



Department of Public Works
Infrastructure Services Division

Ghassan Korban
Commissioner of Public Works

Preston D. Cole
Director of Operations

Jeffrey S. Polenske
City Engineer

May 27, 2015

Subject: Official Notice No. ~~78~~-1-2015

MPD – Data Room UPS units & Cooling Replacement
Various locations
Milwaukee, Wisconsin

For which bid will be received on
Monday, June 1, 2015

Addendum No. 2

- A. In regard to our advertisement for the MPD – Data Room UPS Units & Cooling Replacement, Various locations Milwaukee, Wisconsin this attached Addendum No. 1 is issued to modify the original documents and is hereby made part of the proposal.
- B. Each bidder shall read the entire addendum. Proposals shall include all items included in this Addendum No. 2.

Very truly yours,

Paul R. Fredrich, Facilities Operations Manager
Bridges and Buildings



Official Notice No. 78-1-2015

MPD – Data Room UPS Units & Cooling Replacement
Various locations
Milwaukee, Wisconsin

Addendum No. 2

IMMEDIATELY UPON RECEIPT OF THE ADDENDUM, PLEASE SIGN THIS RECEIPT AND FAX BACK TO DPW-BRIDGES AND BUILDINGS SECTION AT (414) 286-5907 OR EMAIL (Thomas.tarkowski@Milwaukee.gov).

Company Name

Name

Date

DRAWINGS

1. Revise the following Mechanical drawings as follows:
 - a. Sheet N9-M1
 - i. Delete provisions for new 14-inch X 14-inch mechanical duct work shown on the drawing for temporary cooling unit exhaust, and its exterior building wall penetration new work shown.
 - ii. Add provisions for new temporary cooling Exhaust, as follows:

Modify the existing exhaust ductwork in the data room to accept a new 12" round flange and flexible duct connection. Remove and cap existing exhaust grill to prevent any short cycling within the data room. The existing room thermostat shall remain to control existing exhaust fan operation in conjunction with the new portable cooling unit.
 - b. Sheet N10-M1
 - i. Replace Keyed Note 5 to state the following:

"Run Refrigerant piping up the outside of the building to the condensing units located on the roof. Provide trapping as required by manufacturer. Contractor shall provide correct line sizes per manufacturer. Contractor shall provide a 16 gauge galvanized sheet metal cover over all exterior piping, with a 2-inch flanges on each side. The Sheet metal cover sections must overlap each other by 3" and shall be caulked. The cover must be secured to the building every 4 feet with masonry anchors and fasteners and caulked. Provide a minimum of four anchor connections to the building, per galvanized sheet section."
 - c. Sheet N13-PL1
 - i. Replace Keyed Note 2 to state the following:

"Contractor to remove the water fountain and soffit as required to gain access to existing domestic water pipe. Install a Tee into the existing water pipe for new water connection for CRAC units. The backflow preventer shall be installed in mechanical room 328. See Detail 2 for installation requirements. The contractor shall repair the wall and soffit to the construction as found before work started. Reinstall the water fountain."
 - d. Sheet S7-M1
 - i. Replace Keyed Note 5 to state the following:

"Condensing units to be located on grade. Provide concrete equipment pad. Concrete equipment pad requirements can be found in specification section 20 0529, section 2.3.A."
2. Add the following new Mechanical Drawings into the Project Drawings, and update Drawing Index as noted:
 - a. Sheet N10-M2 ENGINE HOUSE NO. 22 – ROOF PARTIAL PLAN – MECHANICAL – NEW WORK.

- b. Sheet N13-M2 SAFETY ACADEMY – ROOF PARTIAL PLAN – MECHANICAL – NEW WORK.
- c. Sheet N14-M2 ENGINE HOUSE NO. 38 – ROOF PARTIAL PLAN – MECHANICAL – NEW WORK.

SPECIFICATIONS

- 1. Replace the following Specifications Sections in the Project Manual in their entirety:
 - a. Section 26 2600 – POWER DISTRIBUTION UNIT (PDU)
 - b. Section 26 3353A – STATIC UNINTERRUPTIBLE POWER SUPPLY (UPS)

ATTACHMENTS

- Drawing Sheet N10-M2
- Drawing Sheet N13-M2
- Drawing Sheet N14-M2
- Specification Section 26 2600
- Specification Section 26 3353

END OF Addendum #2



City of Milwaukee

Department of Public Works

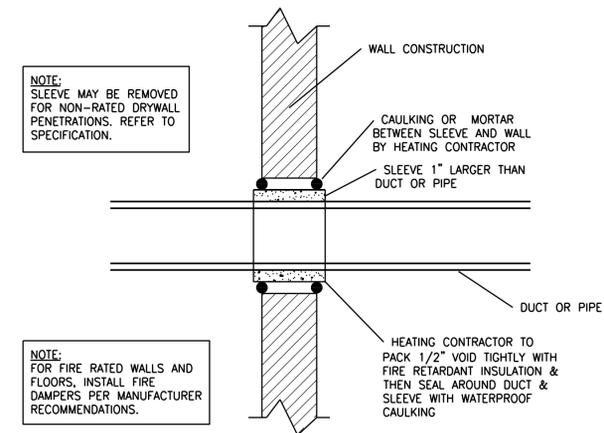
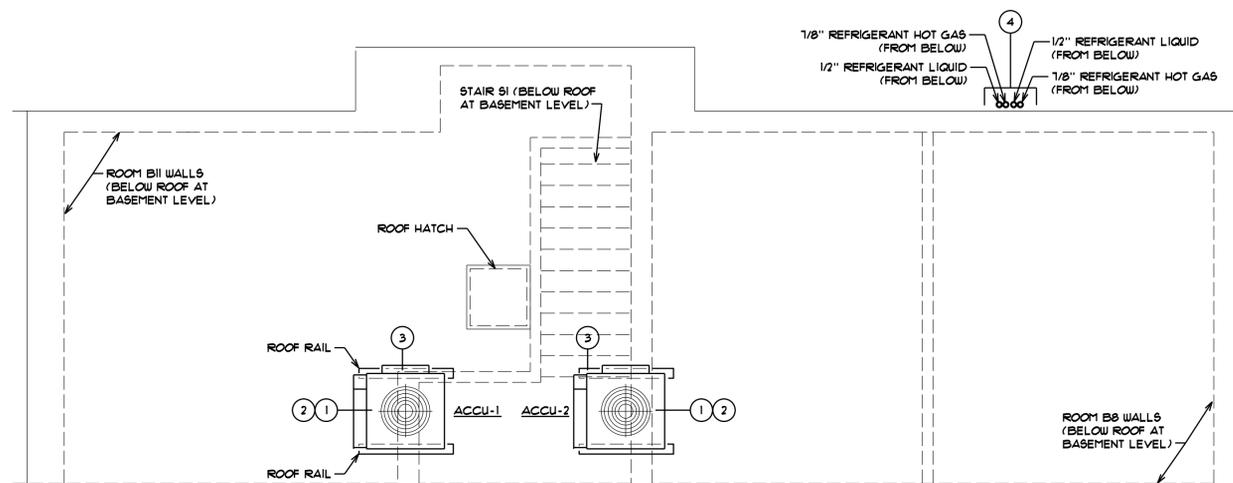
Infrastructure Services Division

Bridges & Buildings Section

APPROVED: Facilities Operations Manager
CITY ENGINEER
COMMISSIONER OF PUBLIC WORKS

ABBREVIATIONS	
DESIGNATION	DESCRIPTION
E.C.	ELECTRICAL CONTRACTOR
M.C.	MECHANICAL CONTRACTOR
MIN	MINIMUM
RA	RETURN AIR
SA	SUPPLY AIR
TYP	TYPICAL

PIPING LEGEND	
DESIGNATION	DESCRIPTION
—NFW—	NON-POTABLE WATER PIPE
—RL—	REFRIGERANT LIQUID PIPE
—RHG—	REFRIGERANT HOT GAS PIPE
—COND—	CONDENSATE DRAIN PIPE
—HWS—	HOT WATER SUPPLY PIPE
—HWR—	HOT WATER RETURN PIPE

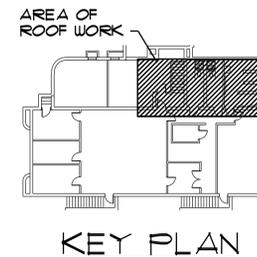


2 DUCTS AND PIPES THROUGH WALL DETAIL
NO SCALE

1 ENGINE HOUSE NO. 22 - ROOF PARTIAL PLAN - MECHANICAL
SCALE 1/4" = 1'-0"
NORTH

KEYED NOTES

- 1 SEE SPECIFICATION SECTION 20 0529 FOR INSTALLATION REQUIREMENTS.
- 2 CONTRACTOR TO UTILIZE LARGER ROOFING FOR EQUIPMENT ROOF RAIL INSTALLATION.
- 3 EQUIPMENT RAIL TO SPAN TWO ROOF JOISTS, TYP.
- 4 SEE PIPES THROUGH WALL DETAIL ON THIS SHEET.



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414 476-9980
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MPD - Data Room UPS Units & Cooling Replacement
N10 - ENGINE HOUSE NO. 22
8814 W. LISBON AVENUE
ROOF PARTIAL PLAN
MECHANICAL - NEW WORK

REVISIONS
1 Addendum #1 5-21-15

DESIGNED BY	MJM
DRAWN BY	JLW
CHECKED BY	MJM
DATE	04/28/15
SCALE	1/4" = 1'-0"
JOB NUMBER	RM5445139922
SHEET NUMBER	N10-M2
OF	



City of Milwaukee

Department of Public Works

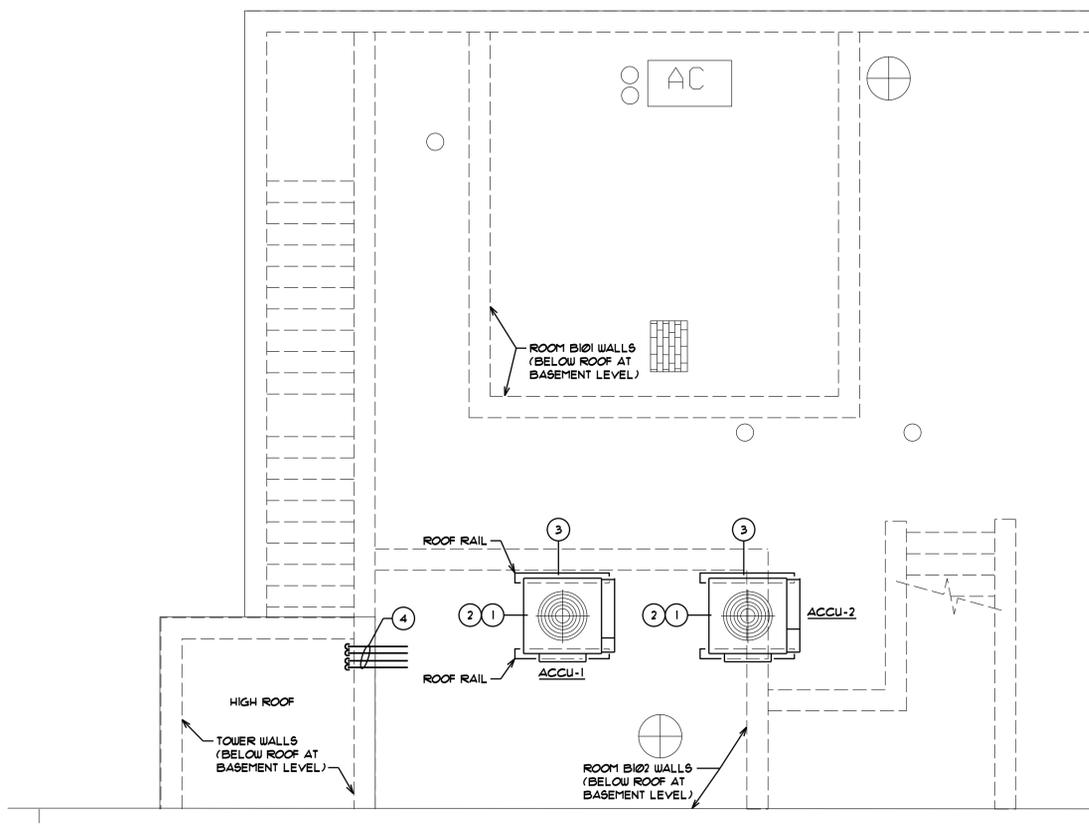
Infrastructure Services Division

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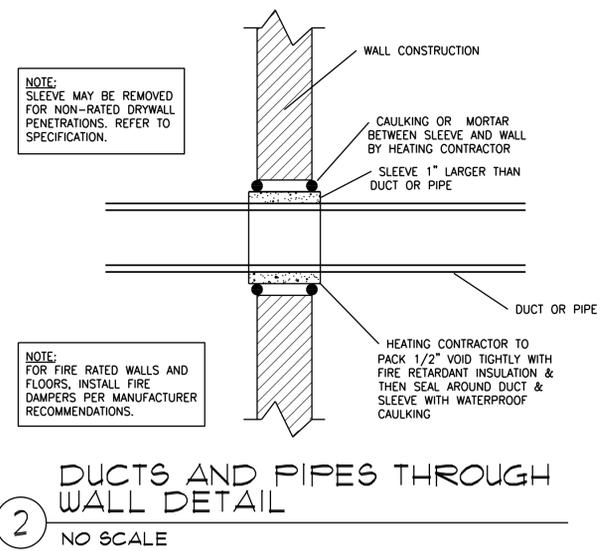
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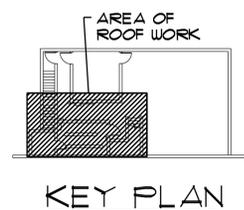
1 ENGINE HOUSE NO. 38 -
ROOF PARTIAL PLAN - MECHANICAL
SCALE 1/4" = 1'-0"
NORTH

KEYED NOTES

- 1 SEE SPECIFICATION SECTION 20 0529 FOR INSTALLATION REQUIREMENTS.
- 2 THERE IS NO ROOF WARRANTY IN PLACE FOR THIS ROOF. ANY QUALIFIED ROOFING CONTRACTOR CAN PERFORM WORK.
- 3 EQUIPMENT ROOF RAIL TO SPAN TWO ROOF JOISTS. (TYP.)
- 4 SEE PIPES THROUGH WALL DETAIL ON THIS SHEET.



2 DUCTS AND PIPES THROUGH WALL DETAIL
NO SCALE



KEY PLAN

**GRUMMAN
/BUTKUS
ASSOCIATES**
Energy Efficiency Consultants
and Sustainable Design
Engineers
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Suite 300
414 476-9990
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MPD - Data Room UPS Units & Cooling Replacement
N14 - ENGINE HOUSE NO. 38
8463 N. GRANVILLE ROAD
ROOF PARTIAL PLAN
MECHANICAL - NEW WORK

REVISIONS
1 Addendum #1 5-21-15

DESIGNED BY	MJM
DRAWN BY	JLW
CHECKED BY	MJM
DATE	SCALE
04/28/15	1/4" = 1'-0"
JOB NUMBER	
R15445139922	
SHEET NUMBER	
N14-M2	
OF	

**SECTION 26 2600
POWER DISTRIBUTION UNITS**

PART 1 - GENERAL**1.1 SCOPE OF WORK**

- A. This section includes the requirements for the supplying of computer grade power to the data processing equipment and other essential loads.
- B. The Contractor shall provide all work necessary to make a thoroughly operating conditioned system. The Contractor shall obtain and implement all wiring requirements from the system manufacturer, and include such costs in his bid.

1.2 DEFINITIONS

- A. TVSS: Transient Voltage Suppression
- B. UPS: Uninterrupted Power Supply
- C. PDU: Power Distribution Unit

1.3 CODE AND STANDARDS

- A. Underwriters Laboratories Standard, UL 60950, UL891
- B. National Electric Code (NEC)
- C. ISO9001
- D. American National Standards Institute (ANSI)
- E. National Electrical Manufacturers Association (NEMA)
- F. National Fire Protection Association (NFPA)

1.4 QUALITY ASSURANCE

- A. Manufacturer Qualifications: A qualified manufacturer. Maintain a service center capable of providing training, parts, and emergency on-site repairs in less than eight hours; maximum response time.
- B. Source Limitations: Obtain power distribution unit and associated components specified in this Section from a single manufacturer with responsibility for entire power distribution unit installation.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

1.5 SUBMITTALS

- A. Product Data: For power distribution units. Include system description, ratings, capacities, and performance characteristics.
- B. Shop Drawings: Include dimensioned plans, sections, and elevations. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 1. Wiring Diagrams: Power, signal, and control wiring.
- C. Product Certificates: For each type of power distribution unit, signed by product manufacturer.

- D. **Manufacturer Seismic Qualification Certification:** Submit certification that power distribution units, accessories, and components will withstand seismic forces defined in Division 26 Section "Vibration and Seismic Controls for Electrical Systems." Include the following:
1. **Basis for Certification:** Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 - a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."
 2. **Dimensioned Outline Drawings of Equipment Unit:** Identify center of gravity and locate and describe mounting and anchorage provisions.
 3. **Detailed description of equipment anchorage devices** on which the certification is based and their installation requirements.
- E. **Source quality-control test reports.**
1. For each factory test of power distribution units.
- F. **Field quality-control test reports.**
- G. **Operation and Maintenance Data:** For power distribution units to include in emergency, operation, and maintenance manuals.

1.6 DELIVERY, STORAGE AND HANDLING

- A. Deliver equipment in fully enclosed vehicles after specified environmental conditions have been permanently established in spaces where equipment is to be placed.
- B. Store equipment in spaces with environments controlled within manufacturer's ambient temperature and humidity tolerances for non-operating equipment.

1.7 SPARE PARTS

Not Applicable

1.8 WARRANTY

- A. The PDU manufacturer warrants that the Product manufactured will conform to Seller's applicable specifications and be free from failure due to defects in workmanship and material for one (1) year from the date of installation of the Product or eighteen (18) months from the date of shipment, whichever occurs first. Warranty is contingent upon having a factory-authorized representative perform the start-up.

1.9 COORDINATION

- A. Coordinate size and location of actual power distribution unit provided.
- B. Coordinate layout and installation of power distribution units with MPD Communications Manager for actual equipment rack mounting location of units.
- C. Coordinate layout and installation of power distribution units with Owner's equipment.
 1. Meet jointly with electronic equipment representatives and Owner's representatives to exchange information and agree on details of equipment arrangements and installation interfaces.
 2. Record agreements reached in meetings and distribute record to other participants.

3. Adjust arrangements and locations of power distribution units to accommodate and optimize arrangement and space requirements of equipment.

1.10 PROJECT CONDITIONS

- A. Environmental Conditions: Units shall be capable of operating continuously in the following environmental conditions without mechanical or electrical damage or degradation of operating capability.
 1. Storage Temperature Range: Minus 67 to plus 185 deg F (Minus 55 to plus 85 deg C)
 2. Operating Temperature Range: 32 to 104 deg F (0 to 40 deg C)
 3. Relative Humidity Range: 0 to 95 percent, noncondensing
 4. Altitude: Sea level to 3600 feet above sea level

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Description: Subject to compliance with contract requirements, provide products that may be incorporated into the Work that include, but are not limited to, the following:
 1. Integrated and coordinated assembly of power-line-conditioning and distribution components packaged in a single cabinet or modular assembly of cabinets. Include the following components:
 - a. Rack mount data equipment
 - b. Rack mounted UPS/Battery Units
 - c. Rack mounted Maintenance Bypass Units
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. APC – Schneider Electric
 2. Pre-Approved Equal

2.2 ELECTRICAL REQUIREMENTS

- A. The PDU shall have a continuous output capacity of 2200 VA.
 - 1. Unit shall carry indicated rms kilovolt-ampere load continuously without exceeding rated insulation temperature for the following input voltage and load current:
 - a. Input Voltage: Within rated input-voltage tolerance band of unit.
 - b. Load Current: Minimum of 3.0 crest factor and 85 percent total harmonic distortion.
- B. The input voltage shall be 120 VAC, single phase, 60Hz, 2-wire plus ground.
- C. The output voltage shall be 120 VAC single phase, two-wire plus ground receptacle plug(s).

2.3 INPUT MAIN CIRCUIT BREAKER

- A. The PDU shall include an input main circuit breaker to provide overcurrent protection and a means of disconnecting power to the unit.
- B. Single Input Unit:
 - 1. The system's input main circuit breaker shall be a 1-pole thermal magnetic molded case circuit breaker sized for 125% of the PDU full load current rating and rated for 600 VAC. The system's input main circuit breaker shall have a minimum interrupting rating of 10,000A @ 120V.
- C. The PDU shall include a means to indicate and alarm a TRIPPED condition of the main circuit breaker.

2.4 MANUAL RESTART (OPTION)

- A. The PDU shall contain a manual restart circuit to protect the connected load and allow for an orderly startup after a power failure. A means shall be provided to deactivate this feature in the field.

2.5 OUTPUT DISTRIBUTION OUTLETS

- A. Description: Rack mount PDU shall have rear panel power distribution units. Include the following features:
- B. The PDU shall contain 12-single receptacle outlet, 250V, NEMA 5-15. Each receptacle shall be individually protected with a short circuit rating of 10k AIC @ 120V.
- C. Cable Racks: Removable and arranged for supporting and routing cables for panelboard entrance.
- D. Access Panels: Arranged so additional branch-circuit wiring can be installed and connected in the future.
- E. Each load shall be protected by an individual branch receptacle outlet. Each branch outlet shall provide overcurrent protection.

2.6 SOURCE QUALITY CONTROL

- A. Factory Tests: Design and routine tests shall comply with referenced standards.
- B. Factory Sound-Level Tests: Conduct sound-level tests on equipment. Comply with IEEE C57.12.91 and NEMA ST 20.

PART 3 - EXECUTION**3.1 INSTALLATION**

- A. Arrange power distribution units to provide adequate access to equipment and circulation of cooling air.
- B. Data room rack-mounting power distribution units according to manufacturer's written instructions and requirements.
- C. Identify equipment and install warning signs according to Section 26 0505 "Identification."

3.2 CONNECTIONS

- A. Ground equipment according to Division 26 Section 26 0526, "Grounding and Bonding."

3.3 FIELD QUALITY CONTROL

- A. Testing Agency Contractor shall engage a qualified testing agency to perform tests and inspections and prepare test reports.
- B. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections. Report results in writing.
- C. Perform tests and inspections and prepare test reports.
 - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- D. Tests and Inspections:
 - 1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification for circuit breakers, molded case. Certify compliance with test parameters.
 - 2. Perform functional tests of power distribution units throughout their operating ranges. Test each monitoring, status, and alarm function.
- E. Remove malfunctioning units, replace with new units, and retest as specified above.

3.4 INSTALLATION, INSPECTION, AND FACTORY AUTHORIZED START UP

Installation and start up shall include the following:

- A. Visual Inspection
 - 1. Visually inspect all equipment for signs of damage and/or foreign materials.
 - 2. Observe type of ventilation, room cleanliness, and the proper application of safety signs.
- B. Mechanical Inspection
 - 1. Check all internal power connections for proper tightness (torque).
 - 2. Check all control wiring terminations and plugs for tightness and/or proper connection.
 - 3. Check all PCBA's for proper configuration wiring or jumper settings.
 - 4. Ensure all subassemblies, barriers, and safety guards are installed and secure.
- C. Electrical Pre-check

1. Verify modules have been installed in accordance to their installation documentation.
 2. Check system for phase to ground shorts internally and externally of the cabinet.
- D. Initial Unit Energization
1. Check input power terminations for proper supply voltage and phase rotation.
 2. Check all power supply voltages and lamp tests, adjust as necessary.
 3. Check all internal and output voltages are within acceptable tolerances.
- E. Waveforms
1. Check all input waveforms (voltage and current)
 2. Check primary output waveforms (voltage and current)
 3. Check logic power supply ripple waveform.
- F. System Verification after Critical Loads Have Been Applied
1. Recheck all measured and displayed values (volts, amps, frequency, and power).
 2. Recheck all input and output, voltage and current waveforms.
 3. Verify output voltage regulation is within acceptable tolerances.

3.5 ADJUSTING

- A. Set field-adjustable switches and circuit-breaker trip ranges as indicated.
- B. Adjust power distribution units to provide optimum voltage to equipment served throughout normal operating cycle of loads served. Record input and output voltages and adjustment settings, and incorporate into test results.

3.6 CLEANING

- A. Vacuum dirt and debris; do not use compressed air to assist in cleaning.

3.7 FLASH PROTECTION WARNING SIGNS

- A. The electrical contractor shall provide all flash protection warning signs as required by the NEC Article 100.16. Warning signs shall conform to the requirements of NFPA 70E.
 1. All electrical equipment such as switchboards, panelboards, control panels, meter socket enclosures, and motor control centers, that are likely to require examination, adjustment, servicing, or maintenance while energized shall be field marked to warn qualified persons of potential electrical hazards. The marking shall be located so as to be clearly visible to qualified persons before examination, adjustment, servicing, or maintenance of the equipment.
 2. All warning signs MUST be installed before owner's personnel are trained on the use of the equipment.

3.8 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain power distribution units. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION

N:\2014\P14-0202-00 COM MPD DATA ROOM UPS AND COOLING\SPESCS\ELECTRICAL\26 2600-POWER DISTRIBUTION UNIT.DOCX

SECTION 26 3353A
RACK MOUNT STATIC UNINTERRUPTIBLE POWER SUPPLY (UPS) SYSTEM

PART 1 - GENERAL

1.1 SCOPE OF WORK

- A. This Section includes the electrical and mechanical characteristic and requirements for a single-phase, on-line, high density, double-conversion, solid state, hot-swappable, Rack/Tower Convertible UPS installation complete with input harmonics reduction, rectifier-charger, inverter, static bypass transfer switch; an external battery pack module(s) with extended scalable run-time and battery monitoring system; an external maintenance bypass/isolation module; and Environmental Monitoring Module with room temperature, security surveillance, leak and intrusion monitoring devices.
- B. The uninterruptible power supply system, hereafter referred to as the UPS system, will provide high-quality AC power for sensitive electronic equipment loads and environmental and security monitoring.

1.2 RELATED SECTIONS

- A. Division 26 section "Power Distribution Units (PDU)

1.3 DEFINITIONS

- A. EMI: Electromagnetic interference.
- B. LCD: Liquid-crystal display.
- C. LED: Light-emitting diode.
- D. THD: Total harmonic distortion.
- E. UPS: Uninterruptible power supply.

1.4 CODES AND STANDARDS

- A. UL 1778 (Underwriters Laboratories) – Standard for Uninterruptible Power Supply Equipment. Product safety requirements for the United States.
- B. CSA C22.2 No 107.1 (Canadian Standards Association) – Commercial and Industrial Power Supplies. Product safety requirements for Canada.
- C. NEMA PE-1 – (National Electrical Manufacturers Association) – Uninterruptible Power Systems standard.
- D. IEC 62040-1-1 (International Electrotechnical Commission) – Uninterruptible power systems (UPS) – Part 1-1: General and safety requirements for UPS used in operator access areas.
- E. IEC 62040-1-2 (International Electrotechnical Commission) – Uninterruptible power systems (UPS) – Part 1-2: General and safety requirements for UPS used in restricted access locations.
- F. IEC 62040-3 (International Electrotechnical Commission) – Uninterruptible power systems (UPS) – Part 3: Method of specifying the performance and test requirements.
- G. IEEE 587 (ANSI C62.41) Category A & B (International Electrical and Electronics Engineers) – Recommended practices on surge voltages in low voltage power circuits.
- H. FCC Rules and Regulations 47, Part 15, Class A (Federal Communications Commission) – Radio Frequency Devices.

- I. MIL-HDBK-217E (Military Handbook) – Reliability prediction of electronics equipment.
- J. ISO 9001 Certified Product Quality Management Systems Standard.
- K. ISO 14001 Environmental Management System (EMS).

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for both installation and maintenance of units required for this Project.
- B. Power Quality Specialist Qualifications: A registered professional electrical engineer or engineering technician, currently certified by the National Institute for Certification in Engineering Technologies, NICET Level 4, minimum, experienced in performance testing UPS installations and in performing power quality surveys similar to that required in Part 3 " Performance Testing" Article.
- C. Manufacturer Qualifications: A qualified manufacturer. Maintain, within 50 miles of Project site(s), a service center capable of providing training, parts, and emergency maintenance repairs with eight hours maximum response time.
 - 1. The UPS manufacturer shall maintain a staffed 7 x 24 x 365 call center for technical and emergency support.
 - 2. Field Engineering Support: The UPS manufacturer shall directly employ a nationwide field service department staffed by factory-trained field service engineers dedicated to startup, maintenance, and repair of UPS equipment. The organization shall consist of local offices managed from a central location. Field engineers shall be deployed in this area to provide on-site emergency response within 24 hours. Third-party maintenance will not be accepted.
 - 3. Spare Parts Support: Parts supplies shall be located in the field to provide 80% of all emergency needs. The factory shall serve as the central stocking facility where a dedicated supply of all parts shall be available within 24 hours.
 - 4. Product Enhancement Program: The UPS manufacturer shall make available feature upgrade service offerings to all users as they are developed. These upgrades shall be available as optional field-installable kits.
 - 5. Maintenance Contracts: A complete range of preventative and corrective maintenance contracts shall be provided and offered with the proposal. Under these contracts, the manufacturer shall maintain the user's equipment to the latest factory revisions.
- D. Testing Agency Qualifications: An independent testing agency, with the experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.
 - 1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.
- E. Source Limitations: Obtain the UPS and associated components specified in this Section from a single manufacturer with responsibility for entire UPS System installation.

- F. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- G. UL Compliance: Listed and labeled under UL 1778.
- H. NFPA Compliance: Mark UPS components as suitable for installation in computer rooms according to NFPA 75.

1.6 SUBMITTALS

- A. Product Data: Include data on features, components, ratings, and performance for each UPS System component indicated.
- B. Shop Drawings: Detail assemblies of equipment indicating dimensions, weights, components, and location and identification of each field connection. Show access, workspace, and clearance requirements; details of control panels; and battery arrangement.
 - 1. Wiring Diagrams: Power, signal, and control wiring.
 - 2. Installation and operations manual.
- C. Qualification Data: For manufacturer.
- D. Manufacturer Certificates: For each product, signed by manufacturers.
- E. Factory Test Reports: Comply with specified requirements.
- F. Field Quality-Control and Performance Test Reports: Indicate test results compared with specified performance requirements, and provide justification and resolution of differences if values do not agree.
- G. Operation and Maintenance Data: For UPS units to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:
 - 1. Lists of spare parts and replacement components recommended being stored at Project site for ready access.
 - 2. Detailed operating instructions covering operation under both normal and abnormal conditions.
- H. Warranties: Special warranties specified in this Section.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Deliver equipment in fully enclosed vehicles after specified environmental conditions have been permanently established in spaces where equipment is to be placed.
- B. Store equipment in spaces with environments controlled within manufacturer's ambient temperature and humidity tolerances for non-operating equipment.

1.8 SPARE PARTS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents. Deliver extra materials to Owner.
 - 1. UPS & Battery Modules: One for every 10 of each type and rating, but no fewer than 2 of each.
 - 2. External Maintenance Bypass Module: One for every 10 of each type and rating, but no fewer than 2 of each.

3. UPS Management Cards: One for every 10 of each type and rating, but no fewer than 2 of each.
4. Environmental Monitoring Module: One for every 10 of each, but no fewer than 2 total.
5. Environmental Monitoring Input Devices: Including; Cameras, Door Contacts, Leak Detectors, High Temperature Detectors: One for every 10 of each, but no fewer than 2 each total.
6. Mini-UPS Rack Enclosure: One for every 5, but no fewer than 2 total.

1.9 WARRANTY

- A. Special Battery Warranties: Specified form in which manufacturer and Installer agree to repair or replace UPS system storage batteries that fail in materials or workmanship within specified warranty period.
 1. Warranted Cycle Life for Valve-Regulated, Lead-Acid Batteries: Equal to or greater than that represented in manufacturer's published table, including figures corresponding to the following, based on annual average battery temperature of 77 deg F:
- B. Special UPS Warranties: Specified form in which manufacturer and installer agree to repair or replace components that fail in materials or workmanship within special warranty period.
 1. Special Warranty Period: Two years from date of Substantial Completion.

1.10 MAINTENANCE

Not Applicable

PART 2 - PRODUCTS

2.1 AVAILABLE MANUFACTURERS

- A. The design of the UPS systems are based on being furnished by a single source supplier for all components, as manufactured by Schneider Electric; Smart APC rack-mounted, UPS component products. An "Or Equal" manufacturer of same UPS components systems may be considered, with strict compliance to the single manufacturer and source supplier requirements.
- B. Subject to compliance with requirements, manufacturers offering products that may be incorporated into the work include the following:
 1. APC Schneider Electric - Smart UPS RT 2200VA RM
 2. Approved Equal.

2.2 UPS SYSTEM DESCRIPTION

- A. UPS System Components: The UPS system shall consist of the following main components:
 1. UPS module, high density, true double-conversion on-line power protection, containing a rectifier, inverter, battery charger, static bypass, with network management control and monitor card and software, rack/tower convertible 2U mounting.

2. Maintenance-free, sealed Valve Regulated Lead-Acid (VRLA) battery pack module; hot swappable, externally rack mount batteries on-line-and-match battery.
 3. Maintenance Bypass module.
 4. Security and Environmental Monitoring Module and input sensors, including; up to (4) cameras, high temperature, door contacts, motion, and spill detection alarming with remote communication data ports.
 5. Mobile/Stationary UPS Mini-Cabinet Enclosures to house UPS systems for mobile or small data equipment installation applications.
- B. UPS Module Modes of Operation: The UPS Module shall operate as an on-line, fully automatic system in the following modes:
1. Normal: Utilizing commercial AC power, the critical load shall be continuously supplied by the inverter. The inverter shall power the load while regulating both voltage and frequency. The rectifier shall derive power from the commercial AC source and shall supply DC power to the inverter. Simultaneously, the battery charger shall charge the battery.
 2. Battery: Upon failure of the commercial AC power, the critical load shall continue to be supplied by the inverter, which shall obtain power from the batteries without any operator intervention. There shall be no interruption to the critical load upon failure or restoration of the commercial AC source.
 3. Recharge: Upon restoration of the AC source, the charger shall recharge the batteries and simultaneously the rectifier shall provide power to the inverter. This shall be an automatic function and shall cause no interruption to the critical load.
 4. Bypass: If the UPS module must be taken out of the Normal mode for overload, load fault, or internal failures, the static bypass switch shall automatically transfer the critical load to the commercial AC power. Return from Bypass mode to Normal mode of operation shall be automatic. No-break transfer to and from Bypass mode shall be capable of being initiated manually from the front panel.

2.3 UPS MODEL STANDARD FEATURES

- A. Rectifier/Charger: The rectifier/charger shall convert incoming AC power to regulated DC output for supplying the inverter and for charging the battery. The rectifier/charger shall be a high-frequency PWM design, using insulated gate bi-polar transistors (IGBTs). The modular design of the UPS shall permit safe and fast removal and replacement of the rectifier/charger module. Mean time to repair (MTTR) for the module shall be no more than 30 minutes in order to return UPS to normal mode. The rectifier/charger module shall also provide the following:
1. The rectifier shall be capable of drawing power from the utility with a power factor of 0.99 under nominal conditions.
 2. The rectifier shall feature protection circuitry that prevents the IGBTs from sourcing current in excess of their published ratings.
- B. Inverter: The inverter shall feature an IGBT pulse-width-modulation (PWM) design with high speed switching. The inverter shall also have the following features:
1. The inverter shall be capable of providing the specified quality output power while operating from any DC source voltage (rectifier or battery) within the specified DC operating range.

2. The modular design of the UPS shall permit safe and fast removal and replacement of the inverter module. MTTR for the module shall be no more than 30 minutes in order to return UPS to normal mode.
 3. The inverter shall feature protection circuitry that prevents the IGBTs from sourcing current in excess of their published ratings.
- C. Static Bypass: The bypass shall serve as an alternative source of power for the critical load when an abnormal condition prevents operation in normal mode. The bypass shall consist of a fully rated, continuous duty, naturally-commutated static switch for high-speed transfers. The bypass shall feature the following transfer and operational characteristics.
1. Transfers to bypass shall be automatically initiated for the following conditions:
 - a. Output overload period expired.
 - b. Critical bus voltage out of limits.
 - c. Over temperature period expired.
 - d. Total battery discharge.
 - e. UPS failure.
 2. Uninterrupted automatic re-transfer shall take place whenever the inverter is capable of assuming the critical load.
 3. Uninterrupted automatic re-transfers shall be inhibited for the following conditions:
 - a. When transfer to bypass is activated manually or remotely.
 - b. In the event of multiple transfers/re-transfer operations the control circuitry shall limit "cycling" to three (3) operations in any ten minute period. The fourth transfer shall lock the critical load on the bypass source.
 - c. UPS failure.
 4. Uninterrupted manual transfers shall be initiated from the control panel. Uninterrupted manual transfers to bypass and from bypass shall be possible with the inverter logic. During manual transfers to bypass mode, the inverter must verify proper bypass operations before transferring the critical load to the bypass.
 5. All transfers to bypass shall be inhibited for the following conditions:
 - a. Bypass voltage out of limits (+/- 10% of nominal)
 - b. Bypass frequency out of limits (+/- 3 Hz, adjustable, factory set)
 - c. Bypass out of synchronization
 - d. Bypass phase rotation / installation error
 6. Static Transfer Time: No break, complete in less than 4ms.
 7. The bypass shall be manually energized using the control panel or remotely through a building alarm input.
- D. Monitoring and Control Components: The following components shall provide monitor and control capability:
1. Control panel with status indicators.
 2. Alarm and metering display.
 3. Building alarm monitoring.
 4. Communication ports.

- E. Battery Management System: The UPS shall contain a battery management system which has the following features:
1. The battery management system shall provide battery time remaining while operating in normal mode and battery mode. Battery time available information shall be displayed real-time, even under changing load conditions. Upon commissioning, battery runtime information shall be available.
 2. The battery management system shall automatically test the battery string(s) to ensure that the battery is capable of providing greater than 80% of its rated capacity. Testing the batteries shall not jeopardize the operation of the critical load. Upon detection of the battery string(s) not capable of providing 80%, the UPS system will alarm that the battery needs attention/replacement. The battery test shall be able to detect the following:
 - a. Open battery string
 - b. Shorted battery string
 - c. Battery capacity (runtime) less than 80% of "new" battery capacity
 3. The UPS shall communicate battery test and monitoring data to the UPS manufacturer's remote monitoring site. Battery life remaining, capacity, and number of on-battery events shall be provided in a monthly report.
 4. An optional temperature sensor shall be available to monitor the ambient temperature internal to the battery cabinet. If the ambient temperature increases, the UPS system charger shall automatically reduce the charging voltage to a level recommended by the battery manufacturer. If the ambient temperature is decreased the UPS shall automatically increase the battery charge voltage to that recommended by the battery manufacturer.

2.4 UPS MODULE OPTIONS AND ACCESSORIES

- A. The UPS module shall consist of the following options and accessories as required:
1. External Maintenance Bypass Module (MBP), Power Distribution Unit (PDU), and Environmental Monitoring Module Cabinet(s): Integrated line-and-match cabinet(s) shall be provided that include(s):
 - a. All hardware and interconnecting cable for connection to UPS module.
 - b. Manual maintenance bypass switch to isolate UPS module from commercial AC input and critical load. Switch shall provide complete isolation of UPS for servicing and, if necessary, complete removal and replacement of UPS while still providing bypass power to critical load. Switch shall be make-before-break, interlocked between UPS and bypass to prohibit improper operation.
- B. SNMP Network Adapter and UPS Power Monitoring Software: SNMP adapters shall provide a communications interface between the UPS module and SNMP-compatible network management systems. This capability shall allow the unit to be monitored remotely over an Ethernet network using a standard web browser.
1. UPS Power Monitoring Software: This system shall continuously monitor critical power elements associated with the UPS, using the communications port on each module and a customer furnished PC. The system shall automatically alarm if any problems arise and notify local or remote personnel of the alarm condition via email, page, or text message.

- C. Battery Cabinet: The battery cabinet shall feature valve regulated, high-rate discharge, lead-acid batteries which provide energy to the support the critical load during a momentary loss of input power to the rectifier. The batteries shall be flame retardant in accordance with UL 94V2 requirements. The battery cabinet shall have the following features:
1. The battery cabinet shall be the same depth and height as the UPS module.
 2. The battery cabinet shall feature a mechanical enclosure of like appearance to the UPS module and shall feature casters. Each battery cabinet shall require front access only for installation, service and maintenance. The battery cabinet shall provide top and bottom cable entry.
 3. Power wiring internal to each battery cabinet shall be factory provided. Each battery cabinet shall feature 10 battery trays which can be individually disconnected from the battery cabinet power wiring with quick disconnect devices. Each battery tray shall be firmly secured to the battery cabinet frame with fasteners. Each battery tray shall be removable from the front of the battery cabinet.
 4. Each battery cabinet shall feature a DC rated circuit breaker. The circuit breaker within the battery cabinet shall only provide protection to the battery string within that battery cabinet. For battery configurations involving multiple battery cabinets, a battery string in one battery cabinet may be isolated from the DC link via its circuit breaker without removing other battery strings from the DC link and the UPS module.
 5. The circuit breaker in each battery cabinet shall feature an A/B auxiliary switch. The UPS module shall be capable of monitoring and alarming an open battery cabinet circuit breaker condition.
 6. The circuit breaker in each battery cabinet shall feature an undervoltage release device. The UV device shall operate to trip the battery breaker(s) for an emergency power off command or battery disable command.
 7. Power and control wiring between the battery cabinet and the UPS shall be factory provided with compression type connectors between cabinets.
 8. The batteries shall be configured with a ¼" spade type connector for attaching sense leads to each jar to facilitate the future addition of a battery monitoring system.
 9. Expected Battery Life: 200 complete full load discharge cycles when operated and maintained within specifications.
 10. Battery Voltage Characteristics. The UPS battery system shall have the following characteristics:
 - a. UPS module will automatically adjust battery shutdown based upon loading and battery capacity.
 - (1) The UPS module shall automatically adjust the final discharge voltage between 1.67 and 1.75 Volts per cell based on the existing load and the rate and length of discharge.
 - (2) The absolute minimum operational voltage is 1.67 V per cell (adjustable).
 - b. Nominal Float Voltage: 2.25 V per cell.
 - c. Equalizing Voltage: 2.38 V maximum per cell (adjustable).

D. Environmental Monitoring Module: An external cabinet shall be available which shall allow connection of up to four (6) inputs, including;

1. video camera surveillance,
2. room motion,
3. room temperature,
4. floor leak alarm,
5. door entry alarm,
6. UPS fail alarm,

The environmental monitoring module sensing devices shall integrate using system wiring to be connected for operation. Provide a spare of each type every 5 units, not less than 10 total.

2.5 UNINTERRUPTIBLE POWER SUPPLY RATINGS AND OPERATING CHARACTERISTICS

A. Rectifier/Charger Input:

1. Nominal Single Phase Input Voltage: 120 VAC.
2. Operating Input Voltage Range: + 10%, - 15% of average nominal input voltage without battery discharge.
3. For 60Hz systems, operating input frequency range shall be 55 to 65Hz.
4. Input power factor 0.99 lagging.
5. Normal Input Current Limit: The UPS shall have the following programmable input current limit settings while operating in normal mode:
 - a. Rectifier/charger input current limit shall be adjustable from 100 to 115% of full-load input current.
 - b. Battery input current limit shall be adjustable from 10% to 15% of the UPS full load input current regardless of the actual load on the UPS.
6. On Generator Input Current Limit: The UPS shall have the following programmable input current limit settings while operating in normal mode on generator:
 - a. Rectifier/charger input current limit shall be adjustable from 100% to 115% of full-load input current.
 - b. Battery recharge input current limit shall be adjustable from 10% to 15% of the UPS full load input current regardless of the actual load on the UPS.
7. Input current total harmonic distortion (THD) shall be less than 4.5%.
8. Power Walk-In: Ramp-up to full utility load adjustable from 3 seconds to 60 seconds.

B. Bypass Input:

1. Synchronizing bypass voltage range shall be +/- 10% of average nominal input voltage.
2. Synchronizing bypass frequency range is centered on the nominal frequency.
3. Input surge withstand capability: The UPS shall be in compliance with IEEE 587 (ANSI C62.41), category A & B (6kV).

C. Rectifier/Charger Output:

1. Nominal DC voltage shall be variable between 384VDC to 480VDC for 208V input.
2. Steady state voltage regulation shall be +/- 0.5%.

3. Voltage ripple shall be less than 0.5% (peak-to-peak).
4. Capacity: The rectifier/charger shall support a fully loaded inverter and recharge the battery to 90% of its full capacity within 10 times the discharge when input current limit is set at maximum.
5. Low Line Operation: The rectifier/charger shall be capable of sharing the DC load with the battery when the input voltage falls below the specified operation input voltage range, the battery indicator shall enunciate operation in this mode.
6. Battery Equalize: Automatic and manual means must be provided for battery equalization.
7. DC Sensing: Redundant DC voltage sensing methods shall be incorporated for providing battery over-voltage protection.

D. UPS Output in Normal Mode:

1. Nominal output voltage 208 VAC, 3-phase, 3 wire or 4-wire plus ground at the output of the Integrated Distribution and Bypass cabinet. Output wiring configuration is based upon input wiring configuration for systems without internal transformers.
2. Steady-state voltage regulation (in inverter) shall be within +/- 1% average from nominal output voltage.
3. Transient voltage response shall be < +/- 5% from nominal voltage for 100% load step, full load re-transfers and full load drop on battery.
4. Transient voltage recovery shall be 25ms to within +/- 1% of steady state.
5. Linear Load Harmonic Distortion Capability: Output voltage THD of less than 2% for 100% linear load.
6. Non-Linear Load Harmonic Distortion Capability: Output voltage THD of less than 5% for 100% non-linear load when tested using the non-linear load described in IEC 62040-3 connected line to neutral.
7. Manual output voltage adjustment shall be +/- 3% from nominal.
8. Line synchronization range shall be +/- 3Hz, adjustable to +/- 5Hz.
9. Frequency regulation shall be +/- 0.01Hz free running.
10. Frequency slew rate shall be 1 Hz/second maximum (adjustable).
11. Phase Angle Control:
 - a. Balanced linear load shall be +/- 1 degree from nominal 120 degrees
 - b. Unbalanced linear loads shall less than +/- 5 degrees from average phase voltage for 100% load unbalance.
12. Phase Voltage Control:
 - a. Balanced linear loads shall be +/- 1% from average phase voltage
 - b. Unbalanced linear loads shall be less than +/- 5% for 100% load unbalanced
13. Overload Current Capability (with nominal line and fully charged battery): The unit shall maintain voltage regulation for up to 110% of resistive/inductive load for 10 minutes, up to 125% for 30 seconds, and up to 150% for 10 seconds.
14. Fault Clearing Current Capability: 150% phase-to-phase for 10 cycles; 300% phase-to-neutral for up to 10 cycles
15. Static Transfer Time: No break, completed in less than 4ms.
16. Common Mode Noise Attenuation:
 - a. 65dB up to 20kHz, -40db up to 100kHz

- b. 100dB with isolation transformer
- 17. Acoustical Noise: Noise generated by the UPS under normal operation shall not exceed 65dbA at one meter from any operator surface, measured at 25 degrees C (77 degrees F) and full load.
- 18. EMI Suppression: The UPS shall meet FCC rules and regulation 47, part 15, for Class A devices.
- 19. Electrostatic Discharge (ESD): The UPS shall meet IEC 801-2 specifications. The UPS shall withstand a 25 kV pulse without damage and with no disturbance or adverse effect to the critical load.
- 20. Efficiency: The UPS efficiency shall be up to 94%.

2.6 MECHANICAL DESIGN

- A. Rack Mounted UPS Modules: 19-inch rail kit for rack mounting of UPS, external battery pack(s) service maintenance bypass, and security and environmental monitoring modules.
- B. Enclosures: Where specified on plans, the UPS system shall be housed in free-standing, front accessible enclosures (safety shields behind doors), lockable, equipped with removable side panels, casters and leveling feet. The enclosures shall be designed for mobile and/or wall-mount smaller radio/data communication installation applications, as noted on Plans.
 - 1. Ventilation: The UPS shall be designed for forced-air cooling. Air inlets shall be on the front of the unit. Air outlets shall be on the top. Eighteen inches of clearance over the UPS outlets shall be required for proper air circulation. Air filters shall be commonly available sizes.
 - 2. No back clearance or access shall be required for the enclosure system. The side enclosure covers shall be capable of being removable and accessible.
 - 3. Cable Entry: Standard cable entry for the UPS cabinet shall be 120 Vac Plug-in type. A dedicated duplex outlet(s) shall be provided adjacent to the UPS cabinet for routing user input and output wiring.
 - 4. Front Access and lockable: All serviceable subassemblies shall be modular and capable of being replaced on the UPS. Front and rear access for installation, service, repair or maintenance of the UPS system shall be possible.
- C. Service Area Requirements: The system shall require no more than thirty-six inches of front service access space and shall also require side or rear access for service or maintenance.

2.7 CONTROLS AND INDICATORS

- A. Microprocessor Controlled Circuitry: The UPS controls shall have the following design and operating characteristics:
 - 1. Fully automatic operation of the UPS shall be provided through the use of microprocessor controlled Digital Signal Processing. DSP shall eliminate variances from component tolerance or drift, and provide consistent operational responses.
 - 2. All operating and protection parameters shall be firmware controlled, thus eliminating a need for manual adjustments. The logic shall include system test capability to facilitate maintenance and troubleshooting. Printed circuit board replacement shall be possible without requiring calibration.

3. Start-up and transfers shall be automatic functions.
- B. Digital Front Panel Display: The UPS control panel shall be a digital front panel display that features an 8x40 (8 lines, each with 40 characters) backlit LCD display. The LCD shall display UPS status, metering, battery status, alarm/event queue, active alarms and UPS configurations. The front panel display shall show a system mimic diagram with an outlined power path, current operating mode and event logs.
- C. Control Panel Indicators: The UPS control panel shall provide the following monitoring functions with indicator LED's:
1. NORMAL: This shall indicate that the commercial AC utility or generator source is supplying power to the rectifier and the inverter is supporting the critical load. A text message shall indicate if the bypass line is not within tolerance.
 2. BYPASS: This shall indicate that the UPS has transferred the load to the bypass circuit.
 3. BATTERY: This shall indicate that the commercial AC utility or generator source has failed and the battery is supplying power to the inverter, which is supporting the load. A text message shall indicate if the battery charge is low or if the battery is installed but disconnected.
 4. ALARM: This shall indicate that the UPS detects an alarm condition, outlined in detail in the operator's manual.
- D. Control Panel Controls: The UPS control panel shall provide the following functions from front panel push buttons:
1. EVENTS: Displays the list of Active System Events and a historical log of system events. Historical logs shall include a detailed time stamped list of the latest 500 events.
 2. METERS: Displays performance meters for the system or critical load. When selected, the front display shall show individual screens of input parameters, output parameters or bypass parameters including; voltage, current and frequency. In addition, the battery display shall show runtime remaining.
 3. CONTROLS: Displays a System Controls screen. Allows selection of operating mode, normal, bypass, charger on/off and Power Module on/off.
 4. SETUP: Allows display contrast, date and time information serial communication port configuration and display of firmware revision numbers.
 5. RETURN: Confirms selection or returns to previous screen.
- E. Interface Panel: The UPS shall be equipped with an interface panel, located behind a protective cover, which provides the following signals and communication features in a Class 2 environment:
1. Alarm Contact: A dry contact for annunciating a summary alarm shall be provided for customer use. This contact shall be Form "C" capable of supplying both N/O and N/C contacts. Contact ratings shall be 5A max at a voltage not to exceed 28VDC or 277VAC.
 2. RS232 (EIA / TIA-232) Communications Interface: Circuitry shall be provided for one RS232 (EIA / TIA-232) communication port for connection to automated service department diagnostic tools. This port may be used with simple ("dumb") terminals to gain remote access to all unit operation information.

3. Building Alarms: Two inputs shall be provided for monitoring the status of external dry contacts. Building alarms shall be set up through the UPS configuration mode function on the RS232 (EIA / TIA-232) port.
4. External EPO Contacts: Shall be provided to connect an external remote emergency power off switch to shutdown the UPS and de-energize the critical load.
5. Battery Control Contacts: Contacts shall be provided to connect the battery UVR and auxiliary signals from a battery breaker or battery disconnect switch.

2.8 UPS MODULE PROTECTION

- A. Rectifier/charger and bypass protection shall be provided through individual fusing of each phase.
- B. Battery protection shall be provided by thermal-magnetic molded-case circuit breakers in each battery cabinet (if standard battery pack is provided) or external protective device for an external battery.
- C. Output protection shall be provided by electronic current limiting circuitry and fuses in the Inverter circuit.
- D. To comply with agency safety requirements, the UPS module shall not rely upon any disconnect devices outside of the UPS module to isolate the battery cabinet from the UPS module.

2.9 SERVICE CONDITIONS

- A. Environmental Conditions: The UPS shall be capable of operating continuously in the following environmental conditions without mechanical or electrical damage or degradation of operating capability, except battery performance.
 1. Evaluation Ambient Temperature for Electronic Components: 32 to 104 deg F.
 2. Ambient Temperature for Battery: 41 to 95 deg F.
 3. Relative Humidity: 0 to 95 percent, non-condensing.
 4. Altitude: Sea level to 4000 feet.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install system components on manual leveling bases.
- B. Maintain minimum clearances and workspace at equipment according to manufacturer's written instructions and NFPA 70.
- C. Connections: Interconnect system components. Make connections to supply and load circuits according to manufacturer's wiring diagrams, unless otherwise indicated.

3.2 GROUNDING

- A. Separately Derived Systems: 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 piping near isolation transformer.

3.3 IDENTIFICATION

- A. Identify components and wiring according to Division 26 Section "Identification."
 1. Identify each battery cell individually.

3.4 BATTERY EQUALIZATION

- A. Equalize charging of battery cells according to manufacturer's written instructions. Record individual-cell voltages.

3.5 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust equipment installation including connections, and to assist in field testing. Report results in writing.
- B. Electrical Tests and Inspections: Perform tests and inspections according to manufacturer's written instructions and as listed below to demonstrate condition and performance of each UPS component:
 - 1. Inspect interiors of enclosures, including the following:
 - a. Integrity of mechanical and electrical connections.
 - b. Component type and labeling verification.
 - c. Ratings of installed components.
 - 2. Test manual and automatic operational features and system protective and alarm functions.
 - 3. Test communication of status and alarms to remote monitoring equipment.
 - 4. Load the system using a variable-load bank to simulate kilovolt amperes, kilowatts, and power factor of loads for unit's rating. Use instruments calibrated, within the previous six months according to NIST standards.
 - a. Simulate malfunctions to verify protective device operation.
 - b. Test duration of supply on emergency, low-battery voltage shutdown, and transfers and restoration due to normal source failure.
 - c. Test harmonic content of input and output current less than 25, 50, and 100 percent of rated loads.
 - d. Test output voltage under specified transient-load conditions.
 - e. Test efficiency at 50, 75, and 100 percent of rated loads.
 - f. Test remote status and alarm panel functions.
 - g. Test battery-monitoring system functions.
- C. Retest: Correct deficiencies and retest until specified requirements are met.
- D. Record of Tests and Inspections: Maintain and submit documentation of tests and inspections, including references to manufacturers' written instructions and other test and inspection criteria. Include results of tests, inspections, and retests.

3.6 DEMONSTRATION AND TRAINING

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain the UPS.
- B. Conduct a minimum of one, eight (8) hour session of training for Owner's employees in the operation, programming, maintenance of the UPS and all system devices at Owner's facility.

3.7 PERFORMANCE TESTING

- A. Engage the services of a qualified power quality specialist to perform tests and activities indicated below.

- B. Monitoring and Testing Schedule: Perform monitoring and testing in a single 10-day period.
1. Schedule monitoring and testing activity with Owner, with at least 14 days' advance notice.
 2. Schedule monitoring and testing after Substantial Completion, when the UPS is supplying power to its intended load.
- C. Monitoring and Testing Instruments: Single-phase, recording power monitors. Instruments shall provide continuous simultaneous monitoring of electrical parameters at UPS input terminals and at input terminals of loads served by the UPS. Instruments shall monitor, measure, and graph voltage current and frequency simultaneously and provide full-graphic recordings of the values of those parameters before and during power-line disturbances that cause the values to deviate from normal beyond the adjustable threshold values. Instruments shall be capable of recording either on paper or on magnetic media and have a minimum accuracy of plus or minus 2 percent for electrical parameters. Parameters to be monitored include the following:
1. Current: Each phase and neutral and grounding conductors.
 2. Voltage: Phase to neutral, phase to ground, and neutral to ground.
 3. Frequency transients.
 4. Voltage swells and sags.
 5. Voltage Impulses: Phase to neutral, phase to ground, and neutral to ground.
 6. High-frequency noise.
 7. Radio-frequency interference.
 8. THD of the above currents and voltages.
 9. Harmonic content of currents and voltages above.
- D. Monitoring and Testing Procedure:
1. Exploratory Period: Make recordings at various circuit locations and with various parameter-threshold and sampling-interval settings. Make these preliminary measurements with the objective of identifying optimum UPS, power system, load, and instrumentation set-up conditions for subsequent test and monitoring operations.
 2. Remainder of Test Period: Perform continuous monitoring of at least two circuit locations selected on the basis of data obtained during exploratory period.
 - a. Set thresholds and sampling intervals for recording data at values selected to optimize data on performance of the UPS with respect to values specified in Part 2, and to highlight any need to adjust, repair, or modify the UPS or any distribution system or load component that may influence its performance or that may require better power quality.
 - b. Perform load and UPS power source switching and operate the UPS on generator power during portions of test period according to directions of Owner's power quality specialist.
 - c. Operate the UPS and its loads in each mode of operation permitted by UPS controls and by the power distribution system design.
 - d. Create and simulate unusual operating conditions, including outages, voltage swells and sags, and voltage, current, and frequency transients that can be performed using loads and devices available as part of the

- facility's installed systems and equipment. Maintain normal operating loads in operation on system to maximum extent possible during tests.
- e. Make adjustments and repairs to UPS, distribution, and load equipment to correct deficiencies disclosed by monitoring and testing and repeat appropriate monitoring and testing to verify success of corrective action.
- E. Correlation with Specified UPS Monitoring Functions: Obtain printouts of built-in monitoring functions specified for the UPS and its components in this Section that are simultaneously recorded with portable instruments in this Article.
1. Provide the temporary use of an appropriate personal computer and printer equipped with required connections and software for recording and printing if such units are not available on-site.
 2. Correlate printouts with recordings for monitoring performed according to this Article, and resolve and report any anomalies in and discrepancies between the two sets of records.
- F. Monitoring and Testing Assistance by Contractor:
1. Open UPS and electrical distribution and load equipment and wiring enclosures to make monitoring and testing points accessible for temporary monitoring probe and sensor placement and removal as requested.
 2. Observe monitoring and testing operations; ensure that UPS and distribution and load equipment warranties are not compromised.
 3. Perform switching and control of various UPS units, electrical distribution systems, and load components as directed by power quality specialist. Specialist shall design this portion of monitoring and testing operations to expose the UPS to various operating environments, conditions, and events while response is observed, electrical parameters are monitored, and system and equipment deficiencies are identified.
 4. Make repairs and adjustments to the UPS and to electrical distribution system and load components, and retest and repeat monitoring as needed to verify validity of results and correction of deficiencies.
 5. Engage the services of the UPS manufacturer's factory-authorized service representative periodically during performance testing operations for repairs, adjustments, and consultations.
- G. Documentation: Record test point and sensor locations, instrument settings, and circuit and load conditions for each monitoring summary and power disturbance recording. Coordinate simultaneous recordings made on UPS input and load circuits.
- H. Analysis of Recorded Data and Report: Review and analyze test observations and recorded data and submit a detailed written report. Include the following in final report:
1. Description of corrective actions performed during monitoring and survey work and their results.
 2. Recommendations for further action to provide optimum performance by the UPS and appropriate power quality for non-UPS loads. Include a statement of priority ranking and a cost estimate for each recommendation that involves system or equipment revisions.
 3. Copies of monitoring summary graphics and graphics illustrating harmonic content of significant voltages and currents.

4. Copies of graphics of power disturbance recordings that illustrate findings, conclusions, and recommendations.
 5. Recommendations for operating, adjusting, or revising UPS controls.
 6. Recommendation for alterations to the UPS installation.
 7. Recommendations for adjusting or revising generator-set or automatic transfer switch installations or their controls.
 8. Recommendations for power distribution system revisions.
 9. Recommendations for adjusting or revising electrical loads, their connections, or controls.
- I. Interim and Final Reports: Provide an interim report at the end of each test period and a final comprehensive report at the end of final test and analysis period.

END OF SECTION

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