AIA SPECIFICATIONS & TECHNICAL DESCRIPTION
For 1.5, 2.25, 3.0, 3.75, 5.0, 6.0, 8.0, 10.0, 12.5 or 16.7 kW / kVA
Cooper Lighting Solutions / Sure-Lites INV-U-S Single-Phase Central Inverter System

This description contains all the necessary functional and technical information for the Sure-Lites **INV-U-S** family of uninterruptible power supplies.

This specification also provides electrical and mechanical characteristics and an overall description of the typical operation of an **INV-U-S** Series uninterruptible line interactive power supply.

For any further information, please contact our Authorized Sales Representative or **Cooper Lighting Solutions** directly.

Cooper Lighting Solutions reserves the right to modify at any time, without notice, the technical characteristics, illustrations and weights indicated in this document.

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SECTION 1.0 GENERAL

1.1 SPECIFICATION

This specification defines the electrical and mechanical characteristics and requirements for a line interactive, single-phase, solid-state uninterruptible power supply, hereafter referred to as the UPS system. The UPS shall provide high quality, computer grade AC power for today's electronic lighting loads (power factor corrected and self-ballast fluorescent, incandescent, quartz re-strike or halogen and HID) during emergency backup.

The UPS shall incorporate a high frequency pulse width modulated (PWM) inverter utilizing IGBT technology, a microcontroller controlled inverter and a temperature compensating battery charger, communication port, and a user friendly control panel with audible and visual alarms.

1.2 DESIGN STANDARDS

The UPS shall be designed in accordance with the applicable sections of the current revision of the following documents. Where a conflict arises between these documents and statements made herein, the statements in this specification shall supersede.

- UL 924 Standard Emergency Lighting and Power Equipment
- National Electrical Code
- NFPA- 101 (Life Safety Code)
- OSHA

1.3 SYSTEM DESCRIPTION

1.3.1 Design Requirements - Electronics Module

A. Nominal Input/Output Voltage
The Input and Output voltage of the UPS shall be pre-configured to match the user specified input and load requirements. Standard voltages are 120, 208, 240, 277 or 480VAC.

Input: _____ VAC, 1-phase, ___ -wire-plus-ground
Output: _____ VAC, 1-phase, ___ -wire-plus-ground

B. Output Load Capacity
The output load capacity of the UPS shall be rated in kVA at unity power factor. The UPS shall be able to supply the rated kW from .5 lagging to .5 leading.

Rating: _____ kVA / kW

1.3.2 Design Requirement - Battery System

A. Battery Cells

The UPS shall be provided with sealed, valve regulated, front access, lead acid batteries.

B. Reserve Time

The battery system shall be sized to provide the necessary reserve time to feed the inverter in case of a mains failure.

Battery Reserve time: 90 minutes at the full load rating of the system

C. Recharge Time

The battery charger shall recharge the fully discharged batteries within a 24 hour period. The charger shall be an integrated, microcontroller controlled, and two stage charger.

1.3.2 Design Requirement - Transformer Module

For systems with mixed input/output voltages the use of an isolation and/or auto transformer may be required. The transformer(s) is not bypassed when optional maintenance bypass circuit is activated.

1.3.3 Modes of Operation

The UPS shall be designed to operate with less than a 2-millisecond transfer time:

A. Normal

The UPS Inverter is a line interactive standby system and the commercial AC power continuously supplies the critical load. A boost tap transfer protection circuit will maintain the desired output voltage during low voltage "brownout" situations, without continuously switching to battery, thereby preserving battery capacity. The input converter (bi-directional transformer) derives power from the commercial AC power source and supplies to the inverter while simultaneously providing floating charge to the batteries.

B. Emergency

Upon failure of the commercial AC power the inverter instantaneously with a maximum of a 2-millisecond break, switches its power supply from the input converter to the battery system. There shall be no loss of power to the critical load upon the failure or restoration of the utility source.

C. Recharge

Upon restoration of commercial AC power after a power outage, the input converter shall automatically restart and start charging the batteries. The critical loads are powered by the commercial AC power again.

1.3.4 Performance Requirements

1.3.4.1 AC Input to UPS

A. Voltage Configuration for Standard Units: 1-phase, 2-wire-plus-ground.

B. Voltage Range: (+10%, -20%)

C. Frequency: 60 Hz (+/- 3%)

D. Short Circuit Rating: UL Listed for 65kAIC, RMS symmetrical

E. Power Factor: . 5 lagging / leading

F. AC Overcurrent: 1.25 times nominal input current

G. Voltage Distortion: Less than 10% THD from 50% to full load (For Resistive Load)

H. Surge Protection: Sustains input surges without damage per standards set in UL924

1.3.4.2 AC Output, UPS Inverter

A. Voltage Configuration for Standard Units: 1-phase, 2-wire-plus-ground

B. Static Voltage Stability: Load current changes +/- 4%, Battery Discharge +/- 12.5%

C. Dynamic Voltage Stability: +/- 3% (25% step load), +/- 6% (50% step load)

D. Dynamic Recovery Time to within 1% of nominal: 10 cycles (0-100% load step)

E. Output Harmonic Voltage Distortion: < 3% (with linear load)

F. Frequency: 60 Hz (+/- .05Hz during emergency mode)

G. Load Power Factor Range: 0.5 lagging to 0.5 leading

H. Output Power Rating: kVA = kW

I. Overload Capability: to 100% continuous rating
to 115% for 10 minutes
to 150% for 16 line cycles

J. Crest Factor: <= 2.8

1.4 ENVIRONMENTAL CONDITIONS

The UPS shall be capable to operate within the specified design and performance criteria provided that the following environmental conditions are met:

A. Storage/Transport Temperature:
-4 to 158 deg. F (-20 to 70 deg. C) without batteries
0 to 104 deg. F (-18 to 40 deg. C) with batteries*

*Note: Maximum recommended storage temperature for batteries is 77 deg. F (25°C) for up to six months. Storage at up to 104° F (25°C) is acceptable for a maximum of three months.

B. Operating Temperatures: (Conditioned Space)
68° to 86° F (20° to 30° C) Per UL924 Rating

C. Relative Humidity: 0 to 95% non-condensing

D. Altitude:
Operating to 10,000 ft. (3,048m)
De-rated 4% per 1,000 ft. (304.8m) above 10,000 ft. (3,048m)
Storage/Transport: to 40,000 ft. (12,192 m) above sea level

E. Audible Noise: 50 dBA @ 1 meter from surface of the UPS
During Emergency Mode

1.5 SUBMITTALS

1.5.1 Proposal Submittals

Submittals with the proposal shall include the following:

A. System configuration with single-line diagrams

B. Functional relationship of equipment including weights dimensions and heat Dissipation

C. Descriptions of equipment to be furnished, including deviations from these specifications

D. Size and weight of units to be handled by installing contractor

1.5.2 UPS Delivery Submittals

Submittals upon UPS delivery shall include:

A. A complete set of submittal drawings

B. One set of instruction manuals. Manuals shall include a functional description of the equipment, installation, safety precautions, instructions, step-by-step operating procedures and routine maintenance guidelines, including illustrations.

1.6 WARRANTY

1.6.1 UPS Module
The UPS manufacturer shall warrant the UPS module against defects in materials and workmanship for 12 months after initial start-up (if start-up purchased) or 12 months after ship date, whichever occurs first. The standard warranty will be increased to 2 years with the purchase of a factory start-up.

1.6.2 Battery
The battery manufacturer's standard warranty shall be passed through to the end user.
Sealed Lead Calcium VRLA, 10-year life expectancy – one-year full replacement warranty plus an additional nine years pro-rata.

1.7 QUALITY ASSURANCE

1.7.1 Manufacturer Qualifications
A minimum of 35 years experience in the design, manufacture, and testing of emergency power systems is required.

1.7.2 Factory Testing
Before shipment, the manufacturer shall fully and completely test the system to assure compliance with the specification.

SECTION 2.0 PRODUCT

2.1 FABRICATION

All materials of the UPS shall be new, of current manufacture, high grade, free from all defects and shall not have been in prior service except as required during factory testing.

The UPS module and batteries shall be housed in a single freestanding NEMA type 1 enclosure. Front access only shall be required for installation, adjustments and expedient servicing (MTTR: < 15 minutes). All components shall have a modular design and quick disconnect means to facilitate field service.

The UPS shall be powder painted with the manufacturer's standard color. The UPS shall be constructed of replaceable subassemblies. Like assemblies and like components shall be interchangeable.

Cooling of the UPS shall be forced-air in emergency mode with internally mounted fans to minimize audible noise. Fans shall not operate in the standby mode. Fan power shall be provided by the UPS. No air filters shall be required.

2.2 COMPONENTS

The UPS shall be comprised of the following components:

A. UPS Module - The UPS module shall contain an inverter, an AC distribution module with an input circuit breaker, back-feed relay, a boost tap transformer, control, and monitoring subsystems.

B. Battery Module - The battery module shall contain the battery plant required to produce the reserve energy to supply the inverter during abnormal AC mains conditions. The 90 - minute battery module shall be contained in same cabinet as electronics regardless of the system VA.

2.2.1 Battery Charger

A. General

In normal operating mode, the AC input voltage is rectified and boosted to the proper DC level by controlling the power bridge with a microcontroller to recharge the batteries. The battery charger circuit supplies first a constant current during bulk charge and a constant voltage during float charge to the batteries. Once the batteries have received a full recharge, a constant trickle charge maintains batteries at maximum level. Recharge time is 24 hours maximum at nominal AC input voltage. The AC ripple current of the DC output meets the battery manufacturer specification, thus ensuring the maximum battery lifetime.

B. AC Input Current

The charger unit is provided with an ac input current limiting circuit whereby the maximum input current shall not exceed 150% of the output full current rating.

C. Automatic Restart

Upon restoration of utility AC power, after a utility AC power outage and after a full UPS automatic end-of-discharge shutdown, the UPS will automatically restart, performing the normal UPS start up.

D. DC Filter

The charger shall have an output filter to minimize AC ripple voltage into the battery.
Under no conditions shall ripple voltage into the battery exceed 2% RMS.

E. Battery Recharge

The charger is capable of producing battery-charging current sufficient to recharge the fully discharged battery bank within a 24-hour period. After the battery is recharged, the charger shall maintain full battery charge until the next emergency operation.

F. Over-voltage Protection

The charger is equipped with a DC over-voltage protection circuit so that if the DC voltage rises above the pre-set limit, the charger shuts down automatically and initiates an alarm condition.

2.2.2 Inverter

A. General
The inverter converts dc voltage supplied by the battery to ac voltage of a precisely stabilized amplitude and frequency that is suitable for powering most sophisticated electrical equipment. The inverter output voltage is generated by sinusoidal pulse width modulation (PWM). The use of a high carrier frequency for PWM and a dedicated ac filter circuit consisting of a transformer and capacitors, ensure a very low distortion of the output voltage (THD<3% on linear loads).

B. Overload Capability
The inverter during emergency modes shall be capable of supplying current and voltage for overloads exceeding 100% and up to 150% of full load current for 16 line cycles, 115% for 10 minutes.

C. Output Power Transformer
A dry type power transformer provides the inverter AC output. The transformer is built with copper wiring exclusively. The hottest winding temperature of the transformer shall not exceed the temperature limit of the transformer insulation class of material at ambient temperature.

2.2.3 Display and Controls

A. Monitoring and Control
The UPS system provides operation monitoring and control, audible alarms, and diagnostics. The front-mounted control panel includes a 4-line by 20-character vacuum fluorescent display and a keypad for user interface. The display will be menu driven. The system will have a continuous scrolling display of the following: Date & time, System Status (AC Status, Battery Status, Charger Status) and any system faults: This allows the operator to easily "watch" system functions as they occur and check on virtually any aspect of the system's operation. Monitoring and control are microprocessor-based for accuracy and reliability. To ensure only authorized personnel can operate the unit, the system is multi-level password protected for all control functions and parameter changes.

B. Metering
Scrolling through the meter functions can monitor the following measurements:
- Utility input voltage
- System output voltage
- Battery voltage
- Battery current
- System output current
- System output VA
- Inverter wattage
- System temperature
- Date & time
- System Days

C. Audible Alarm
Audible alarm will activate with any of the following conditions and automatically store the 75 most recent events.
- High battery charger voltage

- Charger Fault
- High AC input voltage
- Low AC input voltage
- Near low battery voltage
- Low battery voltage
- Load reduction fault
- High Ambient temperature
- Inverter fault
- Output fault
- Output overload
- Output Overload shutdown
- System Test Failure

2.2.4 Communication Interfaces

2.2.4.1 RS-232 Interface

The system shall be equipped with an RS-232 serial port (DB9) for remote communications over a serial cable. A proprietary (but publicly available) communication protocol shall be provided to access the following inverter telemetry over RS-232:

- Input Voltage(s)
- Output Voltage(s)
- Output Current(s)
- Total Output Power
- Ambient Temperature
- Battery Voltage
- Battery Current
- Total Time On Battery
- Days of Operation
- The results of the inverter's last auto-run monthly self-test
- The results of the inverter's last auto-run yearly self-test
- Alarm states (no utility, on battery, battery low, input voltage high or low, inverter failure detected, inverter overloaded and overload shutdown, 'load reduction' activated, ambient temperature high, and battery charger fault).
- Event logs, Alarm logs and Test logs

2.2.4.2 Serial to Ethernet Interface

The system shall be equipped with an RJ-45 Ethernet port for remote communications over a Local Area Network (LAN). The Serial to Ethernet Interface shall provide a Telnet, SSH and web (HTTP) interface to the inverter using a proprietary (but publicly available) communication protocol to access the following inverter telemetry over the LAN:

- Input Voltage(s)
- Output Voltage(s)
- Output Current(s)
- Total Output Power
- Ambient Temperature
- Battery Voltage

- Battery Current
- Total Time On Battery
- Days of Operation
- The results of the inverter's last auto-run monthly self-test
- The results of the inverter's last auto-run yearly self-test
- Alarm states (no utility, on battery, battery low, input voltage high or low, inverter failure detected, inverter overloaded and overload shutdown, 'load reduction' activated, ambient temperature high, and battery charger fault).
- Event logs, Alarm logs and Test logs

2.2.4.4 BACnet MS/TP Interface

The system shall be equipped with an RS-485 serial port for remote communications to a Building Management System (BMS) via BACnet MS/TP protocol. The BACnet interface shall support standard baud rates (9600, 19200, 38400, 57600, 115200) and MAC addressing (0-127), and have a programmable systemwide Device Instance number. The BACnet interface shall support standard BACnet discovery. The BACnet interface shall provide read-only access to the following inverter telemetry:

- Input Voltage(s)
- Output Voltage(s)
- Output Current(s)
- Total Output Power
- Ambient Temperature
- Battery Voltage
- Battery Current
- Total Time On Battery
- Days of Operation
- The results of the inverter's last auto-run monthly self-test
- The results of the inverter's last auto-run yearly self-test
- Alarm states (no utility, on battery, battery low, input voltage high or low, inverter failure detected, inverter overloaded and overload shutdown, 'load reduction' activated, ambient temperature high, and battery charger fault).
- Event logs, Alarm logs and Test logs, as text files downloadable via BACnet file transfer

2.2.4.5 BACnet IP Interface

The system shall be equipped with an RJ-45 Ethernet port for remote communications to a Building Management System (BMS) via BACnet IP protocol. The BACnet IP interface shall support standard IP network settings (DHCP or static IP address, subnet mask, default gateway, programmable port number) and shall have a programmable systemwide Device Instance number. The BACnet IP interface shall provide read-only access to the following inverter telemetry:

- Input Voltage(s)
- Output Voltage(s)
- Output Current(s)
- Total Output Power
- Ambient Temperature
- Battery Voltage

- Battery Current
- Total Time On Battery
- Days of Operation
- The results of the inverter's last auto-run monthly self-test
- The results of the inverter's last auto-run yearly self-test
- Alarm states (no utility, on battery, battery low, input voltage high or low, inverter failure detected, inverter overloaded and overload shutdown, 'load reduction' activated, ambient temperature high, and battery charger fault).

2.2.4.6 MODBUS Serial (RTU or ASCII) Interface

The system shall be equipped with an RS-485 serial port for remote communications to a Building Management System (BMS) via MODBUS RTU or MODBUS ASCII protocol (selectable). The MODBUS Serial interface shall support standard baud rates (9600, 19200, 38400, 115200), parity (no parity or even parity) and device addressing (1-247). The MODBUS Serial interface shall support setting a custom Device/User ID string (via Function Code 0x15) and retrieving it (via Function Code 0x11 – Report Server ID – or Function Codes 0x2B/0x0E – Encapsulated Interface Transport 'Read Device Identification'). The MODBUS Serial interface shall provide read-only access to the following inverter telemetry (via MODBUS Function Codes 0x01 through 0x04, and 0x14 for retrieving log files):

- Input Voltage(s)
- Output Voltage(s)
- Output Current(s)
- Total Output Power
- Ambient Temperature
- Battery Voltage
- Battery Current
- Total Time On Battery
- Days of Operation
- The results of the inverter's last auto-run monthly self-test
- The results of the inverter's last auto-run yearly self-test
- Alarm states (no utility, on battery, battery low, input voltage high or low, inverter failure detected, inverter overloaded and overload shutdown, 'load reduction' activated, ambient temperature high, and battery charger fault).
- Event logs, Alarm logs and Test logs, as text files downloadable via MODBUS Read File Record function code 0x14

2.2.4.7 MODBUS TCP Interface

The system shall be equipped with an RJ-45 Ethernet port for remote communications to a Building Management System (BMS) via MODBUS TCP protocol. The MODBUS TCP interface shall support standard IP network settings (DHCP or static IP address, subnet mask, default gateway, programmable port number). The MODBUS TCP interface shall provide read-only access to the following inverter telemetry:

- Input Voltage(s)
- Output Voltage(s)
- Output Current(s)

- Total Output Power
- Ambient Temperature
- Battery Voltage
- Battery Current
- Total Time On Battery
- Days of Operation
- The results of the inverter's last auto-run monthly self-test
- The results of the inverter's last auto-run yearly self-test
- Alarm states (no utility, on battery, battery low, input voltage high or low, inverter failure detected, inverter overloaded and overload shutdown, 'load reduction' activated, ambient temperature high, and battery charger fault).

2.2.4.8 SNMP Interface

The system shall be equipped with an RJ-45 Ethernet port for remote communications to a Building Management System (BMS) or Network Manager via SNMP protocol. The SNMP interface shall support standard IP network settings (DHCP or static IP address, subnet mask, default gateway).The SNMP interface shall support SNMP v1 and v2c. The SNMP interface shall support the programming of SNMP traps when user defined alarm conditions are met. The SNMP interface shall support standard 'SNMP Get', as well as standard SNMP MIB walking via 'SNMP Get Next'. The SNMP interface shall provide read only objects (OIDs) for the following inverter telemetry:

- Input Voltage(s)
- Output Voltage(s)
- Output Current(s)
- Total Output Power
- Ambient Temperature
- Battery Voltage
- Battery Current
- Total Time On Battery
- Days of Operation
- The results of the inverter's last auto-run monthly self-test
- The results of the inverter's last auto-run yearly self-test
- Alarm states (no utility, on battery, battery low, input voltage high or low, inverter failure detected, inverter overloaded and overload shutdown, 'load reduction' activated, ambient temperature high, and battery charger fault).

2.2.5 Manual and Programmable Testing

The system shall incorporate a manual test function and two automatic test modes. The system will perform a programmable, self-diagnostic monthly test for 5 minutes, which is preset for the 15th of every month and the user can program the event day and time. The yearly self-diagnostic test is for 90 minutes and the user can program the day and time the event is to take place. The microcontroller automatically records the last 75 test events in its own separate test result log.

2.2.6 Battery Assembly

The batteries are a front access sealed, lead-acid valve regulated battery cells with a one year full, nine year prorated warranty. Batteries shall be interconnected via buss bars and cables will be provided for shelf interconnects where required. A disconnect means shall be included for isolation of battery assembly from the UPS module.

2.2.7 System Options

- **Output Circuit Breakers:**
  Distribution circuit breakers are for output load protection - Protection for the normally on and/or for the optional normally off loads. System dependent, a maximum of __ unsupervised 1-pole and a maximum of __ supervised 1-pole circuit breakers are available. All circuit breakers are rated for 10,000 AIC @120VAC.

- **Output Circuit Breaker Trip Alarm:**
  An audible and visual alarm activates when an output distribution circuit breaker is open or has tripped.

- **Dimmer Bypass:**
  Internal relays with individual overload protection circuit breakers that will allow individual dimmed circuits to be used as emergency circuits.

- **Summary Form "C" Contacts:**
  Form "C" contacts rated at 5 amps maximum at 250VAC/30VDC. Dry contacts will change state when any system alarm activates. Contacts change states with the following alarms: High battery charger fault, near low battery, low battery, load reduction fault, output overload, high/low AC input volts, high ambient temperature, inverter fault, system test fault, and with optional circuit breaker trip alarm.

- **Normally Off Dry Contacts:**
  Form "C" contacts rated at 5 amps maximum at 250VAC/30VDC. Dry contacts will change state when the system transfers to emergency mode.

- **Fast Charge:**
  This is a battery charger upgrade, which decreases the time to recharge a fully discharged battery bank to a full charge. The recharge time is decreased from the standard 24-hour period to a 12-hour period.

- **Maintenance Bypass Switch:**
  This device is internally mounted in the system and permits maintenance personnel to easily bypass the protected equipment directly to the AC utility power. The make before break switch isolates the system to perform routine maintenance or servicing.

- **Normally Off Output:**
  This output circuit is dedicated for the "emergency only" equipment. "Emergency only" equipment operates during power outages and when the system is on battery back up. This option leaves the load circuits off during normal utility power conditions.

- **Long Life Sealed Lead Calcium, VRLA Battery:**
  Maintenance free battery that requires no addition of water over the life of the battery. The battery cells are housed in protective, steel cases. Life expectancy is designed for 20-years at 77ºF (25ºC). Warranty is one-year full replacement plus an additional nineteen years pro-rata.

- **RS232:**
  Allows for communication of data from the inverter over RS-232. See Communication Interfaces specification.

- **Serial To Ethernet:**
  Allows for communication of data from the inverter over a LAN using Telnet, SSH or HTTP protocol. See Communication Interfaces specification.

- **BACnet MS/TP:**
  Allows for communication of data from the inverter over RS-485 using BACnet MS/TP protocol. See Communication Interfaces specification.

- **BACnet IP and SNMP:**
  Allows for communication of data from the inverter over a LAN using BACnet IP protocol or SNMP protocol. See Communication Interfaces specification.

- **MODBUS Serial:**
  Allows for communication of data from the inverter over RS-485 using MODBUS RTU or MODBUS ASCII protocols. See Communication Interfaces specification.

- **MODBUS TCP and SNMP:**
  Allows for communication of data from the inverter over a LAN using MODBUS TCP protocol or SNMP protocol. See Communication Interfaces specification.

2.2.8 Accessories

- **Remote Meter Panel:**
  This allows greater flexibility to monitor all the system parameters from a remote location, up to 150 feet away from the system. This allows the user to remotely monitor the status of the inverter. Also allows user to control and program the inverter from a remote location. See section 2.2.3 “Display and Controls” for specific details.

- **Serial to Ethernet Adapter:**
  Extends the RS-232 Serial signal to a network that allows a user to telnet into the CIS via a LAN.

- **External Maintenance Bypass Switch:**
  This maintenance bypass switch is mounted in a NEMA 1 enclosure with a hinged door measuring 20” high by 16” wide by 9” deep and permits maintenance personnel to easily bypass the protected equipment directly to the AC utility power. The make before break switch isolates the system to perform routine maintenance or servicing. This accessory cannot be used in conjunction with more than one output circuit breaker in the system and the output circuit breaker must be sized for the total system current.

- **Remote Summary Alarm Panel**
  A 4” high by 4” wide by 2 1/4” deep box containing a red alarm light and buzzer with a silence switch will activate on any alarm condition.

SECTION 3.0 EXECUTION

3.1 WIRING

All wiring shall be installed in conduit. Input and output wiring shall enter the cabinet in separate conduits.

3.2 UNIT START-UP and SITE TESTING

Site start-up and testing shall be provided by the manufacturer’s field service representative during normal working hours (Mon. - Fri. 8 a.m. - 5 p.m.). Individual scheduling requirements can usually be met with 7 working days advance notice. Site testing shall consist of a complete test of the UPS and accessories by the UPS manufacturer in accordance with manufacturer’s standards. Manufacturer’s approved service representative must perform commissioning for two-year warranty to apply.

3.3 REPLACEMENT PARTS

Parts shall be available through Field Service Centers throughout the country. Recommended spare parts shall be fully stocked by local field service personnel with back up available from manufacturing location.

3.4 MAINTENANCE CONTRACTS

A complete offering of preventive and full-service maintenance contracts for both the UPS system and batteries shall be available. An extended warranty and preventive maintenance packages shall be available. Factory-trained service personnel shall perform warranty and preventive maintenance service. A five-year maintenance contract will include a unit start-up and site testing.