

This annex to TCDS EASA.A.037 was created to publish selected special conditions / deviations / equivalent safety findings that are part of the applicable certification basis:

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<b>SPECIAL CONDITION</b>	<b>F-23 SC: Non-rechargeable Lithium Battery Installations</b>
APPLICABILITY:	F28 all marks
REQUIREMENTS:	CS 25.601, 25.863, 25.869, 25.1301, 25.1309, 25.1353(c), 25.1529, 25.1360 (b)
ADVISORY MATERIAL:	N/A

## BACKGROUND

The current requirements governing the installation of batteries in Large Aeroplanes are covered under (CS) 25.1353(c). Requirements from (CS) 25.1353(c) are essentially unchanged from initial JAR code and do not adequately address several failure, operational, and maintenance characteristics of Li-Batteries that could affect safety and reliability of those battery installations.

Recent 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 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 aircraft 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 intent of this CRI is to ensure that these non-rechargeable Lithium battery installations are not unsafe, to an extent necessary to support issuance of an airworthiness certificate.

### **SPECIAL CONDITION**

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 airplane.
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 airplane 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 airplane 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 airplane.

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 to all non-rechargeable lithium battery installations in lieu of 25.1353(c)(1) through (c)(4). Section 25.1353(c)(1) through (c)(4) will remain 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 MoC with this Special Conditions is showing these batteries compliant with Underwriters Laboratories (UL) 1642.

Note 4: For the purpose of SCs 7 and 8, “safe operation of the airplane” 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 airplane: 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 airplane.

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**ACRONYMS AND ABBREVIATIONS**

<b>ADS</b>	Automatic Dependent Surveillance
<b>AC</b>	Advisory Circular
<b>ACJ</b>	Advisory Circular Joint
<b>AFM</b>	Airplane Flight Manual
<b>AMC</b>	Acceptable Means of Compliance
<b>AMJ</b>	Advisory Material Joint
<b>AMM</b>	Aircraft Maintenance Manual
<b>AOA</b>	Angle Of Attack
<b>APU</b>	Auxiliary Power Unit
<b>ARAC</b>	Aviation Rulemaking Advisory Committee
<b>ASPSU</b>	Auxiliary Standby Power Supply Unit
<b>ATN</b>	Air Traffic Network
<b>ATS</b>	Air Traffic Service
<b>AVM</b>	Airborne Vibration Monitor
<b>AWO</b>	All Weathers Operations
<b>CC</b>	Cargo Compartment
<b>CCRC</b>	Cabin Crew Rest Compartments
<b>CFD</b>	Computational Fluid Dynamics
<b>CLS</b>	Cargo Loading System
<b>CLTA</b>	Conventional Large Transport Aircraft
<b>CMR</b>	Certification Maintenance Requirements
<b>CFR</b>	Code of Federal Regulations
<b>CFRP</b>	Carbon Fiber Reinforced Plastic
<b>CPDLC</b>	Controller-Pilot Data Link Communications
<b>CRC</b>	Crew Rest Compartments
<b>CRI</b>	Certification Review Item
<b>CRT</b>	Cathode Ray Tube
<b>CVR</b>	Cockpit Voice Recorder
<b>DEV</b>	Deviation
<b>DFZ</b>	Designated Fire Zones
<b>D-FIS</b>	Data Link Flight Information Services
<b>DOP</b>	Delegation Of Power
<b>DOT</b>	Department of Transportation
<b>DH</b>	Decision Height
<b>DRI</b>	Dynamic Response Index
<b>DSG</b>	Design Service Goal
<b>EAS</b>	Equivalent Airspeed
<b>ECAM</b>	Electronic Centralized Aircraft Monitoring
<b>EEC</b>	Engine Electronic Control
<b>EFCS</b>	Electrical Flight Control System
<b>ELOS</b>	Equivalent Level of Safety
<b>EPF</b>	Emergency Passage Feature
<b>EPS</b>	Executive Power System
<b>EPSUs</b>	Emergency Power Supply Units
<b>ESF</b>	Equivalent Safety Finding

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<b>ETSO</b>	European Technical Standard Order
<b>FCRC</b>	Flight Crew Rest Compartments
<b>FDR</b>	Flight Data Recorder
<b>FMJ RN</b>	Full Metal Jacket, Round Nose
<b>FQIS</b>	Fuel Quantity Indicating Systems
<b>FWS</b>	Flight Warning System
<b>GFI</b>	Ground Fault Interruption
<b>GVT</b>	Ground Vibration Test
<b>HIC</b>	Head Injury Criterion
<b>HIRF</b>	High Intensity Radiated Fields
<b>HP</b>	High Pressure
<b>HWG</b>	Harmonisation Working Group
<b>ICA</b>	Instructions for Continued Airworthiness
<b>ICAO</b>	International Civil Aviation Organisation
<b>ID</b>	Inside Diameter
<b>IDF</b>	Imbalance Design Fraction
<b>IFE</b>	In-Flight Entertainment
<b>IFSD</b>	In Flight Shut Down
<b>ILD</b>	Inertia Locking Device
<b>IM</b>	Interpretative Material
<b>IMC</b>	Instrument Meteorological Conditions
<b>IP</b>	Intermediate Pressure
<b>ISPSS</b>	In-Seat Power Supply System
<b>JHP</b>	Jacketed Hollow Point
<b>JTSO</b>	Join Technical Service Order
<b>LCD</b>	Liquid Crystal Display
<b>LDCC</b>	Lower Deck Cargo Compartment
<b>LRS</b>	Limit of Reasonable Survivability
<b>LP</b>	Low Pressure
<b>MMEL</b>	Master Minimum Equipment List
<b>MOC</b>	Means Of Compliance
<b>NPA</b>	Notice of Proposal Amendment
<b>NPRM</b>	Notice of Proposed Rulemaking
<b>NTSB</b>	National Transportation Safety Board
<b>OSD</b>	Operational Suitability Data
<b>PBE</b>	Protective Breathing Equipment
<b>PDU</b>	Power Drive Unit
<b>PED</b>	Portable Electronic Device
<b>PPHWG</b>	Power Plant Harmonisation Working Group
<b>RMS</b>	Root Mean Square
<b>RR</b>	Rolls Royce
<b>RTCA</b>	Radio Technical Commission for Aeronautics
<b>RVR</b>	Runway Visual Range
<b>SC</b>	Special Condition
<b>TAS</b>	True Airspeed
<b>TCDS</b>	Type Certificate Data Sheet
<b>TSO</b>	Technical Service Order
<b>TT&amp;L</b>	Taxi, Tack off and Landing

**TWA** Trans World Airline  
**VLTA** Very Large Transport Aeroplane

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