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DEPARTMENT OF TRANSPORTATION

Federal Aviation Administration

14 CFR Part 25

[Docket No. NM352; Special Conditions No. 25-339-SC]

Special Conditions: Airbus Model A380-800 Airplane, Lithium Ion Battery Installation

AGENCY: Federal Aviation Administration (FAA), DOT.

ACTION: Final special conditions.

SUMMARY: These special conditions are issued for the Airbus A380-800 airplane. This airplane will have novel or unusual design features when compared to the state of technology envisioned in the airworthiness standards for transport category airplanes. The Airbus A380-800 will incorporate the use of high capacity lithium ion battery technology in on-board systems. For this design feature, the applicable airworthiness regulations do not contain adequate or appropriate safety standards regarding lithium ion batteries. 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.

DATES: *Effective Date:* The effective date of these special conditions is November 30, 2006.

FOR FURTHER INFORMATION CONTACT: Holly Thorson, FAA, International Branch, ANM-116, Transport Airplane Directorate, Aircraft Certification Service, 1601 Lind Avenue SW., Renton, Washington 98055-4056; telephone (425) 227-1357; facsimile (425) 227-1149.

SUPPLEMENTARY INFORMATION:

Background

Airbus applied for FAA certification/validation of the provisionally-designated Model A3XX-100 in its letter AI/L 810.0223/98, dated August 12, 1998, to the FAA. Application for certification by the Joint Aviation Authorities (JAA) of Europe had been made on January 16, 1998, reference AI/L 810.0019/98. In its letter to the FAA, Airbus requested an extension to the 5-year period for type certification in accordance with 14 CFR 21.17(c). The request was for an extension to a 7-year period, using the date of the initial application letter to the JAA as the reference date. The reason given by Airbus for the request for extension is related to the technical challenges, complexity, and the number of new and novel features on the airplane. On November 12, 1998, the Manager, Aircraft Engineering Division, AIR-100, granted Airbus' request for the 7-year period, based on the date of application to the JAA.

In its letter AI/LE-A 828.0040/99 Issue 3, dated July 20, 2001, Airbus stated that its target date for type certification of the Model A380-800 has been moved from May 2005, to January 2006, to match the delivery date of the first production airplane. In a subsequent letter (AI/L 810.0223/98 issue 3, January 27, 2006), Airbus stated that its target date for type certification is October 2, 2006. In accordance with 14 CFR 21.17(d)(2), Airbus chose a new application date of December 20, 1999, and requested that the 7-year certification period which had already been approved be continued. The FAA has reviewed the part 25 certification basis for the Model A380-800 airplane, and no changes are required based on the new application date.

The Model A380-800 airplane will be an all-new, four-engine jet transport airplane with a full double-deck, two-aisle cabin. The maximum takeoff weight will be 1.235 million pounds with a typical three-class layout of 555 passengers.

Type Certification Basis

Under the provisions of 14 CFR 21.17, Airbus must show that the Model A380-800 airplane meets the applicable provisions of 14 CFR part 25, as amended by Amendments 25-1 through 25-98. If the Administrator finds that the applicable airworthiness regulations

do not contain adequate or appropriate safety standards for the Airbus A380-800 airplane because of novel or unusual design features, special conditions are prescribed under the provisions of 14 CFR 21.16.

In addition to the applicable airworthiness regulations and special conditions, the Airbus Model A380-800 airplane must comply with the fuel vent and exhaust emission requirements of 14 CFR 34 and the noise certification requirements of 14 CFR part 36. In addition, the FAA must issue a finding of regulatory adequacy pursuant to section 611 of Public Law 93-574, the "Noise Control Act of 1972."

Special conditions, as defined in 14 CFR 11.19, are issued in accordance with 14 CFR 11.38 and become part of the type certification basis in accordance with 14 CFR 21.17(a)(2).

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 novel or unusual design feature, the special conditions would also apply to the other model under the provisions of 14 CFR 21.101.

Discussion of Novel or Unusual Design Features

Statement of Issue

The Airbus A380-800 airplane will use lithium ion batteries for its emergency lighting system. Large, high capacity, rechargeable lithium ion batteries are a novel or unusual design feature in transport category airplanes. This type of battery has certain failure, operational, and maintenance characteristics that differ significantly from those of the nickel-cadmium and lead-acid rechargeable batteries currently approved for installation on large transport category airplanes. The FAA is proposing this special condition to require that (1) All characteristics of the lithium ion battery and its installation that could affect safe operation of the Airbus A380-800 airplane are addressed, and (2) appropriate maintenance requirements are established to ensure the availability of electrical power from the batteries when needed.

Background

The current regulations governing installation of batteries in large

transport category airplanes were derived from Civil Air Regulations (CAR) Part 4b.625(d) as part of the recodification of CAR 4b that established 14 CFR Part 25 in February, 1965. The new battery requirements, 14 CFR 25.1353(c)(1) through (c)(4), basically reworded the CAR requirements.

Increased use of nickel-cadmium batteries in small airplanes resulted in increased incidents of battery fires and failures which led to additional rulemaking affecting large transport category airplanes as well as small airplanes. On September 1, 1977 and March 1, 1978, respectively the FAA issued 14 CFR 25.1353c(5) and c(6), governing nickel-cadmium battery installations on large transport category airplanes.

The proposed use of lithium ion batteries for the emergency lighting system on the Airbus A380 airplane has prompted the FAA to review the adequacy of these existing regulations. Our review indicates that the existing regulations do not adequately address several failure, operational, and maintenance characteristics of lithium ion batteries that could affect the safety and reliability of the Airbus A380's lithium ion battery installation.

At present, there is limited experience with use of rechargeable lithium ion batteries in applications involving commercial aviation. However, other users of this technology, ranging from wireless telephone manufacturers to the electric vehicle industry, have noted safety problems with lithium ion batteries. These problems include overcharging, over-discharging, and flammability of cell components.

1. Overcharging

In general, lithium ion 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. This is especially true for overcharging which causes heating and destabilization of the components of the cell, leading to the formation (by plating) of highly unstable metallic lithium. The metallic lithium can ignite, resulting in a self-sustaining fire or explosion. Finally, the severity of thermal runaway due to overcharging increases with increasing battery capacity due to the higher amount of electrolyte in large batteries.

2. Over-discharging

Discharge of some types of lithium ion batteries beyond a certain voltage (typically 2.4 volts) can cause corrosion of the electrodes of 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 crews as a means of checking battery status—a problem shared with nickel-cadmium batteries.

3. Flammability of Cell Components

Unlike nickel-cadmium and lead-acid batteries, some types of lithium ion batteries use liquid electrolytes that are flammable. The electrolyte can serve as a source of fuel for an external fire, if there is a breach of the battery container.

These problems experienced by users of lithium ion batteries raise concern about the use of these batteries in commercial aviation. The intent of the proposed special condition is to establish appropriate airworthiness standards for lithium ion battery installations in the Airbus A380–800 airplane and to ensure, as required by 14 CFR 25.601, that these battery installations are not hazardous or unreliable. To address these concerns, the proposed special conditions adopt the following requirements:

- Those sections of 14 CFR 25.1353 that are applicable to lithium ion batteries.
- The flammable fluid fire protection requirements of 14 CFR 25.863. In the past, this rule was not applied to batteries of transport category airplanes, since the electrolytes utilized in lead-acid and nickel-cadmium batteries are not flammable.
- New requirements to address the hazards of overcharging and over-discharging that are unique to lithium ion batteries.
- New maintenance requirements to ensure that batteries used as spares are maintained in an appropriate state of charge.

Discussion of Comments

Notice of Proposed Special Conditions No. 25–06–08–SC, pertaining to the lithium ion battery installation in the Airbus A380 airplane, was published in the **Federal Register** on September 7, 2006. Comments were received from Acme Electric Corporation and the Airline Pilots Association (ALPA). In addition, comments submitted to the European Aviation Safety Agency (EASA) by the Civil Aviation Authority of the United Kingdom were sent to the FAA by EASA.

Comments From Acme Electric Corporation

Requested change 1: The commenter suggests that “ * * * charging in environments of less than 0 °C [degrees Celsius] will need to be addressed; several references have stated that Lithium metal may plate onto the anode if charged in this environment.”

FAA response: Paragraph 1 of the special conditions addresses charging environment by requiring that “safe cell temperatures and pressures must be maintained during any foreseeable charging or discharging condition.” We consider charging in environments of less than 0 degrees C to be foreseeable. In our judgment, therefore, this concern is adequately addressed by the special conditions, as proposed.

Requested change 2: The commenter indicates that the special conditions should address the effects of a short circuit in the battery on the battery itself and on its surroundings.

FAA response: This issue is addressed in Paragraphs 1 and 6 of the special conditions. Paragraph 1 specifies that

Safe cell temperatures and pressures must be maintained during any foreseeable charging or discharging condition and during any failure of the charging or battery monitoring system not shown to be extremely remote. The lithium ion battery installation must preclude explosion in the event of those failures.

Paragraph 6 specifies that

Each lithium ion 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.

We consider short circuits in the battery to be a failure that is covered by these special conditions.

Requested change 3: The commenter also states that “At the present time, Lithium Ion batteries require non-passive electronics and/or software as an integral part of the assembly; therefore, additional requirements of 14 CFR 25.1309, 25.1316 and 25.1431 are also needed.”

FAA response: The requirements of § 25.1309, 25.1316, and 25.1431 do apply to the lithium ion battery installation. The special conditions specify additional requirements that are needed, but not already provided by the part 25 requirements in the A380 certification basis.

Comments From the Airline Pilots Association

The Airline Pilots Association (ALPA) conditionally supports the FAA's proposal for special conditions for

lithium ion batteries on the A380–800 aircraft, but “strongly maintains that there needs to be adequate protections and procedures in place to ensure that concerns regarding lithium ion batteries are fully addressed and protected against.” Appended to the ALPA comments was a copy of FAA report DOT/FAA/AR–06/38, September 2006, *Flammability Assessment of Bulk-Packed, Rechargeable Lithium-Ion Cells in Transport Category Aircraft*. With the knowledge of the safety hazards described in the appended report and by others, ALPA requested that the FAA consider the specific concerns discussed below.

Requested change 4: The commenter requests that Paragraph 3 of the special conditions be revised to ensure that the certification design of the A380 prevents explosive or toxic gasses emitted by a lithium ion battery from entering the cabin. The commenter also requests that the FAA assure that flight crew procedures and training are adequate to protect both passengers and crew, if explosive or toxic gasses do enter the cabin.

FAA response: The FAA has no regulations that prohibit smoke or gasses from electrical equipment in the electrical equipment bays from entering the flightdeck or passenger cabins. However, 14 CFR 25.857 prohibits hazardous quantities of smoke, flames, or extinguishing agents from cargo compartments from entering any compartment occupied by the crew or passengers.

Paragraph (3) of these special conditions specifies that

No explosive or toxic gasses emitted by any lithium ion battery in normal operation or as the result of any failure of the battery charging system, monitoring system, or battery installation—not shown to be extremely remote—may accumulate in hazardous quantities within the airplane.”

The special conditions require that any explosive or toxic gasses emitted by a lithium ion battery be limited to less than hazardous quantities anywhere on the airplane. (A separate set of special conditions pertaining to fire protection for the A380 requires a demonstration of means to prevent hazardous quantities of smoke originating from an electrical equipment bay from penetrating into the flightdeck or passenger cabins.)

Finally, FAA operational requirements ensure that all crewmembers receive adequate training in both normal and emergency equipment and procedures. Flight attendants are cognizant of cabin environmental conditions and are trained to report smoke or fumes in the cabin. Flightdeck crew are aware of

emergency procedures for responding to smoke, gasses, or fumes from known or unknown sources.

Requested change 5: The commenter states,

We are very concerned with a fire erupting in flight, and being able to rapidly extinguish it. The Special Conditions should require that there be a means provided to apply extinguishing agents by the flight (cabin) crew instead of promoting it as an option in managing the threat posed by the use of lithium-ion batteries. ALPA maintains that the petitioner must provide means for extinguishing fires that occur vs. listing it as an option in § 25.863.

FAA response: The FAA shares the commenter’s concern over a fire erupting in flight. We have concluded that providing a means for controlling or extinguishing a fire—such as stopping the flow of fluids, shutting down equipment, or fireproof containment, as described in paragraph (4) of 14 CFR 25.863—is an adequate alternative to requiring the flight or cabin crew to use extinguishing agents.

Requested change 6: The commenter suggests that the special conditions address means to ensure that the lithium ion batteries do not overheat or overcharge in the event of failure or malfunction of the automatic disconnect function, when a means of disconnecting the batteries from the charging source is not available.

FAA response: The FAA agrees that there should be a means to prevent overheating or overcharging of lithium ion batteries in the event of failure or malfunction of the automatic disconnect function, described in Paragraph (7). Paragraphs (1), (2), and (6) of these special conditions address the issue of failure modes of the lithium ion batteries.

Requested change 7: Finally, ALPA commented on monitoring and warning features that will indicate when the state-of-charge of the batteries has fallen below levels considered acceptable for dispatch of the airplane. The commenter suggested that the special conditions address the location of the warning indication; whether it is displayed to the captain, the crew, or both; and the training to be incorporated in the crew training programs.

FAA response: Flightdeck warning indicators associated with the state of charge of the lithium ion battery and appropriate training of the crew will be addressed during certification as part of the flight deck evaluation. As required by § 25.1309(c), this evaluation will ensure that the warning indication is effective and appropriate for the hazard.

Comments From the Civil Aviation Authority of the United Kingdom (UK CAA)

Requested change 8: In its comments to EASA, the UK CAA states that Paragraph 5 of the special conditions should be revised to read as follows:

No fluids or gasses that may escape from any Li-ion battery may be allowed to damage surrounding aeroplane structure, or any adjacent systems or equipment, including electrical wiring, in such a way as to hazard the aeroplane.

The UK CAA indicates that Paragraph 5, as proposed, specifies that no escaping corrosive fluids or gasses may damage aeroplane structures or adjacent essential equipment. The reasons for this are obvious, and the requirement is fully supported. However, it is noted that CS/JAR 25.1309 [EASA and Joint Aviation Authority regulation 25.1309] in its title makes a distinction between equipment and systems. Thus a requirement that specifies protection only for essential equipment could be misinterpreted as not applying to essential systems. For absolute clarity, this requirement should be extended to show that it applies to both essential equipment and essential systems.

Furthermore, corrosive fluids and gasses could also damage any non-essential electrical equipment or electrical wiring in such a way as to cause short circuits or arcing that could itself pose a hazard to the aeroplane. For completeness, this requirement should also seek to preclude damage to any adjacent electrical equipment or wiring whose failure could present a hazard to the airplane.

FAA Response: The wording of Paragraph (5) is identical to that of 14 CFR 25.1353(c)(4), applicable to all batteries. For clarity, we will revise the text to read as follows:

No corrosive fluids or gasses that may escape from any lithium ion 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, in accordance with 14 CFR 25.1309 (b) and applicable regulatory guidance.

Requested change 9: The UK CAA also commented to EASA that Paragraph 9 of the Special Conditions should be revised to read “The instructions for Continued Airworthiness, required by 14 CFR 25.1529, must contain maintenance requirements for * * *.”

FAA Response: The FAA concurs with this editorial comment and has revised the text of Paragraph 9 of the Special Conditions accordingly.

Applicability

As discussed above, these special conditions are applicable to the Airbus A380–800 airplane. Should Airbus apply at a later date for a change to the type certificate to include another model incorporating the same novel or unusual design features, these special conditions would apply to that model as well under the provisions of § 21.101.

Conclusion

This action affects only certain novel or unusual design features of the Airbus A380–800 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 issued as part of the type certification basis for the Airbus A380–800 airplane.

In lieu of the requirements of 14 CFR 25.1353(c)(1) through (c)(4), the following special conditions apply:

Lithium-ion batteries on the Airbus Model 380–800 airplane must be designed and installed as follows:

(1) Safe cell temperatures and pressures must be maintained during any foreseeable charging or discharging condition and during any failure of the charging or battery monitoring system not shown to be extremely remote. The lithium ion battery installation must preclude explosion in the event of those failures.

(2) Design of the lithium ion batteries must preclude the occurrence of self-sustaining, uncontrolled increases in temperature or pressure.

(3) No explosive or toxic gasses emitted by any lithium ion battery in normal operation or as the result of any failure of the battery charging system, monitoring system, or battery installation—not shown to be extremely remote—may accumulate in hazardous quantities within the airplane.

(4) Installations of lithium ion batteries must meet the requirements of 14 CFR 25.863(a) through (d).

(5) No corrosive fluids or gasses that may escape from any lithium ion 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, in accordance with 14

CFR 25.1309 (b) and applicable regulatory guidance.

(6) Each lithium ion 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 ion battery installations must have a system to control the charging rate of the battery automatically, so as to prevent battery overheating or overcharging, and,

(i) A battery temperature sensing and over-temperature warning system with a means for automatically disconnecting 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 for automatically disconnecting the battery from its charging source in the event of battery failure.

(8) Any lithium ion battery installation whose function 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 14 CFR 25.1529, must contain maintenance requirements for measurements of battery capacity at appropriate intervals to ensure that batteries whose function is required for safe operation of the airplane will perform their intended function as long as the battery is installed in the airplane. The Instructions for Continued Airworthiness must also contain procedures for the maintenance of lithium ion batteries in spares storage to prevent the replacement of batteries whose function is 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.

Note: These special conditions are not intended to replace 14 CFR 25.1353(c) in the certification basis of the Airbus A380–800 airplane. The special conditions apply only to lithium ion batteries and their installations. The requirements of 14 CFR 25.1353(c) remain in effect for batteries and battery installations of the Airbus A380–800 airplane that do not utilize lithium ion batteries.

Issued in Renton, Washington, on November 30, 2006.

Kevin Mullin,

Acting Manager, Transport Airplane Directorate, Aircraft Certification Service.

[FR Doc. E6–21188 Filed 12–12–06; 8:45 am]

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DEPARTMENT OF TRANSPORTATION

Federal Aviation Administration

14 CFR Part 25

[Docket No. NM313; Special Conditions No. 25–340–SC]

Special Conditions: Airbus Model A380–800 Airplane; Fire Protection

AGENCY: Federal Aviation Administration (FAA), DOT.

ACTION: Final special conditions.

SUMMARY: These special conditions are issued for the Airbus A380–800 airplane, which has novel and unusual design features, such as a full-length, double deck passenger cabin and electrical equipment bays distributed throughout the airplane. For these design features, the applicable airworthiness regulations do not contain adequate or appropriate safety standards regarding fire protection. 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. Additional special conditions will be issued for other novel or unusual design features of the Airbus Model A380–800 airplane.

DATES: *Effective Date:* The effective date of these special conditions is November 30, 2006.

FOR FURTHER INFORMATION CONTACT: Holly Thorson, FAA, International Branch, ANM–116, Transport Airplane Directorate, Aircraft Certification Service, 1601 Lind Avenue, SW., Renton, Washington 98055–4056; telephone (425) 227–1357; facsimile (425) 227–1149.

SUPPLEMENTARY INFORMATION:

Background

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