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USACE / NAVFAC / AFCEC **UFGS-26 33 53 (May 2019)**

Preparing Activity: USACE **Superseding**
UFGS-26 32 33.00 10 (October 2007)
UFGS-26 33 53.00 20 (April 2008)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
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SECTION 26 33 53

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SECTION 26 33 53

STATIC UNINTERRUPTIBLE POWER SUPPLY (UPS)
05/19

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NOTE: This guide specification covers the requirements for static UPS to provide continuous ac power to critical loads and/or to improve the quality of ac power to critical loads. The specification is intended to cover three-phase systems starting with the smallest unit at 20 kVA. The upper end for a single module is around 750 kVA; however, parallel systems can have a larger total output. This guide specification is intended to be used with individual UPS units which contain a single module, parallel systems of the same size module, and scalable modular UPS systems. Single phase systems are not addressed. This specification covers UPS with electro-chemical batteries. Electro-mechanical (stored energy) UPS are not addressed. White paper TSEWG TP-19 is on Static Uninterruptible Power Supplies and should be reviewed while editing this specification. See https://www.wbdg.org/ffc/dod/supplemental-technical-criteria/tsewg-tp-19 **This specification supercedes previous versions of UFGS-26 32 33.00 10 Static Uninterruptible Power Supply (UPS) and UFGS-26 33 53.00 20 Uninterruptible Power Supply (UPS).**

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for

this guide specification are welcome and should be submitted as a Criteria Change Request (CCR).

****

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NOTE: For Air Force projects only: UPS specifications, criteria, and purchases are to be approved by the Power Conditioning and Continuation Interfacing Equipment (PCCIE) Group Manager at Ogden Air Logistics Center (OO-ALC/LGHC). Contact the PCCIE Product Group Manager, 500 CBSS/GBLD, Building 1207-N, 6029 Wardleigh Road, Hill AFB, UT 84056-5838. If you have access to the Air Force portal, then search PCCIE.

****

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NOTE: Show the following information on the project drawings:

1. Location of equipment

2. Single-line diagrams, elevations, limiting dimensions, and equipment ratings which are not covered in the specifications

3. Remote indicating requirements.

4. Maintenance bypass switching cabinet and configuration.

****

PART 1 GENERAL

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a RID outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ACOUSTICAL SOCIETY OF AMERICA (ASA)

ASA S1.4	(1983; Amendment 1985; R 2006) Specification for Sound Level Meters (ASA 47)

ASTM INTERNATIONAL (ASTM)

ASTM B173	(2017) Standard Specification for Rope-Lay-Stranded Copper Conductors Having Concentric-Stranded Members, for Electrical Conductors
ASTM D709	(2017) Standard Specification for Laminated Thermosetting Materials

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE 100	(2000; Archived) The Authoritative Dictionary of IEEE Standards Terms
IEEE 450	(2020) Recommended Practice for Maintenance, Testing, and Replacement of Vented Lead-Acid Batteries for Stationary Applications
IEEE 485	(2020) Recommended Practice for Sizing Lead-Acid Batteries for Stationary Applications
IEEE C2	(2023) National Electrical Safety Code
IEEE C57.110	(2008) Recommended Practice for Establishing Liquid-Filled and Dry-Type Power and Distribution Transformer Capability When Supplying Nonsinusoidal Load Currents
IEEE C62.41	(1991; R 1995) Recommended Practice on Surge Voltages in Low-Voltage AC Power Circuits
IEEE C62.41.1	(2002; R 2008) Guide on the Surges Environment in Low-Voltage (1000 V and Less) AC Power Circuits
IEEE C62.41.2	(2002) Recommended Practice on Characterization of Surges in Low-Voltage (1000 V and Less) AC Power Circuits

INTERNATIONAL ELECTRICAL TESTING ASSOCIATION (NETA)

NETA ATS	(2021) Standard for Acceptance Testing Specifications for Electrical Power Equipment and Systems

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION (ISO)

ISO 9001	(2015) Quality Management Systems-

Requirements

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA 250	(2020) Enclosures for Electrical Equipment (1000 Volts Maximum)
NEMA PE 1	(2012; R 2017) Uninterruptible Power Systems (UPS) - Specification and Performance Verification

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2023; ERTA 1 2024; TIA 24-1) National Electrical Code
NFPA 70E	(2024) Standard for Electrical Safety in the Workplace

U.S. DEPARTMENT OF DEFENSE (DOD)

UFC 3-301-01	(2023; with Change 2, 2024) Structural Engineering

U.S. DEPARTMENT OF ENERGY (DOE)

Energy Star	(1992; R 2006) Energy Star Energy Efficiency Labeling System (FEMP)

U.S. FEDERAL COMMUNICATIONS COMMISSION (FCC)

FCC Part 15	Radio Frequency Devices (47 CFR 15)

UL SOLUTIONS (UL)

UL 1778	(2014; Reprint Apr 2023) UL Standard for Safety Uninterruptible Power Systems

1.2 DEFINITIONS

Unless otherwise specified or indicated, electrical and electronics terms used in these specifications, and on the drawings, are as defined in IEEE 100.

1.3 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a G to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy, and Air Force.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

UPS Drawings; G, [_____]

[UPS Installation; G, [_____]]

SD-03 Product Data

UPS Module; G, [_____]

Technical Requirements UPS System

Energy Star Label for Battery Charging Systems and AC-DC/AC-AC Power Supply Products; S

****

NOTE: Delete submittal for spare parts on Navy projects.

****

[Spare Parts; G, [_____]]

SD-06 Test Reports

Work Plan; G, [_____]

Factory Test Plan; G, [_____]

Factory Test Report; G, [_____]

SD-09 Manufacturer's Field Reports

Initial Inspection and Tests; G, [_____]

Performance Tests; G, [_____]

Performance Test Plan; G, [_____]

Performance Test Report; G, [_____]

SD-10 Operation and Maintenance Data

UPS Operation and Maintenance, Data Package 5; G, [_____]

Submit operation and maintenance data in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA and as specified herein.

SD-11 Closeout Submittals

Installation

1.4 OPERATION AND MAINTENANCE MANUALS

1.4.1 Additions to UPS Operation and Maintenance Manuals

In addition to requirements of SD-10 Data Package 5, include the followings on the actual UPS system provided:

a. An outline drawing, front, top, and side views.

b. Prices for spare parts and supply list.

c. Routine and field acceptance test reports.

d. Date of Purchase.

e. Corrective maintenance procedures.

1.4.2 Spare Parts

****

NOTE: Army Only. Do not provide spare parts for Navy projects.

****

Furnish the following spare parts, of the same material and workmanship, meeting the same requirements, and interchangeable with the corresponding original parts.

a. Fuses: Two of each type and rating.

b. Circuit boards: One circuit board for each critical circuit.

c. Air Filters: One set of filters, when used on the UPS unit.

d. Special tools, calibration devices, and instruments required for operation, calibration, and maintenance of the equipment: One complete set.

1.5 QUALITY ASSURANCE

The manufacturer must have a documented quality assurance program including:

a. Inspections of incoming parts, modular assemblies and final product.

b. Final test procedure for the product including proof of performance specifications.

c. The on-site test procedure includes an inspection of controls and indicators after installation of the equipment.

d. ISO 9001 quality certification.

1.5.1 UPS Drawings

Drawings are to include the following: Detail drawings consisting of a complete list of equipment and materials, manufacturer's descriptive and technical literature, battery sizing calculations per IEEE 485, installation instructions, single-line diagrams, elevations, layout drawings, and details required to demonstrate that the system has been coordinated and will function properly as a unit.

a. One-line diagram.

b. Outline drawings including front elevation, section views, footprints, and overall dimensions.

c. Manufacturer's descriptive and technical literature.

d. Markings and NEMA nameplate data.

e. Battery sizing calculations per IEEE 485.

f. Wiring and control diagrams with terminals identified, and indicating prewired interconnections between items of equipment and interconnection between the items.

g. Complete list of materials and equipment covering major components. Ensure the bill of material and the schematic have a direct correlation between items in order to easily identify the various components.

h. Details required to demonstrate that the system has been coordinated and will function properly as a unit.

1.5.2 UPS Installation

Include wiring diagrams and installation details of equipment indicating proposed location, layout and arrangement, control panels, accessories, piping, ductwork, and other items that must be shown to ensure a coordinated installation. Wiring diagrams are to identify circuit terminals and indicate the internal wiring for each item of equipment and the interconnection between each item of equipment. Drawings are to indicate adequate clearance for operation, maintenance, and replacement of operating equipment devices. Submittals include the nameplate data, size, and capacity. Submittals also include applicable federal, military, industry, and technical society publication references.

1.5.3 Work Plan

Submit schedules of dates for factory tests, installation, field tests,

and operator training for the UPS system. Furnish a list of instrumentation equipment for factory and field test reports.

1.5.4 Factory Test Plan

Submit factory test plans and procedures at least [21][_____] calendar days prior to the tests being conducted. Provide detailed description of test procedures, including test equipment and setups, to be used to ensure the UPS meets the performance specification and explain the test methods to be used. Provide test procedures that include the test required under the paragraph entitled "Factory Testing."

1.5.5 Factory Test Report

Submit a factory test report within [21][_____] calendar days after completion of tests. Receive approval of test prior to shipping unit. Factory test reports are to be signed by an official authorized to certify on behalf of the UPS manufacturer of that the system meets specified requirements in accordance with the requirements set forth in paragraph entitled "Factory Testing". Provide test reports in booklet form tabulating factory tests and measurements performed, upon completion and testing of the installed system. Reports are to state the Contractor's name and address, the name of the project and location, and list the specific requirements which are being certified.

1.5.6 Performance Test Plan

Submit test plans and procedures at least [15][_____] calendar days prior to the start of field tests. Provide detailed description and dates and times scheduled for performance of tests, and detailed description of test procedures, including test equipment (list make and model and provide functional description of the test instruments and accessories) and setups of the tests to be conducted to ensure the UPS meets the performance specification. Explain the test methods to be used. Provide test procedures that include the tests required under the paragraph entitled "Performance Tests."

1.5.7 Performance Test Report

Submit report of test results as specified by paragraph entitled "Performance Tests" within [15][_____] calendar days after completion of tests. Field test reports are to be signed by an official authorized to certify on behalf of the UPS manufacturer that the system meets specified requirements in accordance with the requirements set forth in paragraph entitled "Performance Tests". Provide test reports in in booklet form tabulating factory tests and measurements performed, upon completion and testing of the installed system. Reports are to state the Contractor's name and address, the name of the project and location, and list the specific requirements which are being certified.

1.5.8 Regulatory Requirements

In each of the publications referred to herein, consider the advisory provisions to be mandatory, as though the word, "must" had been substituted for "should" wherever it appears. Interpret references in these publications to the "authority having jurisdiction," or words of similar meaning, to mean the Contracting Officer. Provide equipment, materials, installation, and workmanship in accordance with the mandatory and advisory provisions of NFPA 70 unless more stringent requirements are

specified or indicated.

1.5.8.1 Reference Standard Compliance

Where equipment or materials are specified to conform to industry and technical society reference standards of the organizations such as American National Standards Institute (ANSI), American Society for Testing and Materials (ASTM), National Electrical Manufacturers Association (NEMA), Underwriters Laboratories (UL), and Association of Edison Illuminating Companies (AEIC), submit proof of such compliance. The label or listing by the specified organization will be acceptable evidence of compliance.

1.5.8.2 Independent Testing Organization Certificate

In lieu of the label or listing, submit a certificate from an independent testing organization, competent to perform testing, and approved by the Contracting Officer. The certificate is to state that the item has been tested in accordance with the specified organization's test methods and that the item complies with the specified organization's reference standard.

1.5.9 Standard Products

Provide materials and equipment that are products of manufacturers regularly engaged in the production of such products which are of equal material, design and workmanship and:

a. Have been in satisfactory commercial or industrial use for 2 years prior to bid opening including applications of equipment and materials under similar circumstances and of similar size.

b. Have been on sale on the commercial market through advertisements, manufacturers' catalogs, or brochures during the 2-year period.

c. Where two or more items of the same class of equipment are required, provide products of a single manufacturer; however, the component parts of the item need not be the products of the same manufacturer unless stated in this section.

d. The service organization is to be, in the opinion of the Contracting Officer, reasonably convenient to the site.

e. Provide new parts and materials comprising the UPS system from the current manufacture, of a high grade and free of defects and imperfections, and has not been in prior service except as required during aging and factory testing.

1.5.9.1 Alternative Qualifications

Products having less than a 2-year field service record will be acceptable if a certified record of satisfactory field operation for not less than 6000 hours, exclusive of the manufacturers' factory or laboratory tests, is furnished.

1.5.9.2 Material and Equipment Manufacturing Date

Products manufactured more than 6 months prior to date of delivery to site are not acceptable.

1.6 INSPECTION

Inspection before shipment is required. The manufacturer must notify the Government at least 2 weeks before shipping date so that an inspection can be made.

1.7 DELIVERY AND STORAGE

Protect equipment placed in storage from humidity and temperature variations, moisture, water intrusion, dirt, airborne corrosives, or other contaminants. In harsh environments where temperatures exceed non-operational parameters established within this specification, provide an environmentally controlled equipment storage facility to ensure temperature parameters are within equipment specification. Provide documentation of same to the Government when storage is implemented.

1.8 PROJECT/SITE CONDITIONS

****
NOTE: Army Only. This paragraph and its associated subparagraphs is used by the Army. Delete for other projects.
****

1.8.1 Environmental Conditions

The UPS and battery system must be capable of withstanding any combination of the following external environmental conditions without mechanical or electrical damage or degradation of operating characteristics.

****
NOTE: Designer must show approximate elevation above sea level for project location if it exceeds 1,000 meters 3,300 feet. UPS system including batteries must be derated if 50 degrees C 122 degrees F operating temperature is required.
****

a. Operating altitude: Sea level to 1,000 meters 3,300 ft. (Systems applied at higher altitudes are to be derated in accordance with the manufacturer's instructions).

b. Non-operating altitude: Sea level to 11,000 meters 36,000 ft.

c. Operating ambient temperature range: 0 to 40 degrees C 32 to 104 degrees F. Range for batteries is 20 to 25 degrees C 68 to 77 degrees F. Provide batteries that are capable of operating in a larger ambient temperature range of 10 to 30 degrees C 50 to 86 degrees F, but some degradation of life span is understood when operating outside the range of 20 to 25 degrees C 68 to 77 degrees F.

d. Non-operating and storage ambient temperature range: Minus 20 to plus 50 degrees C Minus 4 to plus 122 degrees F. Range for batteries or UPS modules with internal batteries: 10 to 30 degrees C 50 to 86 degrees F.

e. Operating relative humidity: 0 to 95 percent, without condensation.

1.8.2 Sound Pressure Levels

NOTE: UPS modules rated up to 125 kVA should have a dB rating of 65 dBA or lower at 1 meter 39 inches. UPS modules rated above 125 kVA should have a dBA rating of 75 dB or lower at 1.5 meters 5 feet.

Sound pressure levels produced by the UPS, when operating under full rated load, at a distance of[1.5 meters 5 feet][1 meter 39 inches][_____] in any direction from the perimeter of the unit, must not exceed [75][65][_____] dB as measured on the A scale of a Type 1 sound level meter at slow response conforming to ASA S1.4.

1.8.3 Verification of Dimensions

The Contractor is to become familiar with details of the work, verify dimensions in the field, and is to advise the Contracting Officer of any discrepancy before performing the work. Do not proceed until the discrepancy or unsatisfactory condition(s) have been corrected.

PART 2 PRODUCTS

[2.1 SYSTEM DESCRIPTION

NOTE: Connect alternate power source to bypass/maintenance bypass for systems requiring dual input. Edit for the configuration used in this project. There are other configurations that the UPS system can be configured, but these are the more common ones.

Note: Delete system cabinet when specifying a single module UPS system.

Provide continuous duty, three-phase, solid state, on-line double conversion reverse transfer static UPS(s). The UPS by means of solid state conversion techniques, must provide continuous regulated AC power to its output terminals, while operating from an input power source, cabinet or rack-mounted direct current (DC) storage battery or other approved means. The performance of the UPS must not be degraded when operating without a system battery, provided the input AC source is within tolerance. Provide an UPS system that conforms to UL 1778 and consists of UPS module, battery system, battery protective device, [system cabinet,]static bypass transfer switch, controls and monitoring, system protective devices, means of isolating the UPS system from the critical load, and remote monitoring interfaces. Connect input ac power the normal source ac input of the UPS module. [Connect alternate power source bypass/maintenance bypass.]Connect battery to the dc input of the UPS module through the battery protective device. The following configuration is used:

NOTE: Three main choices: Non-Redundant, Redundant System, and Scalable Units. The Redundant system herein is strictly various parallel configurations, where a N+1 as a minimum is to be achieved.

Scalable units are becoming the standard, since they allow modularity and reduce the number of UPS models for a manufacturer. Scalable units in a Redundant configuration would also need to indicate the Redundant System configuration.

****

[a. Non-Redundant.

(1) Single Module. On-line, single module UPS configuration capable of supplying power to the total load, with bypass availability.

(2) Parallel Multi-Module. Two or more UPS modules, of the same size, on-line, operating in parallel, with enough capacity to supply the total load.

][b. Redundant System.

[(1) Isolated Redundant System (Segmented Redundant or Hot Standby). One unit on-line supporting the load, while the other unit is operating to provide the bypass source.

][(2) Parallel Redundant System. Two or more UPS modules, of the same size, on-line, operating in parallel, with more capability than is required to support the total load. If any unit fails, the remaining unit or units is able to support the critical load.

][(3) Split Bus System. Two parallel redundant systems that may be operated separately or through a tie breaker for increased redundancy. Each UPS system on either side of the split bus is able to support the total critical load.

][(4) Distributed Redundant System. Distributed redundant configurations is also called tri-redundant. The basis of this design uses three or more UPS modules with independent input and output feeders. The independent output buses are connected to the critical load via multiple PDUs.

]]c. Scalable Units.

****

NOTE: Scalable units are rack or cabinet mounted UPS power modules of the same size, which have scalable architecture to allow expansion/contraction to a different kVA size within the same vertical rack or cabinet lineup. The kVA is achieved by adding or subtracting power modules to achieve the desired kVA rating. Each power module, depending on the manufacturer, has a rectifier, inverter and battery converter. There is an UPS system module that works with these power modules to form the UPS. Scalable Units can be specified to have be non-redundant or be redundant. An explanation for each configuration is below.

****

][(1) Scalable Unit Non-Redundant. Non-redundant:scalable unit consists of a UPS system module with one or more power modules. The power modules provided are all required to handle the critical load.

][(2) Scalable Unit Internal Redundant. Internal Redundant: scalable unit consists of a UPS system module with more than one power module. There is at least one additional power module that is not required to handle the load within the system. The additional power module or power modules can be sized to handle only part of the critical load or all the critical load. This is not a true parallel redundant system system since it still uses one UPS system module.

][(3) Scalable Unit Redundant. Redundant:scalable unit consists of a UPS system module with one or more power modules. The number of power modules can be to just support the load or also have at least one extra power module to internal redundancy. This UPS system module is parallel with a matching scalable unit previously discussed under "Redundant System".

]

]2.2 MODES OF OPERATION

2.2.1 Normal

The UPS module rectifier/charger must convert the incoming ac input power to dc power for the inverter and for float charging the battery. The inverter continuously coverts the dc power to ac power to supply the critical load. The inverter output must synchronize with the bypass ac power source, provided that the bypass ac power source is within the specified voltage and frequency range.

2.2.2 Battery - Emergency Operation (Loss or deviation of AC Input Power)

Whenever the ac input power source deviates from the specified tolerances including complete failure, the inverter must draw power from the battery system and supply AC power to the critical load without any interruption or switching transient. The battery system must supply power to the inverter for the specified protection time or until return of ac input source. Provide an audible alarm to indicate the UPS is on battery and provide provisions for a remote alarm signal to be sent via the communication network and a relay output, allowing startup of a secondary power source or orderly shutdown of the critical load.

2.2.3 Failure of AC Input Power to Return

If the ac input power fail to return before the battery voltage reaches the discharge limit, then the UPS system must disconnect from the critical load to safeguard the battery.

2.2.4 Recharge

Upon restoration of normal power to the UPS unit, the input converter and output inverter must simultaneously recharge the batteries and provide regulated power to the critical load.

2.2.5 Transfer to Static Bypass AC Power Source

****

NOTE: Choose the first paragraph for non-redundant systems, i.e. single module, parallel multi-module, or scalable unit non-redundant UPS. Choose the second paragraph for redundant systems to include scalable unit internal redundant and scalable unit

redundant.
****

[When the UPS controller senses an overload, two or more inverter shutdown signals or degradation of the inverter output, the static bypass switch automatically transfers the critical load from the inverter output to the bypass ac power source without an interruption of power. If the static bypass ac power source is outside of specified tolerance limits, the UPS and the critical load shut down. Transfer to static bypass can also be done manually (requested bypass). Transfer to bypass does not take place under these conditions: 100% stepload; and, loss or return of input power, momentary sags, surges or spikes on the input to the UPS.
][When the UPS controller senses an overload, two or more inverter shutdown signals or degradation of the inverter output, the static bypass switch automatically transfers the critical load from the inverter output to the bypass ac power source without an interruption of power only if the connected load exceeds the capacity of the remaining on-line modules. If the static bypass ac power source is outside of specified tolerance limits, the UPS and the critical load shut down. Transfer to static bypass can also be done manually (requested bypass). Transfer to bypass does not take place under these conditions: 100% stepload; and, loss or return of input power, momentary sags, surges or spikes on the input to the UPS.]

2.2.6 Transfer to Inverter

Provide a static bypass switch that is capable of automatically transferring the load back to the inverter output after the inverter overload condition has returned to normal conditions. Transfer only occurs once the two sources are synchronized. UPS system logic is to monitor the number of retransfer's within any one-hour period and is to allow 1 to 3 transfers in order to prevent cyclical transfers caused by overloads.

[2.2.7 Maintenance Bypass
****

NOTE: The majority of systems should provide an external maintenance bypass in order to isolate the UPS for maintenance. Internal switches still provide a benefit, but do not provide complete isolation when doing maintenance (arc flash hazard still exist). The configuration on the maintenance bypass is covered more fully later in paragraph 'MAINTENANCE BYPASS CIRCUIT'.

****

Provide the system with an external make-before-break maintenance bypass cabinet/panel to electrically isolate the UPS during routine maintenance and service. Manual transfer to the maintenance bypass circuit transfers the critical load from the inverter output to the bypass ac power source without disturbing the critical load bus.

][2.2.8 Off-Battery (Battery Maintenance)

Provide a battery protective device which disconnects the battery from the rectifier/charger and inverter for maintenance. The device may be located external to the UPS cabinet. The UPS module continues to function and meet the performance criteria specified except for the battery back-up time function.

][2.2.9 Failure of a Module

****
NOTE: Delete for non-redundant systems, i.e. single module, parallel multi-module, or scalable unit non-redundant UPS.
****

In a redundant configuration, failure of one module causes that module to be disconnected from the system critical load bus by its internal protective devices and its individual output protective device. Remaining module(s) are to continue to carry the load.

][2.2.10 UPS Module Servicing

****
NOTE: Delete for non-redundant systems, i.e. single module, parallel multi-module, or scalable unit non-redundant UPS..
****

Provide a means the manually disconnect the UPS modules from the critical load bus for maintenance without disturbing the critical load bus.

]2.2.11 Component Performance

Do not exceed 75% of the working voltage and current ratings as established by the manufacturer on solid-state power components and electronic devices. Do not exceed 75% of the operating temperature of solid-state component sub-assemblies. Use computer grade electrolytic capacitors and operate at no more than 95% of the voltage rating at the rectifier charging voltage.

2.3 GENERAL UPS SYSTEM COMPONENTS AND FABRICATION

2.3.1 Semiconductor Fusing

Protect power semiconductors with fast-acting fuses to prevent cascaded or sequential semiconductor failures. Bolt fuses at both ends to bus bars to ensure mechanical and electrical integrity. Indicator lamp or display panel denoting blown fuse conditions must be readily observable by the operator without removing panels or opening cabinet doors.

2.3.2 EMI/RFI Protection

Provide an UPS that complies with and is labeled compliant, with FCC Part 15, Subclass B, Class A.

2.3.3 Internal Wiring

Wiring practices, materials, and coding must be in accordance with the requirements of NFPA 70, OSHA, UL 1778, and other applicable standards. Protect wire runs in a manner which separates power and control wiring. Provide control cabling that is at least No. 16 AWG extra-flexible stranded copper. Logic-circuit wiring may be smaller. Provide ribbon cables that are at least minimum No. 22 AWG. Provide control wiring with permanently attached wire numbers.

2.3.4 Internal Assembly

The printed circuit board (PCB) subassemblies are to be mounted in

pull-out swing-out trays where feasible. Provide cable connections to the trays that are sufficiently long to allow easy access to all components. Where not feasible to mount PCB subassemblies in pull-out or swing-out trays, then mount them firmly mounted inside the enclosure. Monitor every PCB subassembly. Include self-test and diagnostic circuitry in the logic circuits such that a fault can be isolated down to the PCB subassembly level. When used, control logic cards are to have test points or logic indicators on the front edge of the control logic card and be labeled.

2.3.5 Cable Lugs and Terminations

2.3.5.1 Cable Lugs

Provide appropriate compression type lugs or pre-drilled bus bars on all ac and dc power connections to the UPS system and battery as required. Aluminum or bare copper cable lugs are not suitable.

2.3.5.2 Terminations

Supply terminals for making power and control connections. Provide terminal block for field wiring terminals. Provide terminal blocks that are the heavy-duty, strap-screw type or screw terminals that are integrated into removable plugs. Locate terminal blocks for field wiring in one place in each module. Extend control wiring to the terminal block location. Any terminal point is limited to land a maximum of two wires. Where control wiring is attached to the same point as power wiring, Provide a separate terminal where control wiring is attached to the same point as power wiring, . If bus duct is used, provide bus stubs where bus duct enters cabinets.

2.3.6 Cabinets

****

NOTE: UPS units are normally made to be handled by a fork lift.

****

Install the UPS system in cabinets of heavy-duty structure meeting the NEMA PE 1 standards for floor mounting. Provide a structurally adequate UPS module that can be forklift handled and lifted. [Provide removable lifting eyes on top of each cabinet.] Provide the UPS module cabinet with hinged and key lockable doors on the front only and with assemblies and components accessible from the front. Provide dead-front construction behind the door for those UPS module cabinets that are not lockable. Operating controls are to be located outside the locked doors. Install input, output, and battery cables through the top or bottom of the cabinet.

[2.3.6.1 Cabinet Finish

****

NOTE: On Army projects choose the bracketed option; otherwise delete. Designer needs to coordinate with the requirements found in UFC 3-560-01 for arc-flash signage requirements.

****

Provide an equipment cabinet that is cleaned, primed and painted in the manufacturer's standard colors, in accordance with accepted industry standards. Cabinets are to be labeled in accordance with NFPA 70 and NFPA 70E.

]2.3.6.2 Factory Applied Finish

Provide electrical equipment with a factory-applied painting systems which, as a minimum, meets the requirements of NEMA 250 corrosion-resistance test.

[2.3.6.3 Drawout Assemblies

****

NOTE: Drawout applies to large units for removing inverter modules, static switches assemblies, etc. This is not a standard option even on larger units. Delete for units smaller than 500 kVA.

****

Provide a means of lifting, either and overhead device or a hoisting device for drawout assemblies weighing 23 kg 50 lbs or more. Device can either be part of the UPS or a separate portable device that can be used to perform the lifting.

]2.3.7 Manufacturer's Nameplates

Provide a nameplate for each item of equipment bearing the manufacturer's name, address, model number, and serial number securely affixed in a conspicuous place; the nameplate of the distributing agent will not be acceptable.

2.3.8 Field Fabricated Nameplates

ASTM D709. Provide laminated plastic nameplates for each equipment enclosure, relay, switch, and device; as specified or as indicated on the drawings. Provide an inscription on each nameplate that identifies the name of the item, calculated short circuit rating with date, and source of power e.g. 'Panel A in Electrical Room 103'. Provide nameplates that are made of melamine plastic, 3 mm 0.125 inch thick, white with [black][_____] center core. Provide the nameplate with a surface that is matte finished and that has square corners.. Accurately align lettering and engrave into the core. Provide nameplates that are at least 25 by 65 mm 1.0 by 2.5 inches with a minimum lettering size of 6.35 mm 0.25 inch high normal block style.

2.3.9 Safety

Provide UPS with instruction plates including warnings and cautions, suitably located, and describing any special or important procedures to be followed in operating and servicing the equipment. Provide control panel displays, which also provide warning messages prior to performing a critical function.

2.3.9.1 Maintenance Isolation

All energized terminals, both AC and DC, and control voltage exposed points are to be insulated or enclosed to ensure the safety of maintenance personnel. Provide the system with the ability to isolate the static switch to enable repair when the UPS is bypassed.

2.3.9.2 Remote Emergency Power Off (REPO) Switch

Provide a remote emergency power off switch that is separate from the UPS. Provide a red, pushbutton with a cover with a label indicating "UPS

Emergency Power Off". The switch disconnects all breakers or contactors including battery, input, output, and bypass breakers when activated.

2.4 TECHNICAL REQUIREMENTS UPS SYSTEM RATINGS

Unless stated otherwise, the parameters listed are under full output load over the range of0.9 lagging power factor to 0.9 leading power factor, with batteries fully charged and floating on the dc bus and with nominal input voltage.

2.4.1 UPS SYSTEM LOAD PROFILE

****

NOTE:
The UPS may exhibit load interface problems with certain types of ac load. The items which present the greatest problems are motors, transformers, electric discharge lighting, and SCR and mag-amp power supplies. Problems with these loads are caused by either load nonlinearity or inrush currents required for their operation. The Contractor will be better able to accommodate specific applications if well-defined load data is available.

****

Provide an UPS system that is compatible with the load characteristics defined in the LOAD PROFILE below and load configuration. The UPS system is to provide compensation for UPS/load interaction problems resulting from nonlinear loads or transformer and motor inrush.

LOAD PROFILE

Type of load:

Data processing equipment. Size of load: [_____][kVA][kW], [_____]voltage, [[_____]power factor].

****

NOTE: If known, provide the actual nameplate full load amps and the locked rotor code letter. If not known, delete the option.

****

Motors - type [_____]. Size of load: [_____]horsepower, [_____]voltage[, [_____] full load amps, [_____] locked rotor code letter].

Electric Discharge Lighting. Size of load: [_____][kVA][kW], [_____]voltage, [[_____]power factor].

****

NOTE: Variable Frequency Drives that are powered from an UPS, need to be specified with input inductors.

****

Variable Frequency Drive(s). Size of load: [_____]horsepower, [_____]voltage

Load switching pattern: [unswitched][cycled daily][cycled hourly][operated by thermostat][building management system control][_____].

****

NOTE: Coordinate this with the UPS System Load

Profile paragraph. Power factors have been improving and it is becoming common to have 0.9 lagging or higher power factor.

Steady-state characteristics: [0.9 lagging][_____] power factor.

Special factors: [harmonic characteristics - Total Harmonic Distortion [_____] percent][high elevation][nonstandard input and output voltages][_____].

2.4.2 System Requirements

NOTE: Typical capacities in kVA are 10, 15, 20, 30, 40, 50, 80, 100, 125, 150, 225, 250, 275, 300, 500 and 750.

NOTE: System capacity for single module UPS is same as module capacity. Paralleling can be for capacity or for redundancy. Parallel redundant UPS typically provide on additional module that can be down while still carrying the entire load.

NOTE: Scalable Unit sizes listed can vary from manufacturer to manufacturer as well as the number that can be paralleled. If paralleling more than 4 modules, check with the main manufacturers for availability.

The UPS is to support and maintain full battery charging under the following conditions: indicated environmental conditions, a.c input voltage range, air filters blocked up to 50% and a single failed fan. The UPS size and configuration is indicated below.

[Single Module (non-redundant). Provide one UPS sized for [_____] kVA and [_____] kW.
]
[Parallel System is comprised of [_____] UPS system-level redundancy. The parallel system is sized for [_____] kVA and [_____] kW.]

NOTE: Scalable units are flexible so there are several choices. The power module are the units that provide the load and can provide internal redundancy if desire. The total load is the estimated demand for the critical load. The UPS system module is the overall controlling module. Example: One can have a system module at 60 kVA and have two 20 kVA power modules to allow for future expansion.

[Scalable Units. Each UPS power module is rated [10][20][25][_____] kVA. Provide at least [_____] UPS power modules to handle the system

load. [Provide one additional UPS power modules for internal redundancy] The total load is [_____] kVA and [_____] kW. The UPS system module is sized for [_____] kVA and [_____] kW.
]

2.4.3 Battery Capacity

****

NOTE: Typical battery discharge times are 5, 10, 12, 15, and 30 minutes. If no emergency source is available, longer battery discharge time may be required.

IEEE 450 defines end of life to be at 80% of the initial capacity. The industry standard is to size an end of life battery for 125% of initial capacity. Choose 125% unless another value is required.

****

Discharge time to end voltage: [10][15][30][_____] minutes, at 25 degrees C 77 degrees F. Provide a battery that is capable of delivering [125][_____] percent of full rated UPS kW load at 0.9 power factor at initial start-up.

2.4.4 Static Switch

****

NOTE: The static switch or static disconnect is a solid-state disconnect device used to apply or disconnect ac power. The interrupting capacity requirements must be determined for each project distribution system. Typical interrupting capacities are 30,000 AIC and 50,000 AIC. Interrupting capacities are normally found on the single line diagram or in the short circuit calculations provided with the drawings.

****

[____] amperes (continuous duty)

2.4.5 Short Circuit Withstand Rating

Braced for at least [____] amperes symmetrical interrupting capacity.

2.4.6 AC Input

****

NOTE: Be certain that units having foreign voltages are clearly specified since they are not standard for U.S. manufactured products.

****

a. Voltage [208][240][480][_____] volts line-to-line.

****

NOTE: Scalable unit systems do not come with an output transformer, so the input and output voltage needs to be the same when editing. Transformerless help with the efficiency of the UPS unit and keeps the foot-print smaller. Single unit UPS are still available with step-down output transformers

****

b. Number of phases: Three-phase[+ neutral] + ground configuration..

c. Voltage Range: Plus 10 percent, minus 15 percent nominal (no battery discharge), without affecting battery float voltage or output voltage.

****
NOTE: Use 50 Hz for units shipped or purchased in Europe.
****
d. Frequency: [60][50] Hz, plus or minus 5 percent.

****
NOTE: For scalable units choose the second bracketed option. For other type units, choose the first bracketed option.
****
e. Power walk-in: [20 percent to 100 percent input current over 10 to 15 seconds.] [0 percent to 100 percent input current over 10 to 15 seconds with an adjustable setting that can be set from 5 seconds to 30 seconds.]

****
NOTE: Total harmonic current distortion (THD) is usually 5 percent. If UPS will be supplied from a generator, the generator capacity must be at least twice the UPS capacity if THD exceeds 5 percent.
****
f. Total harmonic current distortion (THD) reflected into the primary line: [5][10] percent maximum at full load.

g. Sub-cycle magnetizing inrush: [2 to 3][_____] times full load current for modules without an isolation transformer.

h. Input surge protection: per IEEE C62.41.1 and IEEE C62.41.2, meeting IEEE C62.41 requirement of Category B3 6kV, 100k Hz ring wave and 6kV, combined wave.

i. Input power factor: Lagging from 1-100 percent load.
****
NOTE: Delete transformer inrush paragraph if input isolation transformer is not required. For transformer sub-cycle inrush, selecting a lower value like 6 or 4 in lieu of the range (4 to 8) is better for coordination of UPS feeder protection but might add some cost and extra components. If the range is selected than upstream breaker should have instantaneous current adjustment.
****

[j. Transformer sub-cycle magnetizing inrush: [5 to 8][_____] times full load current with optional isolation transformer and optional input filter.
]

2.4.7 AC Output

****
NOTE: If the output voltage is 208Y/120 V and the

same voltage is not available for the static bypass and maintenance bypass, a transformer will be required in the bypass distribution system.

NOTE: Scalable units do not come with an output transformer, so the input and output voltage needs to be the same when editing. These scalable, expandable module systems are typically 208V, 480V, and 600V. Transformerless designs help with the efficiency of the UPS unit and keeps the foot-print smaller. Single unit UPS are still available with step-down output transformers.

****

a. Voltage [208][220][240][480][_____] volts line-to-line[, [120][127][277][_____] volts line-to-neutral].

b. Number of phases: Three-phase[+ neutral] + ground configuration.

c. Voltage regulation:

(1) Balanced load: Plus or minus 1.0 percent.

(2) 50 percent load imbalance, phase-to-phase: Plus or minus 2 percent.

(3) 100 percent load imbalance, phase-to-phase Plus or minus 3 percent.

(4) Voltage drift: Plus or minus 1 percent over any 30 day interval (or length of test) at stated ambient conditions found in paragraph Environmental Conditions.

d. Voltage adjustment: Plus or minus 5 percent.

e. Frequency: [60][50] Hz.

f. Frequency regulation: Plus or minus 0.1 percent, when on internal oscillator. Internal oscillator is to be temperature compensated.

g. Frequency drift: Plus or minus 0.1 percent over any 24 hour interval (or length of test) at stated ambient conditions when on internal oscillator.

h. Harmonic content (RMS voltage): Provide a system that meets the following voltage THD levels: maximum of 4% RMS total,2 percent total with 100 percent on any single harmonic (linear load) and 5 percent RMS total for up to 100 percent nonlinear load.

****

NOTE: The load factor range can vary with the presence of a transformer. choose the first set of brackets in "i" when the UPS does not have a transformer and choose the second set of brackets when there is a transformer or provide own values. The load factor range is the range the UPS can operate at without derating.

****

i. Load power factor operating range (without derating): [0.9 leading to 0.9 lagging][0.95 leading to 0.9 lagging][_____].

j. Phase angle displacement/imbalance:

(1) Balanced load: 120 degrees plus or minus [0.5][1] degree of bypass input.

(2) 50 percent load imbalance phase-to-phase: 120 degrees plus or minus 3 degrees of input.

k. Inverter overload capability (at full voltage with plus or minus 2 percent regulation) (excluding battery):

****

NOTE: Designer needs to determine the overload requirements against protection for the load. Any number can be used that falls within the range for each percent overload. Default values are 10 minutes for 125 percent and 60 seconds for 150 percent.

****

(1) 125 percent load for [10 minutes][30 seconds][60 seconds][_____].

(2) 150 percent load for [60 seconds][40 ms].

(3) Fault clearing. Provide an UPS that is able to maintain output current during a fault condition for 20 cycles if bypass is unavailable or 1 cycle with bypass available. If the fault is not cleared and a bypass is available, the UPS is to transfer to bypass without interruption to clear the fault.

l. Load sharing of parallel modules: Plus or minus 5 percent at full rated system load.

m. Bypass Overload Capability.

****

NOTE: For scalable units choose the second option. Choose the first option for all others.

****

[(1) 0 percent load for 15 seconds.

][(2) Expandable units. 125 percent continuous at rated output voltage (phase-to-phase). 1000 percent for 1000 milliseconds.

]

2.4.8 Transient Response

2.4.8.1 Voltage Transients

a. 100 percent load step: Plus or minus 5 percent.

b. Loss or return of ac input: Plus or minus [1][5] percent.

c. Automatic transfer of load from UPS to bypass: Plus or minus 1 percent.

d. Manual retransfer of load from bypass to UPS: Plus or minus 5 percent.

****

NOTE: The default value is 20 milliseconds unless a

faster recovery time is required. For scalable units, use 50 milliseconds.
****

e. Response time: Recovery to 1 percent of nominal within [20][50][16] milliseconds where there was a maximum deviation from nominal system output of volts plus or minus 5 percent.

2.4.8.2 Frequency

a. Transients: Plus or minus 0.6 Hz maximum.

****
NOTE: If there is a generator in the project, which will power the UPS during a utility power outage, then choose the second option.
****

b. Slew Rate: under all conditions of operation, [provide 0.4 to 1.0 Hz per second][0.25 to 0.8 Hz per second].

2.4.9 Efficiency

****
NOTE: Efficiencies do vary some with the size of the UPS; however, the variance between lower rated UPS and higher rated UPS have narrowed. Almost all sizes in double-conversion mode will meet 94%. The higher double-conversion efficiency is 97%. UPS systems loaded to 50 percent will typically see a reduction of 1-2 percentage in efficiency. Units with a transformer could have a lower efficiency.

Delete system efficiency requirements for single module UPS systems.

Energy Star only covers the battery charging systems and the AC-DC/AC-AC power supplies. Energy Star does not cover all components of the complete UPS System. Energy Star UPSs cannot be one of the following types:
(a) Products that are internal to a computer or other end load.
(b) Industrial UPSs designed to protect critical control, manufacturing or production processes.
(c) Utility UPSs that are part of electrical transmission and distribution
(d) Cable TV UPSs designed to power cable distribution systems.
(e) UPSs designed to comply with specific UL safety standards for safety-related applications e.g. emergency lighting, medical diagnostic equipment
(f) UPSs designed for mobile, ship board, marine or airborne applications.
****

[a. Minimum Single-Module Efficiency: [94][_____] percent at full load kW and [92][____] percent at 50 percent load.

][b. Minimum System Efficiency: 93 percent at full system load kW.
]

[c. Provide Energy Star labeled battery charging systems and AC-DC/AC-AC power supplies. Provide proof of Energy Star label for battery charging systems and AC-DC/AC-AC power supply products.
]
[2.4.10 Energy Saving Mode
****
NOTE: The UPS industry has developed various energy saving methods. If this is desired then edit appropriately; otherwise, delete. Smaller units may not have this option available. There are some issues that need to be considered since energy saving methods typically do not regulate the voltage or the frequency, Areas with unstable power may not consider this appropriate. UPS installations that require the double-conversion to filter (clean-up) the incoming power should not enable an energy saving mode that allows facility power to the critical load. If the UPS unit is powering IT equipments (such as a data center), choose 2 milliseconds; otherwise 13 milliseconds is acceptable.
****

Provide the UPS with an energy saving mode that operates by having the inverter charged and batteries on at all times, while the main power to the output is through the static bypass switch. When a power problem is sensed, the system is to operate in double-conversion mode and revert to energy saving mode after a pre-set period of time. Maximum transition time is [2][13] miliseconds.

]2.5 UPS MODULE

2.5.1 General Description
****
NOTE: This part is for Scalable units only. If a scalable unit is not desired, then delete this part.
****

UPS module consists of an input converter, output converter, with associated transformers, synchronizing equipment, protective devices, surge suppression, and accessories as required for operation.

2.5.1.1 Interchangeability

The subassemblies in one UPS module are to be interchangeable with the corresponding modules within the same UPS, and from one UPS system to another of identical systems.

2.5.1.2 Rectifier/Charger Unit

Scalable, expandable modular input converts for the system are to be housed within removable power modules. Input converters control the power from the mains input of the system, provide the necessary UPS power for precise regulation of the DC bus voltage, battery charging, and main inverter regulated output power.

2.5.1.2.1 Input Protective Device
****
NOTE: Calculate/verify AIC on the single line

diagram at input of the UPS.

****

Provide the rectifier/charger unit with an input protective device. Size the protective device to accept simultaneously the full-rated load and the battery recharge current. Provide a protective device that is capable of shunt tripping and has an amperes symmetrical interrupting rating of [____]. Provide the protective device with an under-voltage release to open automatically when the control voltage is lost.

[2.5.1.2.2 Input Isolation Transformer

****

NOTE: An input isolation transformer is not normally required. Delete unless specifically required to be part of the UPS. Also, delete when requiring scalable, expandable modular UPS systems. Isolation transformers provide isolation of line induced EMI, common mode noise and dc offsets. Some of the UPS manufacturers require a separate cabinet for the transformer.

UPS industry is transitioning away from transformers being part of the UPS. Having the transformer separate can save space, reduce cooling, improve energy efficiency, reduce weight and cost. In general, those unit smaller than 200 kW will benefit more by not having a transformer as part of the UPS. The threshold level of 200 kW is increasing as more manufacturers go to "transformerless" designs.

Transformers rated 500 kVA and higher typically have the transformer connections on the backside.

****

The rectifier unit is to use a dry-type, isolated-winding power transformer. The transformer's hottest spot winding temperature must not exceed the temperature limit of the transformer insulation material when operating at full load. Provide a transformer with Class H, 150 degrees C rise insulation. [Transformer connections are to be accessible from the front.] If there is a separate transformer cabinet, it is is to match the UPS cabinet and attach to it.[Provide a Department of Energy CSL-3 transformer.]

]2.5.1.2.3 Power Walk-In

Input convert is to have an adjustable soft-start (either by manufacturer or owner), capable of limiting the input current form 0 percent to 100 percent of the input over a default 10 second period when returning to ac input bus from battery operation. The change in current over time is to be done in a linear manner.

2.5.1.2.4 Sizing

Size the rectifier/charger unit for the following two simultaneous operating conditions:

a. Supplying the full rated load current to the inverter.

b. Recharging a fully-discharged battery to 90 percent of rated

ampere-hour capacity within ten times the discharge time after normal ac power is restored.

2.5.1.2.5 AC Input Current Limiting

Provide a circuit to the input converter that controls and limits the current draw form utility to 130 percent of the rated UPS output. During conditions where input current limit is active, the UPS system is to be able to support 100 percent of the load, charge the batteries at 10 percent of the UPS output rating, and provide voltage regulation with mains deviation of +15/-5 percent.

****

NOTE: Delete second step current limiting option if the UPS system will not be supplied with ac power from an auxiliary generator system or if the generator has been sized to accommodate the higher input current.

****

[Second step current limiting: Provide the rectifier/charger unit with a second-step input current limit. Provide a separately adjustable second-step current limit that is adjustable from 85 percent to 125 percent of the maximum discharge current with initial setting at 100 percent. Activate the second-step current-limit circuit by a dry contact signal from the generator.

]2.5.1.2.6 Battery Charging Current

a. Primary current limiting: Battery-charging current is to be voltage regulated and current limited. Provide a separately adjustable battery-charging current limit that is adjustable from 1 percent to 20 percent of the maximum discharge current. Set the limit at the factory to 10 percent. After the battery is recharged, the rectifier/charger unit maintains the battery at full float charge until the next operation under input power failure. Battery charger is capable of providing equalizing charge to the battery.

****

NOTE: Delete second step current limiting if the UPS system (paragraph below) will not be supplied with ac power from an auxiliary generator system or if the generator has been sized to accommodate the recharge current of the battery. Second step current limit is usually found in larger units of 150kVA and above.

****

[b. Second step current limiting: The rectifier/charger unit is also to have a second-step battery current limit. Provide a separately adjustable second-step current limit that is adjustable from 0 percent to 20 percent of the maximum discharge current with initial setting at [1][10][__] percent. The second-step current-limit circuit is activated by a dry contact signal from the generator set controls and it will prevent normal rate battery recharging until utility power is restored.

]2.5.1.2.7 DC Ripple (Output Filter)

Rectifier/charger unit is to minimize ripple current and voltage supplied to the battery; the ripple voltage into the battery is not to exceed 1 percent RMS of the float voltage. Ensure the AC ripple voltage of the rectifier DC output does not exceed 0.5 percent of the float voltage.

[2.5.1.2.8 DC Voltage Adjustment

****
NOTE: Delete this requirement on units smaller than 50 kVA.
****

Provide a manual means at the rectifier/charger unit that allows for adjusting the dc voltage for battery equalization in order to provide voltage within plus 10 percent of nominal float voltage.

]2.5.1.2.9 Battery Isolation Protective Device

Provide the module or external battery system with a dc protective device to isolate the module from the battery system. The protective device size and interrupting rating are as required by system capacity and is to incorporate the trip required by circuit design. Provide the protective device with a provision for locking in the "off" position.

[2.5.1.2.10 Battery Equalize Charge

****
NOTE: Delete this requirement on units smaller than 50 kVA.
****

Equalize charge timer is to provide an equalizing charge automatically to the battery after a 30 second or longer utility outage. The equalize charging time is to be adjustable form 0-72 hours. Provide a manual override for the automatic equalize circuit.

]2.5.2 General Description

****
NOTE: This option applies to single-module and, in some remote cases, multi-module UPS systems that are not specifically required to be scalable. Most applications do not require an isolation transformer as part of the UPS, so delete unless required.
****

UPS module consists of a rectifier/charger unit and a 3-phase inverter unit with their associated transformers, synchronizing equipment, protective devices, surge suppression, [input isolation transformer,] and accessories as required for operation.

2.5.2.1 Interchangeability

The subassemblies in one UPS module are to be interchangeable with the corresponding modules within the same UPS, and from one UPS system to another of identical systems.

2.5.2.2 Rectifier/Charger Unit

Provide a solid state rectifier/charger unit that converts alternating current to direct current, and provides regulated direct current to the dc

bus, supplying power to the inverter and charging the battery plant.

2.5.2.2.1 Input Protective Device

****

NOTE: Calculate/verify AIC on the single line diagram at input of the UPS.

****

Provide the rectifier/charger unit with an input protective device. Size the protective device to accept simultaneously the full-rated load and the battery recharge current. Provide a protective device that is capable of shunt tripping and has an amperes symmetrical interrupting rating of [____]. Provide the protective device with an under-voltage release to open automatically when the control voltage is lost.

[2.5.2.2.2 Input Isolation Transformer

****

NOTE: An input isolation transformer is not normally required. Delete unless specifically required to be part of the UPS. Also, delete when requiring scalable, expandable modular UPS systems. Isolation transformers provide isolation of line induced EMI, common mode noise and dc offsets. Some of the UPS manufacturers require a separate cabinet for the transformer.

UPS industry is transitioning away from transformers being part of the UPS. Having the transformer separate can save space, reduce cooling, improve energy efficiency, reduce weight and cost. In general, those unit smaller than 200 kW will benefit more by not having a transformer as part of the UPS. The threshold level of 200 kW is increasing as more manufacturers go to "transformerless" designs.

Transformers rated 500 kVA and higher typically have the transformer connections on the backside.

****

The rectifier unit is to use a dry-type, isolated-winding power transformer. The transformer's hottest spot winding temperature must not exceed the temperature limit of the transformer insulation material when operating at full load. Provide a transformer with Class H, 150 degrees C rise insulation. [Transformer connections are to be accessible from the front.] If there is a separate transformer cabinet, it is is to match the UPS cabinet and attach to it.[Provide a Department of Energy CSL-3 transformer.]

]2.5.2.2.3 Power Walk-In

Protect the rectifier/charger unit with a power walk-in feature such that when ac power is returned to the ac input bus, the total initial power requirement will not exceed 20 percent of the rated full load current. This demand is to gradually increase to 100 percent of the rated full load current plus the battery charging current over the specified time interval.

2.5.2.2.4 Sizing

Size the rectifier/charger unit for the following two simultaneous operating conditions:

a. Supplying the full rated load current to the inverter.

b. Recharging a fully-discharged battery to 90 percent of rated ampere-hour capacity within ten times the discharge time after normal ac power is restored.

2.5.2.2.5 AC Input Current Limiting

Provide a circuit on the rectifier/charger to limit AC input current to an adjustable level of 100 percent to 125 percent with a factory setting at [100][115] percent.

****

NOTE: Delete second step current limiting option if the UPS system will not be supplied with ac power from an auxiliary generator system or if the generator has been sized to accommodate the higher input current.

****

[Second step current limiting: Provide the rectifier/charger unit with a second-step input current limit. Provide a separately adjustable second-step current limit that is adjustable from 85 percent to 125 percent of the maximum discharge current with initial setting at 100 percent. Activate the second-step current-limit circuit by a dry contact signal from the generator.

]2.5.2.2.6 Battery Charging Current

a. Primary current limiting: Battery-charging current is to be voltage regulated and current limited. Provide a separately adjustable battery-charging current limit that is adjustable from 1 percent to 20 percent of the maximum discharge current. Set the limit at the factory to 10 percent. After the battery is recharged, the rectifier/charger unit maintains the battery at full float charge until the next operation under input power failure. Battery charger is capable of providing equalizing charge to the battery.

****

NOTE: Delete second step current limiting if the UPS system (paragraph below) will not be supplied with ac power from an auxiliary generator system or if the generator has been sized to accommodate the recharge current of the battery. Second step current limit is usually found in larger units of 150kVA and above.

****

[b. Second step current limiting: The rectifier/charger unit is also to have a second-step battery current limit. Provide a separately adjustable second-step current limit that is adjustable from 0 percent to 20 percent of the maximum discharge current with initial setting at [1][10][__] percent. The second-step current-limit circuit is activated by a dry contact signal from the generator set controls and it will prevent normal rate battery recharging until utility power is restored.

]2.5.2.2.7 DC Ripple (Output Filter)

Rectifier/charger unit is to minimize ripple current and voltage supplied to the battery; the ripple voltage into the battery is not to exceed 1 percent RMS of the float voltage. Ensure the AC ripple voltage of the rectifier DC output does not exceed 0.5 percent of the float voltage.

[2.5.2.2.8 DC Voltage Adjustment

****

NOTE: Delete this requirement on units smaller than 50 kVA.

****

Provide a manual means at the rectifier/charger unit that allows for adjusting the dc voltage for battery equalization in order to provide voltage within plus 10 percent of nominal float voltage.

]2.5.2.2.9 Battery Isolation Protective Device

Provide the module or external battery system with a dc protective device to isolate the module from the battery system. The protective device size and interrupting rating are as required by system capacity and is to incorporate the trip required by circuit design. Provide the protective device with a provision for locking in the "off" position.

[2.5.2.2.10 Battery Equalize Charge

****

NOTE: Delete this requirement on units smaller than 50 kVA.

****

Equalize charge timer is to provide an equalizing charge automatically to the battery after a 30 second or longer utility outage. The equalize charging time is to be adjustable form 0-72 hours. Provide a manual override for the automatic equalize circuit.

]2.5.3 Inverter Unit

****

NOTE: Choose the first option for all systems except for scalable unit UPS systems. Second option is for scalable unit UPS systems.

****

[Provide a solid-state inverter with sinusoidal output deriving its power from the dc bus (rectifier or battery source) and providing ac power within specified limits to the critical load. Inverter is to utilize microprocessor controlled solid state Pulse Width Modulation (PWM) controlled insulated gate bipolar transistor (IGBT) power transistor technology to shape the ac output.

][Provide an output converter that constantly develops the UPS output voltage waveform by converting the dc voltage to ac voltage through a set of semiconductor power converters. In both normal operation and battery operation, the output inverters are creating and output voltage independent of the mains input voltage. Input anomalies such as brown-outs, spikes, surges, sags and outages do not affect the amplitude or sinusoidal nature of the output voltage sine wave of the inverters.

]

****

NOTE: Keep this option/paragraph when there is a generator available to supply power to the UPS.

****

[Include a bypass phase synchronization window adjustment to optimize compatibility with local engine-generator-set power source.]

2.5.3.1 Output Overload

****

NOTE: Choose the first option for all systems except for scalable unit UPS systems. Second option is for scalable unit UPS systems.

****

[Provide an inverter that is able to sustain an overload as specified across its output terminals. The inverter is to remain on and continue to operate within rated parameters, with inverse-time overload shutdown protection. If the overload condition persists beyond the rated parameters of the inverter, the load is to be transferred to the bypass source where the inverter disconnects automatically from the critical load bus. If the bypass source is not available and the overload/fault condition continues, the inverter is to current limit for the time as determined by the manufacturer and then shut down to protect the internal components.

][Provide the output inverter with overload capabilities that allows steady state overload conditions of up to 150 percent of system capacity to be sustained by for 30 seconds in normal and battery operation. If the overload condition persists beyond the rated parameters of the inverter, the load is to be transferred to the bypass source where the inverter disconnects automatically from the critical load bus.]

2.5.3.2 Output Protective Device

Provide an output protective device that is capable of opening on an applied control signal and has the proper frame size and trip rating to supply overload current as specified. Provide the external output protective device with provision for locking in the "off" position. The inverter output protective device works in conjunction with the bypass protective device for both manual and automatic load transfers to and from bypass power.

[2.5.3.3 Output Transformer

****

NOTE: Delete the output transformer unless required or when the design output voltage is different then the normal UPS output voltage. Some of the UPS manufacturers require a separate cabinet for the transformer. The preferred option is a harmonic mitigating transformer instead of a K rated transformer.

UPS industry is transitioning to transformerless UPS modules. Having the transformer separate can save space, reduce cooling, improve energy efficiency, reduce weight and cost. In general, those units smaller than 200 kW will benefit more by not having a transformer as part of the UPS. The threshold level of 200 kW is increasing as more manufacturers go to "transformerless" designs.

****

The inverter output transformer is [harmonic mitigating transformer type.] [or] [capable of handling up to [K-13][_____] nonlinear loads as described in IEEE C57.110].[Provide a transformer that meets the requirements for Department of Energy CSL-3.]

]2.5.4 External Protection

Provide the UPS module with built-in self-protection against undervoltage, overvoltage, overcurrent and surges introduced on the ac input source and/or the bypass source. Provide the UPS with built-in self-protection against overvoltage and voltage surges introduced at the output terminals by paralleled sources, load switching, or circuit breaker operation in the critical load distribution system.

2.5.5 Internal Protection

Provide the UPS module with the ability to be self-protected against overcurrent, sudden changes in output load and short circuits at the output terminals. Provide the UPS module with output reverse power detection which causes the module to be disconnected from the critical load bus when output reverse power is present. Provide the UPS module with built-in protection against permanent damage to itself and the connected load for predictable types of failure within itself and the connected load. At the end of battery discharge limit, the module shuts down without damage to internal components.

2.5.6 Battery Protection

Provide the inverter with monitoring and controls circuits to protect the battery system from damage due to excessive discharge. Inverter shutdown is be initiated when the battery has reached the end of discharge voltage. Manufacturer is to calculate the end-of-discharge voltage and automatically adjusted for partial load conditions to allow extended operation without damaging the battery. Automatic shutdown based on discharge time is not acceptable.

[2.5.7 Modular Inverter Isolation

****
NOTE: Delete for single module UPS system.
****

Provide each inverter in the UPS system with fault sensing and static isolation as well as an output protective device, to remove a faulted module from the system without affecting the critical load bus beyond the stated limits.

][2.5.8 Parallel Operation

****
NOTE: Delete for single module UPS system.
****

For parallel operation, ensure the protection system has control logic capable of isolating only the faulted module, and does not shut down the entire UPS system upon a fault in one module. Open protective devices are to be indicated by an alarm and indicator light.

]2.6 STATIC BYPASS TRANSFER CIRCUIT

****

NOTE: Circuit breaker can be fixed or drawout type. In units 500 kVA and larger, the breaker will typically be drawout.
150 kVA or larger units may need to use fuses for the protection of the static switch

****

Provide the control logic with an automatic transfer circuit that senses the status of the inverter logic signals and alarm conditions and provides an uninterrupted transfer of the load to the static bypass ac power source, without exceeding the transient limits specified herein, during times when maintenance is required, when a malfunction occurs in the UPS or when an external overload condition occurs. [The power section of the static bypass transfer circuit consists of a plug-in type assembly to facilitate maintenance.] The static bypass transfer circuit is to be used to connect the input bypass ac power source to the critical load when required. Provide the static bypass transfer circuit with the following features:

2.6.1 Construction

****

NOTE: Last sentence on "modular" is only for the scalable unit UPS systems.

****

Provide a static with a continuous duty rating of at least 100 percent of the UPS output rating. Provide a static bypass transfer circuit as an integral part of the UPS that consists of a static switch, made up of two reverse-paralleled SCRs (silicon-controlled rectifiers) per phase conductor, and a bypass protective device, made up of a [circuit breaker][circuit breaker and fuses]. The bypass protective device is to be in series with the static switch. The inverter output protective device disconnects and isolates the inverter from the bypass transfer circuit. [Provide a static switch that is of a modular design.]

2.6.2 Automatic Uninterrupted Transfer

The static bypass transfer switch automatically causes the bypass ac power source to assume the critical load without interruption when the bypass control logic senses one of the following conditions and the UPS inverter output is synchronized to the bypass ac power source:

a. Inverter overload exceeds unit's rating.

b. Battery protection period is expired and bypass is available.

c. System failure.

d. Inverter output undervoltage or overvoltage.

2.6.3 Interrupted Transfer

If an overload occurs and the UPS inverter output is not synchronized to the bypass ac power source, the UPS inverter output current-limits for 200 milliseconds minimum. The inverter then turns off and an interrupted transfer to the bypass ac power source is made.

If the bypass ac power source is beyond the conditions stated below, an interrupted transfer is made upon detection of a fault condition:

a. Bypass voltage greater than plus or minus 10 percent from the UPS rated output voltage.

b. Bypass frequency greater than plus or minus 0.5 Hz from the UPS rated output frequency.

c. Phase differential of ac bypass voltage to UPS output voltage greater than plus or minus 3 degrees.

2.6.4 Manual Load Transfer

It must be possible to make a manually-initiated static transfer from the system status and control panel by turning the UPS inverter off or by initiating it through the UPS display interface. The transfer is to make-before-break utilizing the UPS output and system bypass circuit breakers. Do not use the static switch for manual transfer unless there isn't a parallel by-pass circuit breaker or contactor.

2.6.5 Automatic Uninterrupted Forward Transfer

Automatic transfer of the load back to the inverter is to take place when the transfer was caused by an overload and only after the load has returned to a level within the inverter souse. Provide the ability to allow 1 to 3 transfers within any one-hour period to prevent cyclical transfers caused by overloads.

2.6.6 Forced Transfer

Provide control logic circuitry with the means of making a forced or reverse transfer of the static bypass transfer circuit on an interrupted basis. Minimum interruption is 200 milliseconds when the UPS inverter is not synchronized to the bypass ac power source.

2.6.7 Overload Ratings

****

NOTE: Select choice "c" for scalable unit UPS systems.

****

The static bypass transfer switch is to withstand the following overload conditions:

a. 1000 percent of UPS output rating for one cycle.

b. 125 percent of UPS output rating for 1 minute.

[c. 110 percent of UPS output continuously.
]

2.6.8 System Protection

Incorporate into the static bypass circuit back-feed protection per UL 1778. To achieve back-feed protection, provide a back-feed protection breaker/mechanical contactor upstream and in series with the bypass switch that is controlled by the UPS/static switch, to open immediately upon sensing a condition where back-feeding of the static switch by any source connected to the critical output bus of the system is occurring.

[2.6.9 Static Bypass Switch Disconnect

****

NOTE: Delete if the static switch is of the draw-out type or if the UPS module is 30 kVA or smaller.

Delete last option if a maintenance by-pass system is not provided/used.

****

Incorporate a static switch disconnect that can be used to isolate the static bypass transfer switch assembly so it can be removed for servicing. [Equip the device with auxiliary contacts and provisions for padlocking in either the "on" or "off" position.]

]2.7 MAINTENANCE BYPASS CIRCUIT

2.7.1 General

****

NOTE: See the TP-19, Static Uninterruptible Power Supply for full discussion on maintenance bypass circuit configurations. UPS units typically come standard with certain internal circuit breakers or switches and these include: one ahead of the rectifier, one on the output of the rectifier, and one ahead of the static switch. In addition, the maintenance bypass switch can be internal to the UPS or external and typically consists of a circuit breaker(s). UPS units up to 500 kVA can have an internal maintenance bypass switch.

Multi-module UPS systems that have UPS modules rated 500 kVA (typically) and higher can have a different configuration. Each module can consist of a rectifier/battery/inverter without an internal maintenance bypass switch or a static switch. In this case, there is a centralized static switch that is sized for the entire load and has its own dedicated feeder. The maintenance by-pass cabinet will typically have two breakers and a single feed. The output of the UPS modules, centralized static switch are in a system control cabinet that connects to the maintenance bypass cabinet. Edit appropriately for multi-module systems.

****

Provide a maintenance bypass switch or arrangement of switch devices [in a matching NEMA 250, type 1 cabinet adjacent to the UPS cabinet][in a wall-mounted NEMA 250, type 1 enclosure][in a free-standing floor-mounted NEMA 250, type 1 enclosure]. [Provide a maintenance bypass enclosure configured as indicated.] [Provide a [two][three][four]switch maintenance bypass enclosure.][Provide a two switch maintenance bypass with an input switch for each module.]

2.7.2 Interlock

****

NOTE: Choose the last sentence option for scalable

unit UPS systems.
****

Electrically and mechanically interlock the switch(es) to prevent interrupting power to the load when switching to bypass mode. Key interlock requires unlocking bypass/isolating switch before switching from normal position with key that is released only when the UPS is bypassed by the static bypass transfer switch. Lock is designed specifically for mechanical and electrical component interlocking. [Provide auxiliary contacts for the purpose of relaying status information of each circuit breaker/switch actuator to the UPS and static bypass.]

2.7.3 Load Transfer

The maintenance bypass switch provides the capability of transferring the critical load from the UPS static bypass transfer switch to maintenance bypass and then back to the UPS static bypass transfer switch with no interruption to the critical load.

[2.7.4 Load Bank Protection Device
****
NOTE: Delete if the ability to load bank test the UPS system if not required. It is not recommended under normal circumstances for units smaller than 225 kVA.
****

Provide a load bank protective device that allows the UPS system to be tested using a portable load bank. The load bank protective device is connected on the line side of the maintenance bypass switch isolation protective device. Provide a [full system load bank][partial system load bank] sized at[_____].

][2.7.5 [Voltage Matching][Isolation Transformer]
****
NOTE: Delete if the input and output voltages are the same and an isolation transformer is not required.

UPS industry is transitioning away from transformers being part of the UPS. Having the transformer separate can save space, reduce cooling, improve energy efficiency, reduce weight and cost. In general, those unit smaller than 200 kW will benefit more by not having a transformer as part of the UPS. The threshold level of 200 kW is increasing as more manufacturers go to "transformer less" designs.
****

The maintenance bypass cabinet contains [a voltage matching transformer][an isolation transformer] as required to match the output voltage requirements.Ensure the transformer and UPS are phase matched.

]2.8 DISPLAY,CONTROLS AND ALARMS
****
NOTE: The first paragraph is for non-redundant systems, i.e. single module, parallel multi-module, or scalable unit non-redundant UPS. The second

paragraph is for redundant systems to include scalable unit internal redundant and scalable unit redundant.

****

[Provide the UPS module with a microprocessor-controlled display unit located on the hinged door on the front of the system. Provide a LCD color alphanumeric display that operated by touchscreen to access the various information. Controls, meters, alarms and indicators for operation of the UPS module are to be on this panel. Provide a menu driven graphical user interface for browsing the screens. All three-phases of three-phase parameters are to be displayed simultaneously.

][Provide the modules with separate, optically isolated, communication paths to the power and static switch modules. Provide redundant power supplies, each having a separate AC and DC input and output for the logic power for the control modules. Provide a microprocessor-controlled display unit with alphanumeric display with back or side lighting. Controls, meters, alarms and indicators for operation of the UPS module are to be on this panel. Provide a menu driven graphical user interface for browsing the screens. All three-phases of three-phase parameters are to be displayed simultaneously.]

****

NOTE: Delete the output kilowatt hour meter information unless required. This option is rarely available with an UPS and if needed it would be better to consider a separate meter on the load.

****

2.8.1 Module Meters

2.8.1.1 Monitored Functions

Display the actual value along with the ability to show the peak, average and low values over various periods of time. Monitor and display the following functions:

a. Input voltage, phase-to-phase (all three phases).

b. Input current, all three phases.

c. Input frequency.

d. Bypass voltage, phase-to-phase and phase-to-neutral (all three phases).

e. Bypass frequency.

f. Battery voltage.

g. Battery current (charge/discharge).

h. Output voltage, phase-to-phase and phase-to-neutral (all three phases).

i. Output current, all three phases.

j. Output frequency.

k. Input power factor.

l. Maintenance bypass voltage, phase-to-phase and phase-to-ground (all

three phases)

[m. Output kilowatts or kilovoltamps.
]

****
NOTE: This option is available on all systems. .
****

[n. Bypass voltage, phase-to-phase and phase-to-ground (all three phases).

]

2.8.1.2 Meter Construction

Display alphanumeric parameters based on true RMS metering with 2 percent accuracy at full scale(minimum 4 significant digits) at the display panel.

2.8.2 Module Controls

Provide a module or equivalent features via touchscreen with the following controls:

a. Silence audible alarm..

b. Display or set the date and time.

c. Adjust setpoints on various alarms.

d. Alarm test/reset pushbutton.

e. Battery protective device trip pushbutton[, with guard].

f. Emergency off pushbutton, with guard. Provide a hard-wired pushbutton even if touchscreen system is provided.

g. DC voltage adjustment potentiometer, with locking guard or AC output voltage adjustment potentiometer. Provide potentiometer that is accessible only by authorized personnel.

h. Control power off switch.

i. Transfer load to and from static bypass circuit.

j. Display control pushbuttons: up, down, select.

****
NOTE: Delete UPS/bypass transfer switch reference except for parallel redundant or parallel multi-module systems. The parallel redundant multi-module configuration must also be specified to have a system control cabinet instead of having individual (distributed) bypass parallel system, so only keep if specified and used.
****

[k. UPS/bypass transfer selector switch.

]

****
NOTE: Module input and output protective device trip pushbuttons are only available when an Emergency Power Off feature is provided.

****
[l. Module input protective device trip pushbutton.

m. Module output protective device trip pushbutton.
]777

2.8.3 Module or System Alarm Indicators

Provide the module with indicators for the following alarm items. Any one of these conditions is to turn on an audible alarm and the appropriate summary indicator. The system is to register each new alarm without affecting any previous alarm. Provide a processor that time-date stamps each event.

a. Input ac power source failure.

b. Input protective device open.

c. Input power out of tolerance.

d. Overload.

e. Overload shutdown.

f. DC overvoltage/shutdown.

g. DC ground fault.

h. Low battery.

i. Battery discharged.

j. Battery protective device open.

k. Blower fan failure or overtemperature.

l. Overtemperature shutdown.

m. Hardware shutdown.

n. Equipment overtemperature.

o. Fuse blown with annunciation..

p. Control power failure.

q. Charger off/problem.

r. Inverter fault/off.

s. Emergency power off.

t. External shutdown (Remote Emergency Power Off) activated.

u. Output protective device open.

v. Operating on internal oscillator

w. UPS on battery

x. Critical load on static bypass.

y. Static bypass transfer switch disabled/failure.

z. Inverter output overvoltage.

aa. Inverter output undervoltage.

ab. Inverter output overfrequency.

ac. Inverter output underfrequency.

ad. Bypass source overvoltage.

ae. Bypass source undervoltage.

af. Bypass source overfrequency.

ag. Bypass source underfrequency.

ah. Bypass source to inverter out of synchronization.

****

NOTE: The following additional alarms are only required when the system is scalable unit UPS system; otherwise, delete.

****

[ai. Load no longer above alarm threshold.

aj. Intelligent module inserted or removed.

ak. Redundancy restored.

al. Need battery replacement.

am. Bad battery module.

an. Bad power module.

ao. Redundant intelligent module installed and failed.

ap. Load above alarm threshold.

]

2.8.4 Module Emergency OFF Button

Provide an emergency off pushbutton with a protective cover. Pressing the emergency off button causes the module input, output, and battery circuit breakers or contactors to open, completely isolating the UPS system from sources of power and transfer of the load to bypass.

System Mimic Panel

Provide a mimic panel in the format of a single-line diagram that graphically depicts whether the load is supplied from the inverter, bypass, or battery. Provide on status on the following:

a. Module on-line, one per UPS module.

b. UPS output protective device status, one for closed (red), one for

open (green), and one for withdrawn (amber).

c. Static bypass protective device status, one for closed (red), one for open (green), and one for withdrawn (amber).

d. Static switch status, one for connected (red), and one for disconnected (green).

e. Status on the AC input circuit breaker, battery circuit breaker, and inverter circuit breaker. Connected (red) and disconnected (green).

[2.9 SYSTEM CONTROL CABINET

****

NOTE: This section is for multi-module UPS systems that has a system control cabinet that contains a single bypass static switch that handles the entire load provided by the multi-modules. Delete for single module UPS Systems and for scalable unit UPS systems.

****

2.9.1 General Description

Provide the multi-module UPS system with a separate control cabinet for system output that contains; bus bar connections to collect the output from each module, the static switch and its bypass breaker, the UPS system output protective device, and the UPS output switchgear.

2.9.2 UPS Output Switchgear

The UPS output switchgear consists of a main protective device feeding the UPS output switchgear critical load bus, a load bank protective device (connected on the line side of the main protective device), a maintenance bypass protective device and associated feeder protective devices for the critical loads.

2.9.2.1 Interlocking

****

NOTE: Delete references to load bank protective device if not used.

****

[The main protective device and the load bank protective device are interlocked to prevent both being closed at the same time.]The maintenance bypass protective device is interlocked with the UPS system output protective device and the static bypass switch. The maintenance bypass protective device is not capable of closing until the static bypass switch is closed and the UPS system output protective device is open. Once the maintenance bypass protective device is closed, the UPS output switchgear main protective device is capable of opening to isolate the critical loads from the UPS output.[The load bank protective device as well as the UPS system output protective device is then capable of closing to permit load bank testing.]

2.9.2.2 Switchgear

****

NOTE: Army only. This is only used on Army projects.

****

Provide the UPS output switchgear in accordance with Section 26 05 73 POWER SYSTEM STUDIES.

][2.10 SELF-DIAGNOSTIC CIRCUITS

****

NOTE: Delete if self-diagnostic circuits are not required. These circuits are normally required in high reliability applications where it becomes critical to identify the faulty circuit card in the shortest time possible. This option is not normally available in off the shelf UPS units.

****

Provide control logic with status indicators for trouble-shooting the control circuits. These indicators are mounted on the circuit card edge or face such that they will be visible without repositioning the card, and are labeled with the function name.

][2.11 REMOTE MONITORING PANEL

****

NOTE: Delete if a remote monitoring panel is not required.

****

Provide a remote monitoring panel to monitor system status. Wall mount the panel near the critical load or as indicated.

2.11.1 Indicators

Provide indicators for the following (minimum):

a. Load on UPS.

b. Battery discharging.

c. Load on bypass.

d. Low battery.

e. Overload.

f. summary alarm.

g. New alarm (to alert the operator that a second summary alarm condition has occurred).

2.11.2 Audible Alarm

Any single indicator turns on the audible alarm. An audible alarm test/reset button and lamp test/reset button is to be included. The alarm on the module is not affected nor reset by the reset button.

]2.12 COMMUNICATIONS AND DATA ACQUISITION

****

NOTE: Delete the communication and data options that are not required. RS-485 port is not supported by some of the UPS manufacturers.

Provide an [RS 232][Internet Protocol (IP)][RS 485] communications and data acquisition port. This port allows the system parameters, status, alarm indication and control panel functions specified to be remotely monitored and controlled.

Additionally, provide additional ports for use with the following:

a. Provide the following Form C contacts for remote indication:

(1) UPS on battery.

(2) UPS on-line.

(3) UPS load on bypass.

(4) UPS in alarm condition.

(5) UPS off (maintenance bypass closed).

b. Provide four spare Form C contacts rated at 120V, 0.5A.

[c. Provide a SNMP (Simple Network Management Protocol) adapter to communicate UPS monitoring via a network or direct connection to [a personal computer (PC)][MODBUS][BACnet].
]
[d. Provide a standard Web Browser adapter to remotely view and monitor UPS functions over the Internet.
]
Provide communication ports and contacts that are capable of simultaneous communication.

[2.12.1 Emergency Control Contacts

NOTE: Include this paragraph only when the UPS will be installed in conjunction with a generator/alternate source.

Provide normally open contacts to signal when power is supplied to the UPS from engine generators or alternate source. The signal connects to an automatic transfer switch.

]2.13 TEMPERATURE CONTROL

2.13.1 General

NOTE: Default is to have the exhaust go out the top. If rack mounted UPS is specified, then choose the option to have a rear exhaust.

Ensure cabinet and enclosure ventilation is adequate to operate the components within their ratings. Forced-air cooled rectifier, inverter, and control unit will be acceptable. If UPS input power is lost, then the

cooling fans are to continue to operate. Provide redundancy that ensures failure of one fan or associated circuit breaker does not cause an overheat condition. Cooling air is to enter the lower front of the cabinets and exhaust at the [top][rear]. Provide visual and audible alarms on the control panel that indicate blower power failure. Provide replaceable filters on air inlets, which may be located on the inside of the cabinet doors and are easily accessible for replacement.

2.13.2 Blower Power Source

****

NOTE: Select 'output side' for 10-225kVA; select 'input and output sides' for over 225kVA.

****

Provide a blower power source that is internally derived from the [output side] [input and output sides] of UPS module, with automatic transfer arrangement.

2.13.3 Temperature Sensors

Provide temperature sensors to monitor the air temperature. Provide a sensor or sensors to monitor the temperature of rectifier and inverter heat sinks. [Provide separate sensors to monitor the transformer temperature.] Provide critical equipment over-temperature indication that starts a timer that shuts down the UPS system if the temperature does not return below the setpoint level recommended by the UPS manufacturer.

2.14 BATTERY SYSTEM

****

NOTE: Ventilation of storage battery areas is required by NFPA 70. A safe environment for such areas exists where the concentration of gaseous hydrogen does not exceed 2 percent accumulation per unit volume. Factors used to determine this condition are the size and type of battery to be charged; room volume; maximum volume of hydrogen gas emitted during charging; and ventilation rate. Approximately 0.016 cubic foot per hour of hydrogen gas is produced from each fully charged wet cell per charging ampere. Valve-regulated cells typically produce considerably less. Once sufficient ventilation is produced, no need exists for explosion-proof wiring, vapor-proof fixtures, or other special provisions. Mechanical ventilation (an exhaust fan) should be provided in accordance with the battery manufacturer's recommendations.

Battery Room Temperature. Battery system performance may be affected by battery room temperatures above or below the nominal range of 23 degrees C (74 deg. F) to 27 degrees C (80 deg. F). Battery capacity is reduced at lower temperatures and battery life expectancy is reduced at sustained temperatures greater than 30 degrees C (86 deg. F). Batteries should be derated if battery room temperatures are expected to vary more than plus or minus 2 degrees from the standard 25 degrees C.

****

****

NOTE: Refer to UFC 3-520-01, "Interior Electrical System"s for battery types and selection information. UPS systems either use two basic types: wet cell (also called flooded cell) or valve-regulated lead-acid (VRLA). There are two types of VRLA: gel and absorbed glass mat(AGM). Provide AGM type for UPS applications when choosing between gel and AGM.

****

2.14.1 General

****

NOTE: Valve regulated lead acid (VRLA) batteries are predominately lead calcium and should be chosen for most applications. VRLA batteries that are pure lead have longer life when compared to lead calcium. If considering pure lead, a cost analysis should be performed. Wet cells can be lead calcium, lead antimony or lead selenium with lead calcium the most common. Lead antimony and lead selenium are better for deep cycle applications and should only be considered in areas where there are very frequent power outages e.g. in areas where the battery is normally on a stand-by do not use lead antimony or lead selenium. Lead selenium, or sometimes called low antimony batteries, have a higher cycle capability when compared to lead calcium (5+ times), but not as good a lead antimony batteries (about 70%). Note that lead selenium typically requires less maintenance when compared with lead antimony. If designer wants lead antimony or lead selenium, the choice needs to be added to the wet cell paragraph.

****

****

NOTE: Wet cell batteries require a dedicated room. Small UPS units will typically use the valve-regulated lead-acid type battery. Wet cells can last up to 20 years with proper maintenance. There are two "grades" of VRLA: one for 10 years and one for 20 years. Note that 10 yr batteries typically only get 5-6 years of life in UPS application. If a 20 year VRLA is desired, then a life cycle cost analysis should be performed since the cost can be significantly more than a 10 year VRLA. Refer to UFC 3-520-05, "Stationary Battery Areas" for guidance governing the architectural, mechanical, plumbing and electrical requirements for design of stationary secondary battery installations.

****

****

NOTE: The last option is for modular, expandable scalable cabinet mounted type UPS unit with their associated battery plant.

****

Battery system contains the battery cells, [cabinets,][racks,] battery disconnect, [and battery monitor]. Provide a storage battery with sufficient ampere-hour rating to maintain UPS output at full capacity for

the specified duration for each UPS module. Provide a battery that is heavy-duty, industrial design suitable for UPS service. Provide the cells with flame arrestor vents, intercell connectors and cables, cell-lifting straps, cell-numbering sets, and terminal grease. Size intercell connectors to maintain terminal voltage within voltage window limits when supplying full load under power failure conditions. Provide cell and connector hardware that is the type of stainless steel capable of resisting corrosion from the electrolyte used. The battery plant is to consist of the following:

[a. Provide a [lead calcium][pure lead] battery that is of the float-type, absorbed glass mat (AGM) valve-regulated, lead-acid, sealed, non-gassing, recombinant type (VRLA) that is rated for [10][20] years. [Battery is factory assembled in an isolated compartment of the UPS cabinet complete with battery disconnect switch.][Battery is factory assembled in a separate matching cabinet, complete with battery disconnect switch.]
]
[b. Provide a [lead calcium][_____] battery that is of the wet cell (flooded) type. Provide heavy-duty industrial units in styrene acrylonitrile containers suitable for rack mounting. Assembly includes battery disconnect switch, hydrometer syringe, and thermometer with specific gravity-correction scales.

][c. Provide a lead calcium battery that is of the float-type, absorbed glass mat (AGM) valve-regulated, lead-acid, sealed, non-gassing, recombinant type (VRLA) that is rated for 10 years. Provide the UPS battery plant of modular construction made up of replaceable, hot-swappable, fused, battery modules.
]
[2.14.2 Battery Cabinet

****

NOTE: Delete if a battery cabinet is not required. Cabinet or rack could be used for VRLA type batteries. Cabinets are the preferred method when VRLA are used. Racks are used for wet cell type batteries.

****

Furnish the battery pack assembly in a battery cabinet matching the UPS cabinet. Design the battery cabinet to allow for checking the torque on the connections in the battery system and to provide adequate access for annual housekeeping chores. Provide an external wiring interface through the bottom or top of the assembly. Provide a high temperature alarm that annunciates detection of high temperature within the battery cabinet.

][2.14.3 Battery Rack

****

NOTE: Delete if a battery rack is not required. Three tier racks should be used only where floor space is limited. They increase floor loading and make maintenance more difficult. Use battery rack for wet cell batteries.

****

Provide a suitable number of [two-tier][three-tier] racks to fit the room layout shown for the number of batteries provided. Provide a steel battery rack that is protected with electrolyte-resistant paint. Ship the battery

rack unassembled with all necessary hardware for assembly. Provide each rack with a complete set with bus bars to accommodate cables from UPS module. Provide bus bar connectors for battery-to-battery connections and high-flex multi-stranded copper cable (ASTM B173 stranding class H) with proper cable supports for connecting top row of batteries to bottom row of batteries at rack ends. Cut end sections to length to prevent wasting floor space.

][2.14.4 Cell-Terminal Covers

****
NOTE: Cell-terminal covers are only for wet cells.
****

Provide acid-resistant transparent cell-terminal covers not exceeding 1.83 meters 6 feet in length and with vent holes drilled on top where needed.

]2.14.5 Battery Disconnect

Provide each battery string with a [circuit breaker][or][fused disconnect switch] provided in a NEMA 250, type 1 enclosure, finished with acid-resistant paint and located in line with the assembly. Provide each switch with line side and load side bus bars for connection to battery cells. Rate each switch [500][_____] V dc, [ampere rating per manufacturer][_____ amperes], 3-pole with interrupting rating as required by system capacity, and provide an external operator that is lockable in the "off" position. [Provide either a wall mounted disconnect or a cabinet mounted disconnecting means for cabinet mounted batteries. Disconnect is allowed to be in the battery cabinet.]

[2.14.6 Modular Battery Enclosures

****
NOTE: Paragraph is for scalable unit UPS systems only. For all other delete.
****

Provide battery enclosures that house draw-out battery cartridges. Battery cartridges are to interlock in place within the battery enclosure to ensure proper contact.

][2.14.7 Seismic Requirements

****
NOTE: Do not use this paragraph for Navy projects. When directed to meet Seismic Requirements, 13 48 73 SEISMIC CONTROL FOR MISCELLANEOUS EQUIPMENT and Section 26 05 48 SEISMIC PROTECTION FOR ELECTRICAL EQUIPMENT must be edited to suit the project and be included in the contract documents. Edit the following paragraph and include it in the project specification. When a Government designer is the Engineer of Record, provide seismic requirements on the drawings.
****

.Provide a seismic-restraint design for the battery [racks][cabinets], assemblies, subassemblies, and components to include fasteners, supports, mounting and anchorage devises [that conforms to UFC 3-301-01, Section 13 48 73, SEISMIC CONTROL FOR MISCELLANEOUS EQUIPMENT and to Section 26 05 48, SEISMIC PROTECTION FOR ELECTRICAL EQUIPMENT][as indicated].

]2.14.8 Battery Monitor

****

NOTE: Provide a battery internal resistance monitoring system on and temperature-compensated charging only on mission critical systems.

For the scalable units UPS systems choose the battery module in the first sentence and for all other systems choose the "string in the system". Also, for the scalable unit UPS system choose the temperature-compensated charging option.

****

Provide a battery monitor for each battery [string in the system][battery module]. Monitor the following minimum parameters by the device:

a. Total system voltage.

b. Ambient room temperature.

c. Minimum of 120 days activity history.

d. Programmable alarm functions..

[e. Battery internal resistance.
]
[f. Temperature-compensated charging. Provide a battery temperature sensing unit to automatically reduce the float charge in response to increases in battery temperature. Set the response per the manufacturer's requirements. Monitor is to only indicate when the temperature compensation circuit is active.
]
[g. Provide a remote monitoring panel.
]

The monitor is to record the total accumulated discharge minutes and accumulated battery system discharge kW hours.

[2.15 BATTERY MONITOR - DISCHARGE

****

NOTE: This monitoring option is available on units that are 225 kVA and larger. If UPS system is smaller than 225 kVA then delete this option.

****

The UPS is to have a specialized battery monitor system that collects and stores data related to discharging the UPS battery. The information is to be displayed on a separate screen available through a menu selection. The system is to collect and retain (minimum of 50 events) the following information for each discharge cycle:

a. System time and date.

b. Duration of cycle.

c. DC bus voltage range.

[d. kW carried by batteries at the start of the event.]

]2.16 HYDROGEN GAS MONITORING SYSTEM

****

NOTE: This system is recommended even when valve-regulated lead-acid batteries are used. These batteries can release high amounts of hydrogen outside the battery if there is a malfunction to the battery charging system and functions as a backup in case the charger does not take itself off line during a malfunction.

****

Provide a hydrogen gas monitoring system to monitor the hydrogen levels in the room. The system is to consist of a [remote monitoring panel,]hydrogen sensor and monitor/control panel. Provide a single gas detector/sensor located to be located [near the UPS batteries][as shown]. When a sensor detects hydrogen gas at a level of 1 percent, the system is to initiate an exhaust fan operation and provide a warning on the control panel[and remote monitoring panel]. When a sensor detects hydrogen gas at a level of 2 percent, the system is to initiate an audible alarm and provide an alarm on the control panel[and remote monitoring panel].

2.17 FACTORY TESTING

****

NOTE: Edited as required for a single module system. The designer should carefully evaluate the UPS application and the user's mission to determine critical tests for the UPS that will ensure UPS/load compatibility. These tests should be conducted at the factory and the results validated prior to shipment to the site. The required UPS/load interaction can be achieved by requesting the following tests plus any other tests the designer deems necessary:

a. Tests to ensure that the UPS rated power factor is verified;

b. Tests to ensure that the UPS system will operate in total accord and support the rated load;

c. Tests to ensure that the UPS system can deal with load anomalies (odd harmonics, etc.) associated with the user's equipment load.

****

Factory test the UPS system to meet the requirements specified using a test battery (not the battery to be supplied with the system) or D.C. simulator. Factory load test the UPS module as an independent assembly with 3-phase ac input power and with battery power for a minimum of 8 hours, with meter readings taken every 30 minutes. Balance the load at rated kVA and rated power factor.

a. Submit a detailed description of proposed factory test and field test procedures, including proposed dates and steps outlining each test, how it is to be performed, what it accomplishes, and its duration, not later than [1][_____] months prior to the date of each test.

b. Run the factory test for each UPS module under full load that is

witnessed by the Government. Should a malfunction occur, correct the problem and repeat the test. As a minimum, the factory tests are to include the parameters described in paragraphs ac Input, ac Output, Transient Response and Efficiency. Tests are to encompass all aspects of operation, such as module failure, static bypass operation, battery failure, input power failure and overload ratings.

c. Notify the Government in writing at least 2 weeks before testing. Do not use factory-test time for system debugging and/or checkout. Perform such work prior to notifying the Government that the system is ready for testing. Perform factory tests during normal business hours. Interconnect and test the system for an additional 8 hours to ensure proper wiring and performance.

d. Submit factory and field test reports in booklet form tabulating factory and field tests and measurements performed, upon completion and testing of the installed system. An official authorized to certify on behalf of the manufacturer of the UPS system that the system meets specified requirements will sign the factory and field test reports. Date each report after the award of this contract, which states the Contractor's name and address, name the project and location, and list the specific requirements, which are being certified.

2.17.1 Transient Tests

Conduct transient tests using high-speed oscillograph type recorders to demonstrate the operation of the components to the satisfaction of the Government. These tests consist of 50 percent to 100 percent load changes, manual transfer, manual retransfer, low dc bus initiated transfer and low ac output bus transfer. Use a recording instrument equipped with an event marker.

2.17.2 Efficiency Tests

Perform testing for efficiency at zero output up to 100 percent of stated kW output in 25 percent steps with battery fully charged and floating on the dc bus, with nominal input voltage, and with module connected to represent actual operating conditions.

PART 3 EXECUTION

3.1 INSTALLATION

Conform electrical installations to IEEE C2, NFPA 70, and to requirements specified herein. Provide new equipment and materials unless indicated or specified otherwise. Set the UPS system in place that is wired and connected in accordance with the approved shop drawings and manufacturer's instructions.

3.1.1 Control Cable

****

NOTE: UPS sizes 200 KVA and above are shipped in sections. Control wiring between module sections will be connected by the UPS manufacturer's technical representative.

****

Install UPS control wiring in individual separate rigid steel conduits,

unless connections are made between side by side matching cabinets of UPS. Tag control wires with numeric identification tags corresponding to the terminal strip location to where the wires are connected. In addition to manufacturer's requirements, provide four additional spare conductors between UPS module and remote alarm panel in same conduit. When routing control cables inside UPS module, maintain a minimum 155 mm 6 inches separation from power cables.

3.1.2 Grounding

3.1.2.1 Grounding Conductor Title

Provide a separate grounding conductor that is separate from the electrical system neutral conductor in feeder and branch circuits. Ground battery racks and battery breaker cabinets with a separate equipment grounding conductor to the UPS cabinet.

3.1.2.2 Separately Derived

If not part of a listed power supply for a data-processing room, comply with NFPA 70 requirements for connecting to grounding electrodes and for bonding to metallic pipe.

3.1.3 UPS Output Conductors

Isolate the UPS output conductors from the UPS cabinet to the critical load panels and from other conductors by installing in separate conduit.

[3.1.4 DC Power Conductors

****

NOTE: Include this paragraph only when batteries are remote from the UPS cabinet.

****

When installed in conduits, place dc power conductors from the UPS cabinet to the battery circuit breaker such that each conduit contains an equal number of positive and negative conductors, for example, two positive and two negative conductors in each conduit. Size conductor for a maximum of 2 percent voltage drop at full discharge.

][3.1.5 Seismic Protection

****

NOTE: Do not use this paragraph for Navy projects. When directed to meet Seismic Requirements, 13 48 73 SEISMIC CONTROL FOR MISCELLANEOUS EQUIPMENT and Section 26 05 48 SEISMIC PROTECTION FOR ELECTRICAL EQUIPMENT must be edited to suit the project and be included in the contract documents. Edit the following paragraph and include it in the project specification. When a Government designer is the Engineer of Record, provide seismic requirements on the drawings.

****

Provide seismic details[conforming to[Section 13 48 73, SEISMIC CONTROL FOR MISCELLANEOUS EQUIPMENT][and to][Section 26 05 48, SEISMIC PROTECTION FOR ELECTRICAL EQUIPMENT]][as indicated].

]3.1.6 Conduit Entries

Ensure conduit entries use the available conduit areas shown on manufacturer's installation drawings. Do not make conduit entries through the front, side or rear panels of the UPS[or Maintenance Bypass Cabinet][or battery cabinet][or battery disconnect enclosure].

[3.1.7 Battery Rack Assembly

****

NOTE: Choose this paragraph if racks are required for the batteries. This is typically required when the batteries are wet cell type.

****

Battery racks are typically shipped dismantled in separate rail, frame, and brace packages. Ensure that manufacturer furnished assembly hardware is used to assemble battery racks. Conform battery rack installation to the manufacturer's instructions.

][3.1.8 Battery Cabinet Assembly

****

NOTE: Choose this paragraph when VRLA batteries are required. Battery cabinets are typically factory assembled on units up to 500 kVA. Battery cabinets for larger units may require assembly at the site.

****

Conform battery rack installation to the manufacturer's instructions.

][3.1.9 Battery Installation

****

NOTE: Delete paragraph and subparagraphs for smaller UPS units that have batteries installed in the unit cabinet by the manufacturer at the factory.

****

Conform battery cabinet installation to the manufacturer's instructions.

]3.2 FIELD QUALITY CONTROL

****

NOTE: The UPS manufacturer's technical representative is required to inspect the completed UPS and battery installation. The representative's visit to the site must be scheduled by the Contractor.

****

Notify the Contracting Officer in writing at least 30 calendar days prior to completion of the UPS system installation. At this time the Contractor, will schedule the UPS manufacturer's technical representative to inspect the completed installation. Provide instruction for activity personnel by the UPS technical representative as specified in paragraph titled "DEMONSTRATION".

3.2.1 Installation Preparation

Completely install the following items by the Contractor and be operational prior to the arrival of the UPS representative for inspection, unit start-up and testing:

a. Ventilation equipment in the UPS and battery rooms.

****
NOTE: In subparagraph b.choose the appropriate item based on what was previously specified.
****

b. Battery [cabinets][racks][modules] and cells.

c. Battery connections including cell-to-cell, tier-to-tier, and rack-to-rack connections, with correct polarity;

d. DC power and control connections between UPS and battery circuit breaker, with correct polarity;

e. DC power connection between battery circuit breaker and battery, with correct polarity;

f. Clockwise phase rotation of ac power connections;

g. AC power to rectifier input bus;

h. AC power to UPS bypass input bus;

i. AC power to UPS maintenance bypass circuit breaker;

j. AC power from UPS output to UPS maintenance bypass output circuit breaker;

k. Remote monitors and control wiring;

l. UPS system and battery system properly grounded;

[m. Emergency shower and eye wash;

][n. Control connections between UPS and emergency engine generator signal contacts;
]

****
NOTE: In subparagraph o. delete the bracketed statement when the project does not require a UPS maintenance bypass cabinet.
****

o. Control connections between UPS module [and UPS maintenance bypass cabinet];

p. Clean and vacuum UPS and battery room floors, battery cells, and UPS equipment, both inside and outside

q. Ensure that shipping members have been removed.

****
NOTE: Provide this option for IEEE 450 certification when wet cell ventilated batteries are used.
****

[r. Provide IEEE 450 battery installation certification.
]

3.2.2 Initial Inspection and Tests

The UPS technical representative and the Contracting Officer, in the presence of the Contractor, will inspect the completed installation. The Contractor is responsible to correct construction or installation deficiencies as directed. Perform acceptance checks in accordance with the manufacturer's recommendations and include the following visual and mechanical inspections, performed in accordance with NETA ATS.

a. UPS Unit visual and mechanical inspection

(1) Compare equipment nameplate data with drawings, specifications and approved shop drawings.

(2) Inspect physical and mechanical condition. Inspect doors, panels, and sections for paint, dents, scratches, fit, and missing hardware. Inspect the displays for scratches, dark pixels or uneven brightness.

(3) Inspect anchorage, alignment, grounding, and required clearances.

(4) Verify that fuse sizes and types correspond to drawings.

(5) Verify the unit is clean inside and out.

(6) Test all electrical and mechanical interlock systems for correct operation and sequencing.

(7) Inspect bolted electrical connections for high resistance using one of the following methods:

(a) Use a low-resistance ohmmeter.

(b) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method.

(c) Perform thermographic survey.

(8) Verify operation of forced ventilation.

(9) Verify that vents are clear and new clean filters are installed.

(10) Inspect batteries and chargers according to requirements in NETA ATS

b. UPS Batteries visual and mechanical inspection

(1) Compare equipment nameplate data with drawings, specifications and approved shop drawings.

(2) Inspect physical and mechanical condition. Inspect doors, panels, and sections for paint, dents, scratches, fit, and missing hardware. Inspect the displays for scratches, dark pixels or uneven brightness.

(3) Inspect anchorage, alignment, grounding, and required clearances.

(4) Verify that fuse sizes and types correspond to drawings.

(5) Verify the unit is clean inside and out.

(6) Verify the application of an oxide inhibitor on battery terminal connections.

(7) Inspect bolted electrical connections for high resistance using one of the following methods:

(a) Use a low-resistance ohmmeter.

(b) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method.

(c) Perform thermographic survey.

3.2.3 Performance Tests

Provide equipment, test instruments, power, load bank, materials and labor required for tests. Contracting Officer will witness all tests and the tests are subject to his approval. Perform tests in accordance with the manufacturer's recommendations and include the following electrical tests.

3.2.3.1 UPS Unit Performance Tests

Upon completion of battery activation procedures, Contractor is to connect load bank to UPS output. Size load bank to the full kW rating of the system.

Performance test is to be run under the supervision of the UPS technical representative. Operate UPS unit under full kW load for a minimum of one hour. Operation of the feeder and bypass power feeder breakers during testing of the UPS is the responsibility of the Contractor.

a. Electrical Tests

(1) Test static transfer from inverter to bypass and back. Use normal load, if possible.

(2) Test dc undervoltage trip level on inverter input breaker/relay. Set according to manufacturer's published data.

(3) Test alarm circuits.

(4) Verify synchronizing indicators for static switch and bypass switches.

(5) Perform electrical tests for UPS system breakers.

(6) Perform electrical tests for UPS system batteries.

(a) Measure negative post temperature.

(b) Measure charger float and equalizing voltages.

(c) Verify all charge functions and alarms.

b. Test Values

Verify bolt-torque levels.

c. Maintenance Bypass Panel/Cabinet

Verify interlocks (Kirk-Key or other means) operate properly. Verify that the breaker arrangement operates in the manner required for the number of possible combinations.

[d. Load Test

****

NOTE: Edit as required, depending upon whether a temporary or permanent load bank is to be provided or if a load bank is required. Small UPS systems are normally not required to have a load bank test.

****

[Provide a load bank that stays with the system.]Load test the installed system for a continuous 24 hour period by means of resistive load banks. Continuously test the system at 1/2 load for 8 hours, 3/4 load for 8 hours and full load for 8 hours. Provide variable load banks sized to the full kW load of system to facilitate startup under load conditions, and to conduct load tests described above. Record instrument readings every half hour for the following:

(1) Input voltage (all three phases).

(2) Input current (all three phases).

(3) Input frequency.

(4) Battery voltage.

(5) Output voltage (all three phases).

(6) Output current (all three phases).

(7) Output kilowatts.

(8) Output frequency.

][e. Full Load Burn In Test

****

NOTE: Delete emergency/alternative source testing requirements if no emergency/alternative source is available. This paragraph may be deleted for small UPS system.

****

Provide an additional full load burn-in period of 24 continuous hours for the installed system. If a failure occurs during the burn-in period, repeat the tests. Record instrument readings every half hour as above. Perform the following tests during the burn-in period:

(1) With the UPS carrying maximum continuous design load and supplied from the normal source, switch [100 percent load][50 percent load] on and off a minimum of three times within [the burn-in period] [_____].

(2) [(2) With the UPS carrying maximum continuous design load and supplied from the emergency source, repeat the switching

operations described in step (1). Also, verify that the UPS module rectifier charger unit(s) go into the second-step current limit mode.]

(3) With the UPS carrying maximum continuous design load and operating on battery power, repeat the switching operations described in step (1) above.

(4) Continue operation on battery power for 1 minute, then restore normal power.

Furnish a high-speed dual trace oscillograph to monitor ten or more cycles of the above tests at the ON and OFF transitions and two typical steady-state periods, one shortly after the load is energized (at 30 to 60 seconds) and one after operation has stabilized (at 8 to 10 minutes). Deliver four copies of the traces to the Contracting Officer.

][f. Battery Discharge Test

****

NOTE: This paragraph may be deleted for small UPS system.

****

Allow UPS 24 hrs to recharge batteries and an additional 24 hrs cool down prior to commencing this test, if other tests such as the full load test were performed. With the UPS carrying maximum continuous design load and the battery fully charged, the system is to undergo a complete battery discharge test to full depletion and a recharge to nominal conditions. Record instrument readings every minute during discharge for the following:

(1) Battery voltage.

(2) Battery current.

(3) Output voltage (all three phases).

(4) Output current (all three phases).

(5) Output kilowatts.

(6) Output frequency.

][3.2.3.2 Generator Operation

****

NOTE: Include this paragraph only when the UPS will be installed in conjunction with a generator.

****

Test UPS to observe operation with generator service. UPS technical representative is to verify UPS battery current limiting feature functions properly.

][3.2.3.3 Battery Performance Test (Constant kW)

****

NOTE: This paragraph is applicable for large wet-cell type battery systems. Delete for sealed (valve regulated) battery system.

****

Furnish all labor, material and test equipment necessary to conduct performance test under the direction of UPS technical representative. Accomplish the following:

a. Install a calibrated voltmeter across the battery terminals to measure voltage, and provide current transformers to measure the current from each string.

b. Record temperature of pilot cells in battery immediately prior to start of discharge performance test.

c. Read and record total battery voltage and battery current at start of discharge and every minute during discharge test.

d. Record minutes and seconds when battery voltage drops below minimum discharge voltage. On initial discharge test, a battery may be expected to deliver 95 percent of its rated capacity. This will increase to 100 percent after several complete discharge cycles or after 12 months of float charge service.

e. Should battery fail to meet the requirements of the first discharge performance test, place battery on equalizing charge as defined by the specific battery manufacturer's recommendations. Measure and record time and battery voltage. Run a second discharge performance test.

]3.3 DEMONSTRATION

****

NOTE: Delete recording references if not required.

****

3.3.1 Instructing Government Personnel

Furnish the services of competent instructors to give full instruction to designated Government personnel in the adjustment, operation, and maintenance of the specified systems and equipment, including pertinent safety requirements as required. Instructors are to be thoroughly familiar with all parts of the installation and be trained in operating theory as well as practical operation and maintenance work. Provide instruction during the first regular work week after the equipment or system has been accepted and turned over to the Government for regular operation. Provide [8][_____] hours of instruction for [_____] personnel.[When more than 4 man-days of instruction are specified, use approximately half of the time for classroom instruction. Use other time for instruction with equipment or system. When significant changes or modifications in the equipment or system are made under the terms of the contract, provide additional instructions to acquaint the operating personnel with the changes or modifications.][record the field training with the recording left with the Contracting Officer.][Provide a factory training video or [on-line training] as part of the training materials.]

3.4 FINAL ADJUSTMENTS

a. Remove load bank and reconnect system for normal operation.

b. Equalize battery per manufacturer instructions.

****

NOTE: Delete this paragraph if battery is sealed (valve regulated) type.

****

[c. Bring electrolyte level of all cells up to the bottom of the high level line by adding original filling gravity electrolyte.

] d. Resume charging battery at normal float voltage as defined by battery manufacturer recommendations.

e. Prior to charging, check battery connections are properly torque to manufacturer's specifications. Take and record, for cell-to-cell and terminal connections, detailed micro-ohm resistance readings. Remake connections having a resistance of more than 10 percent above the average.

f. Deliver all manufacturer's data and operation manuals, which are an integral part of, and shipped with UPS, to Contracting Officer.

3.5 NAMEPLATE MOUNTING

Provide number, location, and letter designation of nameplates as indicated. Fasten nameplates to the device with a minimum of two sheet-metal screws or two rivets.

3.6 FIELD APPLIED PAINTING

Paint electrical equipment as required to match finish of adjacent surfaces or to meet the indicated or specified safety criteria. Painting is to comply with Section 09 90 00 PAINTS AND COATINGS.

-- End of Section --