

SUBJECT : **Electric Propulsion Units for CS-23 Normal-Category Aeroplanes up to Level 1**

REQUIREMENTS incl. Amdt. :

ASSOCIATED IM/AMC¹ : Yes ☒ / No ☐

ADVISORY MATERIAL : **AMC 20-115D**

INTRODUCTORY NOTE:

The following Special Condition has been classified as important and as such shall be subject to public consultation in accordance with EASA Management Board decision 12/2007 dated 11 September 2007, Article 3 (2.) which states:

"2. Deviations from the applicable airworthiness codes, environmental protection certification specifications and/or acceptable means of compliance with Part 21, as well as important special conditions and equivalent safety findings, shall be submitted to the panel of experts and be subject to a public consultation of at least 3 weeks, except if they have been previously agreed and published in the Official Publication of the Agency. The final decision shall be published in the Official Publication of the Agency."

IDENTIFICATION OF ISSUE:

An applicant has made an application for the certification of an electric propulsion unit (called hereafter EPU). It consists of an electric motor associated with its controller (inverter). The motor and the inverter are liquid cooled. The liquid cooling system (heat exchanger, coolant tank, draining capabilities...) and the energy storage devices are not included in the scope of this special condition.

This type of EPU is intended to be installed on CS-23 Normal, Utility, Aerobatic and Commuter Aeroplanes up to Level 1.


Any EPU that shows compliance with this Special Condition could also be installed on CS-22 Sailplanes and Powered Sailplanes, CS-LSA Light Sport Aeroplanes and CS-VLA Very Light Aeroplanes (Note that CS-VLA was merged into CS-23 amendment 5).

The certification specifications that are usually applicable to aircraft engines are contained in CS-E amendment 5, CS-22 Subpart H, or Special Condition EA-42 "Airworthiness Standard for CS-22H Electrical Retractable Engine to be operated in Powered Sailplanes"

However they do not cover the case of an EPU for CS-23 Normal, Utility, Aerobatic and Commuter Aeroplanes up to Level 1.

The applicant has proposed to use the ASTM F3338-18 "Standard Specification for Design of Electric Propulsion Units for General Aviation Aircraft" as the basis to define the certification requirements.

¹ In case of SC, the associated Interpretative Material and/or Acceptable Means of Compliance may be published for awareness only and they are not subject to public consultation.

 European Union Aviation Safety Agency	Special Condition	Doc. No. : SC E-18 Issue : 2 Date : 22/10/2020 Proposed <input type="checkbox"/> Final <input checked="" type="checkbox"/>
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The certification specifications necessary to certify a liquid-cooled EPU are considered to be represented by ASTM F3338-18 with the following amended requirements along with the additions below:

[...]

- 5.7 also applies to a liquid cooled EPU

[...]

- 5.15: for the certification of an engine, only a “critical part” should be considered. An engine critical part is a part that relies upon meeting the prescribed integrity specifications of 5.15.2 to avoid its Primary Failure, which is likely to result in a Hazardous Engine Effect. Therefore 5.15.1.2, 5.15.3.1, 5.15.3.2, 5.15.3.3 should not be considered.

[...]

- 5.15.2 is replaced by:

The integrity of the Engine Critical Parts identified under 5.15 shall be established by:

- (a) An Engineering Plan, the execution of which establishes and maintains that the combinations of; loads, material properties, environmental influences and operating conditions, including the effects of parts influencing these parameters, are sufficiently well known or predictable, by validated analysis, test or service experience, to allow each Engine Critical Part to be withdrawn from service at an Approved Life before Hazardous Engine Effects can occur.

Appropriate Damage Tolerance assessments shall be performed to address the potential for Failure from; material, manufacturing and service-induced anomalies within the Approved Life of the part. The Approved Life shall be published as required in 5.1.

- (b) A Manufacturing Plan which identifies the specific manufacturing constraints necessary to consistently produce Engine Critical Parts with the Attributes required by the Engineering Plan.
- (c) A Service Management Plan which defines in-service processes for maintenance and repair of Engine Critical Parts which will maintain the Attributes consistent with those required by the Engineering Plan. These processes shall become part of the instructions for continued airworthiness.

[...]

- 5.15.3.4: regardless of whether or not the EPU provides containment in the event of a rotor burst , all EPU rotors shall have limitations established by an acceptable procedure which specifies the maximum allowable number of start-stop stress cycles (low cycle fatigue) or running hours representative of the typical EPU usage. A cycle includes, as a minimum, starting the EPU, operating at specific power settings and stopping.

[...]

- 5.18.2: The following requirements shall be added:
 - It shall be shown that Hazardous EPU Effects are predicted to occur at a rate not in excess of that defined as Extremely Remote (probability shall be consistent with the safety objective associated with the intended aircraft application). The estimated probability for individual Failures may be insufficiently precise to enable the total rate



for Hazardous EPU Effects to be assessed. For EPU certification, it is acceptable to consider that the intent of this paragraph has been achieved if the probability of a Hazardous EPU Effect arising from an individual Failure can be predicted to be not greater than [10% of the safety objective associated with the intended aircraft application] per EPU flight hour.

- It shall be shown that Major EPU Effects are predicted to occur at a rate not in excess of that defined as Remote (probability shall be consistent with the safety objective associated with the intended aircraft application).

[...]

- 5.19.5 to be replaced by:

Water spray must not result in any abnormal EPU operation (i.e. shutdown, power loss, erratic operation, power oscillations, failures...) throughout the EPU operating range. Spray must be arranged to deliver water in a manner representative of very heavy rain over the whole frontal area of the EPU including cowling, air intakes, etc., throughout the full running time.

[...]

- 5.20.3: The purpose of the Endurance and Durability Test is to establish the ratings and the limitations of the EPU as well as assessing the reliability of the EPU overall design. In the absence of detailed Means of Compliance (MoC) in the ASTM F3338-18, the applicant may refer to CS-E 440 and the associated AMC to define an acceptable means of compliance to 5.20.3.
- 5.25: to be deleted.

Note: If an applicant seeks to include the propeller in the EPU type design, this propeller shall meet all requirements contained in CS-P or CS-22 subpart J depending on the intended aircraft application.

