

**[4910-13]**

**DEPARTMENT OF TRANSPORTATION**

**Federal Aviation Administration**

**14 CFR Part 25**

**[Docket No. NM462; Special Condition No. 25-444-SC]**

**Special Conditions:** Cessna Aircraft Company Model M680 airplane; rechargeable lithium-ion battery installations.

**AGENCY:** Federal Aviation Administration (FAA), DOT.

**ACTION:** Final special conditions.

**SUMMARY:** These special conditions are issued for the Cessna Aircraft Company Model 680 airplane. This airplane will have a novel or unusual design feature associated with lithium-ion batteries. The applicable airworthiness regulations do not contain adequate or appropriate safety standards for this design feature. These special conditions contain the additional safety standards that the Administrator considers necessary to establish a level of safety equivalent to that established by the existing airworthiness standards.

**EFFECTIVE DATE:** October 17, 2011.

**FOR FURTHER INFORMATION CONTACT:** Nazih Khaouly, FAA, Airplane & Flight Crew Interface Branch, ANM-111, Transport Airplane Directorate, Aircraft Certification Service, 1601 Lind Avenue SW., Renton, Washington, 98057-3356; telephone (425) 227-2432; facsimile (425) 227-1149.

## **SUPPLEMENTARY INFORMATION:**

### **Background**

On October 03, 2006, Cessna Aircraft Company applied for a change to type certification (TC) T00012WI for installation of lithium-ion batteries in the Model 680.

### **Type Certification Basis**

Under the provisions of Title 14, Code of Federal Regulations (14 CFR) 21.101, Cessna Aircraft Company must show that the Model 680, as changed, continues to meet the applicable provisions of the regulations incorporated by reference in TC T00012WI or the applicable regulations in effect on the date of application for the change. The regulations incorporated by reference in the type certificate are commonly referred to as the “original type-certification basis.” The regulations incorporated by reference in TC T00012WI are as follows:

Title 14, Code of Federal Regulations, part 25, effective February 1, 1965, as amended by amendments 25-1 through 25-98. Refer to TC T00012WI, as applicable, for a complete description of the type-certification basis for this model, including special conditions and exemptions that are not relevant to these special conditions.

If the Administrator finds that the applicable airworthiness regulations (i.e., 14 CFR part 25) do not contain adequate or appropriate safety standards for the Model 680 because of a novel or unusual design feature, special conditions are prescribed under the provisions of 14 CFR 21.16.

Special conditions are initially applicable to the model for which they are issued. Should the type certificate for that model be amended later to include any other model that incorporates the same or similar novel or unusual design feature, or should any other model already included

on the same type certificate be modified to incorporate the same or similar novel or unusual design feature, the special conditions would also apply to the other model under § 21.101.

In addition to the applicable airworthiness regulations and special conditions, the Model 680 must comply with the fuel-vent and exhaust-emission requirements of 14 CFR part 34 and the noise-certification requirements of 14 CFR part 36.

The FAA issues special conditions, as defined in 14 CFR 11.19, in accordance with § 11.38, and they become part of the type-certification basis under 14 CFR 21.101.

### **Novel or Unusual Design Features**

The Model 680 will incorporate the following novel or unusual design features:

Cessna Aircraft Company proposes to use rechargeable lithium-ion main batteries and Auxiliary Power Unit (APU) start batteries on the Model 680, and is also considering the use of this lithium-battery technology in several other auxiliary-battery applications in these airplanes. This type of battery possesses certain failure and operational characteristics, and maintenance requirements differ significantly from that of the nickel-cadmium (Ni-Cd) and lead-acid rechargeable batteries currently approved for installation in transport-category airplanes. Large, high-capacity, rechargeable lithium batteries are a novel or unusual design feature in transport-category airplanes, and current regulations in 14 CFR part 25 do not address installation of rechargeable lithium batteries.

### **Discussion**

The current regulations governing the installation of batteries in transport-category airplanes were derived from Civil Air Regulation (CAR) 4b.625(d) as part of the re-codification of CAR 4b that established Federal aviation regulations, in 14 CFR part 25, in February 1965.

The new battery requirements, § 25.1353(c)(1) through (c)(4), basically reworded the CAR requirements.

Increased use of Ni-Cd batteries in small airplanes resulted in increased frequency of battery fires and failures, which led to additional rulemaking affecting transport-category airplanes as well as small airplanes. On September 1, 1977, and March 1, 1978, the FAA issued § 25.1353(c)(5) and (c)(6), respectively, which govern Ni-Cd battery installations on transport-category airplanes.

The proposed use of rechargeable lithium batteries for equipment and systems on the Model 680 airplane has prompted the FAA to review the adequacy of existing battery regulations. Our review indicates that the existing regulations do not adequately address several failure, operational, and maintenance characteristics of lithium batteries that could affect the safety and reliability of rechargeable lithium-battery installations on the Model 680 airplane.

The use of lithium rechargeable batteries in applications involving commercial aviation has limited history. However, other users of this technology, ranging from wireless-telephone manufacturers to the electric-vehicle industry, have noted safety problems with lithium batteries. These problems include overcharging, over-discharging, and lithium-battery cell-component flammability.

## **1. Overcharging**

In general, lithium-ion batteries are significantly more susceptible than their Ni-Cd or lead-acid counterparts to internal failures that can result in self-sustaining increases in temperature and pressure (i.e., thermal runaway). This is especially true for overcharging, which causes heating and destabilization of the components of the lithium-battery cell, which can lead

to the formation, by plating, of highly unstable metallic lithium. The metallic lithium can ignite, resulting in a self-sustaining fire or explosion. The severity of thermal runaway due to overcharging increases with increased battery capacity due to the higher amount of electrolyte in large batteries.

## **2. Over-discharging**

Discharge of some versions of the lithium-battery cell, beyond a certain voltage (typically 2.4 volts), can cause corrosion of the electrodes in the cell, resulting in loss of battery capacity that cannot be reversed by recharging. This loss of capacity may not be detected by the simple voltage measurements commonly available to flight crewmembers as a means of checking battery status, a problem shared with Ni-Cd batteries.

## **3. Flammability of Cell Components**

Unlike Ni-Cd and lead-acid cells, some types of lithium-battery cells use flammable liquid electrolytes. The electrolyte can serve as a source of fuel for an external fire if the cell container is breached.

The problems that lithium-battery users experience raise concerns about the use of these batteries in commercial aviation. The intent of these special conditions is to establish appropriate airworthiness standards for lithium-battery installations in the Model 680 airplane, and to ensure, as required by §§ 25.601 and 25.1309, that these battery installations will not result in an unsafe condition.

To address these concerns, these special conditions adopt the following requirements:

- Those sections of § 25.1353 that are applicable to lithium batteries.

- The flammable-fluid fire-protection requirements of § 25.863. In the past, this rule was not applied to batteries in transport-category airplanes because the electrolytes in lead-acid and Ni-Cd batteries are not considered flammable.
- New requirements to address hazards of overcharging and over-discharging that are unique to rechargeable lithium-ion batteries.
- Section 25.1529, Instructions for Continued Airworthiness, must include maintenance requirements to ensure that batteries used as spares are maintained in an appropriate state of charge, and installed lithium batteries are sufficiently charged at appropriate intervals. These instructions must also describe proper repairs, if allowed, and battery part-number configuration control.

In issuing these special conditions, the FAA requires that:

(1) All characteristics of the lithium batteries and their installation that could affect safe operation of the Cessna Model 680 airplane are addressed, and

(2) Appropriate Instructions for Continued Airworthiness, which include maintenance requirements, are established to ensure the availability of electrical power from the batteries when needed.

### **Discussion of Comments**

Notice of proposed special conditions no. 25-11-15-SC for the Model 680 airplane was published in the Federal Register on July 1, 2011 (76 FR 41142 ). No comments were received, and the special conditions are adopted as proposed.

## **Applicability**

As discussed above, these special conditions are applicable to the Model 680 airplane. Should Cessna Aircraft Company apply at a later date for a change to the type certificate to include another model incorporating the same novel or unusual design feature, the special conditions would apply to that model as well.

## **Conclusion**

This action affects only certain novel or unusual design features on the Cessna Model 680 airplane. It is not a rule of general applicability.

## **List of Subjects in 14 CFR Part 25**

Aircraft, Aviation safety, Reporting and recordkeeping requirements.

The authority citation for these special conditions is as follows:

Authority: 49 U.S.C. 106(g), 40113, 44701, 44702, 44704.

## **The Special Conditions**

Accordingly, pursuant to the authority delegated to me by the Administrator, the following special conditions are part of the type-certification basis for Cessna Aircraft Company Model 680 airplanes.

In lieu of the requirements of § 25.1353(c)(1) through (c)(4) at amendment 25-42, lithium-ion batteries and battery installations on the Cessna Model 680 airplane must be designed and installed as follows:

- (1) Safe lithium-ion battery-cell temperatures and pressures must be maintained during any charging or discharging condition, and during any failure of the battery-charging or

battery-monitoring system not shown to be extremely remote. The lithium-battery installation must preclude explosion in the event of those failures.

- (2) Design of lithium batteries must preclude the occurrence of self-sustaining, uncontrolled increases in temperature or pressure.
- (3) No explosive or toxic gases emitted by any lithium battery in normal operation, or as the result of any failure of the battery-charging or battery-monitoring system, or battery installation which is not shown to be extremely remote, may accumulate in hazardous quantities within the airplane.
- (4) Installations of lithium batteries must meet the requirements of 14 CFR 25.863(a) through (d).
- (5) No corrosive fluids or gases that may escape from any lithium battery may damage surrounding structure or any adjacent systems, equipment, or electrical wiring of the airplane in such a way as to cause a major or more-severe failure condition, as determined in accordance with 14 CFR 25.1309(b).
- (6) Each lithium-battery installation must have provisions to prevent any hazardous effect on structure or essential systems caused by the maximum amount of heat the battery can generate during a short circuit of the battery or of its individual cells.
- (7) Lithium-battery installations must have a system to control automatically the charging rate of the battery to prevent battery overheating or overcharging, and
  - (i) A battery-temperature-sensing and over-temperature-warning system with a means to automatically disconnect the battery from its charging source in the event of an over-temperature condition or,

- (ii) A battery-failure sensing-and-warning system with a means to automatically disconnect the battery from its charging source in the event of battery failure.
- (8) Any lithium-battery installation, the function of which is required for safe operation of the airplane, must incorporate a monitoring-and-warning feature that will provide an indication to the appropriate flight crewmembers whenever the state-of-charge of the batteries has fallen below levels considered acceptable for dispatch of the airplane.
- (9) The instructions for continued airworthiness required by § 25.1529 (and § 26.11) must contain maintenance steps to assure that the lithium batteries are sufficiently charged at appropriate intervals specified by the battery manufacturer. The instructions for continued airworthiness must also contain procedures to ensure the integrity of lithium batteries in spares storage to prevent the replacement of batteries, the function of which are required for safe operation of the airplane, with batteries that have experienced degraded charge-retention ability or other damage due to prolonged storage at a low state-of-charge. Precautions should be included in the continued-airworthiness maintenance instructions to prevent mishandling of lithium batteries, which could result in a short circuit or other unintentional damage that could result in personal injury or property damage.

**Note 1:** The term “sufficiently charged” means that the battery retains enough of a charge, expressed in ampere-hours, to ensure that the battery cells are not damaged. A battery cell may be damaged by reducing the battery’s charge below a point where the battery’s ability to charge and retain a full charge is reduced. This reduced charging and charge-retention capability would be greater than the reduction that may result from normal operational degradation.

**Note 2:** These special conditions are not intended to replace § 25.1353(c) in the certification basis of the Cessna Model 680 airplane. These special conditions apply only to lithium-ion batteries and rechargeable lithium-battery-system installations. The requirements of § 25.1353(c) remain in effect for batteries and battery installations on the Cessna Model 680 airplane that do not use lithium-ion batteries.

Issued in Renton, Washington, on September 9, 2011.

*/s/Ali Bahrami*

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