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Airworthiness Certification of Light Ejection Escape Equipment

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Abstract

The effective regulations or standards haven’t provided enough safety requirements for unusual design features of light ejection escape equipment installed on acrobatic aircraft. In this article, this certification problem was discussed. First the design features of normal ejection escape equipment are discussed, and then applicability of effective regulations or standards which could be used to certificate this equipment is studied. According to all these work, the reasonable certification method is put forward at last. And at the same time, the important issues that should be focused on during certification process are listed.

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1. General

In order to escape from cockpit successfully during high speed flying, sometimes the light ejection escape equipment was installed on civil acrobatic aircraft by aircraft manufacture. Generally, this kind of equipments is installed on military aircraft, and seldom installed on civil aircraft. Current civil aviation regulation and TSO could not provide enough technical requirements for this unusual design. Especially for some subsystem of this equipment, for example, initiation subsystem, propulsion subsystem, interseat sequencing subsystem and parachute subsystem. As to this situation and according to CCAR 21 R3³, it is

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necessary to establish a Special Condition for the light ejection escape equipment, and define safety technical requirements. And the special condition will be part of TC certification basis.

2. Features of light ejection escape equipment

Compare to normal pilot seat, the light ejection escape equipment has some new subsystems, such as initiation subsystem, propulsion system, canopy release or break subsystem, parachute subsystem etc. For two-pilot configuration, it needs interseat sequencing subsystem.

In emergency, the pilot will be ejected or dragged out from cockpit by propulsion subsystem through prepared track, and back to the ground by parachute safely.

1). Being added initiation subsystem, propulsion subsystem, interseat sequencing subsystem, and parachute etc, the ejection escape equipment becomes more complicated, and needs a higher reliability.

2). It should be available for the aircraft’s whole flight envelop, for example, the crewmember should be able to evacuate from cockpit at speed between \( V_{SO} \) and \( V_{D} \) for acrobatic aircraft. If ELOS was adapted for complying with CCAR 23.562 “Emergency landing dynamic condition” the escape equipment should have the capability of safety ejection at 0 height and 0 speed.

3). If the canopy could not be released before ejected, the escape equipment should have the capability of breaking the canopy, in the meanwhile, provide proper measures to protect crew from hurt seriously.

4). In order to give crew reliable restraint during high maneuver, ejection and parachute landing, the escape system always takes an abnormal restrain configuration.

3. Certification of ejection escape equipment

3.1. Applicable Civil Aviation Regulation and Standard

Now, the effective regulation and standard which may be used to certificate light ejection escape equipment is listed as follow:

1) CCAR 23. CCAR 23 is the certification basis of acrobatic aircraft. The main requirements of CCAR 23 for general aviation seat are § 23.561 General, § 23.562 “Emergency landing dynamic conditions”, § 23.807 “Emergency exits” and § 23.785 “Seats, berths, litters, safety belts, and shoulder harnesses”. For the special features such as propulsion, canopy breaking, crewmember protection, parachute landing, and interseat sequencing, there are no available requirements.

2) AC 23-19A. According to this AC § § 23.562, FAA made a policy explanation about ejection seat certification. It was clarified that the applicable sections of the Air Force Systems Requirement Document can be used as the minimum safety standard. FAA only approves the ejection seat data, after the air Force has reviewed the data and concurs that the ejection seat satisfies the SRD crew escape, testing, and evaluation requirements. So we can certificate this equipment refer to the experience of FAA.

3) Military standard. An available military standard used by US NAVY for ejection seat, is MIL-S-18471G “System, Aircrew Automated Escape, Ejection Seat Type: General Specification For”. And the military standard of China air force for ejection seat is GJB 1800A-2007 “General specification for ejection seat type of aircrew emergency escape system”.

These two military standards established requirements for design, installation, demonstration, performance, and testing of an open type ejection seat, and have been used as the design requirements of the ejection escape system for the US navy and China air force for many years. They put forward safety requirements for the ejection escape system performance, ejection seat assembly, the aircraft
canopy and escape path clearance subsystem, the sequencing subsystem, parachute system, aircraft interface and the aircrew member interface.

3.2. Special Condition for light ejection escaping system

CCAR 23 was the certification basis, and will be the certification basis of the ejection escape system. But, for those unusual features of light ejection escape system, it has not adequate safety requirements. Base on this situation, follow CCAR21 R3 and AP-21-AA-2011-03-R⁴, it needs to establish an airworthiness special condition related with those unusual features.

GJB 1800A-2007 and MIL-S-1847G were used as the specification for the seat type ejection escape system by military. So these two military standards can be used as a reference to establish airworthiness special condition for the light ejection escape equipment.

Safety requirements should be included in Airworthiness Special Condition as follow:

• 1) The safety requirements for manufacture, manipulating and operating of ejection escape system, besides requirements for material, indicator, mark, safety factor and emergency landing loads, which have already been required in CCAR 23.

• 2) Performance and strength requirements, such as the whole operation envelop, load requirements for structure and crewmember during the whole working process.

• 3) Safety requirements for special structure or system, for example, requirements for propulsion subsystem, interseat sequencing subsystem, path clearance subsystem, restrain subsystem, and parachute subsystem.

3.3. Compliance substantiation of light ejection escaping system

When certificate the light ejection system, the certification basis can be established as CCAR 23, special condition and applicable ELOS. Then, certification plan for this system can be established according to certification basis. And with MOC 1 “Design review”, MOC 2 “Calculation/analysis”, MOC 3 “Safety assessment”, MOC 4 “Laboratory test”, MOC 7 “Design inspection” and MOC 8 “Simulation” to substantiate that the design of the light ejection escape equipment comply with certification basis.

4. Important issues during certification

1) The initiation method of ejection escape equipment should be simple. And there should be a means to safeguard the system against inadvertent fire during normal flight or ground maintenance.

2) The structure, performance and reliability should comply with the requirements of certification basis, and the compliance should be verified sufficiently.

3) There should be a method to provide sufficient protection for crewmember from serious hurt in ejection path, and this ability must be verified by laboratory test and evaluation.

5. Conclusion

For the certification of light ejection escape system installed on the acrobatic aircraft, we can refer the military standards to establish a special condition as part of certification basis, and put forward adequate safety requirements. And applicants should select applicable compliance method according to the certificate basis, to demonstrate that the design of light ejection escape equipment comply with the requirements of certification basis.
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