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Standard Specification for Aircraft Emergency Parachute Recovery Systems[1]

This standard is issued under the fixed designation F3408/F3408M; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This specification covers minimum requirements for the design of emergency parachute recovery systems for aircraft. Airframe emergency parachute systems addressed in this specification refer to parachute systems designed, manufactured, and installed to recover the airframe and its occupants at a survivable rate of descent. This specification is not applicable to deepstall parachutes, spin recovery parachutes, drogue parachutes, or other airframe emergency aerodynamic decelerators not specifically intended for safely lowering the airframe and occupants to the ground. The specification is applicable to these types of parachutes if they are an integral part of an airframe emergency parachute system designed to recover the airframe and occupants at a survivable rate of descent. The material was developed through open consensus of international experts in general aviation. This information was created by focusing on Level 1, 2, 3, and 4 Normal Category aeroplanes. The content may be more broadly applicable; it is the responsibility of the Applicant to substantiate broader applicability as a specific means of compliance. The topics covered within this document are: strength requirements, parachute test method, activation system, deployment system, parachute attachment to the airframe, occupant protection, and system verification.

1.2 An applicant intending to propose this information as Means of Compliance for a design approval must seek guidance from their respective oversight authority (for example, published guidance from applicable CAAs) concerning the acceptable use and application thereof. For information on which oversight authorities have accepted this specification (in whole or in part) as an acceptable Means of Compliance to their regulatory requirements (hereinafter the Rules), refer to the ASTM Committee F44 web page (www.astm.org/COMMITTEE/F44.htm). Annex A1 maps the Means of Compliance of this ASTM specification to EASA CS-23, amendment 5, or later, and FAA 14 CFR Part 23, amendment 64, or later, rules applicable to the Aircraft Emergency Parachute Recovery Systems installation.

1.3 Airframe emergency parachute recovery systems have become an acceptable means of greatly reducing the likelihood of serious injury or death in an in-flight emergency. Even though they have saved hundreds of lives in many different types of conditions, inherent danger of failure, even if properly designed remains due to the countless permutations of random variables (attitude, altitude, accelerations, airspeed, weight, geographic location, etc.) that may exist at time of usage. The combination of these variables may negatively influence the lifesaving function of these airframe emergency parachute systems. They are designed to be a safety device and to be used at the discretion of the pilot when deemed to provide the best chance of survivability.

1.4 *Units*—This document may present information in either SI units, English Engineering units, or both; the values stated in each system are not necessarily exact equivalents; therefore, to ensure conformance with the standard, each system shall be used independently of the other, and values from the two systems shall not be combined.

1.5 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

[1] This specification is under the jurisdiction of ASTM Committee F44 on General Aviation Aircraft and is the direct responsibility of Subcommittee F44.30 on Structures.

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1.6 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

F3060 Terminology for Aircraft

F3083/F3083M Specification for Emergency Conditions, Occupant Safety and Accommodations

F3114 Specification for Structures

2.2 *Other Standards:*

FAA ~~PART~~ 14 CFR Part 23-Amdt 64 A Performance-Based Approach to Type Certification of Small Airplanes[3]

EASA CS-23 / Amendment 5 Certification Specifications for Normal-Category Aeroplanes[4]

3. Terminology

3.1 *Definitions of Terms Specific to This Standard:*

3.1.1 *activation system, n*—the system to mechanically or electrically activate the extraction/ejection device.

3.1.2 *aircraft attachment harness, n*—interface between the parachute riser(s) and the airframe structural attachment.

3.1.3 *deployment device, n*—may include a deployment bag, or sleeve, or any device to contain the packed parachute and stage its deployment in an orderly sequence.

3.1.4 *deployment system, n*—includes the extraction/ejection device, deployment device and any other components that assist in the parachute deployment.

3.1.5 *drop test, n*—a structural test of a parachute assembly using an unmanned test vehicle released from a test aircraft in flight.

3.1.6 *extraction/ejection device, n*—may include rocket motor, mortar, explosive projectile, spring, or other stored energy device.

3.1.7 *line stretch, n*—when all components of the parachute assembly are pulled taut prior to inflation.

3.1.8 *parachute assembly, n*—includes the canopy, or reinforced fabric portion, suspension lines, riser(s), connector links, and reefing systems or devices.

3.1.9 *parachute container, n*—structure to house and protect the packed parachute assembly, extraction/ejection device and related components.

3.1.10 *parachute deployment, n*—process of parachute system activation, extraction/ejection, inflation, and descent.

3.1.11 *parachute system, n*—includes the parachute assembly, extraction/ejection device, activation system, deployment device, aircraft attachment harness, parachute container and other supporting components.

4. Significance and Use

4.1 This specification provides one means for substantiating the design of an Airplane Emergency Parachute Recovery System. This specification satisfies the structural and system requirements for Normal Category Aeroplanes. ~~Table 1~~Annex A1 correlates the paragraphs of this specification with FAA ~~and EASA~~ 14 CFR Part 23, amendment 64, or later, and EASA CS-23, amendment 5, or later, rules.

[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standards Document Summary page on the ASTM website.

[3] Available from Federal Aviation Administration (FAA), 800 Independence Ave., SW, Washington, DC 20591, http://www.faa.gov.

[4] Available from European Union Aviation Safety Agency (EASA), KonradAdenauer-Ufer 3, D-50668 Cologne, Germany, https://www.easa.europa.eu.

5. Parachute System Performance Requirements

5.1 The system shall not adversely affect aircraft performance during normal operations.

5.2 The deployment system shall extract/eject the parachute assembly to full line stretch without obstructions.

5.3 The parachute assembly, parachute attachment harnesses, parachute airframe attachment structure and all related components shall sustain design ultimate load conditions throughout deployment and descent.

5.4 The parachute deployment shall not result in aircraft dynamics that could seriously injure the occupants when properly restrained.

5.5 The design rate of descent shall provide touchdown and post-touchdown conditions that protect the occupants from serious injury.

5.6 All components of the parachute recovery system shall be protected against deterioration or loss of strength in service because of normal operations, weathering, corrosion, abrasion, temperature, vibration, and aging.

5.7 The system shall be evaluated for operations in temperature conditions of –40 °C to 60 °C [–40 °F to 140 °F] as a minimum.

5.8 The installation design and location of the extraction/ejection device shall consider fire hazards associated with the activation of the parachute system and reduce this fire hazard potential without compromising system function.

5.9 Adequate provisions shall be made to prevent contamination of the system compartments and associated structure to ensure the sound condition of the system.

5.10 The hardware used to install the parachute system shall not become loosened or detached because of normal operations.

5.11 The system shall be configured to prevent potential debris from the aircraft from interacting with the parachute during deployment.

5.12 Materials and workmanship and fabrication methods shall comply with requirements of Specification F3114.

6. Parachute System Design Requirements

6.1 *Strength Requirements:*

6.1.1 Strength requirements shall comply with requirements of Specification F3114, and 6.2, Parachute Test Method, of this specification.

6.1.2 Unless otherwise provided, an ultimate load factor of safety shall comply with requirements of Specification F3114.

6.1.3 System evaluation shall be by analysis or testing, or both, and comply with requirements of Specification F3114.

6.2 *Parachute Test Method*—A minimum of three successful drop tests of the parachute assembly shall be conducted under ultimate load conditions to demonstrate the parachute's strength. A new parachute assembly shall be used for each test. The weight of the parachute assembly is included in the test weight. Data shall be acquired for each test and shall include recordings of inflation loads, altitude and rate of descent as a function of time.

6.2.1 For a successful drop test the parachute system shall be able to support the ultimate loads demonstrated during the drop test. No deformations or damage may occur that prevent the system from functioning as intended. The parachute shall maintain a descent rate at or below its designed rate of descent for a given weight and altitude. If there is any failure or anomaly of a specific parachute design, that design shall be re-evaluated.

6.2.2 *Parachute Strength Test Method*—The following test parameters shall be applied to drop tests for parachute strength substantiation. The drop test vehicle does not have to be an actual airframe. A minimum ultimate load safety factor of 1.5 as a function of kinetic energy is achieved by conducting the parachute strength test as follows:

Min. Test Weight = 1.15 × Aircraft Maximum Gross Takeoff Weight
Min. Test Speed = 1.15 × Aircraft Maximum Intended Parachute Deployment Speed (Vpd)
Safety Factor = (Weight SF[A]) × (Speed SF[A])^2 = (1.15) × (1.15)^2 = 1.52 (This meets the minimum 1.5 safety factor)

[A] Note that other combinations of weight and speed safety factors may be selected provided the minimum combined kinetic energy safety factor of 1.5 is demonstrated.

6.2.3 *Ultimate Parachute Opening Loads*—The maximum parachute opening force measured in the three tests will be the ultimate parachute opening load to be used in structural tests and analysis of the airframe, and the attachment harnesses and hardware.

6.2.4 *Rate of Descent*—Rate of descent data shall be corrected for the variation in test vehicle weight to determine the rate of descent at the gross weight of the specific aircraft. Descent rate data shall be corrected to 1500 m [5000 ft] density altitude and standard temperature.

6.3 *Activation System*—The recovery system shall be designed for activation by the pilot/copilot without difficulty by a 10th percentile female to a 90th percentile male. The installation of the activation system in the airframe shall comply with the following conditions:

6.3.1 The routing of the activation system shall not create friction points or other interruptions that may prevent the occupant from activating the system.

6.3.2 The activating system shall be secured along its path such that it will not change during the normal operating life of the parachute system.

6.3.3 If dual activating handles are used, they shall be of a design that allows activation with one handle, even if the other handle is inoperable.

6.3.4 It shall be shown that activating the system can only be accomplished in a manner that makes inadvertent deployment extremely improbable.

6.3.5 Some means to safety the activation system shall be implemented when the aircraft is not in service.

6.4 *Deployment System*—The deployment system shall be demonstrated by test, or analysis supported by test, to comply with the following conditions:

6.4.1 If a parachute container cover is used to protect the parachute system, it shall be removed without damaging the parachute or restricting its path upon egress.

6.4.2 While it is recognized that the aircraft configuration and attitude is unpredictable in an emergency, the system shall be designed to allow the parachute to clear any potential obstacles on the airframe upon deployment.

6.4.3 The deployment loads shall not damage the airframe structure in a manner that would obstruct deployment.

6.4.4 The deployment system shall be designed to stage the deployment sequence in an orderly manner to reduce the chances of entanglements or similar malfunctions.

6.5 *Parachute Attachment to the Airframe*—The parachute assembly shall be attached to the primary structure of the airframe with an airframe attachment harness that may be composed of a single harness section or a series of harness sections. The parachute attachment to the airframe shall comply with the following conditions:

6.5.1 Structural substantiation shall be conducted by test or analysis supported by test.

6.5.2 Parachute deployments induce unique load distributions to the airframe, largely due to geometric locations of the harness

attachment points. The airframe attachment points and airframe attachment harness shall support the ultimate parachute inflation load measured in the parachute strength test described in 6.2.3. No deformations or damage may occur that prevents the system from functioning as intended. In addition, a survivable volume shall be maintained.

6.5.3 The harness system and attach points shall be configured in a manner that presents the aircraft in a descent and touchdown attitude that maximizes the ability of the airframe structure to absorb the anticipated landing loads and minimizes the probability of serious injury to the occupants.

6.5.4 The airframe attachment harness shall be routed from the installed parachute to the airframe attachment points and secured in a manner that will prevent it from impacting normal flight operations.

6.5.5 It shall also be shown that all harnesses will be sufficiently stripped free after activation of the parachute system with less than 1 G of combined force to ensure adequate functioning of the system.

6.5.6 The airframe attachment harness design shall minimize the potential for conflict with the propeller or engine. If conflict with the propeller or engine is unavoidable by installation design or operator instructions such as shutting down the engine, the airframe attachment harness shall be manufactured from materials that yield a reasonable likelihood of surviving a conflict.

6.6 *Occupant Protection*—It shall be demonstrated by test, or analysis supported by test, that parachute deployment and parachute landing will not result in serious injury to the occupants when properly restrained. Appendix X1 provides accepted injury criteria for emergency conditions.

6.6.1 *Occupant Restraint*—Each seat in an airframe with the emergency parachute system shall be equipped with a restraint system that will adequately protect the occupants from head and upper torso injuries during parachute deployment and touchdown.

6.6.2 *Deployment Conditions*—The occupants shall be protected from serious injury during the parachute deployment.

6.6.3 *Touchdown Conditions*—The occupants shall be protected from serious injury during touchdown when subjected to the inertial loads of a parachute landing at the design rate of descent (from 6.2.4) onto a hard surface, such as pavement or soil.

6.6.4 *Post-Touchdown Condition*—Compliance with the following requirements shall be shown for occupant protection in a post touchdown environment, including roll-over.

6.6.4.1 It shall be shown that the occupants will be protected from serious injury after touchdown under various adverse weather conditions, including 15 knot winds.

6.6.4.2 Procedures for emergency egress shall comply with Specification F3083/F3083M. If required, emergency egress equipment shall be provided.

6.7 *System Verification*—The system shall be shown, by in-flight test or analysis supported by test, to satisfactorily perform its intended function, within the specified operational envelope, without exceeding the parachute extraction and deployment design loads.

7. Inspection and Maintenance

7.1 Instructions for continued airworthiness shall be provided for the parachute system. This document shall define life limited components and state the service cycles for relevant components of the system, including but not limited to:

7.1.1 Parachute canopy inspection, repacking and replacement intervals;

7.1.2 Extraction device inspection and refueling or replacement;

7.1.3 Field maintenance checks; and

7.1.4 Any other maintenance instructions.

7.2 Maintenance instructions shall demand the parachute system to be marked “Inoperative” in case instructions for continued airworthiness are not followed.

NOTE 1—An inoperative parachute system may result in the aircraft not being airworthy. This depends on the definition of (required) minimum equipment for the individual aircraft and shall be considered on aircraft level and highlighted in the applicable aircraft level documentation or manuals, or both. This does not affect the parachute documentation.

7.3 Adequate means shall be provided to permit examination of the parachute system in accordance with the Instructions for Continued Airworthiness.

8. Operating Limitations

8.1 Activation procedures and operating limitations shall be prescribed to ensure proper operation of the parachute system. Such information shall be placarded at the system activation point and listed in the Airplane Flight Manual (AFM).

9. Product Marking

9.1 Appendix X2 provides guidance on parachute system markings.

9.2 *Labels*—The parachute or airframe manufacturer shall supply conspicuous placards or labels for placement in unobstructed view to anyone near the egress point (exterior). These placards are to be displayed such that they provide a visual warning to rescue or other personnel at the scene of an accident or incident.

9.2.1 *Installation and Size of Placard or Label*—The airframe manufacturer shall permanently install the warning placards or labels in a manner defined by this specification and documented in the AFM.

9.2.2 *Label Size and Color*—All placards or labels shall follow the coloration methods described below. The three sizes of placards or labels will address different locations for installation.

9.2.2.1 *Danger Placard*—Danger placards or labels shall be printed with a red border with white (or reverse type) letters with a descriptive graphic element.

(1) Danger Placard for Interior Parachute Installation—A 7.62 cm [3 in.] minimum height triangular placard or label with the word Danger (see sample placard Fig. 1) shall be placed adjacent to the parachute egress point for enclosed aircraft where the parachute system may not be visible from the exterior.

(2) Danger Placard for Exterior Parachute Installation—A 5.08 cm [2 in.] minimum height triangular placard or label (see sample label Fig. 1; label shall be resized to fit the size as per this requirement) shall be applied directly on any ballistic extraction device on aircraft that do not have the parachute system inside the aircraft enclosure and that therefore should be visible from the exterior. This placard or label will warn rescue personnel in the event the ballistic device may become separated from the aircraft due to high G forces at impact.

NOTE 2—Not all ballistically deployed emergency parachutes egress the upper surface of an aircraft. Some systems egress the side or underside of the aircraft.

(3) Danger Placard Text Explanation—An explanatory box shall be printed next to the Danger placard or label.

(4) The danger explanatory box shall describe the type of ballistic deployment device and provide contact information for rescue personnel to seek help from the manufacturer of the ballistic device.

9.2.2.2 *Identifying Placard*—A label shall be attached to the body of the extraction/ejection device (for example, the rocket body or mortar housing) so first responders and safety investigators can identify the device should it become separated from the aircraft (discharged or live). This placard shall have contact information as well as graphic images (sample placard is shown in Fig. 2).

9.2.2.3 *Warning Placard*—A 2.54 cm [1 in.] minimum height triangular placard or label (sample placard is shown in Fig. 3) shall be applied to the aircraft adjacent to the door(s) or place(s) where the occupant(s) enter the aircraft or where rescue personnel can readily see it. Warning placards or labels shall be printed with a black border with orange letters surrounding an orange center with a descriptive graphic element.

(1) Warning Text Explanation—An explanatory box shall be printed next to the Warning placard or label.

9.2.3 External placards or labels shall be printed, employing a reflective background material for enhanced visibility in low light or obscured conditions.

9.3 All producers of ballistically deployed rescue systems shall provide on their website or by printed goods made available as

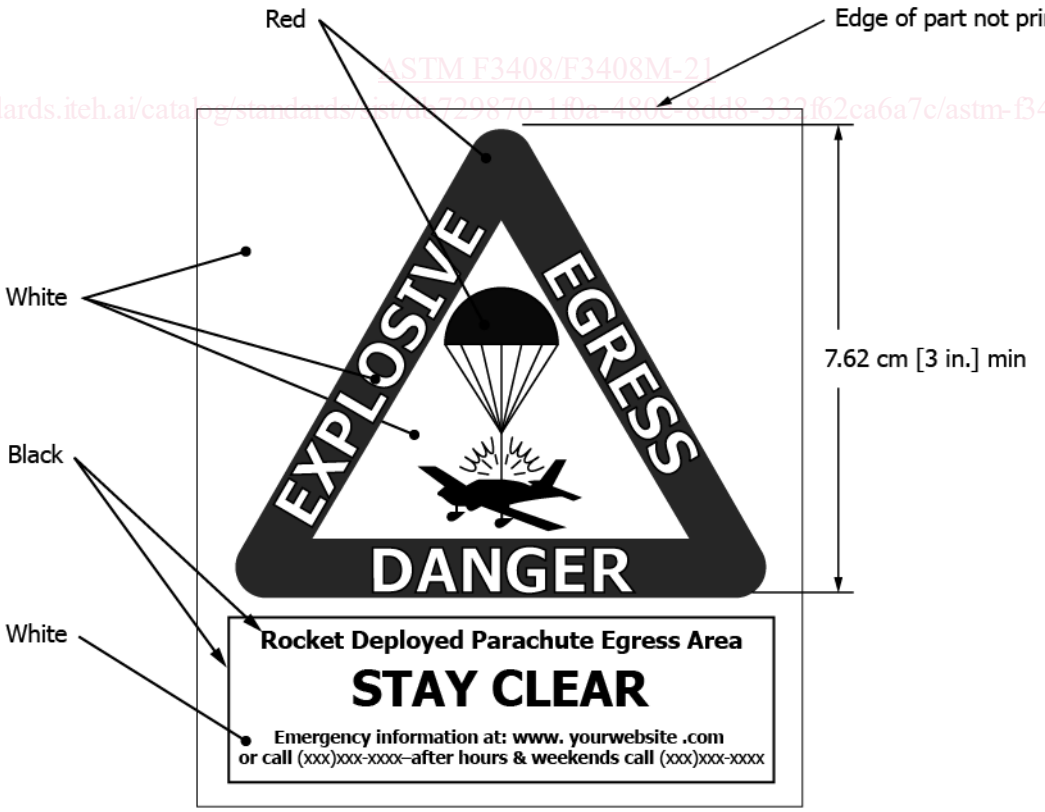

FIG. 1 Sample Danger Label