# SECTION- B 2.18

# INVERTER & UPS SYSTEM

## 2.18.1 PREMABLE

A. General: This section of specification defines the technical requirements for 3 Phase, 4 wire, 50Hz, 415V Inverter Unit, associated Dry Batteries and Battery Circuit Breaker as specified in accordance with the requirements of the Contract Documents and codes having jurisdiction.

B. The static inverter shall be of solid state type using proven Pulse Width Modulation (PWM) technique. The inverter shall be used to feed all emergency load like light fittings etc. in case of power failure and hence when normal supply is available these loads will be directly fed from normal source. This normal power source shall also be used to keep the inverter batteries fully charged. The inverter equipment shall include all necessary control circuitry and devices to conform requirements like voltage regulation, current limiting, wave shaping, transient recovery, automatic synchronization etc. as given below.

1. The inverter shall utilize Insulated Gate Bipolar Transistors (IGBT) or Intelligent Power Module (IPM) Transistors which shall provide intelligent features like the drive circuitry, over-current protection, over temperature protection, control power failure protection and short circuit protection.

2. The IGBT / IPM transistors shall enable high speed switching of 6 Khz thus reducing the heat dissipation in the panel and thereby providing high efficiency.

## 2.18.2 SUMMARY

A. Scope of work: Design, Manufacture, Assembly, Inspection, Testing at Manufacturer's Works, Delivery to Site, Installation and Commissioning of the Static Inverter, complete as specified in the schedule of requirement meeting the intents of the Tender. This specification shall be used in conjunction with all drawings, Schedule of requirement and BOQ attached.

B. Start-up, commissioning and maintenance spares: The Inverter/UPS Vendor shall consider Network connectivity card with the Inverter, which can be used, for remote monitoring. Provision shall be made for Serial Link Communication with BMS, and also LAN connectivity. Vendor shall clearly indicate in the offer, requirement of software package, if any, for the above purpose.

C. Rating & Quantities: As per BOQ

D. Equipment to be Supplied:
1. Dry battery with back up of **30/15 minutes as per drawings/SLD** on full load
2. Static Inverter
3. Interconnecting (Copper) power and control cables between vendors supplied equipment.
4. Battery monitoring.
5. Load rating at 100% of system rating. Battery backup should be 120% of the rated load.

The equipment shall comply with the technical specification and guaranteed technical particulars specified herein. Any deviations to the specification shall be indicated clearly clause by clause.

E. Equipment meeting the requirements of IEC/ANSI or any other internationally recognised standard which ensure a quality equal to or better than as per the standards indicated below shall also be acceptable. When the equipment conforms to any other standards, salient points of difference between the standards adopted and those prescribed in this specification shall be clearly brought out in the tender and a copy of the applicable standards(s) in English language shall also be enclosed by the supplier with the tender.

| | |
|---|---|
| EN 62040-1 | General and safety requirements for UPS used in operator access areas |
| EN 62040-2 | Electromagnetic compatibility requirements (EMC) |
| EN 62040-3 | Performance requirements and test methods. |

## 2.18.3 SUBMITTALS

A. Product Data: Include rated nameplate data, capacities, weights, dimensions, minimum clearances, installed devices and features. Danger/Warning labels shall have white lettering on a red background and shall be in English, Hindi. All other labels shall have black lettering on a white background. All labels shall be fixed by screws or rivets.

B. Shop Drawings: General Arrangement drawings with Dimensioned plans, elevations, sections, and details, including required clearances and service space around equipment BOM. Show method of field assembly and location and size of each field connection. Include the following:
   1. Tabulation of installed devices with features and ratings.
   2. Technical Details: Voltage, KVA, and, efficiency at 25 percent, 50 percent, 75 percent and 100 percent rated loads.
   3. Outline and general arrangement drawing showing dimensions, shipping sections, and weights of each assembled section.
   4. Drawing of cable termination compartments showing preferred locations for conduits and indicating space available for cable terminations.
   5. Floor plan / elevation drawings showing locations for anchor bolts [**and levelling channels**].
   6. Current ratings of buses.
   7. Short-time and short-circuit ratings of switchgear assembly.
   8. Nameplate legends.
   9. Mimic-bus diagram.
   10. Wiring Diagrams: For each type of equipment, include the following:
      a) Power, signal, and control wiring.
      b) Three-line diagrams of current and future secondary circuits showing device terminal numbers and internal diagrams.
      c) Schematic control diagrams.
      d) Diagrams showing connections of component devices and equipment.
      e) Schematic diagrams showing connections to remote devices.

C. Documents shall comprise but not limited to the following :

   1. Indicates that the document to be submitted as per the Lodha approved material submission schedule.
   2. Indicates that the document to be submitted after successful testing and commissioning of the integrated system before handing over of the system.

| Sr. No. | Engineering Data | Reqd With Bid | Required after Purchase Order | | | |
|---|---|---|---|---|---|---|
| | | | For approval | | As built | |
| | | | Qty | Schedule Days | Qty | Schedule Days |
| 1 | Outline dimension drawing (required PO/ Contract issuance) | yes | 4 | A | 6 | B |
| 2 | Battery sizing and heat dissipation calculations(required PO/ Contract issuance) | yes | 4 | A | 6 | B |
| 3 | Cross sections with part description(required PO/ Contract issuance) | yes | 4 | A | 6 | B |
| 4 | Completed Data Sheets(required PO/ Contract issuance) | yes | | | | |
| 5 | Bill of Materials for scope of Supply(required PO/ Contract issuance) | yes | 4 | A | 6 | B |
| 6 | Installation / Operation / Maintenance Manual | | | | 4 | With dispatch |
| 7 | Priced Spare List for 2 years service | yes | | | | |
| 8 | Terminal point schedule / drawing | | 4 | A | 6 | B |

| | | | | | | |
|---|---|---|---|---|---|---|
| 9 | Description of Control Sequences | | 4 | A | 6 | B |
| 10 | Type test certificate for short circuit withstand for panel | | | | | At the time of inspection |
| 11 | Inspection Test Reports | | 4 | A | 6 | At the time of inspection |
| 12 | Test Certificates for bought out items (Battery, Meter, Relay, etc.) | | | | 6 | |

D. Manufacturer Seismic Qualification Certification: Submit certification that inverter, accessories, and components will withstand seismic forces. " Include the following:

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
    a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."
    b. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."
2. Dimensioned Outline Drawings of Equipment Unit: Identify centre of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

E. Manufacturer Certificates: For each product, from manufacturer.
F. Factory Test Reports: Comply with specified requirements.
G. Qualification Data: For testing agency / power quality specialist.
H. Field quality-control test reports.

## 2.18.4 QUALITY ASSURANCE

A. Regulatory Requirements: Comply with applicable requirements of the laws, codes, ordinances, and regulations of Country, State, and Municipal authorities having jurisdiction & applicable Standards.
B. Standards: The inverter and Accessories shall confirm to the requirement of latest revision of all relevant Indian Standards and also IEC Standards.
C. Power Quality Specialist Qualifications: A registered professional electrical engineer or engineering technician, currently certified by the National Institute for Certification in Engineering Technologies, NICET Level 4, minimum, experienced in performance testing Inverter installations and in performing power quality surveys similar to that required in "Performance Testing" Article.
D. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing in accordance with IEC/IS/and BS codes and is acceptable to authorities having jurisdiction.
E. Electrical Components, Devices, and Accessories: Listed and labeled as per INDIAN NEC 2011 and IS 732 1989 (reaffirmed 2005), by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

## 2.18.5 INSPECTION & TESTING AT MANUFACTURER PREMISES

A. The Contractor shall provide test certificates with as per the approved material submission schedule each design and rating of switchgear for Type and Routine tests carried out on the switchgear. Tests shall be those listed in the relevant standards. The routine tests shall be for the precise configuration proposed, including any adapter units between inverter, battery and the switchgear.
B. The Contractor shall provide type test certificates for all ratings of Current transformers, Voltage transformers, relays, meters and other auxiliary equipment used in the switchgear.
C. The Lodha Representative reserves the right to witness the following tests:-
    1. Factory acceptance tests including Routine tests on all as specified in the relevant standards.
    2. Operational (electrical and mechanical) tests on all components.
    3. Functional discharge and duration testing.
    4. Recharge time.
D. The Contractor shall give two weeks' notice of tests prior to commencement.
E. The Lodha Representative reserves the right to inspect equipment at the Manufacturer's works at any time prior to despatch to prove compliance with this specification.

F. The Lodha Representative shall also have the right to carry out intermediate inspection at Seller's works during manufacturing stage.
G. All the travelling & accommodation expenses towards the Inspection or witnessing the testing of equipment by the Lodha Representative will be in Contractors scope.

## 2.18.6 MANUFACTURERS

A. Approved Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to those listed in Section G.
B. Electronic Equipment: Devices shall include, rectifier, inverter, booster, automatic bypass and system controls.
C. Enclosures: Comply with NEMA 250, Type 1, unless otherwise indicated.
D. Control Assemblies: Mount on modular plug-ins, readily accessible for maintenance.

## 2.18.7 CONSTRUCTION

### 2.18.7.1 INVERTER SYSTEM

**A. PARTICULARS**

- Rated system voltage : 415 V
- Input voltage of inverter : 415V, 3 phase, 4 wire
- Rated Frequency : 50 Hz
- Input Voltage Variation : +/- 10%
- Input Frequency Variation : +/- 3%
- Combined Input voltage and Frequency variation : +/- 10%
- Output Voltage of Inverter : 415V, 3 phase, 4 wire
- Output Voltage Variation : +/- 10%

**B. OPERATIONAL REQUIREMENT**

1. Normal Conditions: Load is supplied with power flowing from the normal power input terminals, through the rectifier-charger and inverter, with the battery connected in parallel with the rectifier-charger output.
2. If normal power fails, energy supplied by the battery through the inverter continues supply to the load without switching or disturbance.
3. When power is restored at the normal supply terminals of the system, the rectifier-charger then supplies power to the load through the inverter and simultaneously recharges the battery.
4. If the battery becomes discharged and normal supply is available, the rectifier-charger charges the battery.

**C. PERFORMANCE REQUIREMENT**

.

Minimum Duration of Supply: If battery is sole energy source supplying rated full load current at 80 percent power factor, duration of supply is **15/30 minutes as per SLD.**

**D. RECTIFIER/BATTERY CHARGER**

1. A, solid-state, full-wave bridge rectifier shall convert the incoming AC power to regulated DC voltage, which shall be subsequently filtered to provide power for the inverter and battery charging functions. The rectifier/battery charger shall have sufficient capacity to support a fully loaded inverter and recharge the battery to 95% of its full capacity within 10 times the discharge time. The rectifier/battery charger assembly shall be constructed of modular plug-ins to facilitate maintenance.
2. Input Protection: The rectifier/battery charger shall be protected by means of an AC input circuit breaker. The SCRs shall be protected by semiconductor grade fuses. Overloads in excess of the rectifier/battery charger's normal rating or sensing of an abnormally high DC voltage condition shall cause the AC input circuit breaker to be shunt tripped open.
3. Input Current Limiting: Input current limit shall be set at 150% of nominal input current. A programmable second step input current limit, allowing a further limit of the input current, shall be activated by a dry contact input.
4. Battery Charge Current Limiting: Maximum recharge current shall be limited to 10% of maximum DC discharge current or as recommended by the battery manufacturer.
5. Operating Modes:
    1. **Automatic Charge Sequence:** The rectifier/battery charger shall automatically charge the batteries at an elevated voltage after an outage of a set (selectable between 0-255 seconds) duration.
    2. **Float Service**: Nominal DC bus voltage (programmable) provided under nominal operating conditions.
    3. **Manual Charge Service**: The rectifier/battery charger output voltage shall be selectable to a voltage slightly higher than the normal float voltage setting, normally the maximum float voltage setting specified by the battery manufacturer.
    4. **Equalize/Commissioning Service**: A high charge rate of DC voltage capable of being set at 2.5 volts per cell at a user selected time period.

## E. STATIC INVERTER

1. The inverter assembly shall be constructed of modular rack out assemblies to facilitate maintenance. In case of short circuit at the downstream of inverter, built in current limit control shall suppress the short circuit current within pre-set limits without any dip in the output voltage so that other loads remain unaffected.
2. Inverter shall have provision of line drop compensation to ensure availability of adequate voltage at the load after due compensation for drop in voltage in power cables.
3. Inverter shall have fast transient response to load variation such that the output voltage is maintained within limits.
4. The static inverter shall be of solid state type using proven Pulse Width Modulation (PWM) technique. The inverter shall be used to feed all emergency load like light fittings etc. in case of power failure and hence when normal supply is available these loads will be directly fed from normal source.
5. This normal power source shall also be used to keep the inverter batteries fully charged. The inverter equipment shall include all necessary control circuitry and devices to conform requirements like voltage regulation, current limiting, wave shaping, transient recovery, automatic synchronization etc.
6. The inverter shall utilize Insulated Gate Bipolar Transistors (IGBT) or Intelligent Power Module (IPM) Transistors which shall provide intelligent features like the drive circuitry, over-current protection, over temperature protection, control power failure protection and short circuit protection.
7. The IGBT / IPM transistors shall enable high speed switching of 6 Khz thus reducing the heat dissipation in the panel and thereby providing high efficiency.

## F. VOLTAGE REGULATION

1. The inverter output voltage shall not deviate by more than + 5% RMS due to the following steady state conditions :

    i. From 0 to 100% loading
    ii. Inverter DC input voltage varies from maximum to minimum.
    iii. Environmental conditions variations within the limitations set in the specification.

## G. FREQUENCY CONTROL

1. The inverter output frequency shall be controlled by an oscillator. The oscillator, while running asynchronously, shall maintain the frequency as 50 Hz + 0.01% (or + 0.005 Hz).

2. The inverter output frequency shall not vary during steady state or transient operation due to the following conditions:
   i. From 0 to 100% loading.
   ii. Inverter DC input varies from maximum to minimum.
   iii. Environmental condition variations within the limitations set out in the contract documents.

## H. OUTPUT VOLTAGE HARMONIC DISTORTION

1. The inverter output shall limit the amount of harmonic content to the values stated below.

### i. OUTPUT OVERLOAD CAPABILITY

The inverter output shall be capable of providing an overload current while maintaining rated output voltage. An LED indicator shall be located on the control panel to identify this condition. If the time limit associated with the overload condition expires or the overload is in excess of the set current amplitude, the load shall be transferred to the bypass source without interruption.

### ii. INVERTER CURRENT LIMIT

The inverter output shall be limited to 120% of rated load current. The two sensing locations shall operate separately and independently thus providing redundancy and, in the event of a failure, preventing unnecessary damage to power transistor components / fuses. Load current above 120% shall cause an immediate transfer of the load to the bypass source for fault clearing.

### iii. INVERTER OVERLOAD PROTECTION

1. The AC output from the inverter shall utilize fuses for overload protection. The inverter shall utilize a contactor to isolate the inverter output from the critical bus.
2. The inverter fuses shall be the fast acting semiconductor type.

3. The inverter shall meet the following specifications in addition to other requirements stated herein:

| | | | |
|---|---|---|---|
| | Voltage Input | : | 415 V + 5% AC 3 Phase, 4 Wire |
| | Nominal Voltage Output | : | 415 V + 5% AC 3 Phase, 4 Wire |
| | Inverter Capacity | : | As Shown in the drawings |
| | | | |
| | Wave form | | |
| | | | |
| | a. Normal frequency | : | 50 Hz |
| | b. Frequency regulation for all conditions of input supplies, loads and temperature occurring simultaneously or in any combination (automatically controlled) | : | + 0.01% |
| | Total voltage harmonic distortion | : | < 3% THD for 100% linear load<br>< 5% THD for 100% non-linear load |

| | | | |
|---|---|---|---|
| | Duty | : | Continuous |
| | Cooling | : | Natural |
| | Ambient operating temperature range | : | 0 to 40deg.C maximum continuous. |
| | Operating relative humidity | : | 0-95% non-condensing. |
| | Operating altitude. | : | Sea level to 1000 meters. |
| | Output | : | Suitable terminals are provided for termination of cables for connecting inverter output to AC distribution board. |

### 2.18.7.2 UPS SYSTEM

### A. PARTICULARS

- Rated system voltage : 415 V
- Input voltage of inverter : 415V, 3 phase, 4 wire
- Rated Frequency : 50 Hz
- Power factor : 0.9
- Input Voltage Variation : +/- 10%
- Input Frequency Variation : +/- 3%
- Combined Input voltage and Frequency variation : +/- 10%
- Output Voltage of Inverter : 415V, 3 phase, 4 wire
- Output Voltage variation : +/- 10%
- Topology : On Line Double Conversion VFI;
- Technology : Hi frequency PWM;

### B. OPERATIONAL REQUIREMENT

1. Normal Conditions: Load is supplied with power flowing from the normal power input terminals, through the rectifier-charger and inverter, with the battery connected in parallel with the rectifier-charger output.
2. If normal power fails, energy supplied by the battery through the inverter continues supply to the load without switching or disturbance.
3. When power is restored at the normal supply terminals of the system, the rectifier-charger then supplies power to the load through the inverter and simultaneously recharges the battery.
4. If the battery becomes discharged and normal supply is available, the rectifier-charger charges the battery.

### C. PERFORMANCE REQUIREMENT

.

Minimum Duration of Supply: If battery is sole energy source supplying rated full load current at 80 percent power factor, duration of supply is **15minutes as per SLD.**

D. Topology:- On Line Double Conversion VFI

The Topology of the UPS must be VFI (Voltage and Frequency Independent accordingly with classification mentioned in the EN- IEC62040-3 Standard), in order to guarantee filtered and stable output voltage to the load, independently from the input voltage. This means that the output is obtained by two converters in cascade. The first converter rectifies the AC input voltage, the second converter (Inverter) transforms the DC voltage, coming from the rectifier, in AC voltage to supply the load. This double conversion allows to completely clean eventual disturbs from the mains. In case of anomalies in the input voltage, the DC voltage, which supply the Inverter, can be obtained, thought a booster circuit, from batteries. In this way the output is always guaranteed with continuity. In case of overloads or faults, the automatic static by-pass guarantees the load supply.

**E.** Modularity

The UPS must have modular architectures based on identical power modules which can be interchanged and connected in parallel, inside the UPS cabinet. Similarly also batteries must be contained in battery modules (Battery drawers) identical and interchangeable, to be installed in the system in series and parallel in order to obtain the correct battery voltage and required back up time. It will be not accepted a system where one or more modules are kept in stand by just as spare to be used only in case of another module failure. Power modules will be equipped with control and self-diagnostic circuits, in order to easily individuate the faulty module and the specific failure inside it. Each Battery drawer will contain 5 batteries with nominal 12Vdc, connected in order to have two strings, one with 24Vdc (two batteries) and the other one with 36Vdc (three batteries). In this when battery drawer is removed from the cabinet there are no dangerous voltage for the user (dangerous DC voltage are bigger than 50V as indicated in the EN60950 standard). Either Power Modules or Battery drawers must be lighter than 15kg in order to be managed, in service and maintenance, by only one person.

F. Scalability

The modularity of the UPS must allow to increase the back-up time on site, simply adding battery drawers. The upgrade will not require factory modifications and will not need dedicated special tools.

**G.** POWER MODULE

Each Power Module will be composed by following functional blocks:

1. Rectifier/PFC
2. Inverter
3. Booster
4. Battery Charger
5. Automatic Bypass

## H. RECTIFIER/BATTERY CHARGER

The rectifier must include a control and regulating circuit (PFC), which in addition to normal rectifying functions will allow the:

1. Automatic correction of the power factor to the at value >0,99 (since from the 50% of the nominal load);
2. Reduce the Harmonic distortion of the input current obtaining THDIin = 3% with nominal load

## I. INVERTER

The inverter must be based on a switching IGBT circuit with High Frequency PWM, and must be able to transform the DC supply, coming from rectifier/PFC or buster, in case of battery run, in AC voltage. Furthermore must be present also control circuits which guarantee:

1. Arrest and protection of the inverter in case of strong and long overloads;
2. Keep the harmonic distortion of the output voltage less than 1% (THDuout < 1%) either in normal run than in battery run;
3. Arrest and protect the inverter in case of over temperature of power converters elements; Manage the speed of the Fans accordingly with internal temperature and applied load;

## J. VOLTAGE REGULATION

The “booster” must transform the battery DC voltage from the nominal value of 240 Vdc, to the dual, positive and negative buses, with middle point referred to the passing through neutral. From the positive bus the inverter will obtain the positive half period of the output voltage sine wave, from the negative bus the inverter will obtain the negative half period of the output voltage sine wave. Protection circuits must be present on the booster to protect the booster circuit in case of overload.

## K. BATTERY CHARGER

The Battery Charger must be equipped with control and regulation circuit both for charging voltage and current to batteries, in order to have a controller battery charge and optimize the battery life. The UPS must charge batteries with and early boost charge followed by a constant charge and, at the end, with a floating charge. During normal run the UPS will execute periodically a battery equalizing in order to recover natural charge leakages and keep al batteries at the same capacity. This battery charging cycle will increase the batteries life time over the expected five years, with relevant reduction of the maintenance costs. The battery recharge must be available also when UPS is turned off.

## L. AUTOMATIC BYPASS

The Automatic bypass must be composed by following parts:

1. Static switch with zero time for intervention, connected in parallel with an electro-mechanic switch which needs a transfer time but with zero heat dissipation among the time;
2. Microprocessor Logic command and control which will attend to:
3. Automatically transfer the load to the mains, as soon as following anomalous events occur: overload, over temperature, voltage runaway on the DC buses, anomalies on the inverter;
4. Automatically transfer back the load from the mains to the inverter as soon the anomalous event expires; automatically disable the bypass function in case of output voltage and Mains are not synchronized.

### 2.18.7.3 BATTERY FOR UPS AND INVERTOR SYSTEM

A. Batteries shall be DRY type.
B. Batteries shall be sized to match Inverter requirement, lasting for 15/30 minutes with rated output at 0.8 PF lagging.
C. Batteries shall be installed along with the Inverter near Emergency DBs in Electrical rooms. All battery terminals shall have caps in order to prevent contact with live point.
D. Vendor shall include all the accessories, battery racks, tools and tackles required for commissioning, maintenance of batteries in the offer.
E. Battery Voltage & AH capacity: Battery bank voltage to be decided by the Supplier based on his design. For AH calculations, a factor of 1.25 shall be considered for aging and a factor of 1.1 for design margin.
F. DC Cutoff Voltage: Maximum 1.75V per cell
G. DC Ripple: Maximum 1% of DC voltage
H. A battery management system shall be provided in the inverter for online testing of the batteries.

### 2.18.7.4 MONITORING BY REMOTE COMPUTER

A. Description: Communication module in unit control panel provides capability for remote monitoring of status, parameters, and alarms specified in "Controls and Indications" Article. The remote computer and the connecting signal wiring are not included in this Section. Include the following features:
    1. Connectors and network interface units or modems for data transmission via RS-232 link.
    2. Software designed for control and monitoring of Inverter functions and to provide on-screen explanations, interpretations, diagnosis, action guidance, and instructions for use of monitoring indications and development of meaningful reports. Permit storage and analysis of power-line transient records. Designs for Windows applications, software, and computer are not included in this Section.

### 2.18.7.5 ADDITIONAL BATTERY MONITORING

A. Monitoring features and components shall include the following:
    1. Factory-wired sensing leads to cell and battery terminals and cell temperature sensors.
    2. Connections for data transmission via RS-232 link, [**network interface and**] [**modem and**] external signal wiring to [**computer**] [**electrical power monitoring and control equipment**]. External signal wiring and computer are not specified in this Section.
    3. PC-based software designed to store and analyze battery data. Software compiles reports on individual-cell parameters and total battery performance trends, and provides data for scheduling and prioritizing battery maintenance.
    4. Batteries shall be provided with a device capable of sensing any harmful fumes arising from Battery bank
B. Performance: Automatically measures and electronically records the following parameters on a routine schedule and during battery discharge events. During discharge events, records measurements timed to nearest second; includes measurements of the following parameters:
    1. Total battery voltage and ambient temperature.
    2. Individual-cell voltage, impedance, and temperature. During battery-discharging events such as utility outages, measures battery and cell voltages timed to nearest second.
    3. Individual-cell electrolyte levels.

## 2.18.8 EXECUTION

## 2.18.8.1 INSTALLATION

A. Install freestanding equipment as per site condition.

B. Examine areas and conditions, with Installer present, for compliance with requirements for conditions affecting performance of the Inverter.
C. Proceed with installation only after unsatisfactory conditions have been corrected.

## 2.18.8.2 EXAMINATION

A. Maintain minimum clearances and workspace at equipment according to manufacturer's written instructions, approved equipment layout and IS/IE Standards.
B. Connections: Interconnect system components. Make connections to supply and load a circuit according to manufacturer's wiring diagrams unless otherwise indicated.

## 2.18.8.3 FIELD QUALITY CONTROL

A. Testing Agency: A qualified testing agency to perform tests and inspections.
B. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.
C. Perform tests and inspections.
    - Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
D. Tests and Inspections:
    1. Comply with manufacturer's written instructions.
    2. Inspect interiors of enclosures, including the following:
        a) Integrity of mechanical and electrical connections.
        b) Component type and labeling verification.
        c) Ratings of installed components.
    3. Inspect batteries and chargers according to requirements in NETA Acceptance Testing Specifications.
    4. Test manual and automatic operational features and system protective and alarm functions.
    5. Test communication of status and alarms to remote monitoring equipment.
    6. Load the system using a variable-load bank to simulate kilovolt amperes, kilowatts, and power factor of loads for unit's rating. Use instruments calibrated within the previous [**six months**] according to NIST standards.
        a) Simulate malfunctions to verify protective device operation.
        b) Test duration of supply
        c) Test remote status and alarm panel functions.
        d) Test battery-monitoring system functions.

## 2.18.8.4 DEMONSTRATION

A. General: Manufacturer's factory-authorized service representative to train Owner's personnel in the operation of the UPS systems.
B. Equipment: Check operation of each unit with Owner's personnel present and before Substantial Completion. Determine that operational systems and devices are functioning properly.
C. Instruction: Instruct Owner's personnel in proper use, maintenance, adjustment, and repair of each system.

END OF SECTION- B 2.18