



Department of Transportation
Federal Aviation Administration
Aircraft Certification Service
Washington, DC

TSO-C174

Date: x/x/xx

Technical Standard Order

PROPOSED

Subject: **BATTERY BASED EMERGENCY POWER UNIT (BEPU)**

1. PURPOSE. This Technical Standard Order (TSO) is for manufacturers of battery based emergency power units (BEPU). In it, we (the Federal Aviation Administration, or FAA) prescribe what minimum performance standards (MPS) a BEPU must meet if you apply for a TSO authorization or letter of design approval.

2. APPLICABILITY. This TSO affects new applications submitted after this TSO's effective date.

3. REQUIREMENTS. New models of BEPUs identified and manufactured on or after the effective date of this TSO must meet the requirements in this TSO and in appendixes **1, 2** and **3**. The battery used in the BEPU must meet the requirements of TSO-C173, "Nickel-Cadmium and Lead Acid Batteries" or any equivalent battery standards.

a. Functionality. This TSO applies to BEPUs used for providing emergency backup power for instrument systems, navigation systems, exit lighting, and various other applications on aircraft.

b. Failure Condition Classification. Failure of the function in paragraph **3.a** is a Hazardous/Severe-Major failure condition. Develop the BEPU system to, at least, the design assurance level equal to this failure condition classification.

c. Environmental Qualification. Test the BEPU according to appendix **2** of this TSO.

d. Software Qualification. If the BEPU includes a digital computer, develop the software according to RTCA/DO-178B, "Software Considerations in Airborne Systems and Equipment Certification," dated December 1, 1992.

e. Hardware Qualification. If the hardware element contains electronic devices whose functions cannot be feasibly evaluated by test and/or analysis, the electronic devices must

comply with RTCA/DO-254, "Design Assurance Guidance for Airborne Electronic Hardware," dated April 19, 2000, to the design assurance level determined by the hardware element manufacturer.

f. Battery Qualification. The battery used in the BEPU must meet the requirements of TSO-C173, "Nickel-Cadmium and Lead-Acid Batteries" or any applicable battery standards.

g. Deviations. We have provisions for using alternate or equivalent means of compliance to the criteria in the MPS of this TSO. If you invoke these provisions, show that your BEPU maintains an equivalent level of safety. Apply for a deviation under Title 14 Code of Federal Regulations (CFR) § 21.609.

4. MARKING.

a. Mark at least one major component permanently and legibly with all the information in 14 CFR § 21 .607(d).

b. Indicate on the label:

- The capacity (for 20 hours),
- Nominal voltage, and
- Battery chemistry.

5. APPLICATION DATA REQUIREMENTS. Under 14 CFR § 21.60(a)(2), as a manufacturer-applicant, you must give the FAA Aircraft Certification Office (ACO) manager responsible for your facilities, one copy each of the following technical data to support our design and production approval:

a. Operating instructions and BEPU limitations, sufficient to describe the operational capability of the BEPU.

b. Installation procedures and limitations, sufficient to ensure that the BEPU, when installed according to installation procedures, still meets this TSO's requirements. The limitations must identify any unique aspects of the installation. Finally, the limitations must include a note with the following statement:

The conditions and tests required for TSO approval of this BEPU are minimum performance standards. Those installing this BEPU on or in a specific type or class of aircraft must determine that the aircraft installation conditions are within the TSO standards. TSO articles must have separate approval for installation in an aircraft. The article may be installed only according to part 43 or the applicable airworthiness requirements.

c. Schematic drawings of the installation procedures.

d. Wiring diagrams of the installation procedures.

- e. Minimum performance standards.
- f. List of components by part number.
- g. Instructions for periodic maintenance and calibration for continued airworthiness once the equipment is installed.
- h. An environmental qualification form describing the environmental tests that were conducted in accordance with appendix 2 of this TSO, and RTCA/DO-160E, "Environmental Conditions and Test Procedures for Airborne Equipment," dated December 9, 2004.
- i. Manufacturer's TSO qualification test report.
- j. Nameplate drawing with the information required in paragraph 4 of this TSO.
- k. A list of all drawings and processes (including revision level) to define the BEPU's design.

6. MANUFACTURER DATA REQUIREMENTS. Besides the data given directly to the FAA, a manufacturer must have the following technical data available for review by the responsible ACO:

- a. The functional qualification specifications to be used to qualify each production article to ensure compliance with this TSO.
- b. Equipment calibration procedures.
- c. Corrective maintenance procedures (within 12 months after TSO authorization).
- d. Schematic drawings.
- e. Wiring diagrams.
- f. The results of qualification tests conducted in accordance with appendix 2 of this TSO and RTCA/DO-160E.

7. FURNISHED DATA REQUIREMENTS. Send one copy of the data and information specified in paragraphs 5.a through 5.h to each person receiving one or more battery based emergency power units manufactured under this TSO.

8. HOW TO GET REFERENCE DOCUMENTS.

- a. You can buy copies of RTCA Document Nos. DO-160E and DO-178B from RTCA Inc., 1140 Connecticut Avenue NW, Suite 1020, Washington D.C. 20036-4001 or online at: www.rtca.org.
- b. Buy copies of MIL-STD-704F from DODSSP, Subscription Services Desk, Building 4D, 700 Robbins Avenue, Philadelphia PA 19111-5094.

c. Buy copies of Title 14 Code of Federal Regulations (CFR) part 21, Subpart O, from Superintendent of Documents, Government Printing Office, Washington DC 20402-9325.

d. Order copies of FAA advisory circular (AC) 20-110 (current revision), “Index of Aviation Technical Standard Orders” and TSO-C173, “Nickel-Cadmium and Lead-Acid Batteries” from: U.S. Department of Transportation, Subsequent Distribution Office, Ardmore East Business Center, 3341 Q 75th Avenue, Landover MD 20785.

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APPENDIX 1. MINIMUM PERFORMANCE STANDARD FOR BATTERY BASED EMERGENCY POWER UNITS UNDER STANDARD CONDITIONS

1. PURPOSE. This appendix explains requirements under standard conditions for a BEPU to meet the MPS for this TSO. You can enhance the performance of specific equipment, or make it superior to this specification, depending on your intended application and configuration.

2. GENERAL REQUIREMENTS. The BEPU must meet the power quality requirements per MIL-STD-704F, "Aircraft Electrical Power Characteristics," dated March 12, 2004, and maintain the rated values and functionality according to the specification data sheet, unless otherwise specified in this TSO.

a. Design the BEPU to minimize the risk of causing or spreading a fire.

b. Storage batteries must be designed and installed as follows: safe temperature and pressure of battery cell must be maintained during any probable charging or discharging condition. No uncontrolled increase in cell temperature may result when the battery is recharged (after previous complete discharge):

- At maximum regulated voltage or power,
- During a flight of maximum duration,
 - Under the most adverse cooling condition likely to occur in service.

Show the above conditions by test, unless your experience with similar batteries and installations has shown that maintaining safe cell temperatures and pressures presents no problem.

c. Match the electronic circuits installed in the BEPU with the battery chemistry.

d. During the failure of the emergency bus, the BEPU will supply the load of the emergency bus without intervention of the flight crew. After reestablishment of the emergency bus power, the emergency busload should revert automatically from the BEPU to the emergency bus. The BEPU will automatically return to charging mode.

e. Declare the value of voltage spikes occurring when the BEPU is switched on and off and between modes (if applicable).

f. Any single component failure within the BEPU (either open or short) cannot result in an over voltage condition on the battery.

g. The BEPU will not have any protection/provision that results in automatic removal of power from the emergency load.

h. The BEPU will not discharge through the input side of the BEPU.

APPENDIX 1 CONTINUED

i. If the BEPU provides backup power to multiple loads, equip the BEPU with protection provisions that allow isolation and removal of excess load on any of its output feeders that draw more than its pre-determined maximum current. This will protect remaining loads in case of a load short circuit condition.

j. The BEPU should not drain its battery power when the aircraft power is off.

k. Fully charge the battery before installation. Charge the battery every time the aircraft is powered up, independent of cockpit switch position.

l. The charging time from 20 % to 80 % capacity will be less than 3 hours.

m. Declare the nominal current and the short time maximum current.

n. Design the BEPU so separation devices placed between input, output and battery will enable the current flow from input to output, even when there is a malfunction with BEPU components not related to the power train. The separation devices will prevent current flow from flowing from output to input, and from output to battery. See figure 4-2, appendix 4. The minimum current rating of the separation devices must exceed three times the continuous rated output current. Unless provided in the aircraft, the BEPU will be designed to prevent leakage current from output back to battery of greater than 30 milliAmpere (mA). The breakdown voltage of such separation devices will exceed three times the BEPU rated voltage.

o. The maximum output voltage ripple cannot exceed requirements per MIL-STD-704F. This does not include ripple, which is already on the input line into the BEPU. See figure 4-3 in appendix 4.

p. The BEPU will detect battery temperature and remove battery-charging power when unsafe high temperatures are detected. This is to preclude catastrophic effects of high temperature. Applications where excessive battery temperature cannot cause catastrophic events do not require this monitoring.

q. If the BEPU contains a battery heater device, a single-fault failure redundancy provision is required to prevent heater runaway.

3. CAPACITY AND RELATED PARAMETERS. If you are a manufacturer–applicant, provide the parameters listed in this section under environmentally benign and ground benign conditions at 25°C. These are considered nominal conditions.

a. BEPU capacity. Declare the value for the nominal capacity in Amp-Hours (Ah) based on a constant discharge current for 1.0 hour. During capacity testing, the output voltage cannot degrade under 20V DC.

APPENDIX 1. CONTINUED

b. BEPU Output Voltage Excursions. Graph the output voltage versus time under the following conditions:

- Complete discharge to low voltage dropout point after being fully charged.
- Complete discharge to low voltage dropout point after being charged to 72% capacity. Capacity of 72% represents a BEPU at end of life and 90% state of charge.

c. BEPU Life. Declare the expected battery life based on the number of 100% discharge cycles at the nameplate discharge rate. Battery life is expired when 80% of nameplate stated capacity is reached.

d. BEPU Current Consumption. Declare the maximum current consumption (excluding external loads). Maximum current includes charging at the maximum power point of the charger, battery completely discharged, heating and other functions realized by electronic circuits.

e. BEPU Output Current. Declare the nominal current, which can be delivered by the BEPU related to the nominal Ah rating specified in paragraph 3.a of this appendix, and the short time maximum current, if necessary, versus time.

4. MONITOR AND CONTROL.

a. Indications and controls can be provided by support equipment instead of the BEPU.

b. Design all indicators for easy reading and interpretation.

c. The BEPU can have (but is not limited to) the following optional controls:

- BEPU Off: battery power is disconnected from all loads.
- BEPU Arm: ready to engage power to the loads if aircraft power is lost. The BEPU should be in charging mode unless during failure of the emergency bus.
- BEPU On/Engage: causes the battery to be applied to the loads. The BEPU should be in charging mode unless during failure of the emergency bus.

d. Provide a test function for pre-flight check, showing the system function and battery status. The battery is considered good with 80% state of charge. We recommend an in-flight low battery-warning indicator. Perform a lamp test.

APPENDIX 2. MINIMUM PERFORMANCE STANDARD UNDER ENVIRONMENTAL TEST CONDITIONS

1. GENERAL. Unless otherwise specified, the test procedures for determining equipment performance under environmental test conditions are in RTCA/DO-160E.

2. PERFORMANCE TESTS. Conduct the following environmental tests to verify operation to manufacturer specifications and requirements under extreme environmental influence. If the manufacturer specifications during these tests are different than under benign environmental conditions (see appendix 1, paragraph 3) then the manufacturer will declare the modified rating and under what condition such ratings would occur. Before the following tests, except when otherwise noted, charge the batteries to at least 80 % of manufacturer's rating. For the following tests, establish compliance of the BEPU to the manufacturers nominal ratings (unless otherwise specified hereunder) as referenced in appendix 1, paragraph 3 for BEPU capacity using nominal current discharge, BEPU output voltage excursion, and BEPU current consumption. The applicable sections of RTCA/DO-160E are:

a. RTCA/DO-160E Section 4, Temperature and Altitude.

- Operating Low Temperature Test. Internal battery heater may be used for this test.
- Operating High Temperature Test
- Altitude Test
- Decompression Test
- Overpressure Test

b. RTCA/DO-160E Section 5, Temperature Variation Test. Test should be combined with Section 4 (RTCA/DO-160E) testing.

c. RTCA/DO-160E Section 6, Humidity Test

d. RTCA/DO-160E Section 7, Operational Shocks and Crash Safety Tests. Measure BEPU capacity after tests are complete. After operational shocks and crash safety tests, the equipment will remain in the mounting. No part of the equipment or its mounting will have become detached and free of the shock test table.

NOTE: The application of these tests may damage the equipment, so you may conduct them after the other tests described in this appendix.

e. RTCA/DO-160E Section 8, Vibration Test. While the equipment is tested, ensure that all mechanical devices operate satisfactorily and the mechanical construction remains unharmed.

f. RTCA/DO-160E Section 9, Explosion Proofness Test. Required only if the BEPU contains components that cause inductive arcing.

APPENDIX 2. CONTINUED

- g.** RTCA/DO-160E Section 10, Water Proofness Test (if required).
- h.** RTCA/DO-160E Section 11 Fluids Susceptibility Test (if required). Not mandatory for TSO.
- i.** RTCA/DO-160E Section 12, Sand and Dust Test (if required).
- j.** RTCA/DO-160E Section 13, Fungus Resistance Test (if required). Compliance by analysis is acceptable.
- k.** RTCA/DO-160E Section 15, Magnetic Effect.
- l.** RTCA/DO-160E Section 16, Power Input Test.
- m.** RTCA/DO-160E Section 17, Voltage Spike Test. During and after this test, no failed parts will exist. Failed parts include any compromise on component voltage and current ratings. No parasitic or transient mode switching can occur.
- n.** RTCA/DO-160E Section 18, Audio Frequency Conducted Susceptibility – Power Inputs Test. Conduct test while BEPU is being charged. Charge must be between 0% and 75% of capacity. No parasitic or transient mode switching can occur.
- o.** RTCA/DO-160E Section 19, Induced Signal Susceptibility Test. No parasitic or transient mode switching can occur.
- p.** RTCA/DO-160E Section 20, RF Susceptibility Test. No parasitic or transient mode switching can occur.
- q.** RTCA/DO-160E Section 21, Emission of RF Energy Test. Test while BEPU is being charged. Charge must be between 0% and 75% of capacity.
- r.** RTCA/DO-160E Section 22, Lightning Induced Transient Susceptibility Test. No parasitic or transient mode switching can occur.
- s.** RTCA/DO-160E Section 23, Lightning Direct Effects Test. Not mandatory for TSO. If tested, no failed parts will exist during and after this test. Failed parts include any compromise on component voltage and current ratings. No parasitic or transient mode switching will occur.
- t.** RTCA/DO-160E Section 24, Icing Test (DO-160D). Not mandatory for TSO. If tested, no failed parts will exist during and after this test. Failed parts include any compromise on component voltage and current ratings.
- u.** RTCA/DO-160E Section 25, Electrical Discharge Test.

APPENDIX 3. ELECTRICAL TEST PROCEDURES

1. GENERAL. Conduct electrical tests (covered under environmental test conditions in appendix 2), according to RTCA/DO-160E. Test procedures meeting specific requirements for the BEPU are outlined under paragraph 3 below.

2. GENERAL TEST CONDITIONS. Unless otherwise specified, the following test conditions apply:

a. Conduct all tests under conditions of ambient room temperature (except section 4, 5 and 6) and ambient pressure and humidity as outlined in RTCA/DO-160E, section 1, paragraph 3.

a. Unless otherwise specified, the input supply voltage will be within 10 % of the nominal value at which the equipment is designed to operate.

c. A reasonable warm-up period for stabilization is permissible. Battery nominal capacity is defined at 25 °C.

3. SPECIFIC TEST CONDITIONS. (According to appendix 1, paragraph 4.)

a. Lamp test: All segments lighted.

b. Check load segment on when load is applied.

4. ALIGNMENT, ADJUSTMENT AND CALIBRATION PRIOR TO TEST. If necessary, perform alignment, adjustment and calibration before testing.

5. TEST EQUIPMENT. Calibrate the test equipment you use to verify final test results according to the National Bureau of Standards. Test equipment accuracy will be at least 2 %.

APPENDIX 4. DESCRIPTION OF A BEPU

The BEPU supplies power for a specified time to an emergency power bus (output) in case of main or emergency bus failure.

The BEPU consists of a remote unit or panel-mounted device containing a rechargeable battery pack (accumulator) and means for providing charging, monitoring of battery temperature, battery state, current as well as system testing and related functions. The batteries are kept fully charged during normal operation independent from surrounding temperature.

An indicator/test switch gives information on the battery status of the BEPU before commencing flight.

Figure 4-1 illustrates BEPU functionality. It does not define a requirement.

Figure 4-2 depicts an example BEPU current flow.

Figure 4-3 depicts a recommended measurement of BEPU output voltage ripple.

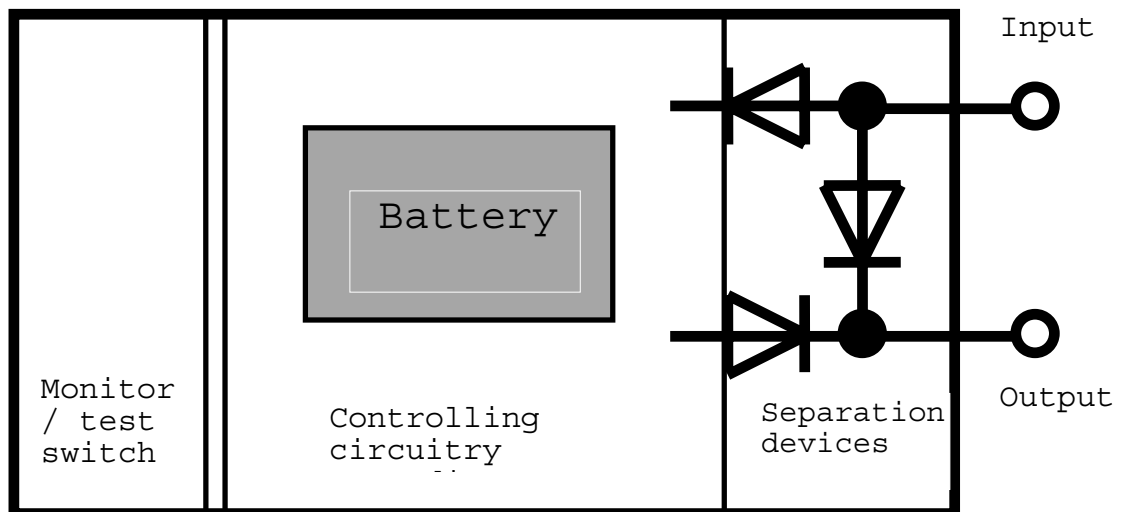


Figure 4-1: BEPU Block Diagram.

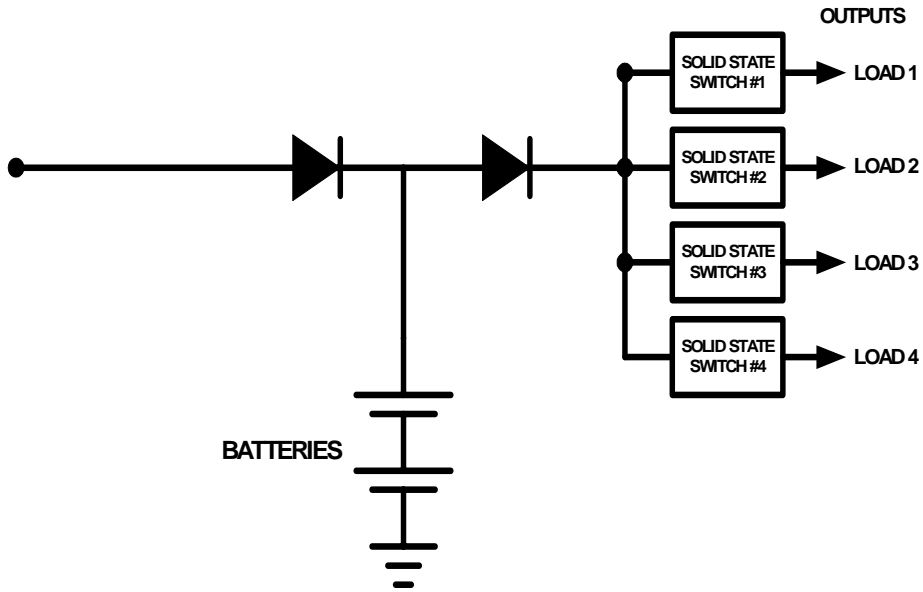


Figure 4-2: An example BEPU Current Flow.

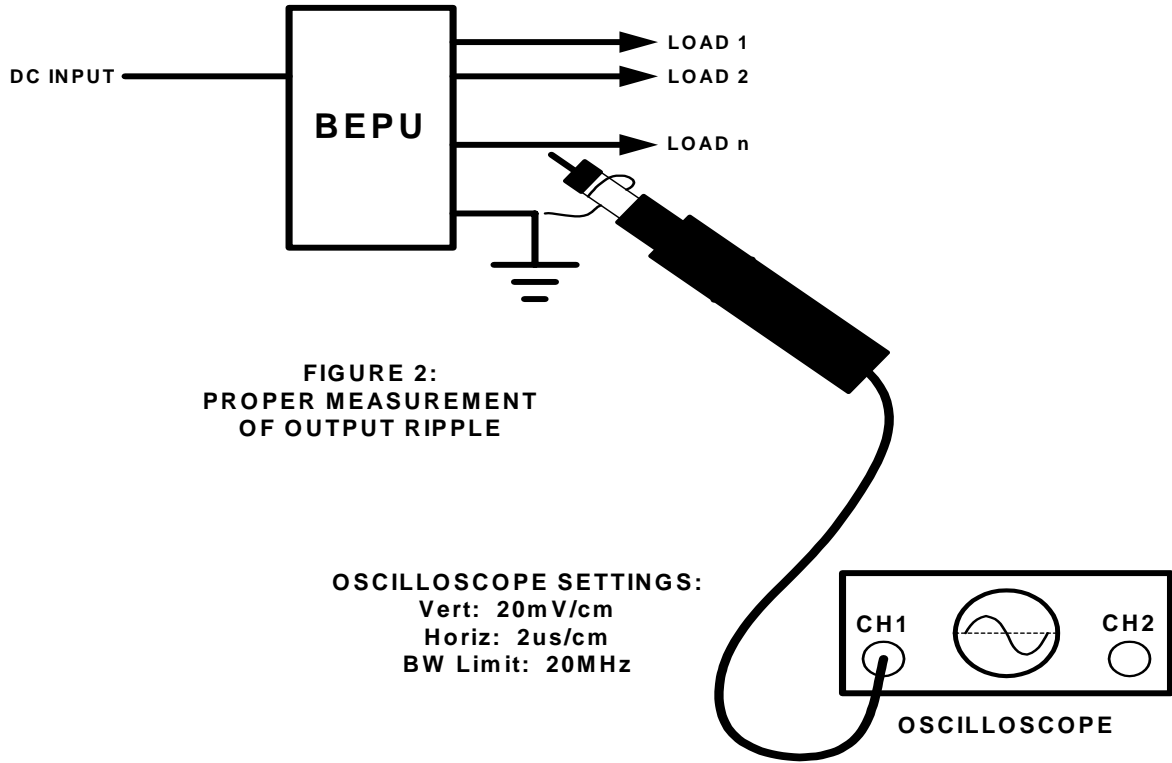


Figure 4-3: Recommended Measurement of BEPU Output Voltage Ripple.