SECTION TABLE OF CONTENTS

DIVISION 26 - ELECTRICAL

SECTION 26 33 53.00 20

UNINTERRUPTIBLE POWER SUPPLY (UPS)

04/08

-- End of Section Table of Contents --

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USACE / NAVFAC / AFCEC / NASA | **UFGS-26 33 53.00 20 (April 2008)**

Preparing Activity: NAVFAC | **Superseding UFGS-26 33 53.00 20 (January 2008)**

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated April 2016

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SECTION 26 33 53.00 20

UNINTERRUPTIBLE POWER SUPPLY (UPS)
04/08

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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 covered range of UPS units is between 10kVA and 750kVA 3-phase systems only. Single phase systems are not addressed. This specification covers UPS with electro-chemical batteries. Electro-mechanical (stored energy) UPS are not addressed.

Use of electronic communication is encouraged.

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 items(s) or insert appropriate information. Brackets are used in the text to indicated designer choices or locations where text must be supplied by the designer.

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 shall be approved by the Power Conditioning and Continuation Interfacing Equipment (PCCIE) Group Manager at Ogden Air Logistics Center (OO-ALC/LGHC)
http://www.hill.af.mil/lg2/WebLGH.htm

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NOTE: This guide specification is intended to be used with individual UPS units which contain a

single module or multiple modules within the same assembly. Parallel units are not specifically addressed and require additional components. There are two types of parallel systems commonly available. One is a parallel system that requires a system control panel, external static bypass switch to control the individual units and additional output switchgear with maintenance bypass to connect the output of all the units; the other is individual units that have integrated controls and static bypass switches that communicate with one another and only require the output switchgear with maintenance bypass to connect the output of all the parallel units. The designer should be aware of the differences and select the system that addresses the design requirements. Parallel systems require additional paragraphs to address the additional components (system control panel with static bypass switch, output switchgear, etc) and overall system requirements.

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NOTE: This guide specification will not be used in the preparation of project documents for installation of Government-furnished (GFE) UPS systems. For UPS and battery installation instructions for GFE projects refer to "UPS Manufacturer's Installation Drawings" and "Battery Manufacturer's Rack Assembly and Battery Installation Instructions" which must be obtained from the Contracting Officer.
All plans/specifications having uninterruptible power supply systems, which were procured as Government-furnished/Contractor installed equipment, must be reviewed and concurred by the Contracting Officer.

****

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.

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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	(2010; R 2015) Standard Specification for Rope-Lay-Stranded Copper Conductors Having Concentric-Stranded Members, for Electrical Conductors
ASTM D709	(2013) Laminated Thermosetting Materials

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE 100	(2000; Archived) The Authoritative Dictionary of IEEE Standards Terms
IEEE 450	(2010) Recommended Practice for Maintenance, Testing, and Replacement of Vented Lead-Acid Batteries for Stationary Applications
IEEE C2	(2012; Errata 1 2012; INT 1-4 2012; Errata 2 2013; INT 5-7 2013; INT 8-10 2014; INT 11 2015) 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 C62.41.1	(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	(2013) Standard for Acceptance Testing Specifications for Electrical Power Equipment and Systems

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION (ISO)

ISO 9001	(2008; Corr 1 2009) Quality Management Systems- Requirements

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA 250	(2014) Enclosures for Electrical Equipment (1000 Volts Maximum)
NEMA PE 1	(2012) Uninterruptible Power Systems (UPS) Specification and Performance Verification

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2014; AMD 1 2013; Errata 1 2013; AMD 2 2013; Errata 2 2013; AMD 3 2014; Errata 3-4 2014; AMD 4-6 2014) National Electrical Code

UNDERWRITERS LABORATORIES (UL)

UL 1449	(2014;Reprint Mar 2015) Surge Protective Devices
UL 1778	(2014; Reprint Aug 2015) Uninterruptible Power Systems

1.2 RELATED REQUIREMENTS

****
NOTE: Include Section 26 08 00 APPARATUS INSPECTION AND TESTING on all projects involving medium voltage and specialized power distribution equipment.
****

Section 26 08 00 APPARATUS INSPECTION AND TESTING applies to this section, with the additions and modifications specified herein.

1.3 DEFINITIONS

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

1.4 SUBMITTALS

****
NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list to reflect only the submittals required for the project.

The Guide Specification technical editors have designated 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 submittals requiring Government approval on Army projects, a code of up to three characters within the submittal tags may be used following the "G" designation to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "RE" for Resident Engineer approval, "ED for Engineering approval, and "AE" for Architect-Engineer approval"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 projects.

An "S" following a submittal item indicates that the submittal is required for the Sustainability Notebook to fulfill federally mandated sustainable requirements in accordance with Section 01 33 29 SUSTAINABILITY REPORTING.

Submittal items not designated with a "G" are considered as being for information only for Army projects and for Contractor Quality Control approval for Navy projects.

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Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are [for Contractor Quality Control approval.][for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government.] Submittals with an "S" are for inclusion in the Sustainability Notebook, in conformance to Section 01 33 29 SUSTAINABILITY REPORTING. 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[, [_____]]

Submittal shall include manufacturer's information for each component, device, and accessory provided with the transformer.

Factory Testing

UPS System

****

NOTE: Delete submittal for spare parts on Navy

projects.
****

[UPS Spare Parts; G[, [_____]]]

SD-06 Test Reports

Work Plan; G[, [_____]]

Factory Test Plan; G[, [_____]]

Performance Test Plan; G[, [_____]]

Factory Tests; G[, [_____]]

Performance Tests Report; G[, [_____]]

Factory Tests Report; G[, [_____]]

SD-09 Manufacturer's Field Reports

Initial Inspection and Tests; G[, [_____]]

Performance Tests; 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

1.5 PERFORMANCE REQUIREMENTS

1.5.1 Normal Operation

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

1.5.2 Emergency Operation (Loss or deviation of AC Input Power)

Whenever the ac input power source deviates from the specified tolerances or fails completely, the inverter shall draw its power from the battery system and shall supply AC power to the critical load without any interruption or switching. The battery shall continue to supply power to the inverter for the specified protection time or until return of ac input source. At the same time, an alarm shall sound to alert operating personnel and a trouble signal shall be sent over the communication network, allowing startup of a secondary power source or orderly shutdown of the critical load.

1.5.3 Return of AC Input Power Source

When stable ac input power source returns the rectifier/charger shall resume operation and shall simultaneously supply the inverter with dc power and recharge the battery. This shall be an automatic function and shall cause no disturbance to the critical load.

1.5.4 Failure of AC Input Power to Return

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

1.5.5 Transfer to Bypass AC Power Source

When the UPS controller senses an overload or degradation of the inverter output, the bypass switch shall automatically transfer the critical load from the inverter output to the bypass ac power source without an interruption of power. If the bypass ac power source is outside of specified tolerance limits, the UPS and the critical load shall shut down.

1.5.6 Retransfer to Inverter

The static bypass switch shall be capable of automatically retransferring the load back to the inverter output after the inverter output has returned to normal conditions. Retransfer shall only occur if the two sources are synchronized.

1.5.7 UPS Bypass Maintenance

Manual closure of the maintenance bypass switch shall transfer the critical load from the inverter output to the bypass ac power source without disturbing the critical load bus. UPS module shall be capable of manual return to normal operation after completion of maintenance.

1.5.8 Battery Maintenance

The battery protective device shall provide the means of disconnecting the battery from the rectifier/charger and inverter for maintenance. The UPS module shall continue to function and meet the performance criteria specified except for the battery back-up time function.

1.6 QUALITY ASSURANCE

The manufacturer shall 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. On-site test procedure shall include an inspection of controls and indicators after installation of the equipment.

d. ISO 9001 quality certification.

1.6.1 UPS Drawings

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, ladder-type schematic diagrams, elevations, layout drawings, and details required to demonstrate that the system has been coordinated and will function properly as a unit.

1.6.2 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 shall identify circuit terminals and indicate the internal wiring for each item of equipment and the interconnection between each item of equipment. Drawings shall indicate adequate clearance for operation, maintenance, and replacement of operating equipment devices. Submittals shall include the nameplate data, size, and capacity. Submittals shall also include applicable federal, military, industry, and technical society publication references.

1.6.3 Work Plan

Submit [6][_____] copies of 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.

1.6.4 Factory Test Plan

Submit [6][_____] copies of 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. As a minimum, the test procedures shall include the test required under the paragraph entitled "Factory Testing."

1.6.5 Performance Test Plan

Submit [6][_____] copies of 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. As a minimum, the test procedures shall include the tests required under the paragraph entitled "Performance Tests."

1.6.6 Factory Tests Report

Submit [6][_____] copies of factory test report within [45][_____] calendar days after completion of tests. Receive approval of test prior to shipping unit. Factory test reports shall 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". Test reports in shall be in booklet

form tabulating factory tests and measurements performed, upon completion and testing of the installed system. Reports shall state the Contractor's name and address, the name of the project and location, and list the specific requirements which are being certified.

1.6.7 Performance Tests Report

Submit report of test results as specified by paragraph entitled "Performance Tests" within [15][_____] calendar days after completion of tests. Field test reports shall 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". Test reports in shall be in booklet form tabulating factory tests and measurements performed, upon completion and testing of the installed system. Reports shall state the Contractor's name and address, the name of the project and location, and list the specific requirements which are being certified.

1.6.8 Regulatory Requirements

In each of the publications referred to herein, consider the advisory provisions to be mandatory, as though the word, "shall" 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. Equipment, materials, installation, and workmanship shall be in accordance with the mandatory and advisory provisions of NFPA 70 unless more stringent requirements are specified or indicated.

1.6.8.1 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.

1.6.8.2 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 shall 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.

1.6.9 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. Products shall have been in satisfactory commercial or industrial use for 2 years prior to bid opening. The 2-year period shall include applications of equipment and materials under similar circumstances and of similar size. The product shall have been on sale on the commercial market through advertisements, manufacturers' catalogs, or brochures during the 2-year period. Where two or more items of the same class of equipment are required, these items shall be 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. Equipment shall be supported by a service organization that is, in the opinion of the Contracting Officer, reasonably convenient to the site.

1.6.9.1 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.

1.6.9.2 Material and Equipment Manufacturing Date

Products manufactured more than 2 years prior to date of delivery to site shall not be used, unless specified otherwise.

1.7 DELIVERY AND STORAGE

Equipment placed in storage shall be protected from humidity and temperature variations, moisture, water intrusion, dirt, dust, or other contaminants. In harsh environments where temperatures exceed non-operational parameters established within this specification, the equipment storage facility shall be environmentally controlled to ensure temperature parameters are within equipment specification. Documentation of same shall be provided to the Government when storage is implemented.

1.8 PROJECT/SITE CONDITIONS

****
NOTE: This paragraph with subparagraphs is used by the Army. Delete for other projects.
****

1.8.1 Environmental Conditions

****
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.
****

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

a. Operating altitude: Sea level to 1,000 meters 3,300 ft. (Systems applied at higher altitudes shall 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 10 to 30 degrees C 50 to 86 degrees F.

d. Non-operating and storage ambient temperature range: Minus 20 to plus 50 degrees C Minus 4 to plus 122 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, shall 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 shall become familiar with details of the work, verify dimensions in the field, and shall advise the Contracting Officer of any discrepancy before performing the work.

1.9 SPECIAL TOOLS

Provide one set of special tools, calibration devices, and instruments required for operation, calibration, and maintenance of the equipment.

1.10 OPERATION AND MAINTENANCE MANUALS

1.10.1 Additions to UPS Operation and Maintenance Manuals

In addition to requirements of 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.

f. Test measurement levels with specific test points.

[1.10.2 Spare Parts

****
NOTE: 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.

]1.11 WARRANTY

The equipment items shall be supported by service organizations which are reasonably convenient to the equipment installation in order to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract.

PART 2 PRODUCTS

2.1 UPS SYSTEM DESCRIPTION

****
NOTE: Connect alternate power source to bypass/maintenance bypass for systems requiring dual input.
****

The UPS system shall conform to UL 1778 and shall consist of UPS module, battery system, battery protective device, static bypass transfer switch, controls and monitoring. Input ac power shall be connected to the normal source ac input of the UPS module. [Alternate power source shall be connected to bypass/maintenance bypass.]The battery shall be connected to the dc input of the UPS module through the battery protective device. The ac output of the UPS system shall be connected to the critical loads.

2.1.1 Semiconductor Fusing

Power semiconductors shall be fused with fast-acting fuses to prevent cascaded or sequential semiconductor failures. Indicator lamp or display panel denoting blown fuse conditions shall be readily observable by the operator without removing panels or opening cabinet doors.

2.1.2 Control Power

****
NOTE: Most manufacturers do not have input and output control power source feature as standard. Use for systems requiring high reliability.
****

Provide dual control power supplies. [Control power shall be derived from two sources, input and output, with automatic selective control.] The control power circuit shall have suitable protection, appropriately marked and located in the immediate vicinity of the input protective device.

2.1.3 EMI/RFI Protection

The components and the system shall be designed to minimize the emission of electromagnetic waves that may cause interference with other equipment.

2.1.4 Internal Wiring

Wiring practices, materials, and coding shall be in accordance with the requirements of NFPA 70, OSHA, and other applicable standards. Wire runs

shall be protected in a manner which separates power and control wiring. Control wiring shall be minimum No. 16 AWG extra-flexible stranded copper. Logic-circuit wiring may be smaller. Ribbon cables shall be minimum No. 22 AWG. Control wiring shall have permanently attached wire numbers.

2.1.5 Internal Assembly

The printed circuit board (PCB) subassemblies shall be mounted in pull-out and/or swing-out trays where feasible. Cable connections to the trays shall be sufficiently long to allow easy access to all components. Where not feasible to mount PCB subassemblies in pull-out or swing-out trays, they shall be firmly mounted inside the enclosure. Every PCB subassembly shall be monitored. Self-test and diagnostic circuitry shall be included in the logic circuits such that a fault can be isolated down to the PCB subassembly level.

2.1.6 Cabinets

UPS system shall be installed in cabinets of heavy-duty structure meeting the NEMA PE 1 standards for floor mounting. UPS module cabinet shall be structurally adequate for forklift handling or lifting. Removable lifting eyes shall be provided on top of each cabinet. UPS module cabinet shall have hinged and lockable doors on the front only, with assemblies and components accessible from the front. Doors shall be [key] lockable. Operating controls shall be located outside the locked doors. Input, output, and battery cables shall be installed through the top or bottom of the cabinet.

2.1.6.1 Cabinet Finish

Equipment cabinet shall be cleaned, primed and painted in the manufacturer's standard colors, in accordance with accepted industry standards. Cabinets shall be labeled in accordance with NFPA 70 for arc flash hazard with warning sign reading: "Warning-Potential Arc Flash Hazard. Appropriate PPE and Tools Required when working on this equipment" or similar wording.

2.1.6.2 Live Parts (300 Volts and Above)

Live parts (300 volts and above) that are exposed when front access doors are open shall be adequately protected or covered to minimize the chance of accidental contact.

2.1.6.3 Drawout Assemblies

****
NOTE: Drawout applies to large units for removing inverter modules, static switches assemblies, etc. Delete for units smaller than 500 kVA.
****

Drawout assemblies weighing 23 kg 50 lbsor more shall be provided with a means of lifting, either an overhead device or a hoisting device.

2.1.7 Safety

UPS shall be equipped 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. The

control panel display shall also provide warning messages prior to performing a critical function.

2.1.8 UPS System Load Profile

****
NOTE: Refer to UFC 3-520-01, "Interior Electrical Systems" for additional information.
****

The UPS system shall be compatible with the load characteristics defined in the LOAD PROFILE below and load configuration. Compensation for UPS/load interaction problems resulting from nonlinear loads or transformer and motor inrush shall be provided.

LOAD PROFILE

Type of load: [data processing equipment][main frame][chilled water pump][_____].

Size of load: [_____][kVA][kW], [_____]horsepower, [_____]voltage, [[_____]amperage].

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

Transient characteristics: inrush current magnitude of [_____] times steady state rms current for duration of [_____] cycle; range of power factor variation of [_____] to [_____] [lagging][leading]; voltage dip of [_____] percent.

Steady-state characteristics: [0.8 lagging][0.9 lagging][1.0][_____] power factor.

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

2.2 UPS SYSTEM RATINGS

Unless stated otherwise, the parameters listed are under full output load at [0.8][0.9] power factor, with batteries fully charged and floating on the dc bus and with nominal input voltage.

2.2.1 System Capacity

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

[_____] kVA, [_____] kW.

2.2.2 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.

****

Discharge time to end voltage: [15][_____] minutes, at 25 degrees C 77 degrees F. End voltage at full discharge shall be 1.67 volts per cell. Battery shall be capable of delivering 150 percent of full rated UPS load at initial start-up.

2.2.3 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 symmetrical interrupting capacity.

2.2.4 Module Bus Bracing

Braced for [_____] amperes symmetrical interrupting capacity.

2.2.5 AC Input

****

NOTE: Total harmonic current distortion (THD) is usually specified as follows: modules 15-224 kVA: 10 percent; modules above 225 kVA: 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. Some of the manufacturers can provide units with the above THD without input filters while others require optional input filters to achieve the desired THD. Delete transformer inrush paragraph if input isolation transformer is not required. Use 50 Hz for units shipped or purchased in Europe. Before specifying them, be certain units having 60 Hz input with 50 Hz output and units having 50 Hz input with 60 Hz output are available in the size specified. Be certain that units having foreign voltages are clearly specified since they are not standard for U.S. manufactured products. 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.

****

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

****
NOTE: Some of the smaller UPS units usually <100 kVA are designed for 3 phase, 4 wire configuration only.
****

b. Number of phases: 3-phase, 3 [4]-wire, plus ground.

c. Voltage Range: Plus 10 percent, minus 20 percent, without affecting battery float voltage or output voltage.

d. Frequency: [50][60] Hz, plus or minus 5 percent.

e. Power walk-in: 20 percent to 100 percent over 10 to 20 seconds.

f. Total harmonic current distortion (THD) reflected into the primary line: [5][10] percent maximum.

[g. Transformer sub-cycle inrush: [4 to 8][_____] times full load rating.

] h. Input surge protection: per IEEE C62.41.1 and IEEE C62.41.2.

i. Input power factor: Lagging from 1-100 percent load.

2.2.6 AC Output

****
NOTE: If the output voltage is 120/208 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.
****

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

b. Number of phases: 3-phase, 4-wire, plus ground.

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) No-load voltage modulation: Plus or minus 1 percent.

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

d. Voltage adjustment: Plus or minus 5 percent manually.

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

f. Frequency regulation: Plus or minus 0.1 percent.

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): Voltage THD shall be a maximum of 2 percent with 100 percent linear load and 5 percent with 100 percent nonlinear load and a crest factor of less than 3 to 1.

i. Load power factor operating range: 1.0 to 0.8 lagging.

j. Phase displacement:

(1) Balanced load: Plus or minus 1 degree of bypass input.

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

k. Wave-form deviation factor: 5 percent at no load.

l. Overload capability (at full voltage) (excluding battery):

(1) 125 percent load for 10 minutes.

(2) 150 percent load for 60 seconds.

(3) 300 percent load for one cycle after which it shall be current limited to 150 percent until fault is cleared or UPS goes to bypass.

2.2.7 Transient Response

2.2.7.1 Voltage Transients

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

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

c. Automatic transfer of load from UPS to bypass: Plus or minus 4 percent.

d. Manual retransfer of load from bypass to UPS: Plus or minus 4 percent.

e. Response time: Recovery to 99 percent steady-state condition within 20 milliseconds after any of the above transients.

2.2.7.2 Frequency

a. Transients: Plus or minus 0.6 Hz maximum.

b. Slew Rate: 1.0 Hz maximum per second.

2.2.8 Efficiency

****

NOTE: Minimum efficiencies at full load are as follows:

UPS capacity	Module
10 kVA to 125 kVA	88 Percent
Above 125 kVA	90 Percent
Above 300 kVA	92 Percent

A higher efficiency UPS will save money on electricity bills on the long run and will pay off to spend more money up front if the funds are available.

****

Minimum Efficiency: [90][_____] percent at full load kW and [90] [_____] percent at 50 percent load.

2.3 UPS MODULE

****

NOTE: Delete input isolation transformer if not required.

****

2.3.1 General Description

UPS module shall consist 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.

2.3.1.1 Interchangeability

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

2.3.2 Rectifier/Charger Unit

Rectifier/charger unit shall be solid state and shall provide regulated direct current to the dc bus, supplying power to the inverter and charging the battery plant.

2.3.2.1 Input Protective Device

****

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

****

Rectifier/charger unit shall be provided with an input protective device. The protective device shall be sized to accept simultaneously the full-rated load and the battery recharge current. The protective device shall be capable of shunt tripping and shall have [_____] amperes symmetrical interrupting rating. The protective device shall have provision for locking in the "off" position.

2.3.2.2 Surge Protection

A surge suppression device shall be installed at the UPS input to protect against lightning and switching surges. Internal components shall be protected from surges that enter at each ac input connection including main input, static bypass transfer switch, [and maintenance bypass/isolation switch]. Surge suppressors shall protect internal components according to IEEE C62.41.1 and IEEE C62.41.2, Category B. Surge suppressors shall be UL 1449 approved to fail in "safe" mode.

[2.3.2.3 Input Isolation Transformer

****

NOTE: Delete the input isolation transformer if it's not required. 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.

****

A dry-type, isolated-winding power transformer shall be used for the rectifier unit. The transformer's hottest spot winding temperature shall not exceed the temperature limit of the transformer insulation material when operating at full load. The transformer insulation shall be Class H, 150 degrees C rise. Transformer connections shall be accessible from the front. Transformer cabinet, if required, shall match the UPS cabinet and attach to it.

]2.3.2.4 Power Walk-In

Rectifier/charger unit shall be protected by 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 shall increase gradually to 100 percent of the rated full load current plus the battery charging current over the specified time interval.

2.3.2.5 Sizing

Rectifier/charger unit shall be sized for the following two simultaneous operating conditions:

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

b. Recharging a fully-discharged battery to 95 percent of rated ampere-hour capacity within ten times the discharge time after normal ac power is restored.

2.3.2.6 Battery Charging Current

****

NOTE: Delete second step current limiting 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 recharge current of the battery. Second step current limit is usually found in larger units of 150kVA and above.

****

a. Primary current limiting: Battery-charging current shall be voltage regulated and current limited. The battery-charging current limit shall be separately adjustable from 2 percent to 25 percent of the maximum discharge current. After the battery is recharged, the rectifier/charger unit shall maintain the battery at full float charge until the next operation under input power failure. Battery charger shall be capable of providing equalizing charge to the battery.

[b. Second step current limiting: The rectifier/charger unit shall also have a second-step battery current limit. This second-step current limit shall sense actual battery current and reduce the input power demand for battery recharging to 50 percent (adjustable from 30 percent to 70 percent) of the normal rate without affecting the system's ability to supply full-rated power to the connected load. The second-step current-limit circuit shall be activated by a dry contact signal from the generator set controls and shall prevent normal rate battery recharging until utility power is restored.

]2.3.2.7 DC Ripple

Rectifier/charger unit shall minimize ripple current and voltage supplied to the battery; the ripple current into the battery shall not exceed 3 percent RMS of the inverter input rated current; the ripple voltage into the battery shall not exceed 2 percent RMS of the float voltage.

2.3.2.8 DC Voltage Adjustment

Rectifier/charger unit shall have manual means for adjusting dc voltage for battery equalization, to provide voltage within plus 10 percent of nominal float voltage.

2.3.2.9 Battery Isolation Protective Device

Module shall have a dc protective device to isolate the module from the battery system. The protective device size and interrupting rating shall be as required by system capacity and shall incorporate a shunt trip as required by circuit design. The protective device shall have provision for locking in the "off" position.

2.3.3 Inverter Unit

Inverter unit shall be a solid-state device deriving its power from the dc bus (rectifier or battery source) and providing ac power within specified limits to the critical load. Inverter shall utilize microprocessor controlled solid state Pulse Width Modulation (PWM) controlled IGBT power transistor technology to shape the ac output.

2.3.3.1 Output Overload

The inverter shall be able to sustain an overload as specified across its output terminals. The inverter shall not shut off, but shall 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 inverter shall current limit, load shall be transferred to the bypass source, and the inverter shall disconnect automatically from the critical load bus.

If the bypass source is not available and the overload/fault condition

continues, the inverter shall current limit for a limited time as determined by the manufacturer and shall shut down to protect the internal components.

2.3.3.2 Output Frequency Control

The inverter shall normally operate in phase-lock and synchronism with the bypass source. When the bypass source frequency deviates by more than ±0.5 Hz, the internal frequency oscillator shall automatically take control and become the new frequency reference. Upon restoration of the bypass source within the required tolerance, the inverter shall synchronize back with that source at a slew rate not exceeding the specified rate. The oscillator shall be temperature compensated and shall be manually adjustable.

2.3.3.3 Output Protective Device

The output protective device shall be capable of shunt tripping or opening on an applied control signal and shall have the proper frame size and trip rating to supply overload current as specified. External output protective device shall have provision for locking in the "off" position. The inverter output protective device shall work in conjunction with the bypass protective device for both manual and automatic load transfers to and from bypass power.

[2.3.3.4 Output Transformer

****
NOTE: Delete the output transformer unless isolation is required or 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 inverter output transformer shall be similar to the input transformer and shall be capable of handling up to [K-13][_____] nonlinear loads as described in IEEE C57.110.

]2.3.4 External Protection

UPS module shall have built-in self-protection against undervoltage, overvoltage, overcurrent and surges introduced on the ac input source and/or the bypass source. The UPS shall also have 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.

2.3.5 Internal Protection

UPS module shall be self-protected against overcurrent, sudden changes in output load and short circuits at the output terminals. UPS module shall be provided with output reverse power detection which shall cause the module to be disconnected from the critical load bus when output reverse power is present. UPS module shall have 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 shall shut down without damage to internal components.

2.4 STATIC BYPASS TRANSFER CIRCUIT

A static bypass transfer circuit shall be provided as an integral part of the UPS and shall consist of a static switch, made up of two reverse-paralleled SCRs (silicon-controlled rectifiers) per phase conductor, and a bypass protective device or bypass switch, made up of a contactor or motor operated circuit breaker. The bypass protective device shall be in parallel with the static switch. The inverter output protective device shall disconnect and isolate the inverter from the bypass transfer circuit.

The control logic shall contain 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 bypass ac power source, without exceeding the transient limits specified herein, when a malfunction occurs in the UPS or when an external overload condition occurs. The power section of the static bypass transfer circuit shall be provided as a plug-in type assembly to facilitate maintenance. The static bypass transfer circuit shall be used to connect the input bypass ac power source to the critical load when required, and shall have the following features:

2.4.1 Uninterrupted Transfer

The static bypass transfer switch shall automatically cause 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.

2.4.2 Interrupted Transfer

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

If the bypass ac power source is beyond the conditions stated below, an interrupted transfer shall be 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.

2.4.3 Manual Transfer

It shall be possible to make a manually-initiated static transfer from the system status and control panel. The transfer shall be make-before-break

utilizing the bypass switch.

2.4.4 Automatic Uninterrupted Forward Transfer

The static bypass transfer switch shall automatically forward transfer, without interruption after the UPS inverter is turned "on", or after an instantaneous overload-induced reverse transfer has occurred and the load current has returned to less than the unit's 100 percent rating.

2.4.5 Forced Transfer

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

2.4.6 Overload Ratings

****
NOTE: Select 'one minute' for greater than 150kVA; select '30 seconds' for 10-150kVA.
****

The static bypass transfer switch shall withstand the following overload conditions:

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

b. 150 percent of UPS output rating for [one minute][30 seconds].

c. 125 percent of UPS output rating for 10 minutes.

2.4.7 Static Switch Disconnect

****
NOTE: Delete if the static switch is of the draw-out type.
****

A static switch disconnect shall be incorporated to isolate the static bypass transfer switch assembly so it can be removed for servicing. The switch shall be equipped with auxiliary contacts.

2.5 MAINTENANCE BYPASS SWITCH

2.5.1 General

****
NOTE: Multi-module UPS systems require a UPS maintenance bypass that should be incorporated into the UPS output switchgear.

There are two methods of installing a maintenance bypass switch. One is a cabinet that bolts to the UPS module and becomes part of the line-up or is integral to the UPS module cabinet. The second is physically isolated from the UPS module in a separate cabinet mounted on the wall or

free-standing floor-mounted. Choose the appropriate method based on project conditions and requirements.

****

A maintenance bypass switch shall be provided [as an integral part of the UPS and located within the UPS module or in a matching cabinet adjacent to the UPS cabinet][in a wall-mounted enclosure][in a free-standing floor-mounted enclosure]. The maintenance bypass switch shall provide the capability to continuously support the critical load from the bypass AC power source while the UPS is isolated for maintenance. The maintenance bypass switch shall be housed [in an isolated compartment inside the UPS cabinet][in a separate cabinet or enclosure] in such a way that service personnel will not be exposed to electrically live parts while maintaining the equipment. Switch shall contain a maintenance bypass protective device and a module isolation protective device.

2.5.2 Load Transfer

The maintenance bypass switch shall provide 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.

[2.5.3 Load Bank Protection Device

****

NOTE: Delete if the ability to load bank test the UPS system is not required.

****

A load bank protective device shall be provided to allow the UPS system to be tested using a portable load bank. The load bank protective device shall be connected on the line side of the maintenance bypass switch isolation protective device.

][2.5.4 [Voltage Matching][Isolation Transformer]

****

NOTE: Delete if the input and output voltages are the same and an isolation transformer is not required.

****

The maintenance bypass cabinet shall contain [a voltage matching transformer][an isolation transformer] as required to match the output voltage requirements.

]2.6 MODULE CONTROL PANEL

The UPS module shall be provided with a control/indicator display panel. The display panel shall be on the front of the UPS module. Controls, meters, alarms and indicators for operation of the UPS module shall be on this panel. The display panel shall be menu driven for browsing all the screens.

2.6.1 Module Meters

2.6.1.1 Monitored Functions

The following functions shall be monitored and displayed:

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

b. Input current, all three phases.

c. Input frequency.

d. Battery voltage.

e. Battery current (charge/discharge).

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

g. Output current, all three phases.

h. Output frequency.

i. Output kilowatts.

j. Elapsed time meter to indicate hours of operation, 6 digits.

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

l. Output kilovars.

m. Output kilowatt hours, with 15-minute demand attachment.

n. Battery temperature.

o. Output Percentage load.

p. Remaining battery time.

2.6.1.2 Meter Construction

The display panel shall display alphanumeric parameters based on true RMS metering with 1 percent accuracy (minimum 4 significant digits).

2.6.2 Module Controls

Module shall have the following controls:

a. Lamp test/reset pushbutton.

b. Alarm test/reset pushbutton.

c. Module input protective device trip pushbutton, with guard.

d. Module output protective device trip pushbutton, with guard.

e. Battery protective device trip pushbutton, with guard.

f. Emergency off pushbutton, with guard.

g. DC voltage adjustment potentiometer, with locking guard.

h. Control power off switch.

i. UPS/bypass transfer selector switch.

j. Static bypass transfer switch enable/disable selector switch.

2.6.3 Module Alarm Indicators

****
NOTE: Delete 'input transformer overtemperature' if input transformer is not provided.
****

Module shall have indicators for the following alarm items. Any one of these conditions shall turn on an audible alarm and the appropriate summary indicator. Each new alarm shall register without affecting any previous alarm.

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.

[l. Input transformer overtemperature.

] m. Low battery shutdown.

n. UPS on battery.

o. Equipment overtemperature.

p. Fuse blown (with indication where).

q. Control power failure.

r. Charger off/problem.

s. Inverter fault/off.

t. Emergency power off.

u. External shutdown (remote EPO activated).

v. Critical load on static bypass.

w. Static bypass transfer switch disabled/failure.

x. Inverter output overvoltage.

y. Inverter output undervoltage.

z. Inverter output overfrequency.

aa. Inverter output underfrequency.

bb. Bypass source voltage outside limits.

cc. Bypass frequency out of range.

dd. Bypass source to inverter out of synchronization.

ee. Overtemperature shutdown.

ff. Hardware shutdown.

2.6.4 Module Emergency OFF Button

Pressing the emergency off button shall cause the module to be disconnected from the system, via its input protective device, output protective device, and battery protective device. The button shall include a protective cover to prevent unintentional activation.

[2.7 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.

****

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

][2.8 REMOTE MONITORING PANEL

****

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

****

A remote monitoring panel shall be provided to monitor system status. The panel shall be designed for wall mounting near the critical load.

2.8.1 Indicators

Minimum display shall include the following indicators:

a. Load on UPS.

b. Load on battery.

c. Load on bypass.

d. Low battery.

e. Summary alarm.

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

2.8.2 Audible Alarm

Any single indicator shall also turn on the audible alarm. An audible alarm test/reset button and lamp test/reset button shall be included. This reset button shall not affect nor reset the alarm on the module.

]2.9 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.

****

An [RS 232][RS 485] communications and data acquisition port shall be provided. This port shall allow the system parameters, status, alarm indication and control panel functions specified to be remotely monitored and controlled.

Additionally, a second communication port shall be provided for use with the following:

a. A set of [six][eight] Form C remote alarm contacts rated at 120V, 0.5A, shall be provided for remote alarm monitoring.

b. Auto-dial modem communication shall be provided to communicate with a remote modem in case an alarm function is active.

c. A SNMP (Simple Network Management Protocol) adapter shall be provided to communicate UPS monitoring via a network or direct connection to a PC.

d. A standard Web Browser adapter shall be provided to remotely view and monitor UPS functions over the Internet.

All the communication ports and contacts shall be capable of simultaneous communication.

[2.9.1 Emergency Control Contacts

****

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

Provide normally open contacts to signal when power is supplied to the UPS from emergency engine generators or alternate source.

]2.10 TEMPERATURE CONTROL

2.10.1 General

Cabinet and enclosure ventilation shall be adequate to ensure that components are operated within their ratings. Forced-air cooled rectifier, inverter, and control unit will be acceptable. The cooling fans shall continue operation if UPS input power is lost. Redundancy shall be provided so that failure of one fan or associated circuit breaker will not cause an overheat condition. Cooling air shall enter the lower front of the cabinets and exhaust at the top. Blower power failure shall be indicated as a visual and audible alarm on the control panel. Air inlets shall have replaceable filters that may be located on the inside of the cabinet doors and shall be easily accessible for replacement.

2.10.2 Blower Power Source

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

Blower power source shall be internally derived from the [output side] [input and output sides] of UPS module, with automatic transfer arrangement.

2.10.3 Temperature Sensors

Temperature sensors shall be provided to monitor the air temperature. Separate sensors shall monitor the temperature of rectifier and inverter heat sinks. Separate sensors shall also monitor the transformer temperature. Critical equipment over-temperature indication shall start a timer that shall shut down the UPS system if the temperature does not return below the setpoint level recommended by the UPS manufacturer.

2.11 BATTERY SYSTEM

NOTE: Refer to UFC 3-520-01, "Interior Electrical System"s for battery types and selection information.

2.11.1 General

Battery system shall contain the battery cells, racks, battery disconnect, battery monitor and cabinet, if required. A storage battery with sufficient ampere-hour rating to maintain UPS output at full capacity for the specified duration shall be provided for each UPS module. The battery shall be of heavy-duty, industrial design suitable for UPS service. The cells shall be provided with flame arrestor vents, intercell connectors and cables, cell-lifting straps, cell-numbering sets, and terminal grease. Intercell connectors shall be sized to maintain terminal voltage within

voltage window limits when supplying full load under power failure conditions. Cell and connector hardware shall be stainless steel of a type capable of resisting corrosion from the electrolyte used.

2.11.2 Battery Ratings

a. Type: [lead calcium][lead antimony][nickel cadmium].

b. Specific gravity when fully charged: [1.215][_____].

c. End voltage [1.67][_____] volts per cell.

d. Float voltage: [2.17 to 2.26][2.15 to 2.22] volts per cell.

e. Equalizing voltage: [2.33 to 2.38][_____] volts per cell.

2.11.3 Battery Construction

The battery shall be of the [valve-regulated, sealed, non-gassing, recombinant type][wet-cell type and shall be supplied complete with thermometer and hydrometer holder].

[2.11.4 Battery Cabinet

****
NOTE: Delete if a battery cabinet is not required.
****

The battery pack assembly shall be furnished in a battery cabinet matching the UPS cabinet. The battery cabinet shall be designed to allow for checking the torque on the connections in the battery system and to provide adequate access for annual housekeeping chores. External wiring interface shall be through the bottom or top of the assembly. A smoke and high temperature alarm shall annunciate detection of either smoke or high temperature within the battery cabinet.

][2.11.5 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.
****

The battery shall be provided with a suitable number of [two-tier][three-tier] racks to fit the room layout shown. Battery rack shall be steel and shall be protected with electrolyte-resistant paint. Battery rack shall be shipped unassembled and shall include hardware necessary for assembly. Each rack shall be complete with bus bars to accommodate cables from UPS module. 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 shall be provided. End sections shall be cut to length to prevent wasting floor space.

]2.11.6 Cell-Terminal Covers

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

2.11.7 Battery Disconnect

Each battery pack assembly shall have a fused disconnect switch provided in a NEMA 1 enclosure, finished with acid-resistant paint and located in line with the assembly. Switch shall be complete with line side and load side bus bars for connection to battery cells. Switch shall be rated [_____] V dc, [_____] amperes, 3-pole with interrupting rating as required by system capacity, and shall have an external operator that is lockable in the "off" position.

[2.11.8 Seismic Requirements

****
NOTE: Do not use this paragraph for Navy projects. When directed to meet seismic requirements for battery supports, Section 13 48 00 SEISMIC PROTECTION FOR MISCELLANEOUS EQUIPMENT and 26 05 48.00 10 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 the Government designer is the Engineer of Record and for Navy projects, provide seismic requirements on the drawings.
****

The battery support system shall [conform to [Section 13 48 00 SEISMIC PROTECTION FOR MISCELLANEOUS EQUIPMENT] [and to] [26 05 48.00 10 SEISMIC PROTECTION FOR ELECTRICAL EQUIPMENT]][be as indicated].

]2.11.9 Battery Monitor

A battery monitor shall be provided for each battery pack assembly. At a minimum, this device shall monitor the following parameters:

a. Total system voltage.

b. Ambient room temperature.

c. Total battery discharge cycles with a duration of [30 seconds or less][greater than 30 seconds but less than 5 minutes][greater than 5 minutes].

The monitor shall also record the total accumulated discharge minutes and accumulated battery system discharge kW hours.

2.12 FACTORY TESTING

****
NOTE: 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.

****

The UPS system shall be factory tested to meet the requirements specified using a test battery (not the battery to be supplied with the system). UPS module shall be factory load tested 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. Load shall be balanced at rated kVA and rated power factor. Factory tests for the UPS module shall be run under full load, and will be witnessed by the Government. Should a malfunction occur, the problem shall be corrected and the test shall be repeated. As a minimum, the factory tests shall include the parameters described in paragraphs ac Input, ac Output, Transient Response and Efficiency. The tests shall encompass all aspects of operation, such as module failure, static bypass operation, battery failure, input power failure and overload ratings. The Contracting Officer shall be notified in writing at least 2 weeks before testing. Factory-test time shall not be used for system debugging and/or checkout. Such work shall be done prior to notifying the Government that the system is ready for testing. Factory tests shall be performed during normal business hours. The system shall be interconnected and tested for an additional 8 hours to ensure proper wiring and performance.

2.12.1 Transient Tests

Transient tests shall be conducted using high-speed oscillograph type recorders to demonstrate the operation of the components to the satisfaction of the Government. These tests shall include 50 percent to 100 percent load changes, manual transfer, manual retransfer, low dc bus initiated transfer and low ac output bus transfer. A recording instrument equipped with an event marker shall be used.

2.12.2 Efficiency Tests

Testing for efficiency shall be performed at zero output up to 100 percent of stated kVA output in 25 percent steps, [0.8][0.9] power factor, with battery fully charged and floating on the dc bus, with nominal input voltage, and with module connected to represent actual operating conditions.

2.13 CABLE LUGS AND TERMINATIONS

2.13.1 Cable Lugs

Provide appropriate compression type lugs on all ac and dc power connections to the UPS system and battery as required. Aluminum or bare

copper cable lugs are not suitable.

2.13.2 Terminations

Terminals shall be supplied for making power and control connections. Terminal blocks shall be provided for field wiring terminals. Terminal blocks shall be heavy-duty, strap-screw type. Terminal blocks for field wiring shall be located in one place in each module. Control wiring shall be extended to the terminal block location. No more than two wires shall land on any terminal point. Where control wiring is attached to the same point as power wiring, a separate terminal shall be provided. If bus duct is used, bus stubs shall be provided where bus duct enters cabinets.

2.14 INSPECTION

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

2.15 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. Each nameplate inscription shall identify the function and, when applicable, the position. Nameplates shall be melamine plastic, 3 mm 0.125 inch thick, white with [black][_____] center core. Surface shall be matte finish. Corners shall be square. Accurately align lettering and engrave into the core. Minimum size of nameplates shall be 25 by 65 mm 1.0 by 2.5 inches. Lettering shall be a minimum of 6.35 mm 0.25 inch high normal block style.

2.16 MANUFACTURER'S NAMEPLATES

Each item of equipment shall have a nameplate 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.

2.17 FACTORY APPLIED FINISH

Electrical equipment shall have factory-applied painting systems which shall, as a minimum, meet the requirements of NEMA 250 corrosion-resistance test.

PART 3 EXECUTION

3.1 INSTALLATION

Electrical installations shall conform to IEEE C2, NFPA 70, and to requirements specified herein. Provide new equipment and materials unless indicated or specified otherwise.

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.

****

UPS control wiring shall be installed 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 Conductor

Provide an insulated equipment grounding conductor in feeder and branch circuits. Conductor shall be separate from the electrical system neutral conductor. Ground battery racks and battery breaker cabinets with a separate equipment grounding conductor to the UPS cabinet.

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. Isolation shall prevent inductive coupling from other conductors.

[3.1.4 DC Power Conductors

****

NOTE: Include this paragraph only when shipping splits occur or 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.

]3.1.5 Seismic Protection

****

NOTE: Do not use this paragraph for Navy projects. When directed to meet seismic requirements for UPS enclosure anchoring, Section 13 48 00 SEISMIC PROTECTION FOR MISCELLANEOUS EQUIPMENT and 26 05 48.00 10 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 the Government designer is the Engineer of Record and for Navy projects, provide seismic requirements on the drawings.

****

The UPS enclosure shall [conform to [Section 13 48 00 SEISMIC PROTECTION FOR MISCELLANEOUS EQUIPMENT][and to][26 05 48.00 10 SEISMIC PROTECTION FOR ELECTRICAL EQUIPMENT]][be as indicated].

3.1.6 Conduit Entries

Conduit entries shall use the available conduit areas shown on manufacturer's installation drawings. Conduit entries shall not be made through the front, side or rear panels of the UPS[or Maintenance Bypass Cabinet].

[3.1.7 Battery Rack Assembly

****
NOTE: Choose this paragraph or the one below entitled "Battery Cabinet".
****

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. Installation of battery racks shall conform to the manufacturer's instructions.

][3.1.8 Battery Cabinet Assembly

Battery cabinets are typically factory assembled for up to 100 KVA UPS systems. Battery cabinets for larger units typically require assembly at the site. Installation of battery cabinets shall conform 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.
****

Installation of batteries shall conform 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.
****

Contractor shall notify Contracting Officer in writing at least 45 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. The UPS technical representative shall provide instruction for activity personnel as specified in paragraph titled "DEMONSTRATION".

3.2.1 Installation Preparation

****
NOTE: In subparagraph b. choose either battery racks or cabinets based on the UPS size and configuration.

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

****

The following items shall be completely installed 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.

b. Battery [racks][cabinets] and cells. This is not applicable for maintenance-free battery.

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;

] 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.

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 shall 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. 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.

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 shall be 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 shall connect load bank to UPS output. Load bank required shall be determined by the following:

UPS KVA RATING X 0.8 = KW of LOAD BANK

Performance test is to be run under the supervision of the UPS technical representative. UPS unit shall be operated under full load for a minimum of one hour. Contractor shall be required to operate feeder and bypass power feeder breakers during testing of the UPS.

a. Electrical Tests

(1) Perform resistance measurements through bolted connections with a low-resistance ohmmeter.

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

(3) Set free running frequency of oscillator.

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

(5) Test alarm circuits.

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

(7) Perform electrical tests for UPS system breakers.

(8) Perform electrical tests for UPS system batteries.

b. Test Values

(1) Compare bolted connection resistances to values of similar connections.

(2) Verify bolt-torque levels.

(3) Micro-ohm or millivolt drop values shall not exceed the high levels of the normal range as indicated in the manufacturer's published data. If manufacturer's data is not available, investigate any values which deviate from similar connections by more than 50 percent of the lowest value.

[c. Load Test

****
NOTE: Edit as required, depending upon whether a temporary or permanent load bank is to be provided and on the type of UPS system. This paragraph may be deleted for small UPS systems.
****

The installed system shall be load tested for a continuous 24 hour period by means of resistive load banks. The system shall be continuously tested at 1/2 load for 8 hours, 3/4 load for 8 hours and full load for 8 hours. Provide resistive load banks of total kW load of equipment to facilitate startup under load conditions, and to conduct load tests described above. Instrument readings shall be recorded 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.

][d. Full Load Burn In Test

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

The installed system shall undergo an additional full load burn-in period of 24 continuous hours. If a failure occurs during the burn-in period, the tests shall be repeated. Instrument readings shall be recorded every half hour as above. During the burn-in period, the following tests shall be performed:

(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 five times within [the burn-in period] [_____].

[(2) With the UPS carrying maximum continuous design load and supplied from the emergency source, repeat the switching operations
described in step a. 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 a above.

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

The Contractor shall 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). Four copies of the traces shall be delivered to the Contracting Officer.

][e. Battery Discharge Test

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

With the battery fully charged, the system shall undergo a complete battery discharge test to full depletion and a recharge to nominal conditions. Instrument readings shall be recorded 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 Emergency Generator Operation

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

Test UPS to observe operation with emergency generator service. UPS technical representative shall 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. The following shall be accomplished:

a. Install a calibrated voltmeter across the battery terminals to measure voltage, and install a calibrated voltmeter across the UPS dc shunt to read charging current. UPS technical representative will advise connection to dc shunt.

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 of 291 volts dc. 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, open the inverted output breaker. Then put battery on equalizing charge, with rectifier adjusted to normal equalizing voltage of [424][_____] volts dc. Equalize for a minimum of [100][_____] hours. Measure and record time and battery voltage. Run a second discharge performance test.

]3.3 DEMONSTRATION

****
NOTE: Delete video tape 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 shall be thoroughly familiar with all parts of the installation and shall be trained in operating theory as well as practical operation and maintenance work. Instruction shall be given 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.][Field training shall be videotaped and the tape shall be left with the Contracting Officer.][A factory training videotape shall be provided as part of the training materials.]

3.4 FINAL ADJUSTMENTS

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

b. Equalize battery at [424][_____] volts for a period of [72] [_____] hours.

****
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 of [411][_____] volts dc.

e. Check battery connections are properly torqued 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. All manufacturer's data and operation manuals, which are an integral part of, and shipped with UPS, shall be delivered 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 shall be as specified in Section 09 90 00 PAINTS AND COATINGS.

3.7 DISPOSAL

Upon completion of UPS installation and testing, Contractor shall remove and dispose of empty, partially full and excess acid drums, including shipping containers, obsolete batteries, and obsolete UPS modules. Removal shall be accomplished off-base and in conformance with local laws and regulations regarding disposal of hazardous material.

-- End of Section --