	Supreme/Prince/Finolex/AKG/BEC
37	Conduit accessories MS & PVC	As approved by HSCC
38	Solar Power system(PV Cell)	TATA Power Solar, CEL, BHEL, BEL
39	Copper conductor PVC insulated wires, Co-axial , Telephone wires & cables	L&T/ Batra Henlay/ Bonton/Havells/Rallision/RR Kabel/Finolex
40	Additional make for telephone & LV wires and Cable	Delton/Fusion polymer
41	Modular Switches & sockets Outlets	Legrand-Myrius or Anti bacterial/L&T Oris/ Schneider -Livia / Philips -Sleek
42	Metal clad Socket outlets With boxes	L & T /Hager/ Siemens/ Schneider/ ABB/Legrand /HPL
43	Lighting protection	Erico/Galaxy electrode /Earth plus/OBO
44	UPS system	Schneider- MG , APC/ Eaton Power ware/ Emerson
45	High Mast poles	Crompton Greaves /Phillips
46	Ceiling fans	Crompton Greaves/ Orient/ Usha
47	PC with CPU and monitor etc	HP/ Compaq/Del/IBM
48	Auto Transfer switch	Cummins/Emerson-Asco/GE/ Russelectric
49	Public address system	Bosch/ Bose/ Honey well /Harman
50	CCTV camera	Pelco /Bosch/Sony/Axis
51	LCD/LED Monitor	Sony/Panasonic/Samsung/ Toshiba
52	Fire Detection System Addressable	Honeywell-Notifier/Edward/Bosch/ Siemens

- **Equivalent makes can be added with price adjustment with the prior approval of Engineer-in-charge**

53	FDA Conventional	Honeywell/Bosch or equivalent as approved by HSCC
54	Portable fire extinguisher	Minimax/Ceasefire/
55	EPABX system	Avaya/ Siemens-unify/Alcatel/Cisco
56	Nurse Call bell system	Honeywell/Schreak/ Rauland
57	Capacitor	Epcos, Schenider, L&T, Ducati
58	APFC Relay	Epcos, L&T, Biluk, Ducati, Schneider
59	Occupancy Sensor	Philips/ Honeywell/ Schneider/Lutron/Legrand
60	Lifts/ Dumb Waiters/Escalators	Otis /Kone/ Mitsubishi/ Scheindler/Johnson
61	BMS, field devices etc	Honeywell-Trend/L&T-Atmos/Siemens/Schneider
62	Lighting Control	Lutron/ Philips/ ABB/ Schneider/ Legrand
63	Chemical Earthing	OBO Bettermann / Erico/Furse / Ingesco/
64	Access Control System	Honeywell-Pro-3000/Schneider/Lenel/Cardex
65	Boom barrier	Magnetic/ Somfy/ RIB/FAAC
66	CAT 6 UTP, CAT 6A UTP/STP, Optical Fibre-cable	Molex/Systimax/Panduit

- **Equivalent makes can be added with price adjustment with the prior approval of Engineer-in-charge**

END OF TECHNICAL SPECIFICATION