Designation: F2316 – 12 (Reapproved 2022)

Standard Specification for Airframe Emergency Parachutes[1]

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 (ε) 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 airframes. Airframe emergency parachutes 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 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 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.

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 *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, health, and environmental practices and determine the applicability of regulatory requirements prior to use.*

1.5 *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 There are currently no referenced documents in this specification.

3. Terminology

3.1 *Definitions of Terms Specific to This Standard:*

3.1.1 *ballistic device, 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.

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 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. Reserved

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

[1] This specification is under the jurisdiction of ASTM Committee F37 on Light Sport Aircraft and is the direct responsibility of Subcommittee F37.70 on Cross Cutting.

Current edition approved April 1, 2022. Published April 2022. Originally approved in 2003. Last previous edition approved in 2014 as F2316 – 12 (2014). DOI: 10.1520/F2316-12R22.

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 (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. 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 × Aircaft'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 = Aircaft'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 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 *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.

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

6.3 *Installation Design*—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 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 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*—Airframe and parachute manufacturers must 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 (lines that connect the parachute canopy to the 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 airframe 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 model must comply with the ultimate parachute 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 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 sufficiently stripped free after activation of the parachute system to ensure adequate functioning of the 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 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 prevent the 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.

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 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

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 in accordance with S3 of this specification apply.

8. Design and 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 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:

9.1.1 Parachute canopy inspection, repacking and replacement intervals;

9.1.2 Extraction device inspection and refueling or replacement;

9.1.3 Field maintenance checks; and

9.1.4 Any other maintenance instructions.

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

NOTE 3—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 has to be considered on aircraft level and highlighted in the applicable aircraft level documentation or manuals, or both. This does not affect the parachute documentation.

9.3 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.

10. Operating Limitations

10.1 Operating limitations must be prescribed to ensure proper operation of the parachute system.

11. Product Marking

11.1 Key components of the parachute system must be marked on the outside of the parachute container with the following information:

11.1.1 Manufacturer’s identification,

11.1.2 Part number and revision,

11.1.3 Serial number,

11.1.4 Date of manufacture, and

11.1.5 Service interval date.

11.2 *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. Reference Appendix X1 for samples of these labels.

11.2.1 *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 PIM.

11.2.2 *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.

11.2.2.1 *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 triangular placard or label with the word "Danger" (see sample placard Fig. X1.1 of Appendix X1) must 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 triangular placard or label (see sample label Fig. X1.1 in Appendix X1, label must be resized to fit the size in accordance with 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 4—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.

11.2.2.2 *Identifying Placard*—A label shall be attached to the body of the extraction device (for example, the rocket body itself) so first responders and safety investigators can identify the device should it become separated from the parachute (discharged or live). This placard shall have contact information as well as graphic images (sample placard is shown in Fig. X1.2 of Appendix X1).

11.2.2.3 *Warning Placard*—A 2.54 cm (1 in.) minimum triangular placard or label (sample placard is shown in Fig. X1.3 of Appendix X1) 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.

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

11.3 All producers of ballistically deployed rescue systems shall provide on their website or by printed goods made available as requested, explanations or instruction about safetying their systems or disabling their systems as required for the safety of rescue personnel arriving at the scene of an incident or accident.

NOTE 5—These explanations or instructions need not inform about handling or disabling ballistic devices, but rather about how to render them not dangerous to rescue personnel.

12. Keywords

12.1 aircraft; airframe; ballistic recovery; parachute

SUPPLEMENTARY REQUIREMENTS

S1. Retained Data

S1.1 The following information must be retained on file at the manufacturer's facility for as long as systems remain in service.

S1.1.1 Technical data that define the parachute system's installation in the aircraft.

S1.1.2 Technical data that define the components, assemblies, and fabrication of the system.

S1.1.3 Engineering analyses and test data prepared for qualification with this specification.

S2. Delivered Data

S2.1 The following information must be delivered to the airframe manufacturer to support installation and operation of the parachute system on that airframe:

S2.1.1 Technical data that define the parachute system's installation in the aircraft.

S2.1.2 Technical data that define the components, assemblies, and fabrication of the system.

S2.1.3 A general operator's manual that defines operating procedures and the parachute system's operating envelope.

S2.1.4 Instructions for continued airworthiness as defined in 9.1.

S3. Quality Assurance

S3.1 Quality assurance may follow other standards. The following requirements must be satisfied (enhanced, if not already included):

S3.1.1 The emergency parachute system manufacturer shall establish inspections and tests necessary to ensure that each article produced conforms to the original engineering specifications, as defined below:

S3.1.1.1 Inspections for raw materials, purchased items, and parts and assemblies produced by suppliers, including methods used to ensure acceptable quality of parts and assemblies that cannot be completely inspected for conformity and quality when delivered to the parachute manufacturer's facility.

S3.1.1.2 Production inspection of individual parts and complete assemblies, including the identification of any special manufacturing processes involved, the means used to control the processes, and the final test quality inspection of the completed emergency parachute system.

S3.1.1.3 A nonconforming materials review system that includes documentation of parts disposition decisions and a system to dispose of rejected parts.

S3.1.1.4 A system for informing company inspectors of current changes in engineering drawings, specifications, and quality control procedures.

APPENDIX

(Nonmandatory Information)

X1. SAMPLE OF LABELS (PLACARDS)

X1.1 The sample label shown in Fig. X1.1 meets the requirements provided in 11.2.2.1.

X1.2 The sample label shown in Fig. X1.2 meets the requirements provided in 11.2.2.2.

X1.3 The sample label shown in Fig. X1.3 meets the requirements provided in 11.2.2.3.

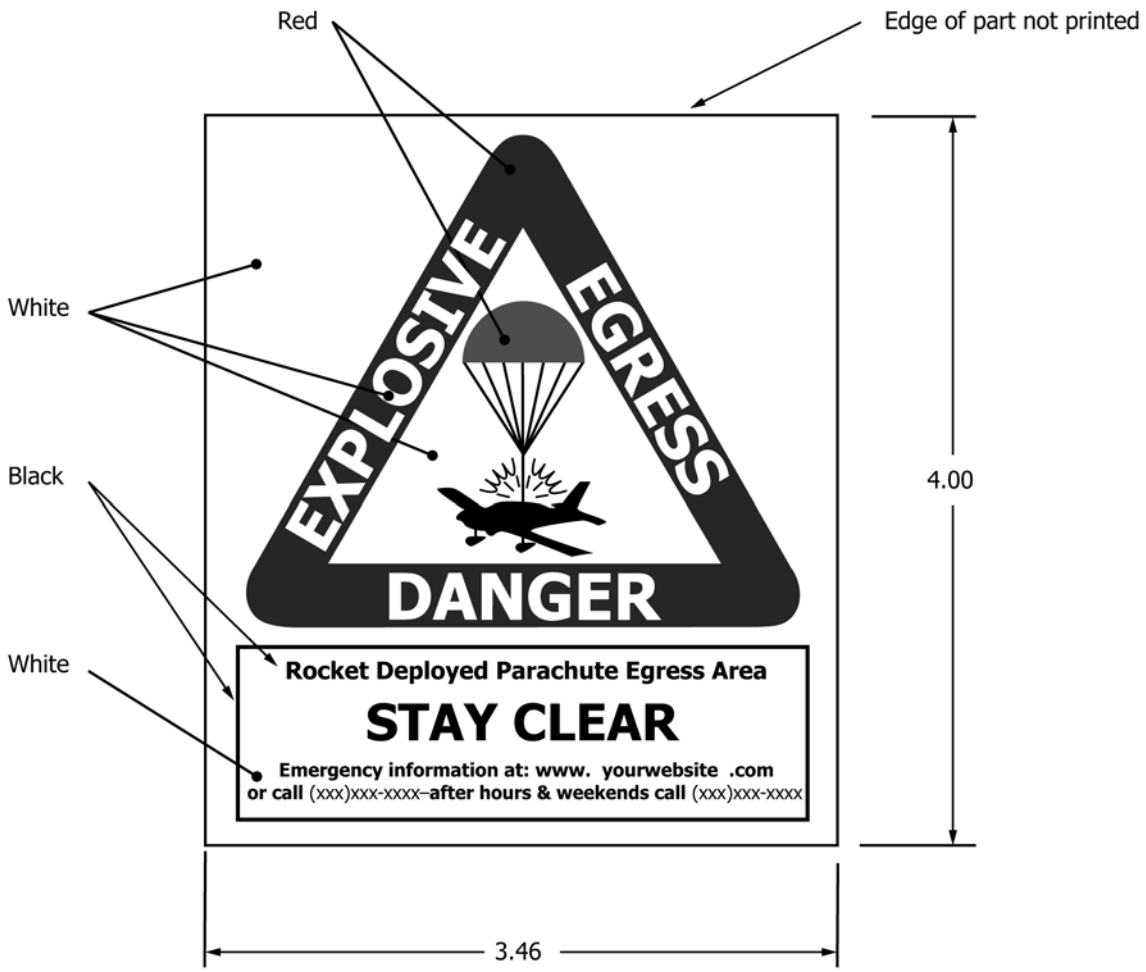

FIG. X1.1 Sample Danger Label

FIG. X1.2 Sample Identifying Label

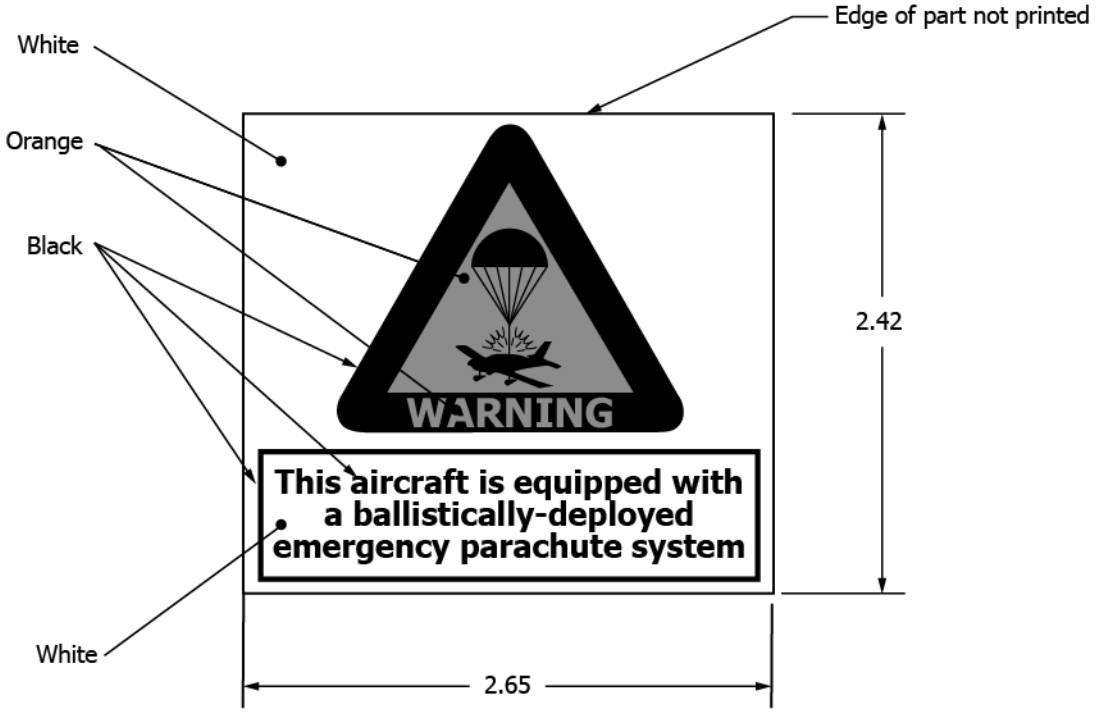

FIG. X1.3 Sample Label