SECTION 26 33 35

~~~ PROJECT NOTE ~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
ARCHITECT OF RECORD/ENGINEER OF RECORD IS RESPONSIBLE FOR REVIEWING THIS SPECIFICATION SECTION IN DETAIL FOR COORDINATION WITH THE PROJECT SCOPE OF WORK.

ALL "PROJECT NOTE" TEXT IS TO BE REMOVED FOLLOWING REVIEW OF THE CONTENT OF EACH NOTE BY THE ARCHITECT OF RECORD/ENGINEER OF RECORD.

EDIT THE DOCUMENT FOOTER TO INCLUDE THE PROJECT NAME AND NUMBER.

EDIT THE DOCUMENT HEADER TO INDICATE THE ARCHITECT OF RECORD PROJECT ISSUE" DATE. THE "CPS CONTROL" DATE SHOULD NOT BE EDITED.

ANY MODIFICATIONS TO THE TECHNICAL STANDARDS IN THIS SECTION - INCLUDING THE REMOVAL OR ADDITION OF MANUFACTURERS - MUST BE APPROVED BY CPS.

REQUESTS FOR MODIFICATION ARE TO BE SUBMITTED TO THE DESIGN MANAGER DURING THE DESIGN PHASE FOR REVIEW AND APPROVAL.

~~~ END OF PROJECT NOTE ~~~~~~~~~~~~~~~~~~~~~~~~

CENTRAL BATTERY INVERTERS

PART 1 - GENERAL

1.01 SUMMARY

A. Section defines the electrical and mechanical characteristics and requirements for a continuous-duty solid-state central battery inverters (lighting inverters) for emergency service with the following features:
   1. Internal maintenance bypass/isolation switch.
   2. Remote monitoring provisions.

1.02 REFERENCE STANDARDS

A. City of Chicago Building Code - Municipal Code of Chicago for the Building Industry; 2017.

B. Chicago Electrical Code - Municipal Code of the City of Chicago, Building/Electrical Code Requirements; 2018.

C. ISO 9001 - Quality management systems -- Requirements; 2015.

D. NFPA 101 - Life Safety Code; 2017.

E. UL 924 - Emergency Lighting and Power Equipment; Current Edition, Including All Revisions.

1.03 DEFINITIONS

A. LCD: Liquid-crystal display.

B. LED: Light-emitting diode.

1.04 SUBMITTALS

A. Product Data: For the following:
   1. Electrical ratings, including the following:
      a. Capacity to provide power during failure of normal ac.
      b. Inverter voltage regulation and THD of output current.
      c. Rectifier data.
      d. Transfer time of transfer switch.
      e. Data for specified optional features.
   2. Transfer switch.
   3. Inverter.
   4. Battery charger.
   5. Batteries.
   6. Battery monitoring.
   7. Battery-cycle warranty monitor.

B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, components, heat dissipation and location and identification of each field connection. Show access, workspace, and clearance requirements; details of control panels; and battery arrangement.
   1. Power, signal, and control wiring diagrams.
   2. Detailed layouts of customer power and control connections.
   3. Detailed installation drawings including all terminal locations.
   4. Elevation and details of control and indication displays.

C. Qualification Data: For Installer.

D. Source quality-control test reports.

E. Factory Test Reports: Comply with specified requirements.

F. Field Quality-Control and Performance Test reports: Indicate test results compared with specified performance requirements, and provide justification and resolution of differences if values do not agree.

G. Operation and Maintenance Data: For central battery inverter equipment to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 01 78 00 - Closeout Submittals include the following:
   1. Lists of spare parts and replacement components recommended being stored at Project site for ready access.
   2. Intended operation narrative with detailed operating instructions covering operation under both normal and abnormal conditions.
   3. Tools Required.
   4. Recommended maintenance practices.
   5. Manufacturer service department contact information.
   6. Submittal Data

H. Warranty: Provide complete manufacturer's warranty information on all products provided.

1.05 QUALITY ASSURANCE

A. Installer Qualifications: Manufacturer’s authorized representative who is factory-trained and approved for both installation and maintenance of units required for this Project.

B. Manufacturer Qualifications: A minimum of twenty (20) years' experience in the design, manufacture, and testing of solid-state central battery inverter systems is required. The

manufacturer shall be ISO 9001 certified. Maintain, within 50 miles of Project site, a service center capable of providing training, parts, and emergency maintenance repairs with fours-hours maximum on-site service response time.

C. Manufacturer Service Qualifications:
   1. The lighting inverter manufacturer shall directly employ a nationwide service organization. The service personal shall be the manufacturers employees and consisting of factory trained field service personnel dedicated to the start-up, maintenance, and repair of lighting inverter and power equipment. Third party or non-manufacturer employees are not allowed. The organization shall consist of regional and local manufacturer offices. A minimum of 5 dedicated manufacturer field service employees trained in lighting inverter service shall be based within 50 miles of the site.
   2. The manufacturer shall provide a fully automated national dispatch center to coordinate field service personnel schedules. One toll-free number shall reach a qualified support person 24hours/day, 7days/week, and 365 days/year. If emergency service is required, response time shall be 20 minutes or less with 4 hours on site service response.
   3. An automated procedure shall be in place to insure that the manufacturer is dedicating the appropriate technical support resources to match escalating customer needs.
   4. Parts shall be available through an extensive network to ensure around-the-clock parts availability throughout the country.
   5. Recommended spare parts shall be fully stocked by local field service personnel with back-up available from national parts center and the manufacturing location. The national parts center Customer Support Parts Coordinators shall be on-call 24 hours/day, 7 days/week, and 365 days/year for immediate parts availability. Parts from the national parts center shall be shipped within 4 hours on the next available flight out and delivered to the customer's site within 24 hours.

D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in the City of Chicago Electrical Code by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

E. Central Battery Inverter System (Lighting Inverter): UL 924.

F. Comply with NFPA 101.

G. Comply with the Chicago Electrical Code.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Deliver equipment in fully enclosed vehicles after specified environmental conditions have been permanently established in spaces where equipment is to be placed.

B. Store equipment in spaces having environments controlled within manufacturers' written instructions for ambient temperature and humidity conditions for non-operating equipment.

1.07 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents. Deliver extra materials to Board.
   1. Fuses: One (1) for every ten (10) of each type and rating, but no less than one (1) of each.
   2. Cabinet Ventilation Filters: One (1) complete set.

1.08 WARRANTY

A. Lighting Inverter Warranties: The lighting inverter manufacturer shall warrant the Uninterruptible power supply (UPS) module against defects in materials and workmanship for 12-months after initial start-up or 18-months after ship date, whichever period expires first.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following manufacturers:
   1. Lighting Inverter
      a. Liebert Corporation, an Emerson Electric company; www.emerson.com.
      b. Chloride Systems, a Philips company; www.lightingproducts.philips.com.
      c. Cooper Industries, Inc., an Eaton Corporation; www.cooperindustries.com.
   2. Battery
      a. C&D Technologies; www.cdtechno.com.
      b. Enersys Data Safe; www.enersys.com.
      c. GNB Absolyte IIP; www.gnb-network-power.com.

2.02 LIGHTING INVERTER PERFORMANCE DESCRIPTION

A. Lighting Inverter Modes of Operation: The lighting inverter shall be designed to operate as an on-line, double-conversion, reverse-transfer system in the following modes:
   1. Automatic Operation:
      a. Normal Conditions: Supply the load with ac power flowing from normal ac power input terminals, through rectifier-charger and inverter, with battery connected in parallel with rectifier-charger output.
      b. Abnormal Supply Conditions: If normal ac supply deviates from specified and adjustable voltage, voltage waveform, or frequency limits, battery supplies constant, regulated, inverter ac power output to the load without switching or disturbance.
      c. Emergency Conditions: If normal power fails, battery continues supply regulated ac power through the inverter to the load without switching or disturbance. When power is restored at normal supply terminals of system, controls automatically synchronize inverter with the external source before transferring the load. Rectifier-charger then supplies power to the load through the inverter and simultaneously recharges battery. There shall be no interruption in power to the critical load upon failure or restoration of the utility AC source.
      d. Recharge: If the battery becomes discharged and normal supply is available, the rectifier-charger charges battery. When battery is fully charged, the rectifier-charger automatically shifts to float-charge mode.
      e. Bypass: If any element of lighting inverter system fails, the lighting inverter is taken out of service for maintenance or repair, or the inverter overload capacity is exceeded and power is available at normal supply terminals of system, static bypass transfer switch transfers the load to normal ac supply circuit without disturbance or interruption of supply.
      f. Fault: If a fault occurs in the system supplied by the lighting inverter and current flows in excess of the overload rating of lighting inverter system, static bypass transfer switch operates to bypass fault current to normal ac supply circuit for fault clearing. When fault has cleared, the static bypass transfer switch returns the load to the lighting inverter system.
      g. If battery is disconnected, lighting inverter continues to supply power to the load with no degradation of its regulation of voltage and frequency of output bus.

2. Manual Operation:
   a. Turning the lighting inverter off causes static bypass transfer switch to transfer the load directly to normal ac supply circuit without disturbance or interruption.
   b. Turning the lighting inverter on causes static bypass transfer switch to transfer the load to the inverter.

B. Maximum Acoustical Noise: Noise generated by the lighting inverter under any condition of normal operation shall not exceed 65 dBA measured 3-feet from the surface of the lighting inverter.

2.03 SERVICE CONDITIONS

A. Environmental Conditions: The lighting inverter system shall be capable of operating continuously in the following environmental conditions without mechanical or electrical damage or degradation of operating capability:
1. Lighting Inverter Module Operating Ambient Temperature: 32 to 104 deg F.
2. Battery Operating Ambient Temperature: 77 +/-9 deg F.
3. Lighting Inverter Module Storage/Transport Ambient Temperature: -4 to 158 deg F.
4. Battery Module Storage/Transport Ambient Temperature: -4 to 92 deg F.
5. Relative Humidity: 0 to 95 percent, noncondensing.
6. Operating Altitude: Mean Sea Level to 6600 feet above Mean Sea Level.
7. Storage/Transport Altitude: Mean Sea Level to 40000 feet above Mean Sea Level.

2.04 SYSTEM DESIGN REQUIREMENTS

A. Lighting Inverter Voltage: Input/Output and bypass voltage of the lighting inverter shall be as shown on the drawings.

B. Lighting Inverter Output Load Capacity: Specified output load capacity of the lighting inverter shall be as shown on the drawings and shall have a 0.8 lagging power factor.

C. Battery Cells: Sealed, lead-acid, valve-regulated.

2.05 EDIT BATTERY RESERVE TIME PER PROJECT REQUIREMENTS

A. Battery Reserve Time: The reserve time shall be 90 minutes or 4 hours as required by the Chicago Electrical Code and based on full load, 0.8 power factor, with ambient temperature between 68 and 86 deg F.

B. Battery Recharge Time: Recharge to 100% capacity within twenty four hours.

2.06 PERFORMANCE REQUIREMENTS

A. AC Input Voltage Range: -20 percent to +10 percent of normal.

B. AC Input Frequency: Nominal frequency +/-5 percent.

C. AC Input Power Factor: 0.90 to 0.96 lagging at nominal input voltage and full rated output load with input filter.

D. Input Inrush Current: 800 percent of full load current maximum.

E. Input Current Limit: 115 percent of nominal AC input current maximum.

F. Input Current Walk-In: 10 seconds to full rated input current maximum. Field selectable 5 through 20 seconds.

G. Input Current Distortion: 10 percent reflected THD maximum at full load when fitted with input filter.

H. Output Voltage Regulation: Automatically regulate output voltage to within plus or minus 5 percent.

I. Output Frequency: Nominal frequency +/-0.1 percent from no load to full load at unit power factor over the operating range of battery voltage.

J. Output Frequency Slew Rate: 5.0 Hertz per second maximum. Field selectable from 0.1 to 5.0 Hz per second.

K. Output Phase Displacement:
1. +/- 0.5 degree for balanced load.
2. +/- 1.0 degrees for 100 percent unbalanced load.

L. Output Bypass Line Sync Range:
1. +/- 0.5 Hertz.
2. Field Selectable +/-0.5 to 5.0 Hertz.

M. Output Voltage Distortion:
1. 1 percent THD for linear loads.
2. 2.5 percent THD for 100 percent nonlinear loads (3:1 crest factor) without kVA/kW derating.

N. Load Power Factor Range: 1.0 to 0.7 lagging without derating.

O. Output Power Rating: Rated kVA at 0.8 lagging power factor.

P. Overload Capability:
1. 125 percent for ten minutes (without bypass source).
2. 150 percent for one minute (without bypass source).
3. 200 percent for 10 cycles, pulse paralleling with the static switch.

Q. Brownout Protection: Produces rated power without draining batteries when input voltage is down to 75 percent of normal.

R. Inverter Output Voltage Adjustment: +/-5 percent manual adjustment

S. Voltage Transient Response:
1. 100 percent load step: Plus or minus 2.5 percent.
2. Loss or return of AC input power: Plus or minus 1 percent.
3. Manual transfer of 100 percent load: Plus or minus 3 percent.

T. Transient Recovery Time: to within 1% of output voltage within one cycle.

U. Voltage Unbalance: 100 percent unbalanced load +/- 1 percent.

V. Fault Clearing: Sub-cycle current of at least 300 percent.

2.07 LIGHTING INVERTER SYSTEM

A. General:
1. All materials of the lighting inverter shall be new, of current manufacture, high grade and free form all defects and shall not have been in prior service except as required during factory testing.
2. The maximum working voltage, current, and di/dt of all solid-state power components and electronic devices shall not exceed 75 percent of the ratings established by their manufacturer.
3. The operating temperature of solid-state component sub-assembly shall not be greater than 75 percent of their ratings.
4. Electrolytic capacitors shall be computer grade and be operated at no more than 95 percent of their voltage rating at the maximum rectifier charging voltage.
5. Wiring practices, materials and coding shall be in accordance with the requirements of the Chicago Electrical Code.
6. All bolted connections of bus bars, lugs and cables shall be in accordance with requirements of the Chicago Electrical Code.
7. All electrical power connections are to be torqued to the required value and marked with a visual indicator.
8. Provision shall be made for power cables to enter or leave from the top or bottom of the lighting inverter cabinet.

B. Surge Protection: Sustains input surges without damage per criteria listed in ANSI C62.41 Category A and B.

C. Cooling: Cooling of the lighting inverter shall be by forced air. Low-velocity fans shall be used to minimize audible noise output. Fan power shall be provided by the lighting inverter output. The thermal design, along with all thermal and ambient sensors, shall be coordinated with the protective devices before excessive component or internal cabinet temperatures are exceeded.

D. Grounding: The AC output neutral shall be electrically isolated from the lighting inverter chassis. The chassis shall have an equipment ground terminal. Provisions for local bonding shall be provided.

2.08 INPUT TRANSFORMER

A. When required, the input transformer shall be factory installed inside the lighting inverter module cabinet without increasing the standard footprint.

2.09 RECTIFIER-CHARGER

A. The term rectifier/charger shall denote the solid-state equipment and controls necessary to convert incoming AC power to regulated DC power for input to the inverter and for battery charging. The rectifier/charger shall be a phase-controlled, solid-state SCR type with constant voltage/current limiting control circuitry.

B. AC Input Current Limiting: The rectifier/charger unit shall be provided with AC input current limiting whereby the maximum input current shall be limited to 115 percent of the full input current rating. The rectifier/charger shall operate at a reduced current limit mode whenever the critical load is powered from the lighting inverter static bypass circuit such that the maximum lighting inverter input current will not exceed 115 percent of full load input current. In addition, the rectifier/charger shall have a separate battery current limit, adjustable from 0 to 15 percent of the full load input current. An optional second circuit shall limit the battery recharge current to zero when activated by a customer-supplied contact closure to signal a customer function such as generator operation.

C. Input Current Walk-In: The rectifier/charger shall contain a timed walk-in circuit that causes the unit to gradually assume the load over a 10-second time interval after input voltage is applied. Walk-in time shall be field selectable for 5 through 20 seconds.

D. Fuse Failure Protection: Power semiconductors in the rectifier/charger shall be fused with fast-acting fuses, so that loss of any one power semiconductor shall not cause cascading failures.

E. DC Filter: The rectifier/charger shall have an output filter to minimize ripple voltage into the battery. Under no conditions shall ripple voltage into the battery exceed 1 percent RMS. The filter shall be adequate to insure that the DC output of the rectifier/charger will meet the input requirements of the inverter. The inverter shall be able to operate from the rectifier/charger with the battery disconnected.

F. Automatic Rectifier Restart: Upon restoration of utility AC power, after a utility AC power outage and prior to an automatic end-of-discharge shutdown, the rectifier/charger shall automatically restart, walk-in, and gradually assume the inverter and battery recharge loads.

G. Battery Recharge: In addition to supplying power for the inverter load, the rectifier/charger shall be capable of producing battery charging current sufficient to replace 100 percent of the battery discharge power within 24 hours. After the battery is recharged, the rectifier/charger shall maintain the battery at full charge until the next emergency operation.

H. Over-voltage Protection: There shall be DC over-voltage protection so that if the DC voltage rises to the pre-set limit, the lighting inverter is to shut down automatically and initiate an uninterrupted load transfer to the static bypass line.

I. Input Filter: The rectifier/charger shall include an input filter to reduce reflected input current distortion to 10% THD at full load with nominal input voltage. The input filter shall maintain the input power factor at 0.90 to 0.96 lagging minimum from full load to half load with nominal input voltage. The input filter shall have a disconnect that automatically disconnects the filter under low load conditions.

2.10 INVERTER

A. Description: The term inverter shall denote the solid-state equipment and controls to convert DC power from the rectifier/charger or battery to regulated AC power for supporting the critical load. The inverter shall use Insulated Gate Bipolar Transistors (IGBTs) in a phase-controlled, pulse width modulated (PWM) design capable of providing the specified AC output.

B. Overload Capability: The inverter shall be capable of supplying current and voltage for overloads exceeding 100 percent and up to 200 percent of full load current. A status indicator and audible alarm shall indicate overload operation. The lighting inverter shall transfer the load to bypass when overload capacity is exceeded.

C. Fault Clearing and Current Limit: The inverter shall be capable of supplying an overload current of 150 percent of its full-load rating for one minute. For greater currents or longer time duration, the inverter shall have electronic current-limiting protection to prevent damage to components. The critical load will be transferred to the static bypass automatically and uninterrupted. The inverter shall be self-protecting against any magnitude of connected output overload. Inverter control logic shall sense and disconnect the inverter from the critical AC load without the requirement to clear protective fuses.

D. Step Load Response: The output voltage shall be maintained to within plus or minus 2.5 percent with a 0-to-100 percent step load change or a 100-to-0 percent load change. The output voltage shall recover to within 1 percent of nominal voltage within 1 cycle.

E. Voltage Distortion: For linear loads, the output voltage total harmonic distortion (THD) shall not be greater than 1 percent. For 100 percent rated load of 3:1 crest factor nonlinear loads, the output voltage total harmonic distortion shall not be greater than 2.5 percent. The output rating is not to be derated in kVA or kW due to the 100 percent nonlinear load with 3:1 crest factor.

F. Output Power Transformer: Where necessary, a dry-type power transformer shall be provided for the inverter AC output. It shall have copper wiring exclusively. The transformers hottest spot winding temperature shall not exceed the temperature limit of the transformer insulation class of material when operating at full load at maximum ambient temperature.

G. Phase Balance: Electronic controls shall be provided to regulate each phase so that an unbalanced loading will not cause the output voltage to go outside the specified voltage unbalance or phase displacement. With 100 percent load on one phase and 0 percent load on the other 2 phases or 100 percent load on 2 phases and 0 percent load on the other phase, the voltage balance is to be within 1 percent and the phase displacement is to be 120 degrees within plus or minus 1 degree.

H. Fuse Failure Protection: Power semiconductors in the inverter unit shall be fused with fast-acting fuses, so that loss of any one power semiconductor will not cause cascading failures.

I. Inverter Shutdown: For rapid removal of the inverter from the critical load, the inverter control electronics shall instantaneously turn off the inverter transistors. Simultaneously, the static transfer switch shall be turned on to maintain continuous power to the critical load.

J. Inverter DC Protection: The inverter shall be protected by the following disconnect levels:
1. DC Over-voltage Shutdown.
2. DC Undervoltage Warning (Low Battery Reserve), user adjustable from 1 to 99 minutes.
3. DC Undervoltage Shutdown (End of Discharge).

K. Overdischarge Protection: To prevent battery damage from overdischarging, the lighting inverter control logic shall automatically raise the shutdown voltage set point as discharge time increases beyond fifteen (15) minutes.

L. Inverter Output Voltage Adjustment: The inverter shall use a software control to adjust the output voltage from plus or minus 5 percent of the nominal value.

M. Output Frequency: The output frequency of the inverter shall be controlled by an oscillator. The oscillator shall be temperature compensated and hold the inverter output frequency to plus or minus 0.1 percent for steady state and transient conditions. Drift shall not exceed 0.1 percent during a 24-hour period. Total frequency deviation, including short time fluctuation and drift, shall not exceed 0.1 percent from the rated frequency.

2.11 BATTERY CHARGER

A. Description: Solid-state, automatically maintaining batteries in fully charged condition when normal power is available. With LED indicators for "float" and "high-charge" modes.

2.12 BATTERIES

A. Description:
1. The battery power pack shall include sealed, lead-acid valve regulated battery cells housed in a separate cabinet that matches the lighting inverter cabinet styling to form an integral system line-up.
2. Battery cells shall be mounted on slide-out trays for ease of maintenance.

3. A battery disconnect circuit breaker with undervoltage release (UVR) shall be included for isolation of the battery pack from the lighting inverter module. The lighting inverter shall automatically be disconnected from the battery by opening the breaker when the battery reaches the minimum discharge voltage level.
4. Casters and leveling feet shall also be provided with the battery power pack cabinet for ease of installation.
5. When the application calls for the battery cabinet to be bolted to the lighting inverter cabinet, the interconnecting cables are to be provided, precut and prelugged.

2.13 ENCLOSURES

A. The lighting inverter unit, comprised of input transformer (if required), rectifier/charger with input filter, inverter, static transfer switch, output transformer and maintenance bypass switch, shall be housed in a single free-standing NEMA Type 1 enclosure, unless otherwise indicated.

B. Cabinet doors/covers shall require a tool for gaining access.

C. Casters and stops shall be provided for ease of installation.

D. Front access only shall be required for expedient servicing, adjustments, and installation.

E. The inverter cabinet shall be structurally adequate and have provisions for hoisting, jacking, and forklift handling.

F. The inverter cabinet shall be cleaned, primed, and painted with the manufacturer's standard color.

G. The lighting inverter shall be constructed of replaceable subassemblies. Like assemblies and like components shall be interchangeable.

2.14 CONTROL AND INDICATION

A. Description: The lighting inverter shall be provided with a microprocessor based unit status display and controls section designed for convenient and reliable user operation. A graphical display shall be used to show a single-line diagram of the lighting inverter, and shall be provided as part of the monitoring and controls sections of the lighting inverter. All of the operator controls and monitors shall be located on the front of the lighting inverter cabinet. The monitoring functions such as metering, status and alarms shall be displayed on the graphical LCD display. Additional features of the monitoring system shall include:
1. Menu-driven display with pushbutton navigation.
2. Real time clock (time and date).
3. Alarm history with time and date stamp.
4. Battery backed-up memory.

B. Minimum displays, indicating devices, and controls include those in lists below. Provide sensors, transducers, terminals, relays, and wiring required to support listed items.

C.

~~~ PROJECT NOTE ~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
EDIT THE FOLLOWING INDICATIONS PER PROJECT REQUIREMENTS

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D. Metering: The following parameters shall be displayed:
1. Input AC voltage for each phase, line-to-line.

2. Input AC current for each phase.
3. Input frequency.
4. Battery voltage.
5. Battery current and direction (charge/discharge).
6. DC bus voltage.
7. Output AC voltage line-to-line and line-to-neutral for each phase.
8. Output AC current for each phase.
9. Output frequency.
10. Percent of rated load being supplied by the lighting inverter.
11. Battery time left during battery operation.

E. Status Messages: The following lighting inverter status messages shall be displayed:
1. Normal operation.
2. On Static Bypass Transfer Switch.
3. Load on lighting inverter.
4. Load on bypass.
5. User Shutdown.
6. Battery Discharging.

F. Alarm Messages: The following alarm messages shall be displayed and an audible alarm shall be provided and activated by any of the following alarm conditions:
1. Input Line Fault.
2. Input Phase Rotation Error.
3. Input Over/Under Frequency.
4. Input Current Limit.
5. Rectifier Fail.
6. Battery Test Failed.
7. Battery Low Warning (Adjustable 1 to 99 Minutes).
8. Battery Low Transfer.
9. DC Overvoltage Steady State.
10. Bypass Frequency Error.
11. Load On Bypass.
12. Excessive Auto Retransfers.
13. Static Bypass Transfer Switch SCR Shorted.
14. Bypass Sync Error.
15. Input Phase Loss.
16. DC Current Peak.
17. Output Undervoltage Transfer.
18. Output Overvoltage Transfer.
19. Inverter Overload.
20. Static Bypass Transfer Switch Overload.
21. Inverter Overload Transfer.
22. Transfer Failed Shutdown.
23. Hardware Shutdown.
24. Output Power Supply Fail.
25. Inverter Control Fault Transfer.
26. System Fan Fail.
27. Ambient Overtemperature Limit.
28. Overtemperature Timeout Shutdown.

G. Controls: Lighting inverter start-up, shutdown, and bypass operations shall be accomplished through the front-panel pushbutton controls. Menu-driven user prompts shall be provided to guide the operator through system operation without the use of additional manuals. Pushbuttons shall be provided to display the status of the lighting inverter and to test and reset visual and audible alarms. A mimic screen shall be available on the LCD screen to depict a

single-line diagram of the lighting inverter, with switch positions and power flow. Pushbuttons shall include the following:

1. Inverter on-off.
2. Lighting inverter start.
3. Battery test.
4. Alarm silence/reset.
5. Output-voltage adjustment.

H. Programmable Relay Board: Eight sets of isolated Form C contacts shall be provided to indicate a change of status of any of the alarm conditions. Any of the lighting inverter alarms can be programmed onto any channel of the programmable relay board.

I. On-Line Battery Test:
1. The lighting inverter shall be provided with a menu-driven On-Line Battery Test Feature. The test shall ensure the capability of the battery to supply power to the inverter while the load is supplied power in the normal mode. If the battery fails the test, the system shall automatically do the following:
   a. Maintain the load through the lighting inverter.
   b. Display a warning message.
   c. Sound an audible alarm.
2. The battery test feature shall have the following user selectable options:
   a. Interval between tests (2 to 9 weeks).
   b. Date and time of initial test.
   c. Enable/disable test.
3. Advanced Battery Monitoring: Reference Section 26 09 11 - Battery Monitoring for advanced battery monitoring requirements.

2.15 STATIC BYPASS TRANSFER SWITCH

A. General:
1. A static transfer switch and bypass circuit shall be provided as an integral part of the lighting inverter. The static switch shall be a naturally commutated high-speed static (SCR-type) device rated to conduct full load current continuously. The switch shall have an overload rating of 110 percent rated load continuously and 200 percent rated load for five seconds. The static transfer switch shall also have fault-clearing capabilities of 1100 amperes for 1 second, 3000 amperes for 10 cycles, and 6000 amperes peak for the first half cycle.
2. The static transfer switch control logic shall contain an automatic transfer control circuit that senses the status of the inverter logic signals, and operating and alarm conditions. This control circuit shall provide an uninterrupted transfer of the load to an alternate bypass source, without exceeding the transient limits specified herein, when an overload or malfunction occurs within the lighting inverter, or for bypassing the lighting inverter for maintenance.

B. Uninterrupted Transfer:
1. The transfer control logic shall automatically turn on the static transfer switch, transferring the critical AC load to the bypass source, after the transfer logic senses any of the following conditions:
   a. Inverter overload capacity exceeded.
   b. Critical AC load overvoltage or undervoltage.
   c. Battery protection period expired.
   d. Fault condition.
2. The transfer control logic shall inhibit an automatic transfer of the critical load to the bypass source if any of the following conditions are present:
   a. Inverter/bypass voltage difference exceeding preset limits.
   b. Bypass frequency out of limits.

c. Bypass out-of-synchronization range with inverter output.

C. Uninterrupted Retransfer: Retransfer of the critical AC load from the bypass source to the inverter output shall be automatically initiated unless inhibited by manual control. The transfer control logic shall inhibit an automatic retransfer of the critical load to the inverter if one of the following conditions exists:
1. Inverter/bypass voltage difference exceeding preset limits.
2. Overload condition exists in excess of inverter full load rating.
3. Fault condition present.

2.16 INTERNAL MAINTENANCE BYPASS SWITCH

A. Description: A manually operated maintenance bypass switch shall be incorporated into the lighting inverter cabinet to directly connect the critical load to the bypass AC input power source, bypassing the rectifier/charger, inverter, and static transfer switch.
1. Switch shall be electrically and mechanically interlocked to prevent interrupting power to the load when switching to bypass mode.
2. Switch shall electrically isolate other lighting inverter components to permit safe servicing. A means to de-energize the static switch shall be provided when the lighting inverter is in the maintenance bypass mode of operation.

B. Switch Rating: Continuous duty at rated full lighting inverter load current.

C. Maintenance Capability: With the critical load powered from the maintenance bypass circuit, it shall be possible to check out the operation of the rectifier/charger, inverter, battery, and static transfer switch.

2.17 MONITORING BY REMOTE STATUS AND ALARM PANEL

A. Description: A remote status panel shall be provided with labeled LEDs on its panel faceplate that indicate the following basic status conditions:
1. Load on Lighting Inverter LED.
2. Load on Bypass LED.
3. Battery Discharge LED.
4. Low Battery Reserve LED.
5. Lighting inverter Alarm Condition LED.
6. New Alarm Condition LED (for a second lighting inverter alarm condition).

B. An audible signal shall be provided to indicate any alarm conditions. A silencing switch in face of panel shall be provided to silence the signal without altering visual indication.

C. The panel shall also be provided with a lamp test/reset pushbutton.

D. The remote status panel shall be provided in a NEMA Type 1 enclosure for wall mounting.

2.18 BATTERY CIRCUIT BREAKER

A. A battery circuit breaker shall be provided to isolate the battery from the lighting inverter. This breaker shall have an undervoltage release (UVR) and auxiliary contacts, and shall be in the battery cabinet. The battery breaker provides a manual disconnecting means, short circuit protection, and overcurrent protection for the battery system. When opened, there shall be no battery voltage in the enclosure. The lighting inverter shall be automatically disconnected from the battery by opening the breaker when the battery reaches the minimum discharge voltage level.

2.19 SYSTEM MONITORING AND ALARMS

A. The control electronics of the lighting inverter shall be designed to automatically operate the functions of the lighting inverter. The control electronics shall monitor the lighting inverter for abnormal function and shall provide intervention to prevent damage to the circuitry.

B. Provisions for Remote Computer Management:
1. The lighting inverter shall provide an RS-232 communication path to a host computer system. Alert messages sent from the lighting inverter shall inform the host of the lighting inverter status. These messages shall be directly interpreted as real time information about the lighting inverter's ability to provide power.
2. The lighting inverter shall be manageable either locally or remotely. The management capability shall include the following:
   a. User configurable low battery, shut down and restart intervals.
   b. Setting of alarm conditions.
   c. Self testing (alarms, battery tests).
3. Include lighting inverter diagnostic, monitoring and management software to provide local or remote diagnostic, monitoring and management of the lighting inverter.

2.20 SOURCE QUALITY CONTROL

A. Factory test complete lighting inverter system before shipment. Include the following:
1. Functional test and demonstration of all functions, controls, indicators, sensors, and protective devices.
2. Full-load test.
3. Transient-load response test.
4. Overload test.
5. Power failure test.

B. Observation of Test: Give 14 days' advance notice of tests and provide access for Board's representative to observe tests at Board's option.

C. Report test results. Include the following data:
1. Description of input source and output loads used. Describe actions required to simulate source load variation and various operating conditions and malfunctions.
2. List of indications, parameter values, and system responses considered satisfactory for each test action. Include tabulation of actual observations during test.
3. List of instruments and equipment used in factory tests.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine areas and conditions for compliance with requirements for ventilation, temperature, humidity, and other conditions affecting performance.
1. Verify that manufacturer's written instructions for environmental conditions have been permanently established in spaces where equipment will be installed, before installation begins.

B. Examine roughing-in for electrical connections to verify actual locations of connections before installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

A. Install system components as shown on drawings and per manufacturer’s recommendation.

B. Maintain minimum clearances and workspace at equipment according to manufacturer's written instructions and Chicago Electrical Code.

3.03 CONNECTIONS

A. Connections: Interconnect system components. Make connections to supply and load circuits according to manufacturer's wiring diagrams, unless otherwise indicated.

B. Ground equipment according to Section 26 05 26 - Grounding and Bonding for Electrical Systems.

C. Connect wiring according to Section 26 05 19 - Low-Voltage Electrical Power Conductors and Cables.

3.04 IDENTIFICATION

A. Identify equipment and components according to Section 26 05 53 - Identification for Electrical Systems.

3.05 FIELD QUALITY CONTROL

A. The following inspections and test procedures shall be performed by factory-trained field service personnel during the startup.
   1. Visual Inspection
      a. Inspect equipment for signs of damage.
      b. Verify installation per drawings.
      c. Inspect cabinets for foreign objects.
      d. Verify neutral and ground conductors are properly sized and configured.
      e. Inspect battery cases.
      f. Inspect battery for proper polarity.
      g. Verify all printed circuit boards are configured properly.
   2. Mechanical Inspection
      a. Check all control wiring connections for tightness.
      b. Check all power wiring connections for tightness.
      c. Check all terminal screws, nuts, and/or spade lugs for tightness.
   3. Electrical Inspection
      a. Check all fuses for continuity.
      b. Confirm input voltage and phase rotation is correct.
      c. Verify control transformer connections are correct for voltages being used.
      d. Assure connection and voltage of the battery string(s).

B. Load Bank Testing: A 4-hour full load, load bank test shall be performed at the site. The resistive load bank shall be supplied by the contractor at no additional cost.

C. Retest: Correct deficiencies and retest until specified requirements are met.

D. Record of Tests and Inspections: Maintain and submit documentation of tests and inspections, including references to manufacturers' written instructions and other test and inspection criteria. Include results of tests, inspections, and retests.

3.06 MAINTENANCE CONTRACTS

A. A complete offering of preventative and full service maintenance contracts for both the lighting inverter system and battery system shall be available. An extended warranty and preventative maintenance package shall be available. Warranty and preventative maintenance service shall be performed by factory-trained service personnel.

3.07 CLEANING

A. Install new filters in each equipment cabinet within fourteen (14) days from date of Preliminary Acceptance.

B. The contractor shall remove all paint spatters and other spots, dirt and debris from the equipment. Clean equipment and devices internally and externally using methods and materials recommended by the manufacturer.

3.08 CONTRACTOR STARTUP AND REPORTING

A. Contractor shall prepare and submit a complete set of record drawings, operation and maintenance data and certificates as outlined in this Section.

B. Contractor shall insure that that the Board has received the test results from the manufacturer and factory-authorized service representative as required in the previous articles.

3.09 COMMISSIONING AND DEMONSTRATION

A. Engage a factory-authorized service representative to train Board's maintenance personnel to adjust, operate, and maintain the central battery inverter system. Refer to Section 01 79 00 - Demonstration and Training.

B. Contractor shall coordinate with the Board and schedule the factory-authorized service representative to perform the field quality control and demonstration requirements listed in the previous articles.

END OF SECTION 26 33 35