English Translation Version for Reference Only

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China Civil Aviation Technical Standard Order

This China Civil Aviation Technical Standard Order (CTSO) is issued according to Part 37 of the China Civil Aviation Regulations (CCAR-37). Each CTSO is a criterion which the concerned aeronautical materials, parts or appliances used on civil aircraft must comply with when it is presented for airworthiness certification.

Battery Based Emergency Power Unit (BEPU)

1. Purpose.

This China Civil Aviation Technical Standard Order (CTSO) is for manufacturers applying for battery based emergency power units (BEPU) CTSO authorization (CTSOA). This CTSO prescribes the minimum performance standards(MPS) that BEPU must first meet for approval and identification with the applicable CTSO marking.

2. Applicability.

This CTSO affects new application submitted after its effective date. Major design changes to article approved under this CTSO will require a new authorization in accordance with section 21.310 of CCAR-21R3.

3. Requirements.

New models of BEPUs identified and manufactured on or after the effective date of this CTSO must meet the requirements in this CTSO,

including appendixes 1, 2 and 3. The battery used in the BEPU must meet the requirements of CTSO-C173a, Nickel-Cadmium and Lead Acid Batteries, dated July 24, 2014, or any other battery standards approved by the authorities.

a. Functionality. This CTSO MPS applies to BEPUs used to provide emergency backup electrical power for, but not limited to, instrument systems, navigation systems, egress lighting, and other emergency or standby electrical power applications on an aircraft.

b. Failure Condition Classification. Failure of the function defined in paragraph 3.a of this CTSO is a hazardous failure. 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 CTSO.

d. Software Qualification. If the article includes software, develop the software according to RTCA, Inc. document RTCA/DO-178B, Software Considerations in Airborne Systems and Equipment Certification, dated December 1, 1992. The RTCA/DO-178B software level should be consistent with the failure condition classification in paragraph 3.b above. In accordance with RTCA/DO-178B, paragraph 9.3, submit the following documents to the authorities for review and approval:

(1) Plan for software aspects of certification (PSAC).

(2) Software configuration index.

(3) Software accomplishment summary.

e. All data supporting the applicable objectives found in RTCA/DO-178B, Annex A, Process Objectives and Outputs by Software Level, must be available for review. For software developed before December 1, 1992, see RTCA/DO-178B, Software Considerations in Airborne Systems and Equipment Certification, dated December 1, 1992. Section 12.1.4 of RTCA/DO-178B provides a way to upgrade a baseline for software development so that changes can be made according to RTCA/DO-178B criteria.

NOTE 1: It is recommended that the applicant submit the PSAC early in the software development process. Early submittal allows the authorities to resolve issues with the software aspects of the certification plan, such as partitioning and determining the software levels.

NOTE 2: Substantiate the software levels in the safety assessment process outlined in RTCA/DO-178B. If the equipment incorporates more than one software level, appropriate partitioning of different software levels is required.

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

RTCA/DO-254, Design Assurance Guidance for Airborne Electronic Hardware, dated April 19, 2000. The design assurance level must be consistent with the failure condition classification in paragraph 3.b of this CTSO.

g. Deviations. For using alternative or equivalent means of compliance to the criteria in this CTSO, the applicant must show that the equipment maintains an equivalent level of safety. Apply for a deviation under the provision of 21.310(b) in CCAR-21R3.

4. Marking.

a. Mark at least one major component permanently and legibly with all the information of 21.312(d) in CCAR-21R3.

b. Indicate on the product label:

- The rated capacity (e.g. 20 hours),
- Nominal voltage, and
- Battery chemistry.

5. Application Data Requirements.

The applicant must furnish the responsible certification personnel with the related data to support design and production approval. The application data include a statement of conformance as specified in section 21.310(c)(3) in CCAR-21R3 and one copy each of the following technical data:

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

b. Installation procedures and limitations, sufficient to ensure the BEPU, when installed per the installation procedures, continue to meet this CTSO's requirements. The limitations must identify any unique aspects of the installation. The limitations must include a note with the following statement:

"This article meets the minimum performance and quality control standards required by a CTSO. Installation of this article requires separate approval."

c. Schematic drawings of the installation procedures.

d. Wiring diagrams of the installation procedures.

e. Minimum performance standards.

f. Instructions for periodic maintenance and calibration for continued airworthiness once the equipment is installed.

g. An environmental qualification form describing the environmental tests conducted in accordance with appendix 2 of this CTSO, and RTCA/DO-160E, Environmental Conditions and Test Procedures for Airborne Equipment, dated December 9, 2004.

h. List of components by part number.

i. Manufacturer's CTSO qualification test report.

j. Nameplate drawing with the information required in paragraph 4

of this CTSO.

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 authorities, have the following technical data available for review by the authorities:

a. The functional qualification specifications to be used to qualify each production article to ensure compliance with this CTSO.

b. Equipment calibration procedures.

c. Corrective maintenance procedures (within 12 months after CTSO authorization).

d. Schematic drawings.

e. Wiring diagrams.

f. The results of qualification tests conducted in accordance with appendixes 1 and 2 of this CTSO, and RTCA/DO-160E.

7. Furnished Data Requirements.

If furnishing one or more articles manufactured under this CTSO to one entity (such as an operator or repair station), provide one copy data in paragraphs 5.a through 5.g of this CTSO.

8. Availability of Referenced Documents.

a. Order RTCA documents from:

Radio Technical Commission for Aeronautics, Inc.

1150 18th Street NW, Suite 910, Washington D.C. 20036

You may also order them online from www.rtca.org.

b. Order MIL-STD-704F from:

DODSSP，Subscription Services Desk

Building 4D, 700 Robbins Avenue, Philadelphia PA 19111-5094.

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

1. PURPOSE.

These are the requirements under standard conditions for a BEPU to meet the MPS for this CTSO. The applicant may enhance the performance of specific equipment, depending on applicant's 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 CTSO.

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 the 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's 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. Fully charge the battery before installation. Charge the battery every time the aircraft is powered up, independent 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 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 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 in appendix 4 of this CTSO. 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 miliAmpere (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 this limit does not include the ripple already on the input line into the BEPU. (See appendix 4, Figure A-3 of this CTSO.)

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 manufacturer-applicant must provide the parameters listed in this section under environmentally benign and ground benign conditions at 25°C. Following are considered nominal conditions.

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 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 nameplate stated capacity 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 appendix, 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. An in-flight low battery warning indication is recommended. Perform a lamp test where the checked segments are lighted.

APPENDIX 2. MINIMUM PERFORMANCE STANDARD UNDER ENVIRONMENTAL TEST CONDITIONS

1. GENERAL.

Unless otherwise specified, applicable test procedures are in RTCA/DO-160E.

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

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

The applicable test requirements contained in RTCA/DO-160E are:

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

• Operating Low Temperature Test. The applicant may use an internal battery heater for this test.

• Operating High Temperature Test

• Altitude Test

• Decompression Test

• Overpressure Test

b. RTCA/DO-160E Section 5, Temperature Variation. Combine this test with RTCA/DO-160E, Section 4 testing requirements.

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

d. RTCA/DO-160E 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, the applicant may want to conduct this test last.

e. RTCA/DO-160E 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. RTCA/DO-160E Section 9, Explosion Proofness. Required only if the BEPU contains components that are known to cause inductive arcing.

g. RTCA/DO-160E Section 10, Water Proofness (if required).

h. RTCA/DO-160E Section 11 Fluids Susceptibility (if required).

Not mandatory for TSO approval.

i. RTCA/DO-160E Section 12, Sand and Dust (if required).

j. RTCA/DO-160E Section 13, Fungus Resistance (if required). Compliance by analysis is acceptable.

k. RTCA/DO-160E Section 15, Magnetic Effect.

l. RTCA/DO-160E Section 16, Power Input.

m. RTCA/DO-160E 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. RTCA/DO-160E 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. RTCA/DO-160E Section 19, Induced Signal Susceptibility. No parasitic or transient mode switching can result from this test.

p. RTCA/DO-160E Section 20, RF Susceptibility. No parasitic or transient mode switching can result from this test.

q. RTCA/DO-160E 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. RTCA/DO-160E Section 22, Lightning Induced Transient

Susceptibility. No parasitic or transient mode switching can result from this test.

s. RTCA/DO-160E Section 23, Lightning Direct Effects. Not mandatory for this CTSO approval. If the applicant conducts 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. RTCA/DO-160E Section 24, Icing (DO-160E). Not mandatory for this CTSO approval. If the applicant conducts this test, no failed parts may exist during and after the test. Failed parts include any degradation on component voltage and current ratings.

u. RTCA/DO-160E Section 25, Electrical Discharge.

APPENDIX 3. ELECTRICAL TEST PROCEDURES

1. GENERAL.

Electrical test procedures covered under environmental test conditions in appendix 2 of this CTSO are conducted according to RTCA/DO-160E. Under paragraph 3 below, test procedures that meet specific requirements for the BEPU is outlined.

2. GENERAL TEST CONDITIONS.

Unless otherwise specified, the following test conditions apply:

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

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 standards. Test equipment accuracy will be at least 2 %.

APPENDIX 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 independent from 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.

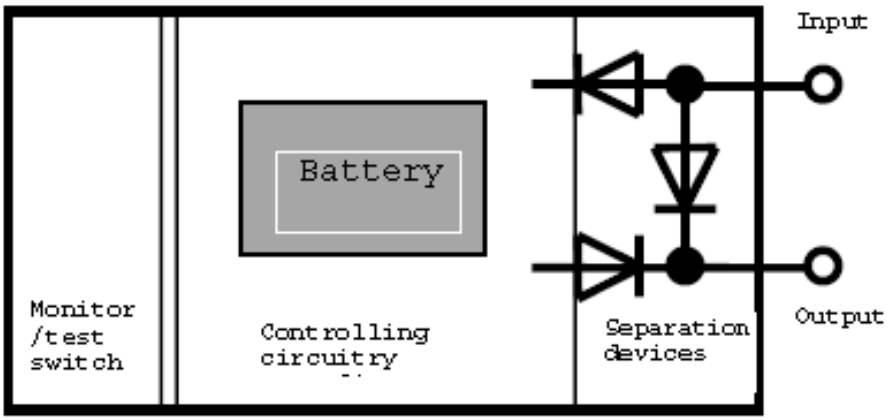

Figure A-1: BEPU Block Diagram.

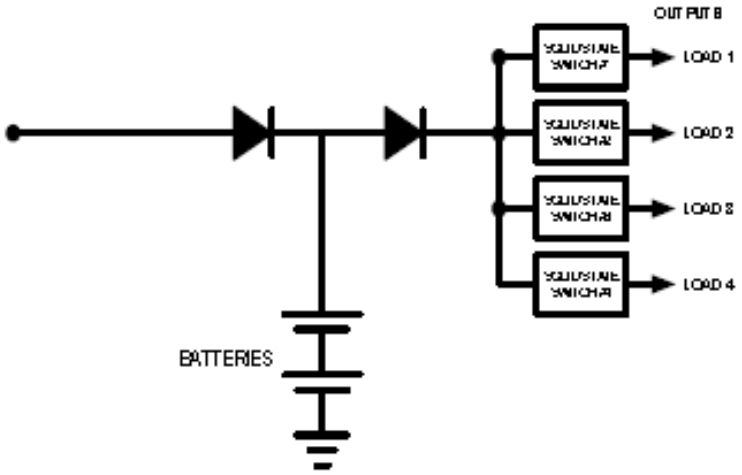

Figure A-2: An example BEPU Current Flow.

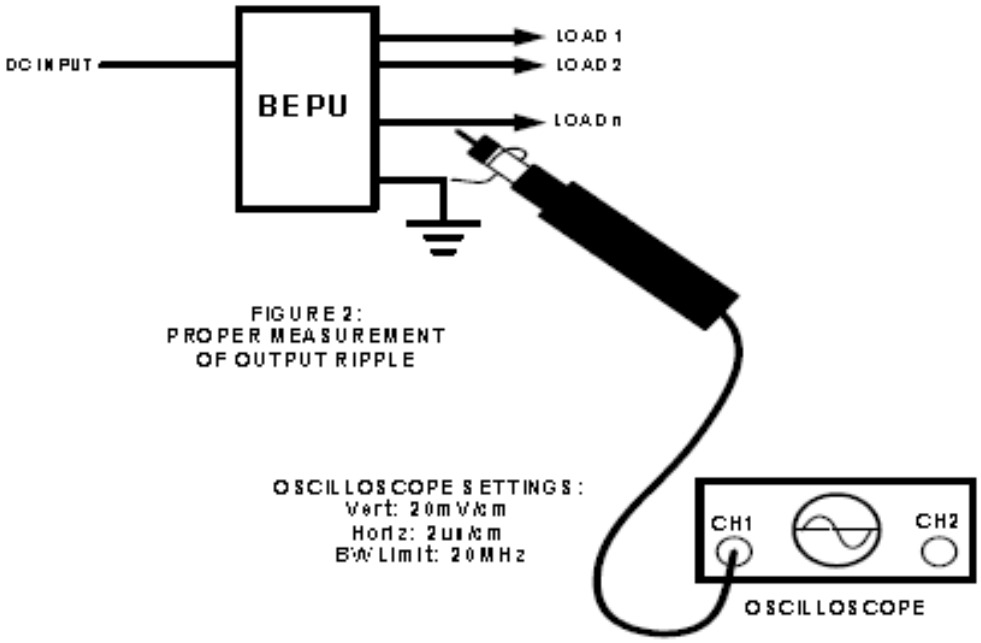

Figure A-3: Recommended Measurement of BEPU Output Voltage Ripple.