ETSO-C174 A1
Date: 12.07.2013

European Aviation Safety Agency

European Technical Standard Order (ETSO)

Subject: BATTERY-BASED EMERGENCY POWER UNIT (BEPU)

1 — Applicability
This ETSO gives the requirements which Battery-based Emergency Power Units (BEPU) that are manufactured on or after the date of this ETSO must meet in order to be identified with applicable ETSO marking.

2 — Procedures

2.1 — General
Applicable procedures are detailed in CS-ETSO, Subpart A.

2.2 — Specific
None.

3 — Technical conditions
3.1 — Basic
3.1.1 — Minimum performance standard
Standards are given in **Appendix 1.**

Note: The battery used in the BEPU must meet the requirements of ETSO-C173 '*Nickel-Cadmium and Lead Acid Batteries'* or any other battery standards acceptable to the Agency.

3.1.2 — Environmental standard
As stated in **Appendix 1,** chapter 2, of this ETSO.

3.1.3 —Software
See CS-ETSO, Subpart A, paragraph 2.2.

3.1.4 — Airborne electronic hardware
See CS-ETSO, Subpart A, paragraph 2.3.

3.2 — Specific
3.2.1 Failure condition classification
See CS-ETSO, Subpart A, paragraph 2.4.

4 — Marking

4.1 — General

Marking is detailed in CS-ETSO, Subpart A, paragraph 1.2.

4.2 — Specific

Product label shall indicate:

- battery capacity (e.g. 20 Amp-Hour (Ah)),
- nominal voltage,
- battery chemistry.

5 — Availability of referenced documents

See CS-ETSO, Subpart A, paragraph 3.

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APPENDIX 1

MINIMUM PERFORMANCE STANDARD
FOR BATTERY-BASED EMERGENCY POWER UNIT (BEPU)

CHAPTER 1: MINIMUM PERFORMANCE STANDARD UNDER STANDARD CONDITIONS

1 — PURPOSE

These are the requirements under standard conditions for a Battery-based Emergency Power Units (BEPU) to meet the Minimum Performance Standard for this ETSO. The performance of specific equipment may be enhanced, depending on its intended application and configuration.

2 — GENERAL REQUIREMENTS

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

(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 cell temperatures and pressures 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, and
- under the most adverse cooling condition likely to occur in service.

(c) Demonstrate the above conditions by test, unless your experience with similar batteries and installations has shown that maintaining safe cell temperatures and pressures do not present a problem.

(d) Systems like electronic circuits installed in the BEPU must be compatible with the battery chemistry.

(e) During a failure of the normal power source to the emergency electrical bus, the BEPU supplies emergency electrical bus loads without intervention by the flight crew. After re-establishment of the normal power source, the emergency bus loads revert automatically from the BEPU to the normal power source, and the BEPU automatically returns to charging mode. To prevent inadvertent recharging of the BEPU from the aircraft battery when a normal power source is not available, the BEPU shall not enter the recharge mode when the BEPU input (source) voltage is below 24VDC.

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

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

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

(i) The BEPU will not discharge through the input side of the BEPU.

(j) If the BEPU provides backup power to multiple loads, equip the BEPU with protection provisions that allow for the 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.

(k) The BEPU should not drain its battery power when the aircraft power is off.

(l) charge fully the battery before installation. Charge the battery every time the aircraft is powered up, regardless of cockpit switch position.

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

(n) Specify the nominal current and the short time maximum current.

(o) Design the BEPU in such a way so that separation devices placed between input, output, and battery will enable the current flow from input to output, even when there is a malfunction with other BEPU components. The separation devices will prevent current flow in the direction from output (respectively the battery) to input, and from output to battery. See Figure A-2 at the end of this appendix. The minimum current rating of the separation devices must be greater than three times the continuous rated output current of the BEPU. Unless provided in the aircraft, design the BEPU to prevent output current greater than 30 milliamperes (mA) from flowing back to battery. The loss (breakdown) of voltage of such separation devices will exceed three times the BEPU rated voltage.

(p) The maximum output voltage ripple cannot exceed the limits stated in MIL-STD-704F. Note that this limit does not include the ripple already on the input line into the BEPU. (See Figure A-3 at the end of this appendix.)

(q) To preclude catastrophic effects of excess temperature, the BEPU will monitor battery temperature during battery–charging cycles, and remove power when over temperature limits are reached. Applications where excessive battery temperature cannot cause catastrophic events do not require monitoring.

(r) If the BEPU contains a battery heater device, a single-fault failure redundancy protection is required to prevent heater runaway.

3 — CAPACITY AND RELATED PARAMETERS

The parameters listed in this section under environmentally benign and ground benign conditions at 25 °C must be provided. Considered nominal conditions follow.

(a) BEPU capacity. Specify 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 below 20VDC.

(b) BEPU output voltage excursions. Provide graphs of output voltage versus time for 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. This (72 % capacity) represents a BEPU at the end of its life and 90 % state of charge.

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

(d) BEPU maximum current consumption. Specify the maximum current consumption (excluding external loads) of the BEPU. Maximum current includes charging, heating, and other functionalities performed by electronic circuits.

(e) BEPU output current. Specify the nominal current that can be delivered by the BEPU related to the nominal Ah rating specified in paragraph 3.a of this Chapter 1 'CAPACITY AND RELATED PARAMETERS', and the short time maximum current~~,~~ versus time, if necessary.

4 — MONITOR AND CONTROL

(a) Instrumentation, data read-outs~~,~~ and controls can be provided by support equipment instead of the BEPU.

(b) Design all instrumentation and data read-outs for easy interpretation to avoid misunderstandings.

(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 there is a 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 indication. Perform a lamp test where the checked segments are lighted.

CHAPTER 2: MINIMUM PERFORMANCE STANDARD UNDER ENVIRONMENTAL TEST CONDITIONS

1 — GENERAL

Unless otherwise specified, applicable test procedures are ~~in EUROCAE ED14E / RTCA DO-160E~~ defined in CS-ETSO, Subpart A paragraph 2.1.

2 — PERFORMANCE TESTS

The following environmental tests verify BEPU operations based on manufacturer specifications and requirements under extreme environmental conditions. If the manufacturer's specifications during these tests are different than those recorded under benign environmental conditions as specified in paragraph 3 of Chapter 1 of this Appendix,

the manufacturer will specify the modified rating and under what condition such ratings would occur. For the following tests determine compliance of the BEPU with the manufacturer's nominal ratings (unless otherwise specified) as referenced in paragraph 3 of Chapter 1 of this Appendix except when otherwise noted, charge the batteries to at least 80 % of manufacturer's rated capacity before conducting these tests:

- BEPU capacity using nominal current discharge;
- BEPU output voltage excursion;
- BEPU current consumption.

For the applicable environmental test requirements see ETSO, Subpart A, paragraph 2.1:

(a) Section 4, Temperature and Altitude.

- Operating Low Temperature Test. You may use an internal battery heater for this test.
- Operating High Temperature Test.
- Altitude Test.
- Decompression Test.
- Overpressure Test.

(b) Section 5, Temperature Variation. Combine this test with Section 4 Testing Requirements.

(c) Section 6, Humidity.

(d) Section 7, Operational Shocks and Crash Safety. After this test, the equipment must remain in its mounting with no part of the equipment or its mounting becoming detached and free on the shock test table. Measure and record the BEPU capacity after completion.

NOTE: These tests may damage the equipment. Therefore, these tests may be conducted last.

(e) Section 8, Vibration. While the equipment is subjected to this test, ensure that all mechanical devices operate satisfactorily and that the mechanical construction remains undamaged.

(f) Section 9, Explosion Proofness. Required only if the BEPU contains components that are known to cause inductive arcing.

(g) Section 10, Water Proofness (if required).

(h) Section 11 Fluids Susceptibility (if required). Not mandatory for ETSO approval.

(i) Section 12, Sand and Dust (if required).

(j) Section 13, Fungus Resistance (if required). Compliance by analysis is acceptable.

(k) Section 15, Magnetic Effect.

(l) Section 16, Power Input.

(m) Section 17, Voltage Spike. During and after this test, no failed parts must exist, including any degradation on component voltage and current ratings. No parasitic or transient mode switching can result from this test.

(n) Section 18, Audio Frequency Conducted Susceptibility — Power Inputs. Conduct by charging the BEPU when its capacity is between 0 % and 75 %. No parasitic or transient mode switching can result from this test.

(o) Section 19, Induced Signal Susceptibility. No parasitic or transient mode switching can result from this test.

(p) Section 20, RF Susceptibility. No parasitic or transient mode switching can result from this test.

(q) Section 21, Emission of RF Energy. Conduct while BEPU is being charged. Charge must be between 0 % and 75 % of capacity during this test.

(r) Section 22, Lightning Induced Transient Susceptibility. No parasitic or transient mode switching can result from this test.

(s) Section 23, Lightning Direct Effects. Not mandatory for this ETSO approval. If you conduct this test, no failed parts may exist during and after the test. Failed parts include any degradation on component voltage and current ratings. No parasitic or transient mode switching should result during this test.

(t) Section 24, Icing. Not mandatory for this ETSO approval. If you conduct this test, no failed parts may exist during and after the test. Failed parts include any degradation on component voltage and current ratings.

(u) Section 25, Electrical Discharge.

CHAPTER 3: ELECTRICAL TEST PROCEDURES

1 — GENERAL

Electrical test procedures covered under environmental test conditions in Chapter 2 of this Appendix are conducted according to the test procedures outlined below.

2 — GENERAL TEST CONDITIONS

Unless otherwise specified, the following test conditions apply:

(a) Conduct all tests under conditions of ambient room temperature (except sections 4, 5 and 6) and ambient pressure and humidity as outlined in Section 1, Paragraph 3.

(b) Unless otherwise specified, the input supply voltage will be within 10 % of the nominal value the BEPU 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

(Per paragraph 4 ‘MONITOR and CONTROL’ of Chapter 1 of this document)

(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 traceable to the National Bureau of Standards. Test equipment accuracy will be at least 2 %.

CHAPTER 4 : DESCRIPTION OF A BEPU

1 — GENERAL

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

2 — PARTS OF A BEPU

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 regardless of surrounding temperature.

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

(b) Figure A-1 block diagram illustrates the description of the BEPU functionality. It does not define a requirement.

(c) Figure A-2 depicts an example BEPU current flow.

(d) Figure A-3 depicts a recommended measurement of BEPU output voltage ripple.

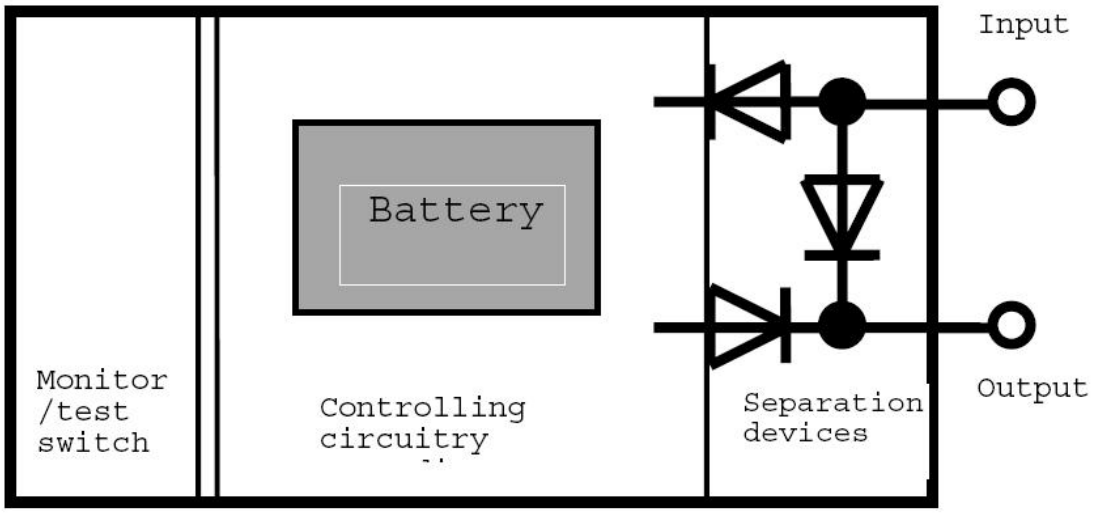

Figure A-1: BEPU Block Diagram

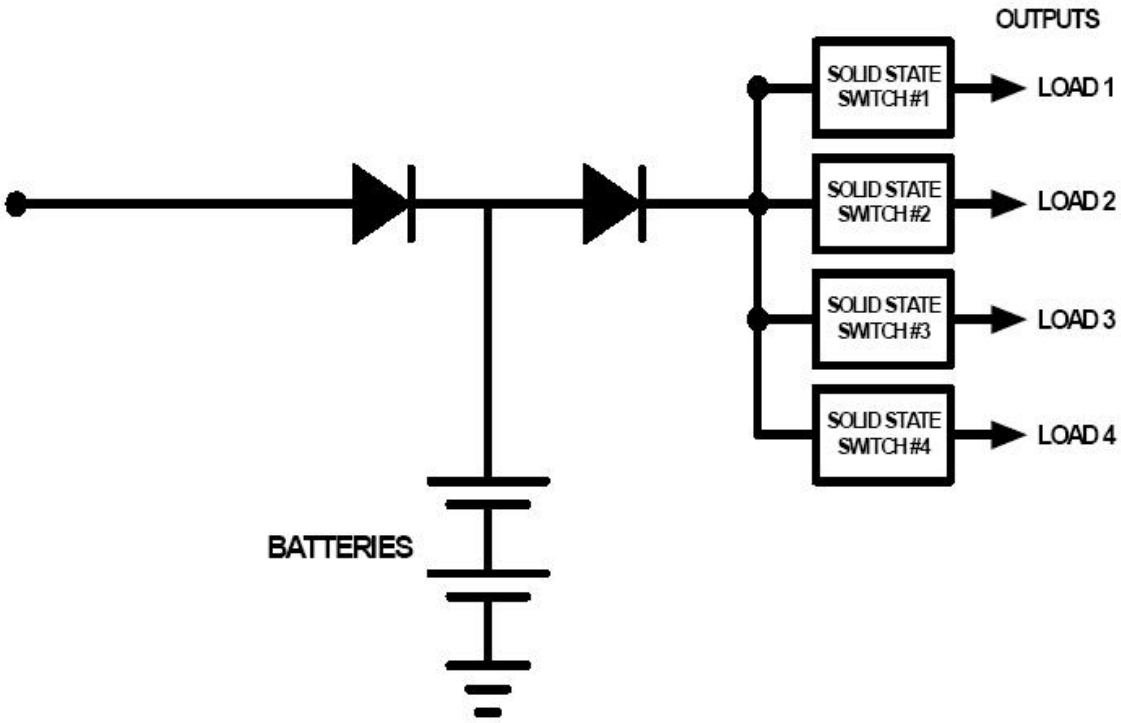

Figure A-2: An example BEPU Current Flow

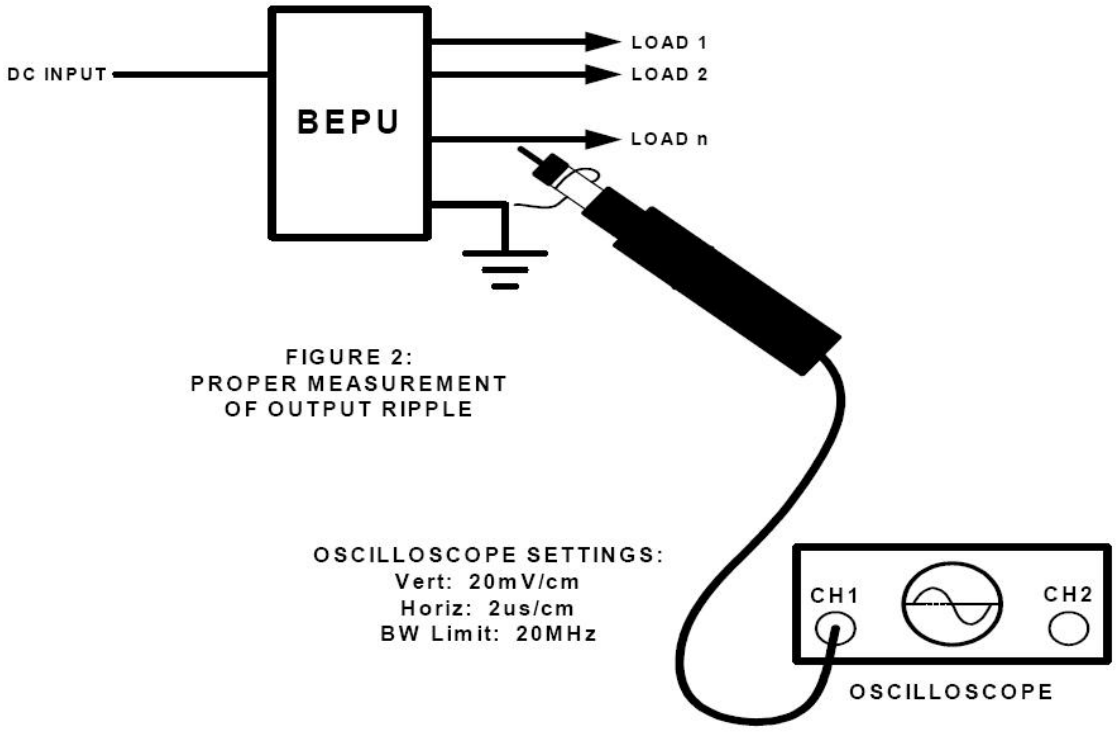

Figure A-3: Recommended Measurement of BEPU Output Voltage Ripple