LITHIUM BATTERY SYSTEM
GUIDE SPECIFICATION
For
Eaton UPS

PART 1 - GENERAL

1.01 SUMMARY

A. This specification describes a lithium-ion, cabinetized battery backup system including the batteries, switchgear, and management system, hereinafter referred to as the P300AF1C3 battery cabinet(s). The battery system shall operate in conjunction with a UPS system to provide battery backup times for critical electrical loads. The battery cabinet shall house a single or two battery string(s), and multiple cabinets may be paralleled for longer backup times, as described in this specification.

1.02 LITHIUM-ION BATTERY SYSTEM DESCRIPTION

A. Battery System Components: The UR22G512F_P300AF31C3 system shall consist of the following main components:

1. Battery cabinet containing multiple battery modules comprised of lithium-ion battery cells.
2. Battery management system (BMS): The 'rack BMS' or RBMS, is modular, internal to each cabinet, with internal communication capabilities. In each battery system, either a single or multiple-cabinet system, one of the cabinets will house a Bank Battery Management System, (BBMS) for system level and external communications to the UPS and building management system, if present.
3. Battery Protection Unit, (BPU), for main DC power terminations, protection circuit breaker, contactor and fusing, internal to the cabinet. The BPU contains disconnect means for each string within a cabinet.

B. Battery System Modes of Operation: The Battery Module shall operate as a constantly connected, fully automatic system in the following modes:

1. Normal: the battery system shall be connected to the DC circuit in the UPS. The BMS shall monitor voltage, current and temperature at all times.
2. Discharge: Upon failure of the commercial AC power, the critical load shall continue to be supplied by the UPS Inverter, which shall obtain power from the batteries without any operator intervention. The battery system shall monitor DC discharge current and terminate the discharge [disconnect] if current or temperature limits are exceeded. There shall be no interruption to the critical load upon failure or restoration of the commercial AC source. The P300AF1C3 battery system shall be applied with UPSs that use 480VDC nominal battery systems.
3. Recharge: Upon restoration of the AC source, the UPS Charger shall recharge the batteries and simultaneously the UPS Rectifier shall provide power to the Inverter. This shall be an automatic function and shall cause no interruption to the critical load. Battery recharge current shall be limited by the UPS and monitored by the battery system to disconnect the string if protection limits are exceeded.

1.03 REFERENCES

A. UL 1642 (Underwriters Laboratories) – Standard for safety for lithium batteries

B. UL 1973 --Standard for batteries for use in stationary applications

C. UL 991 – UL Standard for Safety Tests for Safety-Related Controls Employing Solid-State Devices.

D. UL 1998 – Standard for safety software in programmable components

E. EN 61000-6-2:2005 -- Electromagnetic compatibility (EMC). Generic standards. Immunity for industrial environments

F. EN 61000-6-4:2007 -- Generic standards—Emissions standard for industrial environments

1.04 SUBMITTALS

A. The battery system shall be supplied with sufficient documentation, including the following manuals:

1. Installation Manual, Software User Manual, and Operation and Maintenance Manual: One copy of each these manuals shall be furnished. Together, they shall possess sufficient detail and clarity to enable the owner's technicians or representatives to install and operate the battery equipment and accessories. The manuals shall include the following major items:

a) Battery system description

b) Site planning and unpacking

c) Battery cabinet(s) installation

d) Operating procedures

e) System events

f) Battery maintenance

g) Performance and technical specifications

h) Wiring requirements from battery cabinet to and from UPS

i) Physical features and requirements

j) Cabinet dimensions

1.05 QUALIFICATIONS

A. The battery manufacturer shall have a minimum of 4 years of experience in the design, manufacture and testing of lithium-ion battery systems for UPS applications.

B. The battery manufacturer shall have ISO TS 16949, ISO 26262 and ISO 14001 certifications for engineering/R&D, quality and functional safety.

C. The UPS manufacturer shall maintain a call center for technical and emergency support for this battery system.

D. Field Engineering Support: The UPS manufacturer supporting this battery system shall directly employ a nationwide field service department staffed by factory-trained field service engineers dedicated to startup, maintenance, and repair of UPS and related equipment. The organization shall consist of local offices managed from a central location. Field engineers shall be deployed in key population areas to provide on-site emergency response within 24 hours. A map of the United States showing the location of all field service offices shall be submitted with the proposal.

E. Spare Parts Support: Parts supplies shall be available to provide emergency needs in a timely fashion, based on field population.

F. Maintenance Contracts: A complete range of preventative and corrective maintenance contracts shall be provided and offered with the proposal.

1.06 ENVIRONMENTAL REQUIREMENTS

A. The battery system shall withstand any combination of the following external environmental conditions without operational degradation.

1. Operating Temperature: 23 +/- 4 °C (66 to 81 °F) recommended.
2. Storage Temperature: 0 to 40 °C (32 to 104 °F) recommended. Prolonged storage above + 40 °C (104 °F) will cause rapid self-discharge and permanent damage to the battery and will impact warranty coverage.
3. Relative Humidity (operating and storage): 5-85% non-condensing.
4. Elevation:
   a) Operational: 5000 ft. (1500 m) maximum without de-rating.
   b) Transportation: Capable of air transport, up to 15,000m.

1.07 SAFETY

A. The battery system shall be Listed by Underwriters Laboratories in accordance with UL 1973.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Approved Manufacturers: LG Chem.

2.02 BATTERY CABINET STANDARD FEATURES

The battery cabinet shall consist of the following standard components, housed in a metal frame cabinet. Each cabinet contains 6 or 12 battery modules, 1 Battery Protection Unit, (BPU) assembly, and one SMPS assembly. A conduit box is provided at the top of the cabinet to facilitate power and control cable landing. Note that, if more than 6 cabinets are to be connected to a single UPS, an external breaker and/or collector bus will be required to allow landing of all cables.

A. Battery Module:
Cabinet contains quantity 6 modules for single string, 12 for two parallel strings.
Battery modules are connected in series via provided buss bar links.
- Nominal capacity: 30 Ah
- Nominal voltage: 77.7 V
- Weight: 24 kg (53 lbs.)
- Dimension (L x W x H): 387 mm x 445 mm x 110 mm (15.2 in x 17.5 in x 4.3 in)

B. BPU Assembly
The BPU assembly consists of protection devices and the rack battery management system (RBMS). The key component protection devices are as follows
- Fuse: 400A
- MCCB UL/CE: 400A

- Weight: 54kg (119 lbs.)
- Dimension (L x W x H): 320 mm x 468 mm x 600 mm (12.6 in x 18.5 in x 23.6 in)

C. SMPS Assembly

The SMPS assembly provides power to the BBMS and BPU systems (i.e. rack and bank management and protection systems).

- Weight: 6.5 kg (14.2 lbs.)
- Dimension (L x W x H): 235 mm x 468 mm x 95 mm (9.2 in x 18.5 in x 3.8 in)

D. The rack frame (cabinet), is used to mount battery modules, the battery protection unit (BPU) and SMPS assembly.

- Weight:
  490 kg (1081 lbs.) with 12 battery modules installed.
  346 kg (763 lbs.) with 6 battery modules installed
- Dimension (L x W x H): 500 mm x 520 mm x 2550 mm (19.7 in x 20.5 in x 100.4 in). Note that the cabinet top conduit module is removable and, once removed the cabinet height is reduced by approximately 10 inches (100.4" to 90.2")
- IP rating: 20

E. Monitoring and control components: The following components shall provide monitor and control capability:

1. Status panel: located on the front of the BPU assembly, using a LED status lamp to indicate that the upper (if used) string and lower string RBMS(s) are functioning.
2. SMPS on/off status: located on the SMPS box, green LED located on the lower and upper (if used) 24 VDC power supply(s) labeled SMPS #1 and SMPS #2.
3. BPU power switch; upper and lower: rocker switch (red) to energize the RBMS controls for the associated battery string.
4. Communication ports: Modbus TCP connector, located on front of BBMS module, and shall accommodate Modbus protocol.
5. Hard-wired signal outputs: The BBMS shall provide two hard-wired signal outputs, one indicating a summary alarm, and one indicating battery system status.

F. Battery management system, (BMS): Each cabinet shall contain a battery management system, which has the following features and components:

1. The upper and lower rack BMS (RBMS), shall monitor voltage current and temperature for all battery modules in that string.
2. Bank BMS: In a multi-cabinet system, one cabinet shall contain its rack BMS and additionally, the Bank BMS (BBMS). The BBMS assembly provides data to the external systems (i.e. building management system, UPS, etc.) while controlling and monitoring all connected Rack BMS's.

G. Wiring Terminals: The battery cabinet conduit box shall provide a conduit landing plate and all power wiring terminals for the installer. The conduit box will be connected to the appropriate points inside the cabinet as described in the Installation and Operation Manual provided.

1. BPU module, internal to the cabinet: will contain DC power connections, positive and negative, via busbars provided from the conduit box.

2. SMPS module: will contain terminals for 120-240 VAC wiring derived from the UPS output busses (protected power to be present while UPS is on battery). Each cabinet will require a separate breaker for its 120-240 VAC connection.

3. BBMS bank battery monitoring module: will contain plug connections for Modbus TCP communication, and relay contacts connection to/from the UPS and/or building management system. The monitoring module contact communicates to the UPS that there is at least one battery string connected.

2.03 LITHIUM-ION BATTERY SYSTEM RATINGS AND OPERATING CHARACTERISTICS

A. Acceptable battery cabinet input sources and capabilities:

1. Nominal DC voltage: 466 VDC, 3.7 V/cell
2. Float voltage: 523VDC
3. Nominal input current: 0– 60 A (30A per string), when charging depending upon state of charge of the battery

B. Battery cabinet output

1. Nominal voltage: 466VDC
2. Discharging method: constant power.
3. End of discharge voltage: 400 VDC

2.04 MECHANICAL DESIGN

A. Enclosures: The battery rack frame shall be steel construction, and house battery modules, SMPS, BPU, and all associated interconnect wiring. The enclosures shall be designed for computer room applications. Front doors shall have locks to prevent unauthorized entry. Note battery cabinets are supplied as kitted components. Battery modules, BPU, and SMPS box are to be installed on site.

B. Ventilation: The battery cabinet shall be designed for forced air cooling. Fans operate only during elevated temperature conditions. Air inlets shall be on the front of the unit.

C. No rear or side clearance or access shall be required for the system. The back and side enclosure covers shall be capable of being located directly adjacent to a wall, if applicable codes allow. Each enclosure shall have 6 mounting holes in the base of the enclosure for bolting to the floor.

D. Cable entry: Standard cable entry for the battery cabinet shall be through the enclosure top.

E. Front access: All serviceable subassemblies shall be modular and capable of being replaced from the front of the cabinet (front access only required). Side or rear access for installation, service, repair or maintenance of the system shall not be required.

F. Service area requirements: The system shall require no more than thirty-six (36) inches of front service access room and shall not require side or rear access for service or the installation process.

2.05 CONTROLS AND INDICATORS

A. Battery status display: the BPU module in the battery cabinet shall feature LED status lamps for indicating RBMS “on” status, and rocker switches to energize the BPU controls.

B. The BPU string breaker status is indicated by breaker handle position (on, off, tripped), via a label located above the handle.

C. Remaining indicators are accessible by the Battery System Monitoring (BSM) software provided with the battery system and is accessed by connecting to the BBMS via Modbus TCP. These indicators include:

1. Status

a) System normal; breaker closed

b) System disconnected: breaker or contactor open

c) Monitoring system power off

d) System discharging

e) System charging

f) Bank voltage

g) Bank power

h) Bank current

i) State of Charge

j) Bank temperature

2. Alarms

a) Fault Condition; system automatically disconnected due to over/under voltage, overcurrent, overcharge, communication failure or over temperature

b) Warning Condition: voltage imbalance, voltage sensing error, under/over-temperature, temperature imbalance, fuse blown, fan failure.

2.06 COMMUNICATIONS

A. Front panel indicators: The battery cabinet shall be equipped with LEDs for logic power present, and RBMS on/off status.

B. Remote Monitoring:

1. Modbus TCP protocol communication capabilities will be available for all systems.

2. The battery system communication capability should be able to integrate into industry standard Building Management System (BMS) and/or Network Management Systems (NMS).

2.07 BATTERY MODULE, RACK/STRING/CABINET, AND SYSTEM LEVEL PROTECTION

A. Module management is provided by the BMS that is included in each battery module. Voltage, current and temperature are monitored, and cell balancing is performed.

B. Rack management is provided by the rack BMS (RBMS). It monitors all battery module BMSs. If a major alarm is detected, the RBMS will open the string contactor and/or trip the string circuit breaker in the BPU. This breaker must be manually reset to restore the battery cabinet to service.

C. System management is provided by the bank BMS (BBMS). It monitors all rack/cabinet BMS activity and communicates status or alarms to the UPS and other external monitoring systems.

D. To comply with agency safety requirements, the battery cabinet(s) shall not rely upon any disconnect devices outside of the cabinet or system, to isolate the battery cabinet from the UPS module.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install in accordance with manufacturer's instructions, observing applicable building and fire codes.

3.02 COMMISSIONING

A. Factory start-up shall be provided on a 5x8 basis (7x24 optional). Start-up service shall be provided and shall include one visit to perform all procedures and tests specified within battery system Installation and Operation manual. UPS manufacturer shall also offer the following optional services:

1. Pre-energize visit to inspect installation and provide guidance to installers as required.
2. Post-start-up visit for alarm notification configuration, operator training, generator testing, etc.

B. The following procedures and tests shall be performed by Field Service personnel during the battery system startup:

1. Visual Inspection:
   a) Visually inspect all equipment for signs of damage or foreign materials.
   b) Observe the type of ventilation, the cleanliness of the room, the use of proper signs, and any other safety related factors.
2. Mechanical Inspection:
   a) Check all the power connections for tightness.
   b) Check all the control wiring terminations and plugs for tightness or proper seating.
3. Electrical Pre-check:
   a) Check the DC buss for a possible short circuit.
   b) Verify all power and control wiring
4. Initial battery system startup:
   a) Configure battery cabinets and system using Service software.
   b) Verify that all the alarms are in a "go" condition.
   c) Energize the UPS module and verify the proper DC, walkup, and AC phase on.
   d) Check the battery string voltage
   e) Optional on-site battery discharge tests using supplier furnished load bank, shall also be offered.
5. Operational Training: Before leaving the site, the field service engineer shall familiarize responsible personnel with the operation of the battery system. The UPS equipment shall be available for demonstration of the modes of operation.

3.03 WARRANTY

All components of the battery system shall be covered by a standard three-year limited factory warranty, and ten-year performance warranty.

Limited warranty labor coverage is for 90 days after product startup.

Vendor shall also offer an optional service plan to provide 7x24 on-site coverage (preventive and corrective) for the battery system, with guaranteed response time, and battery preventive maintenance visit(s). Vendor shall also provide an optional battery service plan to provide parts-and-labor coverage for partial and full battery strings, either with preventive maintenance or replacement coverage.

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