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## ~~Standard Specification for Airframe Emergency Parachutes for Light Sport Aircraft~~ Airframe Emergency Parachutes<sup>1</sup>

This standard is issued under the fixed designation F2316; 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 ( $\epsilon$ ) indicates an editorial change since the last revision or reapproval.

### 1. Scope

~~1.1 This specification covers minimum requirements for the design, manufacture, and installation of parachutes for light sport aircraft.~~

~~1.1 This specification covers minimum requirements for the design, manufacture, and installation of parachutes for airframes. Airframe emergency parachutes addressed in this standard refer to parachute systems designed, manufactured, and installed to recover the airframe and its occupants at a survivable rate of descent. This standard is not applicable to deep-stall 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 standard 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.~~

~~1.2 The values stated in SI units are to be regarded as standard. There may be values given in parentheses that are mathematical conversions to inch-pound units. Values in parentheses are provided for information only and are not considered standard.~~

~~1.2.1 Note that within the aviation community mixed units are appropriate in accordance with International Civil Aviation Organization (ICAO) agreements. While the values stated in SI units are regarded as standard, certain values such as airspeeds in knots and altitude in feet are also accepted as standard.~~

~~1.3~~

~~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, manufactured and installed, 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 life saving function of these airframe emergency parachute systems. They are designed to be a supplemental safety device and to be used at the discretion of the pilot when deemed to provide the best chance of survivability.~~

~~1.4 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 and health practices and determine the applicability of regulatory requirements prior to use.~~

### 2. Referenced Documents

~~2.1 FAA Document:~~

~~FAA Special Conditions 23-ACE-76(Docket No. 118C), Ballistic Recovery Systems, Modified for Small General Aviation Aircraft~~

~~2.1 There are currently no referenced documents in this specification.~~

### 3. Terminology

~~3.1 Definitions of Terms Specific to This Standard:~~

~~3.1.1 armed or arming ballistic device,  $v$ —the next action activates the system.~~

~~3.1.1.1 Discussion—Armed or arming is not simply removing a safety pin.  $n$ —may include rocket motor, mortar, explosive projectile, spring, or other stored energy device.~~

~~3.1.2 completely opened parachute,  $n$ —the parachute has reached its maximum design dimensions for the first time.~~

~~3.1.3 parachute deployment,  $n$ —process of parachute activation and inflation.~~

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#### 4. Materials and Manufacture

4.1 *Materials*—Materials used for parts and assemblies, the failure of which could adversely affect safety, must meet the following conditions:

4.1.1 The suitability and durability must be established by experience or tests.

4.1.2 The strength and other properties assumed in the design data must meet approved specifications.

4.1.1 Materials shall be suitable and durable for the intended use.

4.1.2 Design values (strength) must be chosen so that no structural part is under strength as a result of material variations or load concentration, or both.

4.1.3 The effects of environmental conditions, such as temperature and humidity, expected in service must be taken into account.

#### 5. Parachute Model Designations

~~5.1 *Parachute System Parts List*—A parts list is required for each parachute system for each airframe model in accordance with this specification:~~

~~5.2 *New Parachute Model Designations*—Each new parachute system model must be qualified in accordance with this specification:~~

~~5.3 *Design Changes*—Design or configuration changes that impact the parachute installation, performance, or operability require a new parachute model designation. Each design change of a part or component of a parachute system qualified by this specification must be evaluated relative to the requirements of this specification.~~

~~5.4 *Installation Design Changes*—Any airframe manufacturer, builder, or owner changing the design of their aircraft under this specification shall, as soon as possible, inform the parachute manufacturer about changes that may affect the mounting, attaching, deployment, egress, or specifications of the parachute system. Reserved~~

~~5.1 This section is being used as a placeholder to maintain the previous section numbers.~~

#### 6. Parachute System Design Requirements

6.1 *Strength Requirements:*

6.1.1 ~~Strength requirements are specified in terms of limit loads (the maximum loads to be expected in service) and ultimate loads (loads that are experienced while performing parachute strength tests according to 6.2.1 to gain a safety factor (ultimate load factor) of 1.5). Compliance with strength requirements for components other than the parachute assembly may be demonstrated by analysis or testing.~~

6.1.1 Strength requirements are specified in terms of limit loads (the maximum loads to be expected in service) and ultimate loads (limit loads multiplied by a prescribed factor of safety).

6.1.1.1 Unless otherwise provided, prescribed loads are limit loads.

6.1.1.2 Unless otherwise provided, an ultimate load factor of safety of 1.5 must be used.

6.1.2 System evaluation by analysis must use an accepted computational method that has been verified through testing. In other cases, load testing must be conducted.

6.1.3 System evaluation by testing must be supported with instrument calibration verified by an applicable weights and measures regulatory body, for example, state and federal governments.

6.2 *System Design*—The following minimum performance standards for the basic parachute system shall be met.

6.2.1 *Parachute Strength Test*—~~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 may be used for each test. Data acquisition shall include recordings of inflation loads as a function of time. A test under ultimate load condition is meant to achieve a safety factor (ultimate load factor) of 1.5 by applying the Energy Method represented by  $E = \frac{1}{2}mv^2$ . Based on the assumption that the parachute opening force correlates to the kinetic energy present, the ultimate load factor of 1.5 is achieved by: (1) increasing the limit load test mass by 1.25 and (2) increasing the limit load test speed by 1.1. Therefore, the Ultimate Load Factor =  $(1.25) \times (1.1)^2 = 1.5$  and a parachute strength test under ultimate load conditions shall be conducted as follows:~~

$$\text{Min. Test weight} = 1.25 \times \text{Aircraft Gross Takeoff Weight}$$

$$\text{Min. Test Speed} = 1.1 \times \text{Aircraft's Maximum Intended Parachute Deployment Speed}$$

~~—A minimum of three successful drop tests of the parachute assembly shall be conducted under ultimate load conditions to demonstrate the parachute's strength. The maximum parachute opening force measured in the three tests will be the ultimate parachute opening load. A new parachute assembly may be used for each test. The weight of the parachute assembly is included in the test weight. Data acquisition shall be performed for each test and shall include recordings of inflation loads as a function of time.~~

6.2.1.1 For a successful drop test the parachute system must be able to support the ultimate loads demonstrated during the drop test. No detrimental permanent deformations or damages may occur that prevent the system from serving its purpose. The parachute shall:

(1) Maintain a descent rate at or below its designed rate of descent for a given weight and altitude.

(2) Have completely opened within its designed parameter of time.

6.2.1.2 An ultimate load factor of safety of 1.5 is achieved by conducting the parachute strength test as follows:

(1) *Parachute Strength Test with Aircraft in Flight*—If the parachute is strength tested while attached to an aircraft in flight, the following test parameters shall be applied:

Min. Test weight = 1.25 × Aircraft Maximum Gross Takeoff Weight

Min. Test Speed = 1.1 × Aircraft's Maximum Intended Parachute Deployment Speed

NOTE 1—In this test variant, the factor of safety is considered applicable to the energy of the aircraft. However, it is not permissible to scale test results by using an energy equation approach.

(2) Parachute Strength Test with “Dead Weight” Payload—If the parachute is strength tested while attached to a “dead” weight (dense mass—sand, metal chains, water, etc. and limited volume), the following test parameters shall be applied:

Min. Test weight = Aircraft Maximum Gross Takeoff Weight

Min. Test Speed = Aircraft's Maximum Intended Parachute Deployment Speed

NOTE 2—This test method is by nature conservative, as a dead weight does not show any pitching or rotation tendency that absorbs energy during the parachute opening thrust, as a real aircraft always does. Therefore, test with maximum weight and speed results in ultimate loads.

6.2.2 Rate of Descent—Rate of descent data shall be recorded for all tests in 6.2.1. This data may be corrected for the increase/variation in test vehicle weight to determine the rate of descent at the gross weight of the specific aircraft. Descent rate data from parachute canopies shall be corrected to 1500-m (5000-ft) density altitude and standard temperature. Aircraft manufacturer and parachute manufacturer shall coordinate that serious injury to occupants is unlikely while landing under parachute.

6.2.3 Component Strength Test—All critical components (such as bridles, lanyards, harnesses, activation cables, and so forth) shall be designed to meet the ultimate load factor defined in 6.1.

6.2.4 Staged Deployment—The parachute assembly shall be designed to stage the deployment sequence in an orderly manner to reduce the chances of entanglements or similar malfunctions.

6.2.5

6.2.4 Environmental Conditions—The system must be evaluated for operations in temperature conditions of –40 to 48.9°C (–40 to 120°F).

6.3 Installation Design—Each manufacturer of an emergency parachute system shall provide a specific Parachute Installation Manual (PIM) for the installation into each pertaining aircraft with the documentation described in S2. The PIM shall be used for all installations with parties referenced in 6.3.1.

6.3.1—A specific Parachute Installation Manual (PIM) for the installation of a particular parachute system into each aircraft model must be created. The PIM must provide sufficient information to ensure correct installation of the parachute system to the specific airframe.

6.3.1 Coordination—Airframe and parachute manufacturers must coordinate and agree to ensure proper installation. Airframe manufacturers of light sport aircraft—special (fully built) must not alter the installation without consulting the parachute system manufacturer. For light sport aircraft—experimental (kit built), the parachute manufacturer shall work with a new original equipment manufacturer, the aircraft builder, or the aircraft owner to create a proper installation design.—Airframe and parachute manufacturers must coordinate and jointly approve the PIM for correctness. Design or configuration changes that impact the parachute installation, performance, or operability require re-evaluation relative to the requirements of this specification. Both airframe and parachute manufacturer shall coordinate these anticipated changes before implementation. These changes shall be documented in a revised PIM.

6.3.2 Weight and Balance—The installation of the parachute system must not adversely affect the center of gravity of the subject aircraft.—The installation of the parachute system must be accounted for in the design data of weight and balance limits of the airframe.

6.3.3 System Mounting—The hardware used to install the parachute system shall not become loosened or detached as a result of normal wear and tear.

6.3.4 Extraction Performance—It—Airframe and parachute manufacturers must be shown coordinate and show that the extraction device will cleanly penetrate any covering or remove the parachute system's cover, if any, and extract the parachute assembly to full suspension line stretch without inhibiting or damaging (lines that connect the parachute upon egress. Airframe and parachute manufacturers must coordinate canopy to ensure that the extraction device and those components extracted by it have an unobstructed trajectory away from the aircraft.harnesses) without inhibiting or damaging the parachute upon egress. While it is recognized that the aircraft configuration is unpredictable in an emergency situation (for example, broken parts creating debris), all due care must be taken to provide a path of least resistance assuming an extremely rapid rate of departure.

6.3.5 Parachute Attachment to the Airframe—The parachute assembly must be attached to the primary structure of the aircraftairframe with an airframe attachment harness that may be composed of a single harness section or a series of harness sections. The airframe and parachute manufacturers must coordinate and agree to ensure that the parachute attachment to the subject airframe complies with the following conditions:

6.3.5.1 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 for each individual aircraft typemodel must comply with the ultimate loads determinedparachute opening load measured in the parachute strength test described in 6.2.1. This load already contains the required safety factor of 1.5.

6.3.5.2 The harness system and attach points must be configured in a manner that presents the aircraft in a descent and landing

attitude that maximizes the ability of the aircraft/airframe structure to absorb the anticipated landing loads and minimizes the probability of injury to the occupants.

6.3.5.3 The airframe attachment harness must 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. It must also be shown that the harness will be satisfactorily/sufficiently stripped free upon extraction and inflation after activation of the parachute system to ensure adequate functioning of the parachute system.

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

6.3.6 *Activating Housing Routing*—The parachute system must be designed for activation without difficulty. The airframe and parachute manufacturers must coordinate and agree to insure that the installation of the activation system in the subject airframe complies with the following conditions:

6.3.6.1 The routing of the activation system shall not create friction points or other interruptions that may reduce/prevent the occupant's ability to activate/occupant from activating the system.

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

~~6.3.6.3 If dual activating handles are used, they must be of a design that allows activation with one handle, even if the other handle is inoperable. An airframe manufacturer electing to offer dual handle activation must coordinate installation with the manufacturer of the ballistic parachute system.~~

~~6.3.6.4 It must be shown that arming and activating the system can only be accomplished in a sequence that makes inadvertent deployment extremely improbable. The system must not be armed before the initiation of activation procedures.~~

~~6.3.6.5 Some means to secure the activation system must be implemented when the aircraft is not in service.~~

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

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

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

6.3.7 *Occupant Restraint*—Each seat in an airplane modified or fitted with the emergency parachute system must be equipped with a restraint system consisting of a seat belt and shoulder harness that will protect the occupants from head and upper torso injuries during parachute deployment and ground impact at the critical load conditions. —Each seat in an airframe modified or fitted with the emergency parachute system must be equipped with a restraint system that will adequately protect the occupants from head and upper torso injuries during parachute deployment and parachute landing. The restraint system must be designed in accordance with the relevant airframe requirements considering the accelerations to be expected in response to the parachute opening, descent and parachute landing.

## **7. Workmanship, Finish and Appearance**

~~7.1 Workmanship must be of a high standard and performed in accordance with QA standards as established by industry consensus (possibly stand-alone standards established within the ASTM structure, see S3.1). Workmanship~~

7.1 Workmanship must be of a high standard and performed in accordance with QA standards. When no other requirements are made applicable for a specific project, QA requirements as per S3 of this standard apply.

## **8. System Function Design and Operations Construction**

8.1 The installation design and location of the extraction device must consider fire hazards associated with the activation of the parachute system and reduce this fire hazard potential as much as possible without compromising function of the extraction device.

8.2 The parachute system must be labeled to show its identification, function, and operation limitations.

8.3 All components of the parachute system must be protected against deterioration or loss of strength in service as a result of normal wear, weathering, corrosion, and abrasion.

## **9. Inspection and Maintenance**

~~9.1 Owners of parachute system must follow the parachute system manufacturer's maintenance schedule.~~

~~9.2 Instructions for continued airworthiness must be prepared for the parachute system and shall state the service cycles for relevant components of the system, including but not limited to:~~

~~9.2.1 Parachute canopy inspection and repacking.~~

~~9.2.2 Extraction device inspection and refueling or replacement.~~

~~9.3 If the maintenance schedule is not followed, the parachute must be marked "Inoperative."~~

~~9.4 Adequate means must be provided to permit annual examination of the parachute container and other system components to ensure proper functioning, egress alignment, and security of harness bridles and activating housing.~~

~~9.5 Specific climates may require modification to the parachute system's inspection procedures.~~