

Initial Airworthiness Special Condition

Non-rechargeable Lithium Battery Installations

Note

This document contains a number of amendments that will be incorporated into the final published version following consultation.

Warning

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SUBJECT : **Non-rechargeable Lithium Battery Installations**
REQUIREMENTS incl. Amdt. : CS 25.1353(c) at Amendment 18
ASSOCIATED MOC¹ : Yes / No
ADVISORY MATERIAL :

INTRODUCTORY NOTE:

The following Special Condition (SC) 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:

Applicants propose to install electrical components containing non-rechargeable lithium batteries. Recent experience (reference FAA Airworthiness Directives 2013-15-07 and 2013-18-09) has shown that non-rechargeable lithium batteries and battery systems have design features or identified hazards that may lead to the development of unsafe conditions. As the related certification specifications do not contain adequate or appropriate safety standards, in application of point 21.B.75 of Part-21, EASA shall prescribe special conditions containing safety standards necessary in order to establish a level of safety equivalent to that of the applicable certification specifications.

As the proposed installation is a novel and unusual design feature, the applicable airworthiness codes JAR/CS 25 do not provide adequate safety standards. The current requirements governing the installation of batteries in Large Aeroplanes are covered under CS 25.1353(c). The content of CS 25.1353(c) do not adequately address several failure, operational, and maintenance characteristics of Li-Batteries that could affect safety and reliability of those battery installations.

Past events involving a non-rechargeable lithium battery system in emergency locator transmitter (ELT) installations have identified unanticipated failure modes associated with non-rechargeable lithium battery installations. These may include over-discharging, cell imbalance, external short circuit, internal short circuit, and flammability of cell components among other possibilities.

Non-rechargeable lithium batteries, in design and operation, are different than nickel-cadmium and lead-acid non-rechargeable batteries. While the non-rechargeable lithium battery concept is not itself novel, higher energy levels are being introduced into aircraft systems by adopting new chemical composition in various

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

battery cell sizes and construction. Interconnection of these cells in battery packs introduces failure modes that require unique design considerations, such as provisions for thermal management.

In addition to the ELT which was the subject of the referenced ADs, known uses of non-rechargeable lithium batteries and battery systems on large aeroplanes include:

- Flight deck and avionics systems such as displays, global positioning systems, cockpit voice recorders, flight data recorders, underwater-locator-beacons, navigation computers, integrated avionics computers, satellite network/communication systems, communication management units, and remote monitor electronic line replaceable units (LRU);
- Cabin safety, entertainment and communications equipment including life rafts, escape slides, seat belt air bags, cabin management systems, Ethernet switches, routers and media servers, wireless systems, internet/in-flight entertainment systems, satellite televisions, remotes and handsets;
- Systems in cargo areas including door controls, sensors, video surveillance equipment and security systems.

Some known potential hazards and failure modes associated with non-rechargeable lithium batteries and battery systems are described below.

Internal Failures

In general, lithium batteries are significantly more susceptible to internal failures that can result in self-sustaining increases in temperature and pressure (i.e., thermal runaway) than their nickel-cadmium or lead-acid counterparts. The metallic lithium can ignite, resulting in a self-sustaining fire and/or explosion.

Fast discharging

An imbalanced discharge of one cell of a multi-cell non-rechargeable lithium battery system may create an overheating condition that results in an uncontrollable venting condition, which in turn could lead to a thermal event and/or an explosion.

Flammability

Unlike nickel-cadmium and lead-acid batteries, lithium batteries and battery systems use higher energy and current in an electrochemical system that can be configured to maximize energy storage of lithium and use liquid electrolytes that can be extremely flammable. The electrolyte, as well as the electrodes, can serve as a source of fuel for an external fire if there is a breach of the battery case.

The Special Condition F-XX Issue 1 on “*Non-rechargeable Lithium Battery Installations*” was released by EASA for public consultation from 7 to 28 September 2015 and the final version of the subject SC can be found under the following link:

<https://www.easa.europa.eu/document-library/product-certification-consultations/special-condition-non-rechargeable-lithium>

EASA has determined that it is necessary to clarify the applicability of the special conditions:

- Note 2 has been reworded to clarify that the special conditions are not applicable to design changes to previously certified non-rechargeable lithium battery installations that are either cosmetic or consist in a relocation that improves substantially the safety of the aeroplane and of its occupants. EASA has considered that excluding the latter category of design changes from the

applicability of the special conditions may create conditions for improvements in the level of safety of previously certified non-rechargeable lithium battery installations. Previously certified non-rechargeable lithium battery installations are those installations approved before the introduction of the special conditions.

- Note 2 also clarifies that the special conditions are applicable to design changes that affect the environment in which the battery is installed, except for design changes that improve the safety of the non-rechargeable lithium battery installation.
- Note 5 is added to introduce a means of compliance proposal according with the latest MOPS developed after the original publication of the SC's.

Considering all the above, the following updated Special Condition is published for information and awareness (changes compared to the previous "SC F-XX Issue 1 – Final" are tracked):

Special Condition

Non-rechargeable Lithium Battery Installations

The intent of this Special Condition is to ensure that ~~these~~ non-rechargeable Lithium battery installations are not unsafe, to an extent necessary to support issuance of an airworthiness certificate.

In lieu of the requirements of CS 25.1353(c) (1) through (c)(4), non-rechargeable lithium batteries and battery installations must comply with the following special conditions:

1. Be designed so that safe cell temperatures and pressures are maintained under all foreseeable operating conditions to preclude fire and explosion.
2. Be designed to preclude the occurrence of self-sustaining, uncontrolled increases in temperature or pressure.
3. Not emit explosive or toxic gases in normal operation, or as a result of its failure, that may accumulate in hazardous quantities within the **aeroplane**.
4. Must meet the requirements of CS 25.863(a) through (d).
5. Not damage surrounding structure or adjacent systems, equipment or electrical wiring of the **aeroplane** from corrosive fluids or gases that may escape and that may cause a major or more severe failure condition.
6. Have provisions to prevent any hazardous effect on **aeroplane** structure or essential systems caused by the maximum amount of heat it can generate due to any failure of it or its individual cells.
7. Have a means to detect its failure and alert the flight crew in case its failure affects safe operation of the aircraft.
8. Have a means for the flight crew or maintenance personnel to determine the battery charge state if its function is required for safe operation of the **aeroplane**.

Note 1: A battery system consists of the battery and any protective, monitoring and alerting circuitry or hardware inside or outside of the battery. It also includes vents (where necessary) and packaging. For the purpose of this special condition, a battery and battery system are referred to as a battery.

Note 2: These special conditions apply **in lieu of 25.1353(c)(1) through (c)(4) to non-rechargeable lithium battery installations as follows:**

- To all changed installation (new battery part number or new environment) except if the design change can be considered cosmetic. A cosmetic change is a change in appearance only and does not change any function or safety characteristic of the battery installation.
- To all relocated lithium batteries, except if the relocation is demonstrated to improve the safety of the aeroplane and of the occupants, leading to a change that provides a substantial fire safety improvement.
- To all existing non-rechargeable lithium battery installations affected by a design change, even if the battery or battery installation itself does not change.(e.g. change in ambient temperature or pressure

environment in which the battery operates, change on the electrical load on a battery). Except if the design change improves the safety of the non-rechargeable lithium battery installation.

Applicants, who intend to justify that this Special Condition is not applicable, shall generate the evidence that the proposed design meets the above criteria in this note 2. This evidence shall include a detailed assessment of the battery installation on the baseline aircraft and the improvement due to the proposed change considering a battery thermal runaway failure for both installations. The assessment should:

- Consider the battery thermal runaway effects of heat, explosive energy, projecting debris and toxic gases.
- Address the proximity of the battery to occupants, critical systems and equipment, structure, and any other installations that could be a hazard if exposed to a battery thermal runaway (e.g., oxygen bottles/lines, fuel lines).

The above exceptions are limited to changes/relocations to baseline aircraft installations approved for certification projects for which the special condition was not applicable.

CS 25.1353(c)(1) through (c)(4) remains in effect for other battery installations.

Note 3: For Very Small Non-rechargeable Lithium Batteries (equal or less than 2 Watt-hour of energy), an acceptable Means of Compliance with this Special Condition is showing that these batteries are compliant with Underwriters Laboratories (UL) 1642 or UL 2054.

Note 4: For the purpose of SCs 7 and 8, “safe operation of the aeroplane” is defined as continued safe flight and landing following failures or other non-normal conditions. The following are examples of devices with batteries that are not required for continued safe flight and landing of the aeroplane: emergency locator transmitters, underwater locator beacons, seat belt air bag initiators and flashlights. A backup flight instrument with a non-rechargeable lithium battery is an example that would be required for safe operation of the aeroplane.

Note 5: Minimum Operational Performance Standards (MOPS) for Non-Rechargeable Lithium Batteries DO-227A complemented by risk assessment at aeroplane level (limited to SC 3, 4, 5 & 6) is an acceptable Means of Compliance with the above Special Conditions 1 to 6.

Alternative Means of Compliance can be proposed by applicants in the context of individual certification projects to show compliance with the above listed Special Conditions and will be reviewed and agreed by EASA on a case by case basis.