

**CHAPTER 12
(SUPPLEMENTAL)**

SPECIFICATIONS FOR BATTERY BACKUP SYSTEM EQUIPMENT

SECTION 1 – GENERAL REQUIREMENTS

- 12.1.1 The Battery Backup System (BBS) shall provide reliable emergency power to a traffic signal in the event of a utility power failure or interruption. It shall be capable of providing power for full run-time or flashing mode operation.
- 12.1.2 It shall not interfere with the normal operation of any control equipment located in the traffic signal controller cabinet.
- 12.1.3 The BBS shall include, but not be limited to, the following components: inverter/charger(s), automatic utility to battery system power transfer relay/switch, manually operated non-electronic bypass switch, external generator input socket and automatic generator transfer switch, batteries, cabinet, and all necessary hardware and interconnect wiring.
- 12.1.4 The BBS shall be designed for outdoor applications, in accordance with the Chapter 1, Section 7 requirements.
- 12.1.5 Operation
- 12.1.5.1 Upon the loss of utility power or when utility power is outside preset limits, the BBS shall provide electrical power to operate a 1000 VA / 700 watt (minimum) continuous load in full run-time operation for a minimum of two (2) hours.
- 12.1.5.2 The BBS shall bypass or augment the utility power whenever the utility line voltage is not within the voltage range of 100 VAC to 130 VAC (± 2 VAC).
- 12.1.5.3 When the BBS is operating in bypass (battery only mode), the output voltage shall be 120 VAC (± 3 VAC), pure sine wave output, <3% THD, 60 Hz ± 3 Hz. When the BBS is operating in a utility power augment mode (utilizing a buck/boost transformer), the output voltage shall remain within the range of 100 VAC to 130 VAC (± 2 VAC) supplying a pure sine wave output, <3% THD, 60 Hz ± 3 Hz.
- 12.1.5.4 The BBS control equipment operating temperature range shall be -34°C (-30°F) to +73°C (+165°F).
- 12.1.5.5 The system shall be equipped to prevent malfunction feedback from reaching the signal cabinet or the utility power per UL1778.
- 12.1.5.6 Transfers from utility power to battery power or from battery power to utility power shall not interfere with the normal full run-time operating mode of the traffic signal.

- 12.1.5.6.1 Transfer time from utility power to battery power shall occur within 65 milliseconds or less.
- 12.1.5.6.2 Transfer time from battery power to utility power shall occur within 65 milliseconds or less.
- 12.1.5.7 The BBS shall have at least three sets of normally open (NO) and normally closed (NC) single-pole double-throw (SPDT) relay contact closures rated for one (1) amp at 120 VAC, minimum. Access shall be made available on the inverter/charger or control panel unit via a panel-mounted terminal block and labeled so as to identify each contact.
 - 12.1.5.7.1 The first set of NO and NC contacts shall be activated whenever the unit switches to battery power. The contact shall be labeled or marked "On Batt."
 - 12.1.5.7.2 The second set of NO and NC contacts shall be activated whenever the battery approaches approximately 40% of remaining useful capacity. The contact shall be labeled or marked "Low Batt."
 - 12.1.5.7.3 The third set of NO and NC contacts shall be activated two hours after the unit switches to battery power. The contact shall be labeled or marked "Timer."
 - 12.1.5.7.4 Relay contact activation shall be annunciated on the front faceplate of the control panel via visual indication. Indications may be discreet LED or LCD display.
- 12.1.5.8 In the event of inverter/charger failure, battery failure, or complete battery discharge, the automatic utility to battery system power transfer relay/switch shall revert to the NC state, where utility power is reconnected to the signal cabinet.
 - 12.1.5.8.1 Automatic utility to battery system power transfer relay/switch contacts shall be rated for 20 amps at 240 VAC, minimum.
- 12.1.5.9 A manually operated "break-before-make" bypass control switch shall provide a means of placing the BBS in a bypassed position without interruption to normal operation of the traffic signal. It shall be a two-position switch with no "off" or stop position between the two positions. The break interval shall be less than 150 ms.
 - 12.1.5.9.1 The manual bypass relay/switch contacts shall be rated for a minimum of 20 amps at 240 VAC.

- 12.1.5.10 Removal or service of BBS components (batteries, inverter/charger, control panel) shall be possible without interruption of the normal operation of the traffic signal while operating on utility power.

SECTION 2 – SYSTEM COMPONENT MOUNTING/ CONFIGURATION

12.2.1 General

- 12.2.1.1 All BBS system components shall be housed in a separate cabinet mounted to a concrete foundation utilizing a riser frame. The BBS cabinet shall be placed next to the existing signal controller cabinet, preferably on the side away from vehicle traffic, but in all cases no nearer to vehicle traffic. The BBS cabinet shall be placed within three meters of the existing signal controller cabinet such that access to the cabinet will not interfere with access to the signal controller cabinet. The BBS cabinet shall be situated so the doors open with the same orientation as the signal controller cabinet.

Where insufficient right-of-way and intersection geometry does not provide suitable facilities for a foundation mounted BBS cabinet, an optional “piggy-back” version BBS cabinet may be used that attaches to the signal controller cabinet.

Refer to Section 3 of this chapter for cabinet housing requirements.

- 12.2.1.2 The inverter/charger unit(s) and control panel shall be rack or shelf mounted.
- 12.2.1.3 Batteries shall be secured on rack mounted shelves located below other system components using adjustable nylon strapping with quick release connections.
- 12.2.1.4 Individual system component weight shall not exceed 28.6 kg (63 lbs).
- 12.2.1.5 No BBS system component shall be attached to the BBS cabinet shell unless otherwise indicated.
- 12.2.1.6 All necessary hardware for mounting (shelf angles, rack, etc) shall be included. All bolts/fasteners and washers shall be in accordance with Chapter 1.

SECTION 3 – BBS CABINET

- 12.3.1 General
- 12.3.1.1 Housing Requirements
 - 12.3.1.1.1 The standard cabinet shall conform to Chapter 7, Sections 1, 2 and 3. The cabinet shall use Housing and Cage #3. Paragraphs 7.1.1 through 7.1.1.5, 7.1.3.3, 7.2.6.1, and 7.2.6.3 through 7.2.6.3.2 shall not apply. The circuit breaker listed in paragraph 7.2.7.1 shall not apply-- see 12.3.1.6. for cabinet fan and light fixture voltage supply information.
 - 12.3.1.1.2 The optional “piggy-back” version cabinet shall have maximum housing dimensions of 1220 mm (48”) high by 508 mm (20”) wide by 254 mm (10”) deep. It shall have a single door for access to the cabinet interior. The cabinet shall utilize the same housing materials, construction techniques, and incorporate the same finish as the standard BBS cabinet. All ventilation requirements of the standard cabinet apply except that a single 203 mm (8”) high by 380 mm (15”) wide by 25 mm (1”) thick removable air filter shall be used. Door latch and locking requirements shall match those of the standard cabinet. The cage requirements of Chapter 7, Section 3 does not apply. The circuit breaker listed in paragraph 7.2.7.1 shall not apply-- see 12.3.1.6. for cabinet fan and light fixture voltage supply information.
- 12.3.1.2 Two shelves shall be provided to support the system batteries. The shelves shall be capable of supporting a minimum of 68kg (150 lbs).
- 12.3.1.3 The cabinet shall be supplied with one surface mount single-pole, 15 amp, 120 VAC circuit breaker. Circuit breaker power shall be supplied from the utility power source. The breaker shall be labeled or marked as “Cab. Heat / Receptacle”. Battery power shall not be applied to this breaker.
- 12.3.1.4 A 300 watt radiant “strip” heater shall be supplied and mounted near the bottom of the cabinet. A metal screen shall protect the heater strip and electrical connections from inadvertent contact by service personnel and cabinet wiring or equipment.
 - 12.3.1.4.1 The heater shall be thermostatically controlled and manually adjustable to turn on between 15°C (60°F) and 0°C (32°F) with a differential of not more than 6°C (10°F) between automatic turn on and off. The manual adjustment shall be graded in 10°C increments.
 - 12.3.1.4.2 Heater power shall be supplied from the breaker listed previously in 12.3.1.3.

- 12.3.1.5 A 15 amp GFCI duplex receptacle shall be provided and receive power from the circuit breaker listed previously in 12.3.1.3.
- 12.3.1.6 The cabinet fan and light fixture shall be supplied power from the load side of the automatic utility to battery system power transfer switch through separate "in-line" type fuse holders.
- 12.3.1.7 The cabinet shall be wired for connection to an external power generator.
- 12.3.1.7.1 Connection to an external generator shall be made through a flanged inlet type external generator input socket, Hubbell HBL2615 or approved equal.
- 12.3.1.7.2 A single-pole single-throw 20 amp, 120 VAC switch shall be wired in series with the generator socket to transfer relay AC+ wire.
- 12.3.1.7.3 The socket and switch shall be mounted in such a way that access to the switch and connection to the socket is available through the "Police Panel" access door of the standard BBS cabinet. The "piggy-back" version shall incorporate a comparable hinged and weather protected access panel.
- 12.3.2 Automatic Generator Transfer Switch
 - 12.3.2.1 An Automatic Generator Transfer Switch (AGTS) shall be mounted inside the cabinet to provide switching between the utility power source and the external generator input socket.
 - 12.3.2.2 The AGTS shall consist of an inherently double-throw power transfer switch/relay unit and a control module interconnected to provide complete automatic operation.
 - 12.3.2.3 All neutral conductors are to be solidly connected.
 - 12.3.2.4 The ATS shall be furnished with a minimum of one switched pole, rated 20 amps at 120 VAC. It shall be rated for all classes of load, both inductive and non-inductive.
 - 12.3.2.5 The transfer switch unit shall be electrically operated and interlocked to ensure only one of two possible positions, utility or generator. The transfer operation shall be "break-before-make" and occur within 100 milliseconds or less.
 - 12.3.2.6 The voltage of the normal (utility) source shall be monitored, with pickup voltage of 102 volts and dropout voltage of 90 volts.
 - 12.3.2.7 Transfer from generator back to utility shall incorporate a 30 second delay upon recognition of a valid utility source pickup voltage level.

- 12.3.2.8 All main contacts shall be silver composition.
- 12.3.3 Pullout Drawer (standard BBS cabinet only)
 - 12.3.3.1 A pullout drawer/print holder shall be installed in the cabinet cage above all other system components.
 - 12.3.3.2 The drawer shall have a hinged top that covers the storage box area and also provides a smooth writing surface.
 - 12.3.3.3 The drawer shall be General Devices D4080-19W or approved equal.
- 12.3.4 Conductors
 - 12.3.4.1 All conductors used in cabinet wiring shall terminate with properly sized, insulated, spring spade type terminals except when soldered to a through-panel solder lug on the rear side of the TBK or as specified otherwise.
 - 12.3.4.2 All crimp-style connectors shall be applied with a tool that prevents opening of the handles until the crimp cycle is completed.
 - 12.3.4.3 All conductors, unless otherwise specified, shall be stranded #22 AWG (or larger). Conductors shall be rated for 600 volts and shall conform to IMSA Specification 50-2. The insulation shall have a minimum thickness of 10 mils and shall be nylon-jacketed polyvinyl chloride, except that conductors #14 AWG and larger may have Type THHN/THWN insulation.
 - 12.3.4.4 Interconnect wiring provided for system output loads between the BBS cabinet terminal service block, automatic utility to battery system power transfer relay/switch, manual bypass switch, external generator input socket and automatic generator transfer switch, and the signal controller cabinet terminal service block shall be #10 AWG stranded THHN/THWN wire.
 - 12.3.4.5 All conductors, except those that can be readily traced, shall be labeled. Labels attached to each end of the conductor shall identify the destination of the other end of the conductor.
 - 12.3.4.6 All conductors shall conform to the following color-code requirements:
 - a. The grounded conductors of AC circuits shall be identified by a continuous white or gray color.
 - b. The equipment-grounding conductors shall be identified by a solid green color or by a continuous green color with one or more yellow stripes.

c. The ungrounded conductors shall be identified by any color not specified in “a” or “b” above.

- 12.3.4.7 All wiring harnesses shall be neat, bundled, and routed to minimize crosstalk and electrical interference.
 - 12.3.4.7.1 Wiring containing AC shall be routed and bundled separately or shielded separately from all logic voltage control circuits.
 - 12.3.4.7.2 Cabling shall be routed to prevent conductors from being in contact with metal edges.
 - 12.3.4.7.3 Cabling shall be arranged so that any removable assembly may be removed without disturbing conductors not associated with that assembly.
- 12.3.5 Terminal Blocks
 - 12.3.5.1 The terminal blocks (TBKs) (except service TBK) shall be barrier type, rated at 20 amps, 600 volts RMS, minimum. The terminal screws shall be 9 mm (3/8”) minimum length, nickel-plated, brass binder head type with screw inserts of the same material. Screw size shall be 6-32, minimum.
 - 12.3.5.2 The service TBK shall be either a double row, six position screw/insert with shorting bar (screws, inserts, and shorting bars shall be nickel-plated brass) or a Marathon #1206 (or approved equal). The terminals shall be labeled or marked, beginning from the left-most position, “AC+ In”, “AC- In”, “EG In”, “EG Out”, “AC- Out”, and “AC+ Out”. It shall be covered with a clear insulating material to prevent inadvertent contact. It shall have terminating lugs large enough to accommodate #4 AWG conductors and be rated for 50 amps at 600 volts peak, minimum. The AC+, AC-, and EG conductors connecting to the service terminals and appropriate busses shall not be spade lugged.

SECTION 4 -- MAINTENANCE, DISPLAYS, CONTROLS AND DIAGNOSTICS

- 12.4.1 Communications Port
 - 12.4.1.1 The BBS control unit shall have a 9-pin (DB9 female) RS232 serial communications port that allows for connection and monitoring of the BBS.
 - 12.4.1.1.1 Connection to the BBS shall be with a standard, readily available RS232 cable. Custom cabling is not allowed.

- 12.4.1.2 All front panel display information and operator settable parameters shall be accessible via the serial communications port.
- 12.4.1.3 The communications port connections and terminal setup shall be included in the operator's manual.
- 12.4.2 Displays
 - 12.4.2.1 The BBS shall include a display to indicate current battery charge status and condition from 0 to 100%.
 - 12.4.2.2 The BBS shall include a front-panel event counter display to indicate the number of times the BBS was activated and a front-panel elapse time hour meter to display the total number of hours the unit has operated on battery power. These displays shall be individually re-settable via a front panel button or through the serial communications port.
- 12.4.3 The BBS shall be equipped with an integral system to prevent the batteries from destructive discharge and overcharge.
- 12.4.4 The BBS and batteries shall be easily replaced and shall not require any special tools for installation or maintenance.
- 12.4.5 The BBS shall be compliant with IEEE/ANSI C.62.41 for lightning and surge suppression.
- 12.4.6 The Manufacturer shall include two (2) sets of equipment lists, operation and maintenance manuals, board-level schematic and wiring diagrams, and battery data sheets. Manuals shall conform to Chapter 1, Section 2 paragraphs 1.2.1 – 1.2.2.3.1 and 1.2.2.5.

SECTION 5 -- BATTERY SYSTEM

- 12.5.1 General
 - 12.5.1.1 Individual batteries shall be easily replaced and commercially available off the shelf.
 - 12.5.1.2 Batteries shall be deep cycle, sealed prismatic lead-calcium based VRLA (Valve Regulated Lead Acid). They can be either AGM (Absorbed Glass Mat) or Gel type. All batteries supplied as part of the BBS shall be of the same type.
 - 12.5.1.3 Individual battery weight shall not exceed 28.6 kg (63 lbs).

- 12.5.1.4 Battery system bus operating voltage shall not exceed 48 VDC, nominal.
- 12.5.1.5 Batteries shall indicate maximum recharge data and recharging cycles.
- 12.5.1.6 Batteries shall be certified by the manufacturer to operate over a temperature range of -23°C (-10°F) to $+60^{\circ}\text{C}$ (140°F).
- 12.5.2 Charging
 - 12.5.2.1 The BBS shall utilize a temperature-compensated battery charging system. The charging system shall compensate over a range of 2.5 – 4.0 mV/ $^{\circ}\text{C}$ per cell.
 - 12.5.2.2 Batteries shall not be recharged when battery temperature exceeds $50^{\circ}\text{C} \pm 3^{\circ}\text{C}$ ($120^{\circ}\text{F} \pm 5^{\circ}\text{F}$).
 - 12.5.2.3 Recharge time from “protective low-cutoff” to 80% or more of full battery charge capacity, shall not exceed twelve (12) hours.
- 12.5.3 Wiring / Protection
 - 12.5.3.1 The batteries shall be provided with appropriate interconnect wiring and corrosion-resistant mounting trays and/or brackets appropriate for the cabinet into which they will be installed.
 - 12.5.3.2 Interconnect wiring shall be via two-piece modular harness consisting of 8 AWG welding style cable, UL listed, super K90 or approved equal.
 - 12.5.3.3 Cable assembly shall be equipped with insulated, mating, 50 amp Anderson SB50 type power pole style connectors, or approved equal. Where two-piece power pole style connectors are used, Positive (+) shall be red and Negative (-) shall be black.
 - 12.5.3.4 All power pole connectors shall be assembled to ensure proper polarity and circuit configuration throughout the entire harness.
 - 12.5.3.5 Part one of the two-piece harness shall consist of 175 mm (7”) of appropriate colored cable with 6 mm ($\frac{1}{4}$ ”) ring terminals for connecting to the battery terminal and the appropriate colored modular power pole style connector.
 - 12.5.3.6 Battery terminals shall be covered and insulated with appropriate colored molded boots.

- 12.5.3.7 Part two of the harness shall consist of mating two-piece power pole style connectors for connecting to the batteries and a single insulated power pole connector for connecting to the BBS unit.
- 12.5.3.8 Cable length between batteries shall be a minimum of 305 mm (12"). Cable length between BBS unit and the first battery shall be of sufficient length to accommodate independent removal of either device.

SECTION 6 – MANUFACTURER TESTING

- 12.6.1 Quality Assurance
 - 12.6.1.1 Each BBS shall be manufactured in accordance with a manufacturer quality assurance (QA) program. The QA program shall include two types of quality assurance: (1) Design quality assurance and (2) Production quality assurance. The production quality assurance shall include statistically controlled routine tests to ensure minimum performance levels of BBS units built to meet this specification and a documented process of how problems are to be resolved.
 - 12.6.1.2 QA process and test results documentation shall be kept on file with the Manufacturer for a minimum of seven years. One copy of the results shall be submitted with each unit.
 - 12.6.1.3 BBS designs not satisfying design qualification testing and the production quality assurance testing performance requirements described below shall not be labeled, advertised, or sold as conforming to this specification.
- 12.6.2 Production Quality Control Testing
 - 12.6.2.1 Manufacturer Production Quality Control tests shall consist of all of the listed tests of 12.7.3.1 – 12.7.3.9 below and shall be performed on each new system prior to shipment. Failure to meet requirements of any of these tests shall be cause for rejection. The manufacturer shall retain test results for seven years. One copy of the results shall be submitted with each unit.
 - 12.6.2.2 Each BBS shall be given a 1 hour (minimum) burn-in period to detect any premature equipment failures.
 - 12.6.2.3 Each system shall be visually inspected for any exterior physical damage or assembly anomalies. Any defects shall be cause for rejection.

SECTION 7 -- ODOT ELECTRICAL AND ENVIRONMENTAL TESTING

- 12.7.1 Units shall be submitted for testing to:
Oregon Department of Transportation
Traffic Systems Services Unit
2445 Liberty Street NE
Salem, Oregon 97303-6738
- 12.7.2 Unit testing will be conducted in accordance with Oregon Department of Transportation Standard Specification for Microcomputer Signal Controller Chapter 1, Section 7, paragraphs 1.7.1 – 1.7.2.3.
 - 12.7.2.1 Each unit shall be energized while connected to a 1000 watt load for a minimum of 12 hours at temperatures of -34°C (-30°F) and +73°C (+165°F), excluding batteries. The tests specified in 12.7.3.1 – 12.7.3.9 shall be performed with the unit under load at -34°C (-30°F), +73°C (+165°F), and +20°C (+68°F).
- 12.7.3 All specifications will be measured including, but not limited to:
 - 12.7.3.1 Run time while in battery backup mode, at full load.
 - 12.7.3.2 Proper operation of all relay contact closures (“On-Batt”, “Low-Batt” and “Timer”).
 - 12.7.3.3 Inverter output voltage, frequency, harmonic distortion, and efficiency, when in battery backup mode.
 - 12.7.3.4 Battery backup mode transfer voltage levels.
 - 12.7.3.5 Transfer time from loss of utility power to switchover to battery backed inverter power.
 - 12.7.3.6 Transfer operation of automatic generator transfer switch.
 - 12.7.3.6 Backfeed voltage to utility when in battery backup mode.
 - 12.7.3.7 IEEE/ANSI C.62.41 compliance.
 - 12.7.3.8 Battery charging time.
 - 12.7.3.9 Event counter and run-time meter accuracy.

SECTION 8 -- WARRANTY

- 12.8.1 Manufacturer shall provide a two (2) year factory-repair warranty for parts and labor on the BBS from date of acceptance by the State. Batteries shall be warranted for full replacement for two (2) years from date of purchase. The warranty shall be included in the total bid price of the BBS.