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(R 87)
1564-82
(R 85)

Dead Front Switchboards
Industrial Battery Chargers

1.2 GENERAL REQUIREMENTS: Section 16011 "Electrical General Requirements," applies to this section, with the additions and modifications specified herein.

1.3 DESCRIPTION OF WORK: The work includes providing a complete Rotary Uninterruptible Power Supply System.

1.4 SUBMITTALS:

1.4.1 Shop Drawings and Manufacturer's Data: Shop drawings for the Rotary UPS system shall indicate, but shall not be limited to, the following:

- a. Overall dimensions
- b. Certified one-line
- c. Point to point schematics

1.4.2 Certificates of Compliance:

- a. Proof of compliance with UL and NEMA Standards. (Certificates are not required if manufacturer's submitted published data indicate a UL listing and conformance with applicable publications of NEMA.)

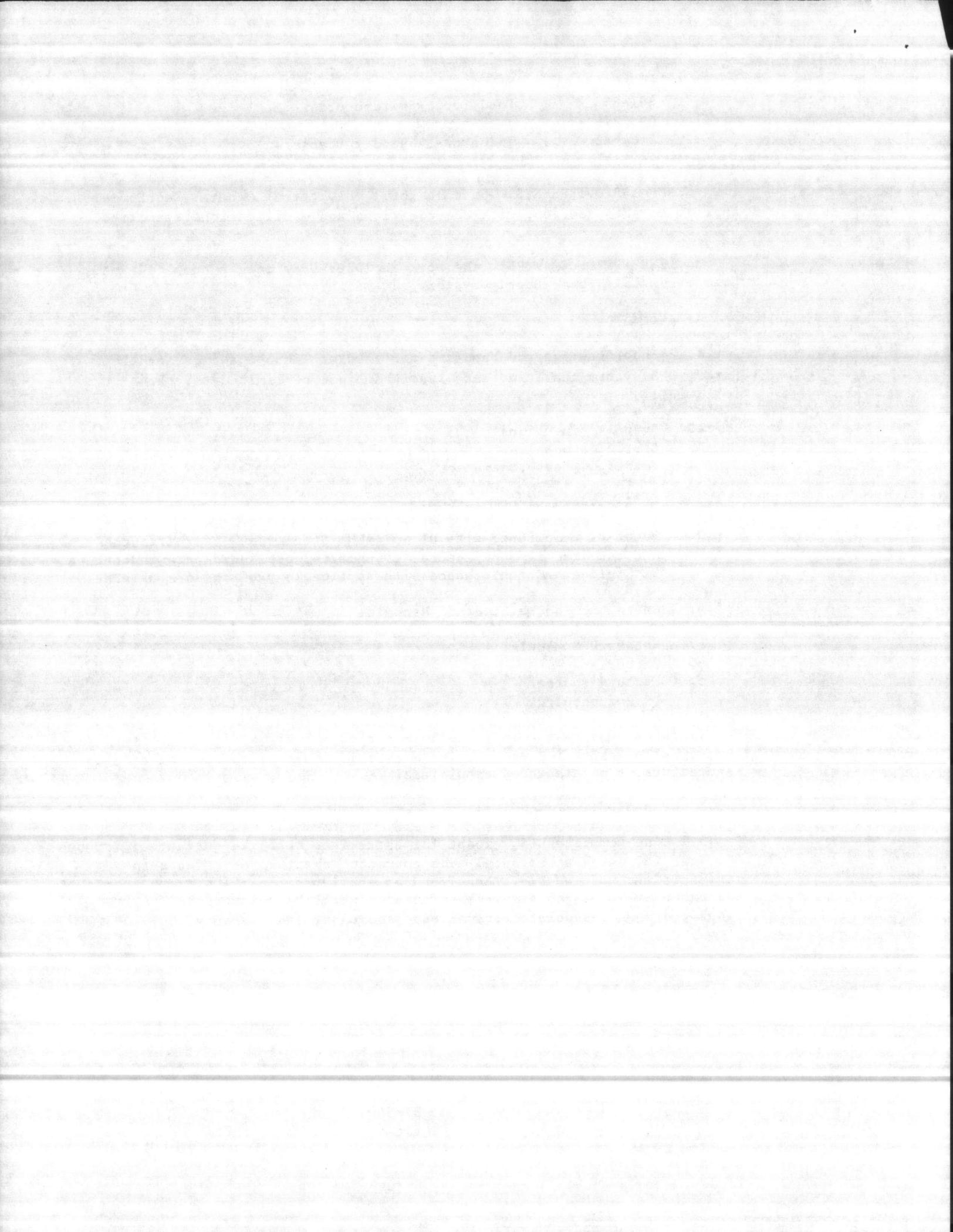
1.4.3 Operating and Maintenance Manuals:

- a. Rotary UPS module
- b. Batteries
- c. Battery charger
- d. DC Switchboard

Manufacturer shall maintain a complete set of manuals at its offices, specifically identified as pertaining to this project, to be available to manufacturer's maintenance technicians.

1.5 GUARANTEE:

1.5.1 The complete UPS, except for batteries, shall be guaranteed for one (1) year following acceptance. The guarantee shall cover defects in materials and workmanship. Manufacturer shall provide all warranty parts at its expense F.O.B. job site. Manufacturer shall be responsible for its labor costs and associated travel expenses under the warranty.



1.5.2 The battery warranty shall be the battery manufacturer's standard 20 year limited warranty.

PART 2 - PRODUCTS

2.1 DEFINITIONS

2.1.1 The term UPS, as used herein, shall denote a rotary uninterruptible power supply module, together with a battery system.

2.1.2 The term, rotary uninterruptible power supply module (UPS module) as used herein, shall denote a rectifier unit used to convert three phase AC power into DC, an inverter that is naturally commutated by the back EMF of the rotating power condition, a rotary power conditioner, a static bypass switch connecting input AC power directly to the input of the rotating power conditioner and an internal electromechanical bypass connecting the UPS module input to its output.

2.1.3 The term battery charger, as used herein, shall denote a rectifier unit separate from the uninterruptible power supply module which is used to convert three phase AC power into clean, well regulated DC power for the purpose of recharging and float charging the battery system.

2.1.4 The term, battery system, as used herein, shall denote lead calcium storage cells used to supply power to the UPS modules when the AC input power is not available, together with associated racks, inter-cell, inter-tier, rack end-to-end and back-to-back connections and customary special tools.

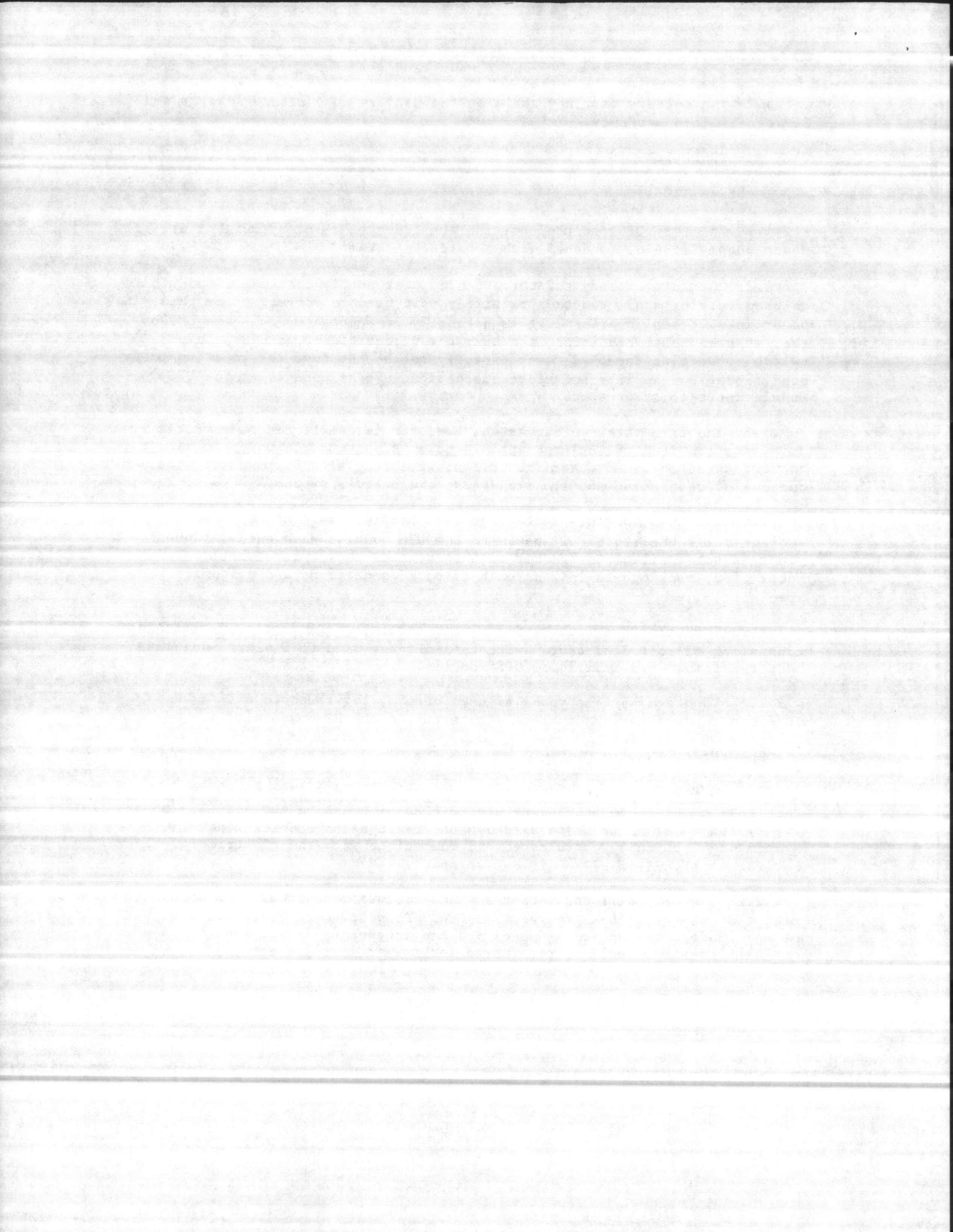
2.1.5 The term DC switchboard, as used herein, shall denote DC switchgear consisting of bolted pressure switches and fuses used to isolate individual battery strings and individual UPS modules.

2.1.6 The term system bypass as used herein, shall denote a non-interruptive bypass completely external to the UPS module(s).

2.2 GENERAL

2.2.1 A Rotary Uninterruptible Power Supply (UPS) system shall be furnished complete to provide regulated 60Hz alternating current (AC) power. The system shall be provided as shown on drawings and specified herein. The system shall be fully coordinated and compatible with the electrical, environmental and space conditions as shown.

2.2.2 The UPS shall consist of a standard equipment rotary UPS module to meet the specified capacity requirements. Only standard equipment that can be used under the conditions specified and integrated as shown on the system one-line drawings shall be considered for use in this project.



2.2.3 Because of the specific requirements of the system, it is anticipated that any 60Hz switchgear, which is to be supplied by the UPS manufacturer as shown on drawings herein, will require some modification of standard products. It is a specific requirement of this specification that any bypass switchgear provided as part of the UPS system prohibit asynchronous transfer between the UPS output and sources of the same or different frequencies.

2.2.4 To be considered for the project, manufacturers shall have manufactured rotary UPS systems for at least ten years and have ten Rotary UPS modules of equal or larger capacity in operation.

2.2.5 The UPS shall be complete as defined by the requirements of these specifications and shall be designed and constructed for unattended operation. Shop and installation drawings, parts lists and any other engineering data for the installation, operation, or routine maintenance of the equipment shall be submitted as required by the Contracting Officer.

2.2.6 The UPS and all associated equipment shall conform to the manufacturer's highest standards. All equipment shall be built to the requirements of UL. Switchgear for AC applications shall be built to the appropriate standards of UL for dead front switchgear.

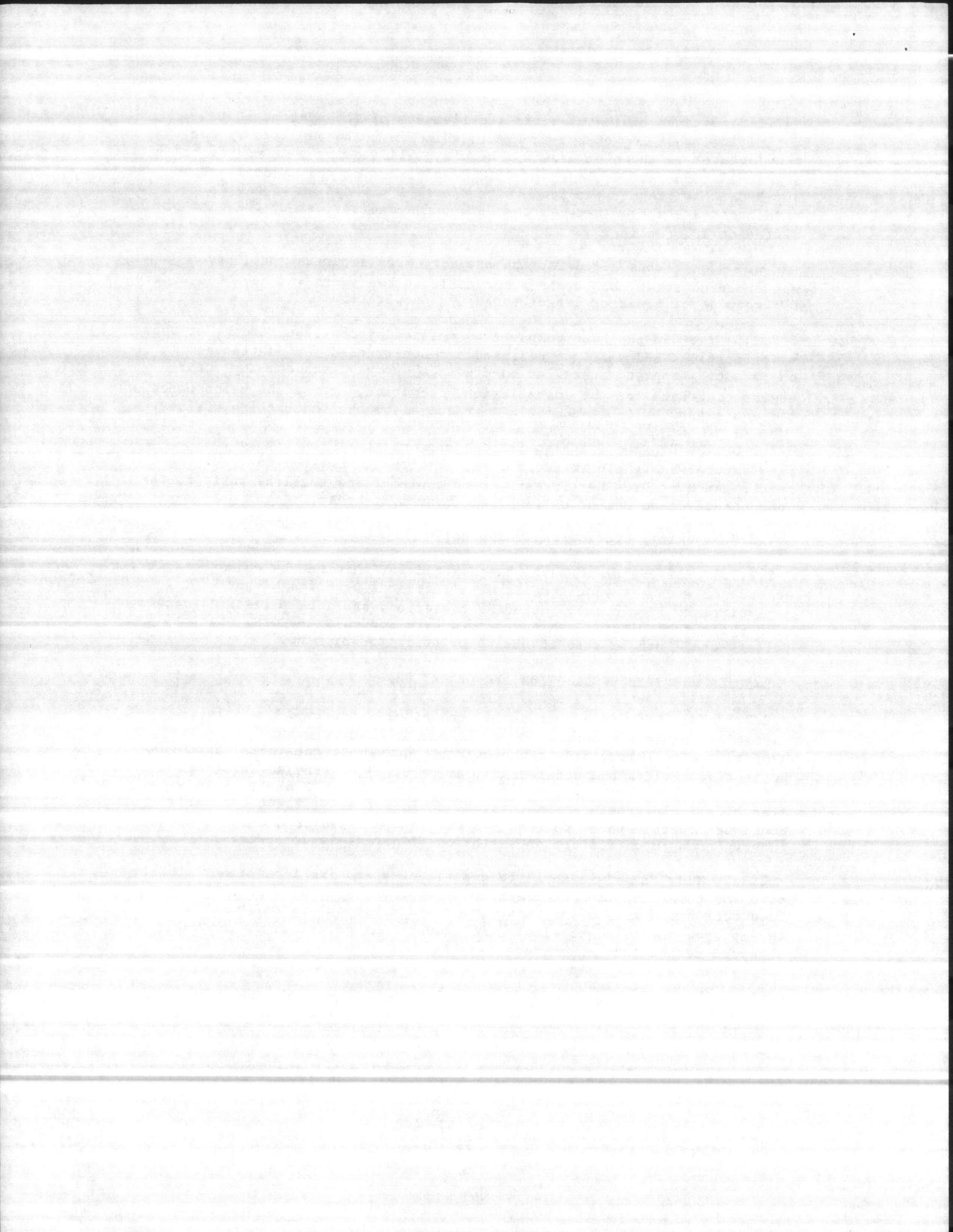
2.2.7 Packing, Crating and Shipment:

2.2.7.1 All equipment shall be packaged for shipment by common carrier in accordance with the requirements of all federal agencies having jurisdiction. Equipment, including batteries, shall be palletized, covered with waterproof plastic and surrounded by a wooden framework. Battery pallets shall not be stacked during or prior to shipment.

2.3 60Hz SYSTEM DESCRIPTION AND OPERATION

2.3.1 The 60Hz UPS system shall consist of a rotary UPS module, batteries, battery chargers, DC switchboard, electro-mechanical system bypass, control circuitry, synchronizing equipment, monitoring circuits, protective devices and accessories, as required to provide regulated uninterruptible electrical power to the load. The UPS shall include all electrical, electronic and mechanical devices that will automatically continue electric power to the load within specified tolerances without interruption, upon failure or variation of normal input power.

2.3.2 The UPS module shall be capable of operating from either utility power or power supplied from a standby source. The UPS system shall not feed back harmonics to the input power distribution system that will result in improper operation of electronic isochronous governors of generally accepted design and manufacture.



2.3.3 If input power fails or deviates outside of limits acceptable to a UPS module, the UPS module shall close its battery input contactor and draw power from the battery. Each UPS module shall continue to draw power from the DC system until the first occurring of the following conditions exists:

- a. Acceptable input power returns either from utility or a standby power source.
- b. The UPS module shuts down upon reaching the minimum acceptable battery voltage level.

2.3.4 The system bypass shall be an in-phase non-interruptive electro-mechanical bypass. Operation of the bypass switch shall cause transfer of the load to AC input power without deviation of the output bus beyond acceptable limits as specified in the requirements of these specifications. At the same time, the bypass switch shall isolate the load bus from the UPS module output bus. The system bypass shall be interlocked with the UPS module, so that the bypass internal to the module must be in bypass mode before the system bypass can be operated. The bypass internal to the UPS module shall have all necessary monitors and controls to prevent transfers to an out of tolerance source.

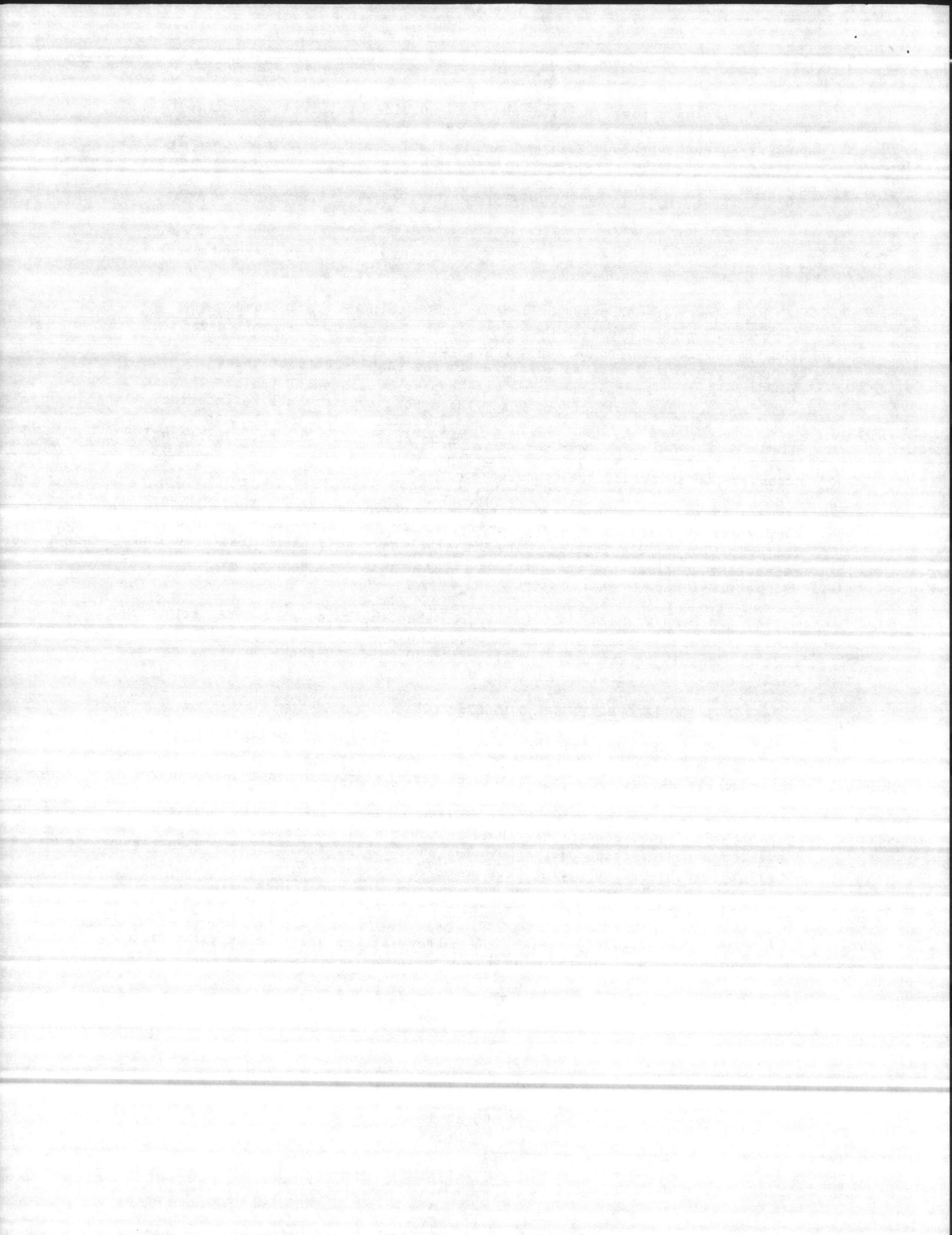
2.3.5 Transfer to bypass shall not be required to clear load faults, supply inrush currents or sudden step loads or to supply loads with power factor as low as 0.4 lagging. The UPS shall have sufficient load transient capability to clear the instantaneous trip of the main output breaker of the UPS parallel bus.

2.4 UPS REQUIREMENTS: The UPS system shall be rated at 240kVA, at 0.8 p.f., 480 volt, 3-phase, 4 wire output. The system shall consist of one module. Supply to the units shall be at 480 volts, 3-phase, 4 wire. System shall be a Piller Uniblock rotating UPS.

2.5 UPS MODULE OPERATION AND DESCRIPTION

2.5.1 Each UPS module shall consist of a rotating power conditioner, naturally commutated inverter, full wave rectifier, and transient protected inverter bypass switch. The utility or standby power source shall supply power to the input of the Uniblock. Internally, the Uniblock shall split this power into two parallel paths to supply the rotating power conditioner. The rotating power conditioner shall be powered simultaneously from both the inverter bypass switch and the inverter and full wave rectifier. Each path shall be capable of supplying full power to the rotating power conditioner. Each path shall be monitored for out-of-tolerance conditions, with corrective action taken prior to system failure.

2.5.2 Under normal operation, the battery system shall be supplied from a battery charger and electrically isolated from the inverter and rectifier,



thus eliminating AC current in the battery caused by rectifier/inverter operation. Whenever the rectifier output falls below a pre-set limit, the DC system shall be connected to the inverter input. The inverter shall then supply full power to the rotating power conditioner. To insure an uninterrupted source, the UPS power system shall provide protection to the load for power interruptions of up to 100 ms at full load, permitting transfer to the DC system. If the DC system is not in service, the UPS module shall provide protected power to the load for a minimum of 100 milliseconds at full load.

2.5.3 Rectifier

2.5.3.1 Description:

- 1) The rectifier shall be a solid state device using full wave circuitry to equally load each phase and each half cycle of the input power source under load condition.
- 2) The rectifier shall be capable of continuous delivery of rated power to the inverter DC load.

2.5.3.2 Input Voltage Tolerance: The rectifier shall operate from AC input power for voltages within a range of at least +10% of nominal.

2.5.3.3 Input Frequency Tolerance: The rectifier shall operate from AC input power within a frequency range of +5% of 60Hz.

2.5.3.4 Output Filtering: Adequate DC output filtering shall be provided to allow the rectifier to operate the inverter without a battery source.

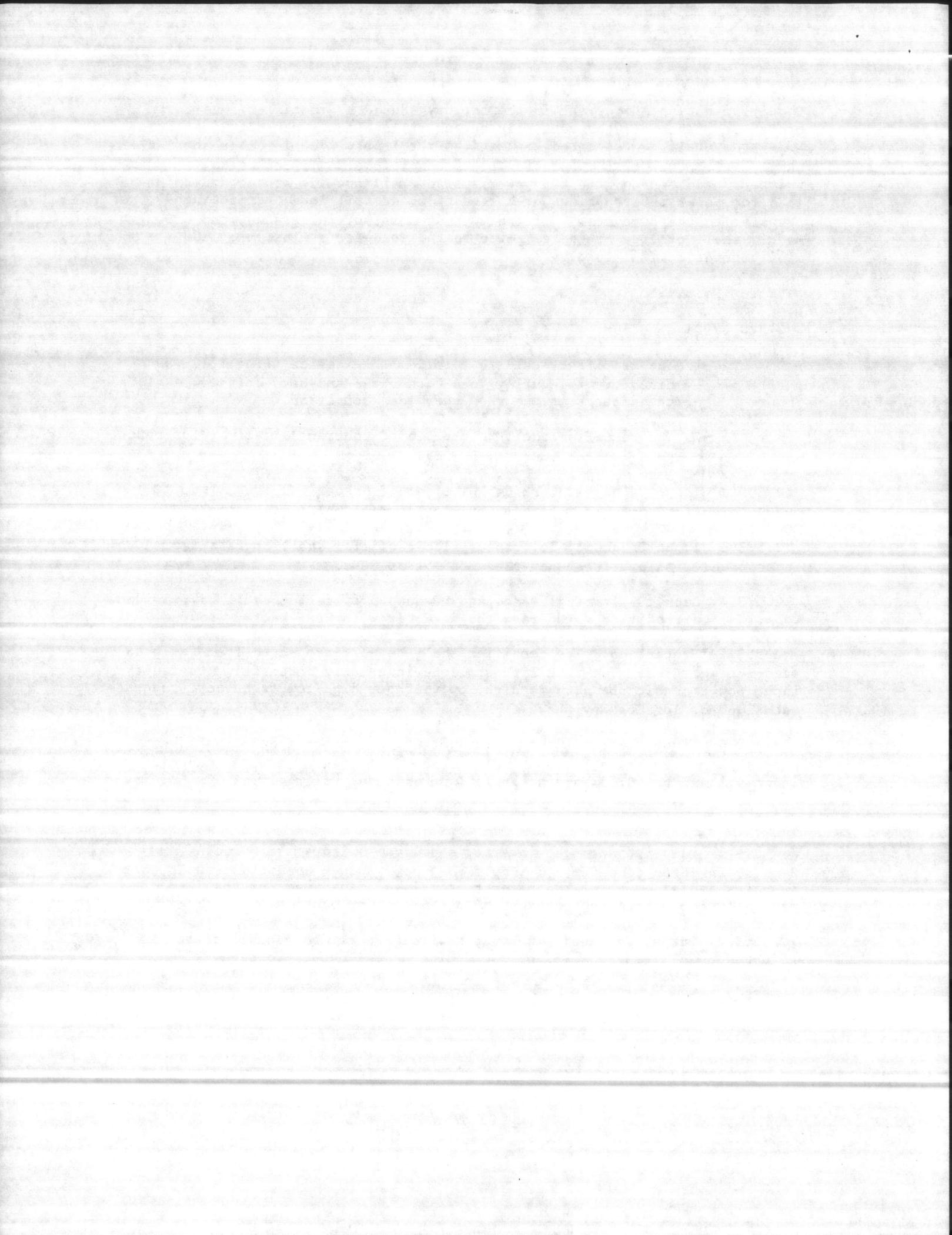
2.5.3.5 Protection: The rectifier shall be self-protected from fault by fast-acting fuses. The rectifier shall be inherently insensitive to faulty input power conditions such as high/low voltage, high/low frequency, phase rotation, or loss of any phase.

2.5.3.6 Power Factor: At full load, the input power factor shall be better than 0.95 at rated input voltage and 0.85 leading at 10% reduction input voltage and 0.85 lagging at 110% rated input voltage.

2.5.4 Inverter/Motor Generator:

2.5.4.1 Description: The inverter shall use solid state DC to AC, 3-phase inverter circuitry to supply the rotary power conditioner unit that supplies isolated, regulated power to the load. The inverter shall be naturally commutated by the back EMF of the rotary section.

2.5.4.2 Output Voltage: The output voltage shall be capable of being adjusted over a range of +5% of the nominal rated output voltage. The



output voltage shall be regulated to within $\pm 1\%$ for the total input voltage range, and for a load range from no load to Full load with a power factor between 1.0 to 0.8 lagging. The phase angle between line-to-line voltages shall be $120^\circ \pm 1\%$ under any balanced load condition. The voltage amplitude modulation shall be less than 2%.

2.5.4.3 Output Frequency: The output frequency shall be synchronized to the input source when operating in the normal mode. When operating from the battery or input rectifier only, the system shall operate at the internal frequency. The system shall operate at the internal frequency if the existing source of power is out of tolerance. The output frequency shall remain at 60Hz ± 0.5 Hz for all operating conditions, within the specified temperature range, including input voltage variations and load changes.

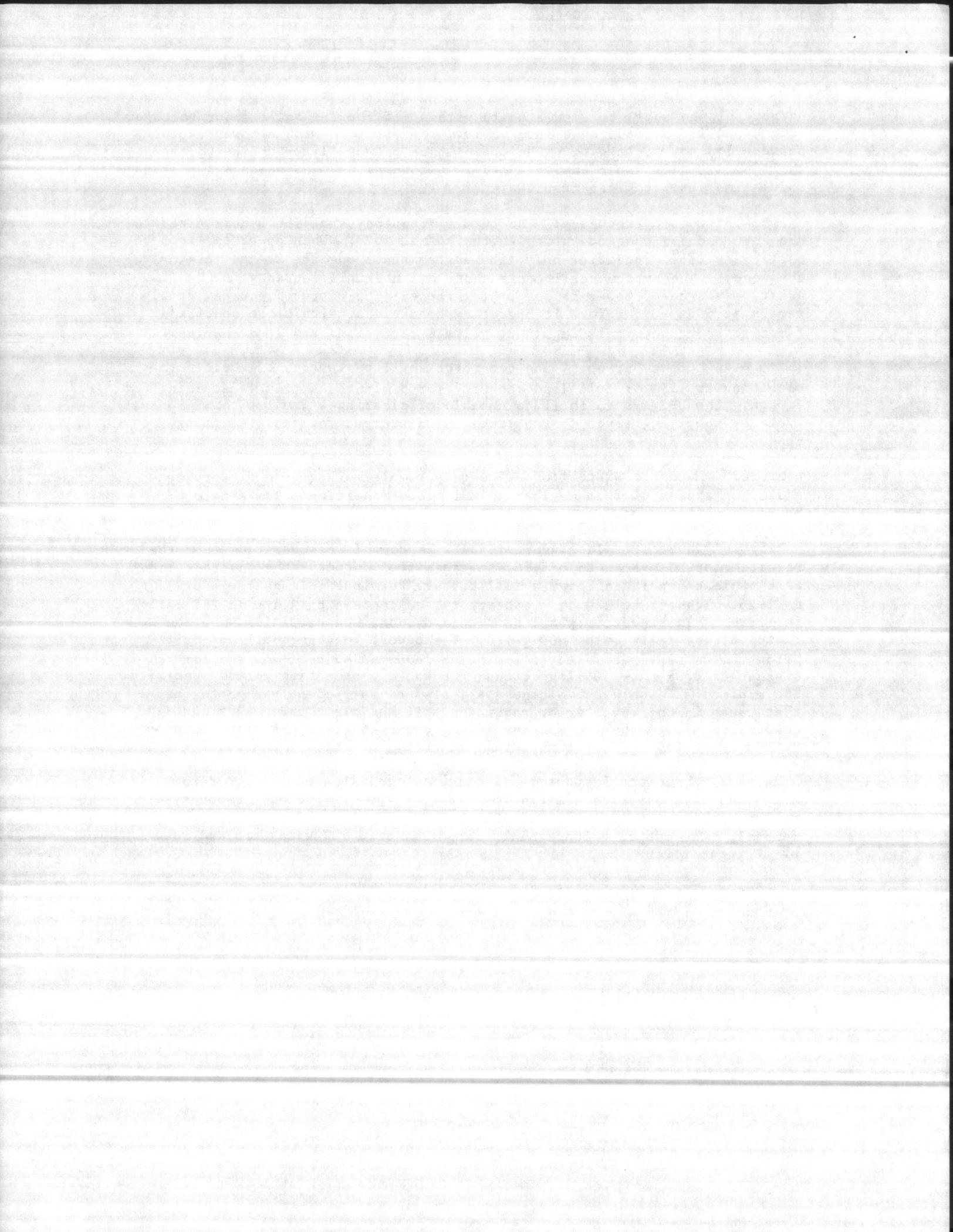
2.5.4.4 Output Current: The generator shall be capable of short term operation at 125% of full load capacity for 5 minutes without sustaining any damage. The UPS system shall be capable of clearing a fault within one-half cycle by supplying seven to ten times rated current for fault clearing capability.

2.5.4.5 Harmonic Distortion: The output voltage harmonic distortion shall not exceed 4% from no load to full load condition. The single harmonic content shall not exceed 3%.

2.5.4.6 Inverter: The inverter shall be capable of operating from the rectifier or DC system to provide the specified output. The inverter shall be capable of operating over a full battery terminal voltage range of 1.60 to 2.25 volts per cell with a battery system containing 1 string 240 cells in series. The inverter shall be set to discontinue operation when the DC input voltage falls below 400 volts. The cutoff voltage shall not fall below the battery manufacturer's minimum recommended cell voltage for discharges of a rate 50% longer than the battery operation period specified. The minimum allowable DC voltage shall also be sufficiently high to ensure that fuses in the inverter or rectifier will not clear under any loading conditions within the UPS modules rating during battery operation or upon return of AC input power immediately prior to low battery shutdown.

2.5.4.7 Transient Response: The maximum excursion of the generator output voltage shall be limited to $\pm 12\%$ with 200 milliseconds recovery time to normal output voltage for a 100%, 0.8 PF step load application and removal. The output voltage shall vary less than $\pm 5\%$ with loss and return of AC input power.

2.5.4.8 Protection: The inverter shall be self-protected from faults by fast acting fuses.



2.5.4.9 Efficiency: The overall UPS module efficiency shall be greater than 91% at rated redundant load, 89% at 3/4 rated load and 88.5% at 1/2 rated load.

2.5.4.10 Input Distortion: The overall input current waveform harmonic distortion under full load shall not exceed 3%. The input current waveform distortion from a sine wave shall not exceed 5%. The additional input voltage deviation from a sine wave shall be less than 3% even when the input is supplied from an engine generator under constant load.

2.5.5 Instrument and Control Devices:

2.5.5.1 Control circuits shall be protected by fuses. Each UPS shall be equipped with the following instrumentation and control devices:

- a. Input AC circuit breaker with handle
- b. Input AC voltmeter with phase selector switch
- c. Input AC ammeter
- d. Output AC voltmeter with phase selector switch
- e. Output ammeters (one per phase)
- f. Output frequency meter
- g. Elapsed time meter
- h. DC voltmeter
- i. DC ammeter
- j. MG set on pushbutton
- k. Emergency Off key operated switch
- l. Output on pushbutton
- m. By-pass on pushbutton
- n. Manual-auto bypass mode switch
- o. Reset pushbutton
- p. Horn off pushbutton

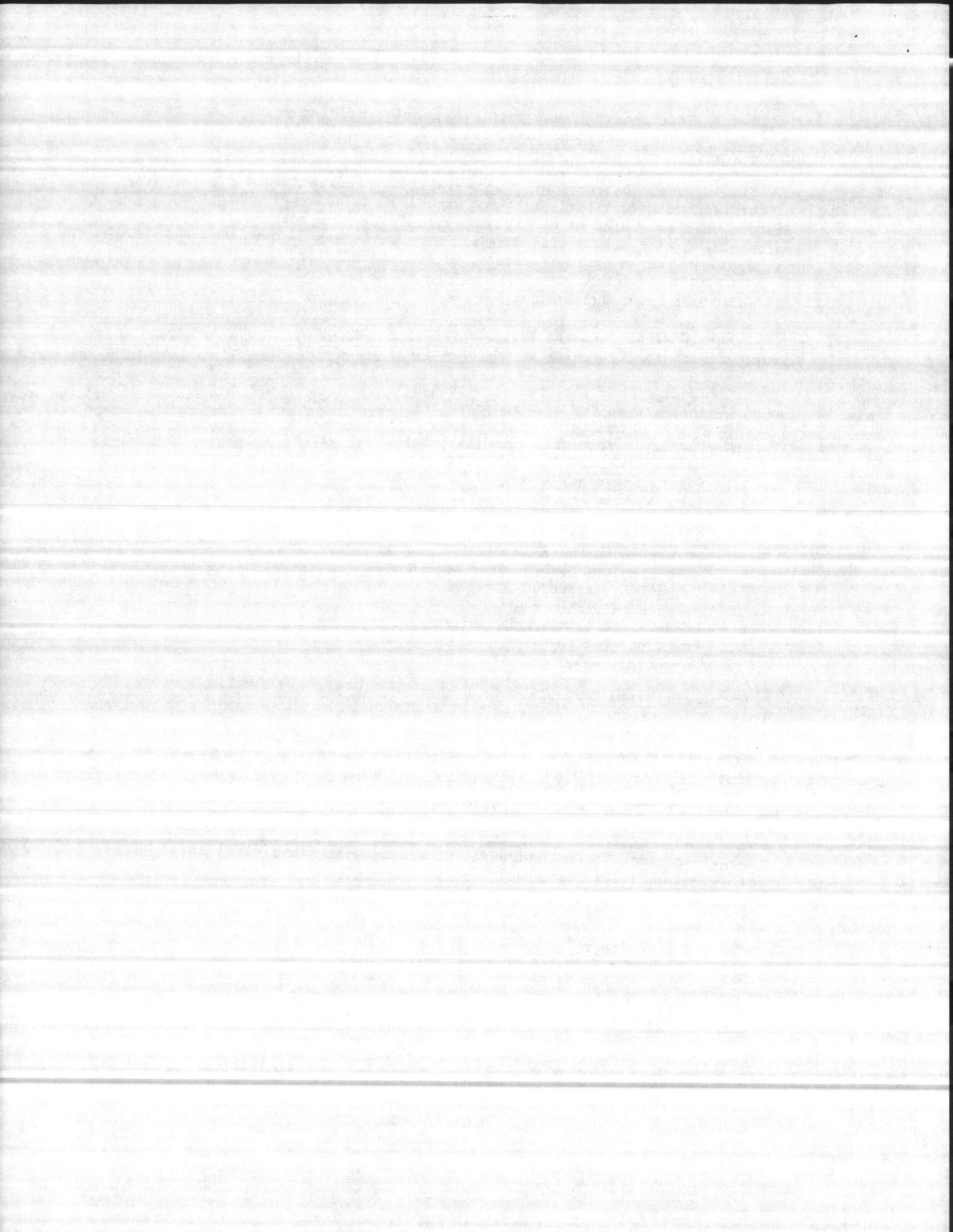
2.5.5.2 Internal Controls:

- a. Inverter on-off reset switch
- b. Static switch on-off reset switch
- c. Bypass off pushbutton
- d. Output off pushbutton
- e. Synchronization test switch
- f. MG set off pushbutton

2.5.6 Alarms: The following visual alarms with mimic panel shall be provided on each UPS furnished:

2.5.6.1 Indicating Lamps:

- a. System Start
- b. Thyrister Switch Operation (Tripped)



- c. Rectifier/Inverter Operation (Tripped)
- d. Battery Operation
- e. Output On
- f. Bypass Synch
- g. Bypass On
- h. Filter Tripped

2.5.6.2 Alarms:

- a. Mains Failure
- b. Bearing Temperature
- c. Winding Temperature
- d. Overload
- e. Battery Low
- f. Summary Failure
- g. Control Voltage Failure
- h. Filter Tripped

2.5.6.3 Internal Alarm:

- a. Frequency
- b. Voltage
- c. Static Switch
- d. Rectifier
- e. Inverter
- f. Battery Charger (external)

2.5.6.4 Remote annunciator alarm contact with reset and lamp test pushbutton shall be provided.

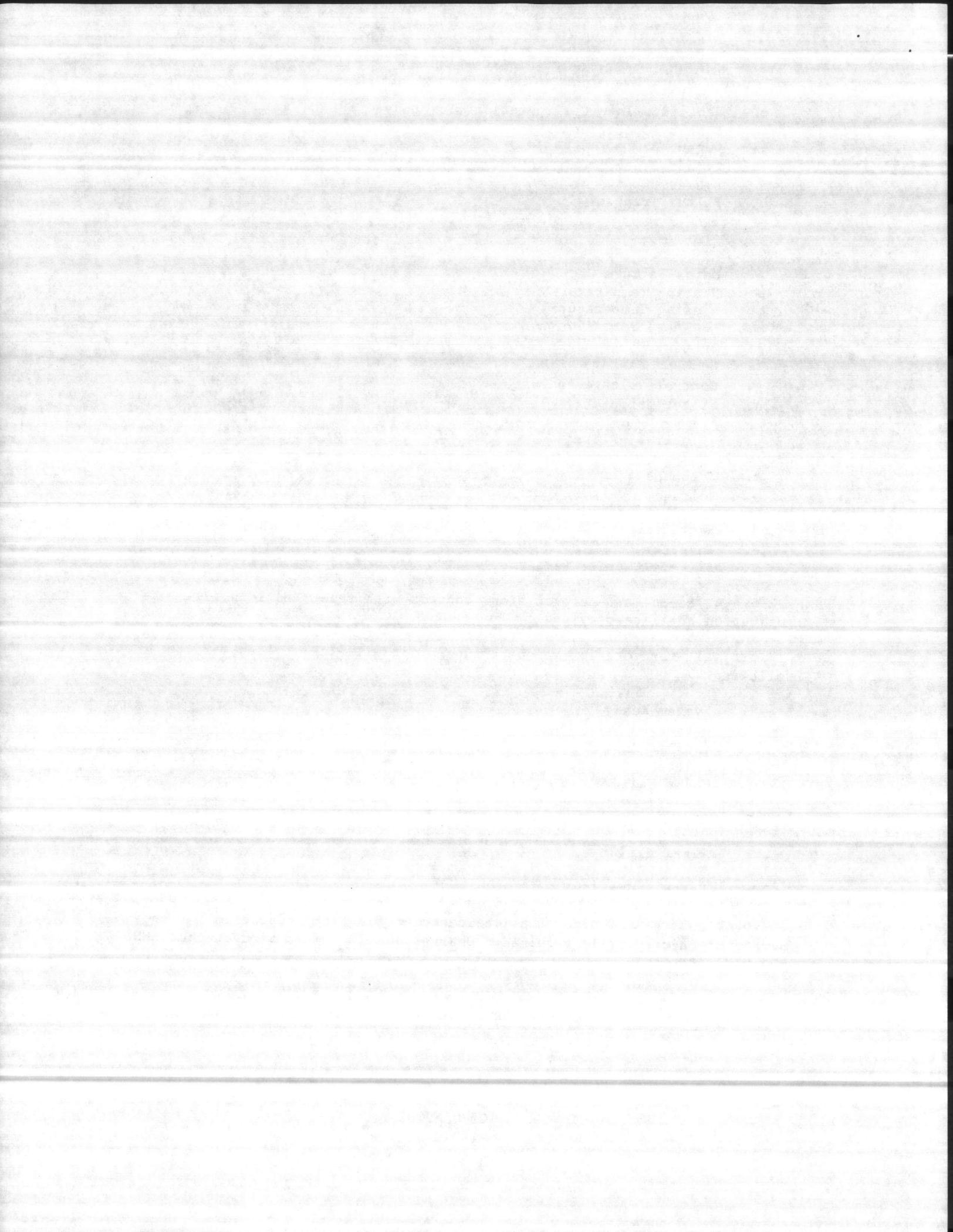
2.5.6.4.1 Contacts for remote annunciation will be provided for the following:

- 1. System Ready
- 2. Output On
- 3. Bypass On
- 4. Maintenance Bypass On
- 5. Mains Failure
- 6. Battery Low
- 7. Alarm

2.6 BATTERY SYSTEM

2.6.1 Battery Charger:

2.6.1.1 Battery Charger shall be designed for float operation for the number of battery cells required. Charger shall conform with current ANSI and NEMA standards.



2.6.1.2 Input to charger shall be 480 volt, 3-phase, 60Hz. Capacity of charger shall be sufficient to charge battery from full 10 minute discharge voltage to fully charge condition in 12 hours.

2.6.1.3 Charger shall have circuit breaker protection for input and fuse protection for the output.

2.6.1.4 Accessories shall include the following:

- a. Manual equalize charge switch.
- b. Low voltage alarm relay.
- c. DC output voltmeter, 2% accuracy.
- d. DC output ammeter, 2% accuracy.

2.6.2 DC Switchboard:

2.6.2.1 Each UPS module shall be isolated from the DC source by a fused bolted pressure switch of appropriate rating. If multiple UPS modules and/or multiple battery strings are connected to a common DC bus, each UPS module and each battery string shall be isolated from the common bus by its own fused bolted pressure switch of appropriate Amp rating. All bus will be silverplated copper rated at 1000A/square inch.

2.6.2.2 The DC switchboard shall also contain an individual fused disconnect of appropriate rating to isolate each battery charger from the DC bus.

2.6.2.3 The DC switchboard shall be constructed so that front access only is required. Fuses shall be located for easy access and replacement.

2.6.3 Storage Battery:

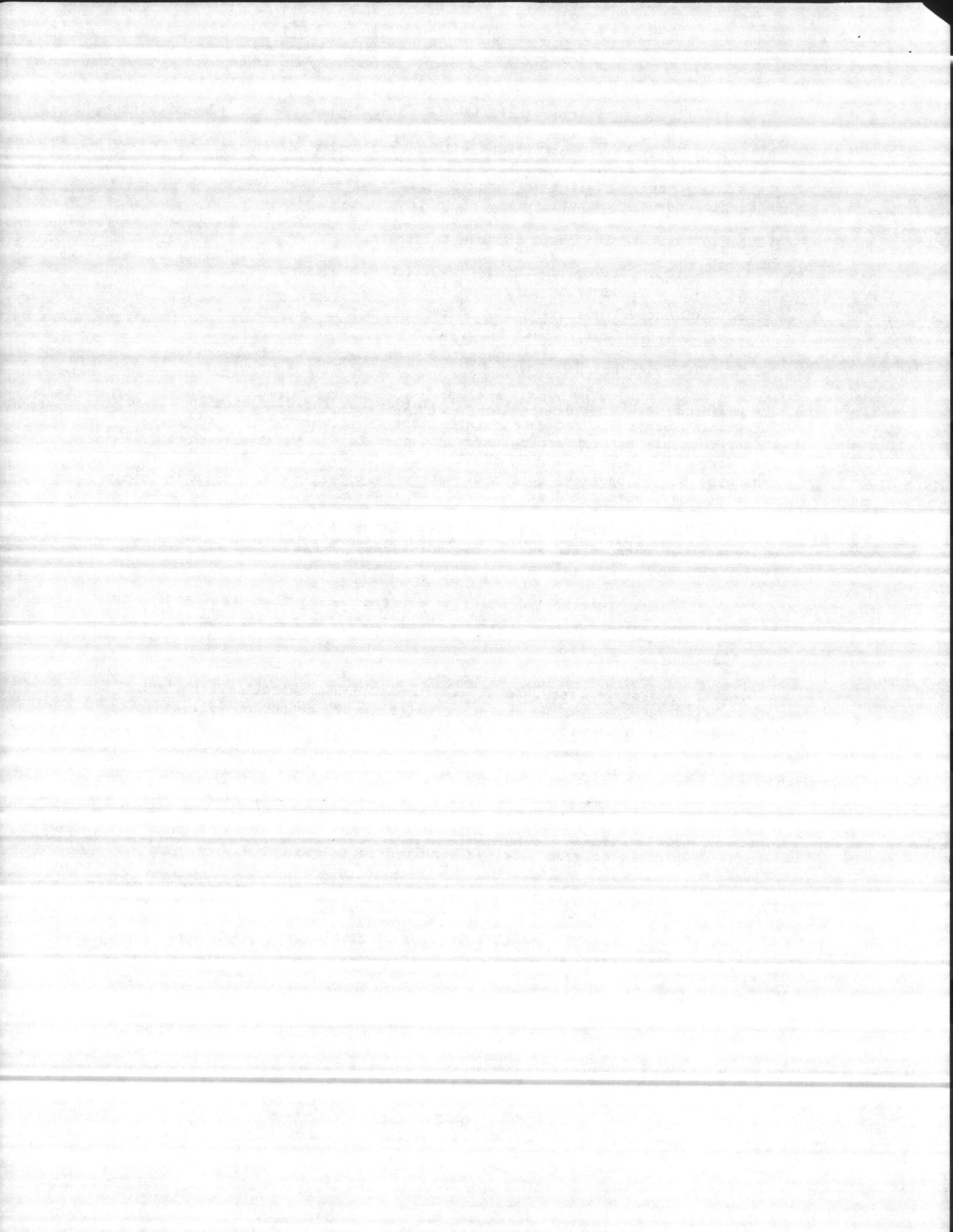
2.6.3.1 A storage battery shall be furnished and installed for the UPS with sufficient ampere hour rating to maintain UPS output at full capacity for a duration of 10 minutes.

2.6.3.2 The battery shall be supplied with:

- a. 2 Tier racks protected with electrolyte resistant paint.
- b. Intercell and inter-tier connectors.
- c. Hydrometer and thermometer.
- d. Special tools or fittings required to assemble the battery.

2.6.3.3 The battery system shall have a design life of at least 20 years and be so guaranteed by the battery manufacturer.

2.6.3.4 The battery shall be insulated to withstand a +1000 volt DC high potential test applied to either the positive or negative terminals, while



connected to the UPS system in operable condition with the DC Disconnect open.

2.6.3.5 The battery shall operate at 2.25 volts per cell on float charging. At the end of discharge, the cell voltage shall not be less than 1.67 volts per cell (per battery manufacturer's recommendations). The full charged cells shall have a specific gravity of 1.250 at 25°C. Battery shall be rated at initial capacity after appropriate freshening charge and not a maximum capacity during system life.

2.7 WIRING

2.7.1 The UPS manufacturer shall provide all internal UPS module connections in prefabricated form for installation at the UPS site. These interconnections will provide all wiring internal to the UPS modules and battery intercell and inter-tier connections. Connections between equipment and to the remote alarm panel shall be furnished and installed by Contractor, in accordance with UPS manufacturer's detail drawings.

2.7.2 All bolted connections of bus bars, lugs, and cables shall be copper to copper connections. They shall be rechecked and tightened prior to request for acceptance of equipment by the Government. All buswork shall be copper or silver plated copper.

2.8 CONSTRUCTION AND MOUNTING

2.8.1 The UPS shall be constructed in modular units which shall be installed in NEMA Type I metal enclosures, designed for floor mounting. The UPS shall be structurally adequate and have provisions for hoisting and forklift handling.

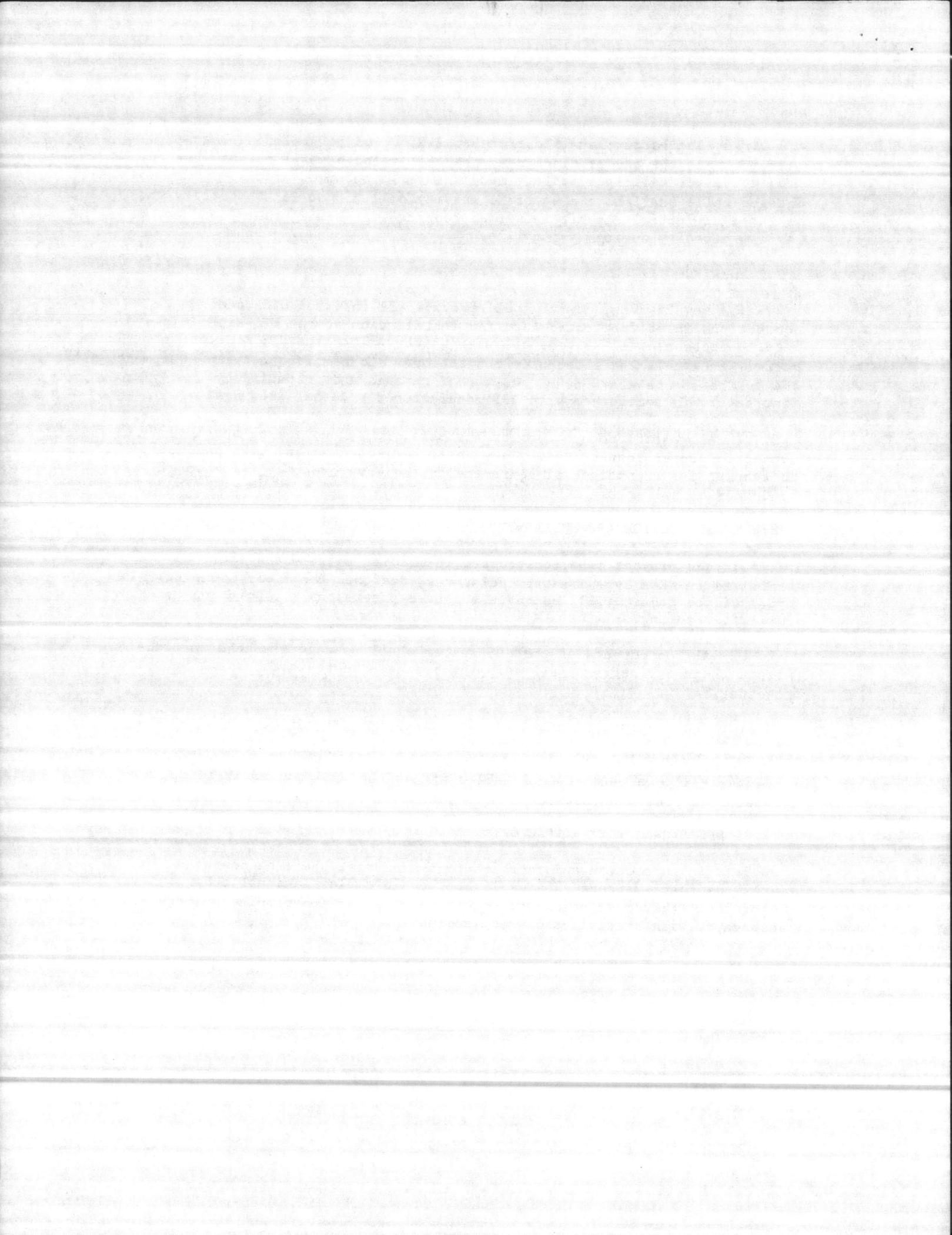
2.8.2 All components of the UPS system shall be securely held in place within their cabinet. At all shipping breaks, the equipment shall be bolted together.

2.8.3 The UPS cabinet shall be cleaned, primed and painted with enamel paint.

2.8.4 All power and control cables within the UPS modules shall be connected by the manufacturer.

2.9 UPS SYSTEM TEST AT FACTORY

2.9.1 An inspection and functional no-load test shall be conducted to determine that switches, status lights, audible alarm and all other operational characteristics of the UPS modules are functioning and are in accordance with specification requirements.



2.9.2 With each UPS module operating from AC power source input voltage, input frequency, input current, input power factor, DC voltage, DC current, output voltage, output frequency, output current, input and output KW and output harmonic distortion shall be measured and recorded under no-load, 25%, 50%, 75%, 100%, 125% load for 5 minutes. Efficiency shall be calculated.

2.9.3 With each UPS module operating from AC power source, with DC source connected, each of the following transient voltage tests shall be recorded:

- 25% load step, 50% to 75% load and return
- 25% load step, 75% to 100% load and return
- 40% load step, 0% to 40% load and return
- 40% load step, 60% to 100% load and return
- Loss of input power with 100% applied load

2.9.4 With each UPS module operating from AC power source at full load, the harmonic current flowing in the input power line shall be determined. The test shall be repeated at 50% load.

2.9.5 During testing, measure the noise level of the UPS module and record.

2.9.6 A complete functional test of the system bypass shall be performed at no load. Bypass operation shall then be tested in both directions under load.

2.9.7 All pertinent data shall be recorded.

PART 3 - EXECUTION

3.1 INSTALLATION

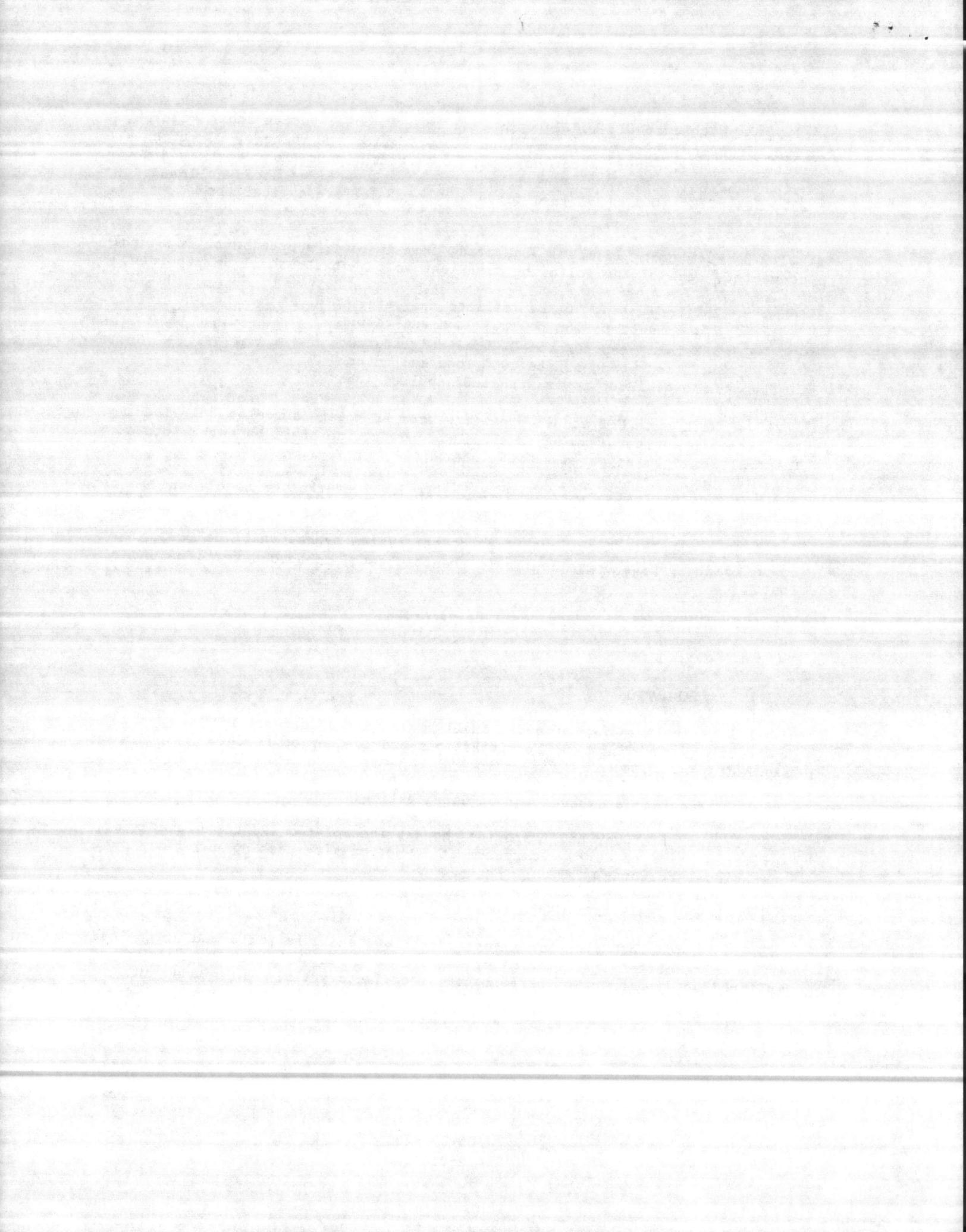
3.1.1 Installation of the UPS shall be in full accordance with instructions, drawings and specifications provided by of the UPS manufacturer.

3.1.2 Provide load banks for on-site testing.

3.1.3 Manufacturer shall provide the services of two (2) technicians for sufficient time to carry out system start-up, on-site testing and 1 day of operational training.

3.2 FIELD TESTS AND INSPECTIONS

3.2.1 A complete functional test of the UPS shall be performed at no-load at the site, after installation of same, to ascertain that the equipment has suffered no impairment of performance since factory tests were made, and



that the installation is in accordance with manufacturer's installation drawings.

3.2.2 With the UPS operating from the prime AC power source at full load, effect bypass and return at normal functions. Record all pertinent data to show compliance with specifications. Factory load tests shall be repeated at the module level and shall also be done at the system level.

3.2.3 With the UPS operating from the standby AC power source of full load, effect bypass and return at normal functions. Perform tests to show compliance with specifications during operation with diesel-engine driven standby generator.

3.2.4 With a fully charged battery and with 100% load, demonstrate battery operation. Disconnect utility input to the UPS. Log time until the battery source available alarm operates. Restart system and log time until batteries are 100% charged. During this test, the battery system meters shall be read and logged at regular intervals. Instrumentation required for testing shall be supplied by the UPS manufacturer.

3.3 ACCEPTANCE

3.3.1 Start-up of the equipment does not constitute an acceptance of the work by Government. Final acceptance shall occur when 1) the manufacturer has adjusted his equipment, 2) demonstrated that it fulfills the requirements of the specification to the extent verifiable by the factory test data and on-site testing specified, and 3) completed all punch list items. Manufacturer shall furnish ten (10) copies of on-site acceptance test report to Contracting Officer.

3.3.2 Should it be found by the Government that the equipment or any portion thereof fails to comply with the specifications with respect to performance, quality, or amount of materials used in the equipment and the manufacturer does not correct such defect in a timely manner, the affected equipment shall be replaced by manufacturer.

*** END OF SECTION ***

