



Department of Transportation
Federal Aviation Administration
Aircraft Certification Service
Washington, D.C.

TSO-C23e

Effective
Date:10/31/08

Technical Standard Order

Subject: *Personnel Parachute Assemblies*

1. **PURPOSE.** This technical standard order (TSO) is for manufacturers applying for a TSO authorization (TSOA) or letter of design approval (LODA). In it, we (the Federal Aviation Administration, or FAA) tell you what minimum performance standards (MPS) your personnel parachute assemblies carried in an aircraft for emergency use by aircrew, or, those reserve parachutes worn by parachutists for intentional jumping, must first meet for approval and identification with the applicable TSO marking.

2. **APPLICABILITY.** This TSO affects new applications submitted after its effective date.

a. Generally we will not accept applications after the effective date of this TSO. However, we may do so up to six months after it, if we know that you were working against the earlier MPS before the new change became effective.

b. Personnel parachute assemblies approved under a previous TSOA may still be manufactured under the provisions of their original approval.

c. Major design changes to personnel parachute assemblies approved under this TSO will require a new authorization. See Title 14 of the Code of Federal Regulations (14 CFR) 21.611(b).

3. **REQUIREMENTS.** New models of personnel parachute assemblies identified and manufactured on or after the effective date of this TSO must meet the MPS qualification and documentation requirements in Parachute Industry Association (PIA) Technical Standard (TS) 135, *Minimum Performance Standards for Personnel Parachute Assemblies and Components*, Revision 1.1.1.1, dated September 14, 2008, as modified by appendix 1 of this TSO, and Paragraph 4.3.6 of SAE International Aerospace Standard (AS) 8015B, *Minimum Performance Standards for Parachute Assemblies and Components, Personnel*, dated July 7, 1992.

a. **Deviations.** We have provisions for using alternate or equivalent means of compliance to the criteria in the MPS of this TSO. If you invoke these provisions, you must show that your equipment maintains an equivalent level of safety. Apply for a deviation under 14 CFR 21.609 before submitting your data package.

4. MARKING.

a. Mark at least one major component permanently and legibly with all the information in PIA TS 135, paragraph 4.2 and 14 CFR 21.607(d), except for the following:

(1) 14 CFR 21.607(d)(2). Use the name, type, and part number. Do not use the optional model number; and

(2) 14 CFR 21.607(d)(3). Use the date of manufacture. Do not use the optional serial number.

b. Also, mark the following permanently and legibly, with at least the manufacturer's name, subassembly part number, and the TSO number:

(1) Each component that is easily removable (without hand tools),

(2) Each interchangeable element, and

(3) Each subassembly of the article that you determined may be interchangeable.

c. Identify any deviations granted to the article by marking "Deviation. See instruction manual (IM)" after the TSO number. You can abbreviate the marking to "(Dev. See IM)."

d. When applicable, identify the equipment as an incomplete system or state that the article performs functions beyond those described in paragraph 3 of this TSO.

5. APPLICATION DATA REQUIREMENTS. As a TSO manufacturer-applicant, you must give the FAA aircraft certification office (ACO) manager responsible for your facilities a statement of conformance, as specified 14 CFR 21.605(a)(1) and (2), and one copy each of the following technical data to support your design and production approval. (Under 14 CFR 21.617(a)(2), LODA applicants submit the same data through their civil aviation authority:)

a. Operating instructions and equipment limitations in an IM, sufficient to describe the equipment's operational capability, donning, retention, adjustment, deployment, folding and packing instructions. Describe any deviations in detail. If needed, identify equipment by part number, version, revision, and criticality level of software/hardware, classification for use, and environmental categories.

b. List of components, by part number, that make up the personnel parachute assemblies or components complying with the standards prescribed under this TSO. Include vendor part number cross-references, when applicable.

c. A component maintenance manual (CMM), covering periodic maintenance, calibration, and repair, for the continued airworthiness of the personnel parachute assemblies. Include

recommended inspection intervals and service life. Describe the details of deviations granted, as noted in paragraph **5.a** of this TSO.

d. Material and process specifications.

e. The quality control system (QCS) description required by 14 CFR §§ 21.143 and 21.605(a)(3), including functional test specifications. The QCS should ensure that you will detect any change to the equipment that could adversely affect compliance with the TSO MPS, and reject the item accordingly. (Not required for LODA applicants.)

f. Manufacturer's TSO qualification test report.

g. Nameplate drawing with the information required by paragraph **4** of this TSO.

h. Provide all detail drawings, material identifications and processes (including revision level) that define the article's design. For a minor change, follow the directions in 14 CFR 21.611(a). Show any revisions to the drawing list only on our request.

6. MANUFACTURER DATA REQUIREMENTS. Besides the data given directly to us, have the following technical data available for review by the responsible ACO or civil aviation authority:

a. Functional qualification specifications for qualifying each production article to ensure compliance with this TSO.

b. Equipment calibration procedures.

c. Corrective maintenance procedures within 12 months after TSOA or LODA.

7. FURNISHED DATA REQUIREMENTS. If furnishing one or more articles manufactured under this TSO to one entity (such as an operator or repair station), provide one copy of the data in paragraphs **5.a** through **5.c** of this TSO. Add any other data needed for the proper certification, use, or for continued airworthiness, of the personnel parachute assemblies.

8. HOW TO GET REFERENCED DOCUMENTS.

a. Download PIA documents free of charge from PIA's website at <http://www.pia.com>. Under "PIA Data, Information and Documents," select "PIA Public Documents."

b. Order SAE documents from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001. Telephone (724) 776-4970, fax (724) 776-0790. You can also order copies online at www.sae.org.

c. Order copies of 14 CFR part 21 from the Superintendent of Documents, Government Printing Office, P.O. Box 37154, Pittsburgh PA 15250-7954. Telephone (202) 512-1800, fax

(202) 512-2250. You can also order copies online at www.access.gpo.gov. Select “Access,” then “Online Bookstore.” Select “Aviation,” then “Code of Federal Regulations.”

d. You can find a current list of technical standard orders on the FAA Internet website Regulatory and Guidance Library at www.airweb.faa.gov/rgl. You will also find advisory circulars and the TSO Index of Articles at the same site.

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APPENDIX 1.**MINIMUM PERFORMANCE STANDARD FOR PERSONNEL PARACHUTE ASSEMBLIES AND COMPONENTS**

This appendix prescribes the MPS for personnel parachute assemblies and components. The applicable standard are: Parachute Industry Association (PIA) Technical Standard (TS) 135, Minimum Performance Standards for Personnel Assemblies and Components, Revision 1.1.1.1., dated September 14, 2008, and, paragraph 4.3.6 of SAE AS8015B, *Minimum Performance Standards for Parachute Assemblies and Components, Personnel*, dated July 7, 1992.

We modified the PIA TS-135, as follows:

1. Page 2, replace Paragraph 2.1.a.: “Administrator” – The chief executive of the cognizant agency and/or his designated subordinate personnel and/or designated subordinate organization acting on his behalf and with his authority in the matter concerned.”, with:

Per Part 1.1, Administrator means the Federal Aviation Administrator or any person to whom he has delegated his authority in the matter concerned.

For the purpose of applying for TSO Authorization (TSOA), or Letter of Design Approval (LODA), the definitions in Paragraphs f. “Approved” and h. “Certified” only mean by the FAA Administrator and i. “Cognizant Agency” is the FAA only.

2. Page 3, delete paragraph 2.1.1 i, Main parachute breakaway device.
3. Page 3, delete paragraph 2.1.1 l, Other components identified by the manufacturer.
4. Page 4, revise paragraph 2.1.7, as follows:

FUNCTIONALLY OPEN:

Functionally open shall mean a parachute sufficiently deployed and inflated to provide a drag area equal to or greater than 75% of the steady state drag area of the canopy ***and*** not to exceed a maximum rate of descent of 24 ft/s (7.3m/s) and a total velocity of 36 ft/s (11.0 m/s). This condition may be demonstrated by video, film or electronic data of the test in a manner determined by the manufacturer.

5. Page 4, revise 2.1.12, as follows:

LIFE LIMITED ITEMS:

Materials or products that, by design, are life limited for any reason (environmental, structural, chemical, etc.) ***need to be approved by the FAA and can not be changed without prior FAA approval.*** Each such item must be marked in a manner that will allow maintenance personnel to determine the status of the part.

6. Page 5, replace Paragraph 4.1.7: **DROGUE PARACHUTE ASSEMBLY & RELEASE**, with:

For reserve or emergency parachute assemblies incorporating a drogue, the drogue release shall be ground tested by a representative group of no less than 6 male and 6 female subjects. They shall be able to operate the release device without any undue difficulty. The drogue release shall be tested with the test subject(s) suspended by the drogue bridle (6 male/6 female), and with an additional test subject, if used, in the passenger harness (6 male/6 female): (24 tests total). A force at the drogue release handle, or equivalent, of not less than 5 lbf (22.2 N) (applied in the direction requiring the least force), nor more than 22 lbf (97.9 N) (applied in the direction requiring the greatest force under normal design operation) while suspending the maximum operating weight, shall result in a positive and quick release of the drogue on all tests. A minimum of 12 tests is required. Dual harness reserve parachute assemblies while being tested with an attached passenger are required to be tested / operated by the parachutist in command. If passenger operated devices are used, all 4.1.7 tests must with a test subject in the passenger harness must be repeated with the passenger operating the device.

7. Page 7, revise Paragraph 4.3.2.(b) as follows:

(b) If the reserve is to be static line actuated by releasing the main canopy, the reserve static line, if used, must not fail under a straight tension test load of **600-lbf** (1334.5 N) applied for not less than 3 seconds.

8. Page 7, revise Paragraph 4.3.3, by deleting “*typically*” in first line.

9. Page 8, delete paragraph 4.3.5.4, **Alternate preconditioning**.

10. Page 9, revise last paragraph 4.3.7, by adding:

Performance Requirement: The parachute must be functionally open *within the time calculated in SAE 8015B, paragraph 4.3.6 + 1 sec* from the time of pack opening.

11. Page 9, substitute Paragraph 4.3.8 with **SAE AS8015B Paragraph 4.3.6**.

12. Page 10, revise paragraph 4.3.8.1 as follows:

There shall be within the allowed time or altitude as calculated in **SAE AS8015B paragraph 4.3.6**.

13. Page 10, delete this note in paragraph 4.3.8.1:

NOTE: If a “MARD device” option is offered, one half of the tests at each speed must be done with the device attached.

14. Page 10, revise paragraph 4.3.8.2 as follows:

Eight drop tests ... functionally open with the altitude or with the allowed time as calculated in *SAE AS8015B paragraph 4.3.6*.

15. Page 10, delete paragraph 4.3.9.2, **RATE OF DESCENT TESTS (Method 2)**.

16. Page 17, revise Table 4 as follows:

PIA TS-135- Table 4

Performance Test Requirements for Component Qualification													
	Reference Paragraph for PIA-TS-135	Complete Parachute Assembly	Deployment Initiation Device (Pilot Chute, etc.)	Deployment Control Device (dbag, etc.)	Canopy, lines, blinks, and reefing device (if used)	Stowage Container	Primary Actuation Device (Ripcord or Equivalent)	Reserve Static Line (if used)	Harness	Risers (if not integral with harness)	deleted	Drogue, Canopy & Riser (if used)	Drogue Release Device (if used)
Drogue Parachute Assembly & Release	4.1.7	X										X	X
Ripcord Strength Tests	4.3.2	X					X	X					
Human Factors	4.3.3	X				X	X					X	X
Environmental	4.3.5	X	X	X	X	X			X	X		X	X
Strength Tests - Assembly	4.3.6.1	X	X		X	X			X	X			
Strength Tests - Canopy Alternate	4.3.6.2												
Strength Tests - Harness Alternate	4.3.6.3												
Strength Tests - Dogue Canopy and Bridle	4.3.6											X	
Strength Tests - Deployment Devices	4.3.6		X	X									
Functional Tests - Twisted Line	4.3.7	X	X	X	X	X							
Functional Tests - Normal Pack, Direct Drop	4.3.8.1	X	X	X	X	X	X	X	X	X		X	X
Functional Tests - Normal Pack, Breakaway	4.3.8.2	X	X	X	X	X	X	X	X	X			
Rate of Descent	4.3.9.1	X			X								
deleted													
Stability	4.3.10	X			X								
Live Drops	4.3.11	X	X	X	X	X	X	X	X	X		X	X

Parachute Industry Association (PIA)

TECHNICAL STANDARD 135

MINIMUM PERFORMANCE STANDARDS FOR PERSONNEL PARACHUTE ASSEMBLIES AND COMPONENTS

1. SCOPE:

This document defines the minimum performance standards for personnel parachute assemblies (and components thereof) to be carried in aircraft for emergency use by aircrew and those reserve parachutes worn by parachutists for intentional jumping.

This document covers three types of personnel carrying parachute assemblies and the operating limitations for each:

1.1 PARACHUTE TYPES:

- 1.1.1 Single harness reserve parachute assembly.
- 1.1.2 Single harness emergency parachute assembly.
- 1.1.3 Dual harness reserve parachute assembly.

1.2 MAXIMUM OPERATING LIMITS, GENERAL:

- 1.2.1 A single harness parachute assembly (or components thereof) may be certified for any maximum operating weight and for any maximum pack opening speed equal to or greater than 150 KTAS (277.8 km/h).
- 1.2.2 A dual harness reserve parachute assembly (or components thereof) may be certified for any maximum operating weight greater than 500 lb (227.3 kg) (with 250 lb (113.6 kg) in each harness) and any maximum pack opening speed equal to or greater than 175 KTAS (324.1 km/h). Note that the maximum operating weight need not be the same for each harness.

1.3 LIST OF TECHNICAL STANDARDS, TABLES AND FIGURES:

Figure 1	Multiplier Factors for Structural Overload Testing
Table 1	Data Marking Requirements
Table 2	Human Factors and Actuation Force Tests – Primary Actuation Device/Ripcord
Table 3	Performance Test Requirements
Table 4	Performance Test Requirements for Component Qualification

2. DEFINITIONS AND GENERAL REQUIREMENTS**2.1 GENERAL DEFINITIONS:**

For the purposes of this document, the following definitions are used:

- a. "Administrator" – The chief executive of the cognizant agency and/or his designated subordinate personnel and/or designated subordinate organization acting on his behalf and with his authority in the matter concerned.
- b. "Airspeed, Calibrated" (KCAS) means the indicated airspeed of an aircraft, corrected for position and instrument error. Calibrated airspeed is equal to true airspeed in standard atmosphere at sea level.
- c. "Airspeed, Equivalent" (KEAS) means the calibrated airspeed of an aircraft corrected for adiabatic compressible flow for the particular altitude. Equivalent airspeed is equal to calibrated airspeed in standard atmosphere at sea level.
- d. "Airspeed, Indicated" (KIAS) means the speed of an aircraft as shown on its pitot static airspeed indicator calibrated to reflect standard atmosphere adiabatic compressible flow at sea level uncorrected for airspeed system errors.
- e. "Airspeed True" (KTAS) – means the airspeed of an aircraft relative to undisturbed air. True airspeed is equal to equivalent airspeed multiplied by $(\rho_0/\rho)^{1/2}$.
- f. "Approved", unless used with reference to another person, means approved by the Administrator.
- g. "Canopy"- The part of the parachute that opens up and fills with air.
- h. "Certified", unless used with reference to another agency, means certified by the cognizant agency as having met the requirements of this standard.
- i. "Cognizant Agency" – The governmental agency or other organization tasked with oversight or regulation of aviation activities within a given geographical area or country. e.g. the Federal Aviation Administration (FAA) within the United States, the Joint Airworthiness Authorities (JAA) within the European Union and similar agencies worldwide. In some cases, the cognizant agency may delegate part or all of its authority to a subordinate agency such as a national aero club.
- j. "Drogue" – A small aerodynamic decelerator towed behind a falling body to slow its velocity.
- k. "Manufacturer" – The responsible person (or business/corporate entity) that controls the design, testing and manufacturing of a certified product.
- l. Main Assisted Reserve Deployment (MARD) device – An automatically releasable connection between the main parachute and the reserve deployment system that uses a malfunctioned main canopy to speed reserve deployment upon breakaway.
- m. "Parachute" means a device used or intended to be used to retard the fall of a body or object through the air.
- n. "Parachutist in Command" – means the person who:
 - (1) Has final authority and responsibility for the operation and safety of the jump; (2) Has been designated as parachutist in command before the jump; and

(3) Holds the appropriate rating for the conduct of the jump.

- o. . "Passenger parachutist" means a person who boards an aircraft, acting as other than the parachutist in command of a tandem parachute operation, with the intent of exiting the aircraft while in-flight using the forward harness of a dual harness tandem parachute system to descend to the surface.

2.1.1 MAJOR COMPONENTS:

For purposes of this document a parachute assembly normally, but not exclusively, consists of the following major components:

- a. Deployment control device such as a sleeve, bag, diaper, or functional equivalent.
- b. Deployment initiation device (pilot chute, drogue, or functional equivalent) and bridle.
- c. Canopy(s) including suspension lines, reefing device, and connector links (if used).
- d. Riser(s), when not integral with harness and/or canopy.
- e. Stowage container(s) or stowage pack(s).
- f. Harness (es).
- g. Primary actuation device (ripcord or functional equivalent).
- h. Reserve static line.
- i. Main parachute breakaway device.
- j. Drogue canopy and bridle (if used with reserve and/or emergency parachutes).
- k. Drogue release device (if used with reserve and/or emergency parachutes).
- l. Other components identified by the manufacturer.

2.1.2 SINGLE HARNESS RESERVE PARACHUTE ASSEMBLY:

A certified parachute assembly that is worn in conjunction with a main parachute assembly and used by one person for premeditated jumps. This includes, as applicable, the reserve deployment initiation device, deployment control device, canopy, risers, stowage container, harness, primary actuation device, and reserve static line.

2.1.3 DUAL HARNESS RESERVE PARACHUTE ASSEMBLY:

A certified parachute assembly used for premeditated jumps by two people: a parachutist in command and a second parachutist (each in his/her own harness), utilizing one main parachute assembly, one reserve parachute assembly. This assembly includes, as applicable, the reserve deployment initiation device, deployment control device, canopy, risers, stowage container, harness, primary actuation device, and reserve static line.

2.1.4 MAIN PARACHUTE ASSEMBLY:

A non-certified parachute assembly that is worn in conjunction with a certified reserve parachute assembly as the primary parachute (the one intended for use) for premeditated jumps. The main parachute assembly shall consist of the main container and all associated parts of the main parachute that are not permanently attached to the certificated harness assembly.

2.1.5 SINGLE HARNESS EMERGENCY PARACHUTE ASSEMBLY:

A certified parachute assembly that is worn by one person for emergency, (unpremeditated) use only. This assembly includes, as applicable, the deployment initiation device, deployment control device, canopy, risers, stowage container, harness, and primary actuation device.

2.1.6 FAILURE OF A PARACHUTE ASSEMBLY OR COMPONENT:

The term "failure" in this document shall mean any change in a component or assembly that adversely affects its airworthiness. However, the use of consumable, frangible or single use parts shall be permitted in all assemblies and shall not be considered a failure if they function as designed.

2.1.7 FUNCTIONALLY OPEN:

Functionally open shall mean a parachute sufficiently deployed and inflated to provide a drag area equal to or greater than 75% of the steady state drag area of the canopy or not to exceed a maximum rate of descent of 24 ft/s (7.3m/s) and a total velocity of 36 ft/s (11.0m/s). This condition may be demonstrated by video, film or electronic data of the test in a manner determined by the manufacturer.

2.1.8 RESERVE STATIC LINE (RSL):

A device connected to the main parachute assembly that is capable of actuating the reserve parachute assembly following a breakaway from the main canopy.

2.1.9 MAIN PARACHUTE BREAKAWAY DEVICE:

A device used by the parachutist in command to separate the main parachute from the harness of a single or dual-harness reserve parachute assembly. The parachutist in command shall be able to operate the main parachute breakaway device for dual harness reserve parachute assemblies.

2.1.10 MAXIMUM OPERATING WEIGHT (MOW):

The maximum operating weight is the total (gross) weight of all individuals or dummies and their equipment including the parachute assembly itself. MOW is also known as the "placard weight".

2.1.11 MAXIMUM PACK OPENING SPEED (MPOS):

The maximum pack open speed in KTAS (knots true airspeed) is the maximum speed at which the parachute pack (container) may be opened. This definition specifically allows for the wearing of parachutes in freefall and/or in aircraft at speeds higher than the maximum pack opening speed. MPOS is also known as the "placard speed".

NOTE: In order to provide an inherently greater margin of safety without requiring that tests be conducted at all possible altitudes, all test conditions in this document are stated in KEAS and that all maximum pack opening speeds are stated in KTAS. In the event that a manufacturer elects to conduct further testing at higher altitudes, the placard limits may be changed to reflect any test conditions successfully conducted.

2.1.12 LIFE LIMITED ITEMS:

Materials or products that, by design, are life limited for any reason (environmental, structural, chemical, etc.) may be used in any manner chosen by the manufacturer. Each such item must be marked in a manner that will allow maintenance personnel to determine the life status of the part.

3. MATERIALS AND WORKMANSHIP:

Materials and workmanship shall be of a quality that documented experience and/or tests have conclusively demonstrated to be suitable for the manufacture of, and appropriate for the intended use in, personnel parachute assemblies. All materials shall remain functional for storage from -

40 to +200°F (-40 to +93.3 °C), and from 0 to 100% relative humidity. All plated ferrous parts shall be treated to minimize hydrogen embrittlement.

4. DETAIL REQUIREMENTS

4.1 DESIGN AND CONSTRUCTION:

4.1.1 MATERIALS:

All materials shall be designed to support the proof loads specified in the applicable specification, drawing, or standard, without failure. In the absence of an applicable specification, drawing, or standard for a particular material, successful completion of the qualification tests listed under section 4.3 shall be considered adequate evidence of suitability.

4.1.2 STITCHING:

Stitching shall generally be of a type that will not ravel when broken. Note that this requirement may not apply to consumable or frangible parts.

4.1.3 MAIN PARACHUTE ASSEMBLY:

When installed but not deployed, the main parachute assembly shall not interfere with the proper function of the reserve parachute assembly. Ref: Table 2

4.1.4 PRIMARY ACTUATION DEVICE/RIPCORDER:

All load bearing joints of the primary actuation device/ripcorder shall withstand the test loads of 4.3.2 without failure.

The primary actuation device/ripcorder shall meet the human-factors requirements of 4.3.3., if applicable. The primary actuation device (ripcorder or equivalent) shall be equipped with a tamper-indicating device (i.e. seal thread or equivalent) that is suitable for long-term use in personnel parachute assemblies.

4.1.5 RESERVE STATIC LINE (RSL):

The reserve static line, if used, including all joints shall withstand the test loads of 4.3.2 without failure and shall meet the functional requirements of 4.3.8.2.

4.1.6 HARNESS RELEASE:

The harness shall be so constructed that, after landing, the parachutist can separate himself from the main and reserve canopies and/or harness assembly unaided. On a dual harness, reserve parachute assembly, the parachutist in command must be able to separate himself and the second parachutist from the reserve canopy and/or harness assemblies unaided.

4.1.7 DROGUE PARACHUTE ASSEMBLY & RELEASE:

For reserve or emergency parachute assemblies, incorporating a drogue, the drogue release shall be tested at an equivalent force to the drag force generated at the MOW and MPOS. The human release force shall not be less than 5 lbf (22.2N) and must not exceed 22 lbf (97.9N). The release shall meet the human-factors requirements of 4.3.3.

4.1.8 DATA CARD POCKET; STOWAGE CONTAINER (REQUIRED):

The stowage container shall be provided with a parachute data card pocket constructed such that the card will not be easily lost but will be readily accessible, when the parachute is packed in the container.

4.2 MARKING REQUIREMENTS:

Marking requirements are listed in Table 1.

NOTE: The data items listed in Table 1 need not be marked at the same location on the component as long as all of the pertinent information is permanently marked.

4.2.1 MARKING, STOWAGE CONTAINER - OPERATING LIMITS (REQUIRED):

The maximum operating limits in Table 1 shall be marked on or attached to the outside of the parachute stowage container (pack). The lowest maximum operating weight of any component in the assembly (canopy, harness, etc.) and the lowest maximum pack opening speed of any component (canopy, harness, etc.) shall be marked on the outside of the stowage container (pack) in such a location as to be readily available to the user during donning of the parachute assembly and subject to a minimum of obliteration during use.

This information may alternately be placed in a pocket marked with the legend 'Operating Limitations Inside'; the pocket must be readily available to the user during donning of the parachute assembly and subject to a minimum of obliteration during use.

NOTE: The maximum pack opening speed and maximum weight markings shall be in a block typeface, in a minimum size of 0.375 inch (9.5 mm) tall (27 point type). The other information required by Table 1 may be marked in another location, if desired.

4.2.2 MARKING, CANOPY - STATEMENT OF USE (REQUIRED):

Each certified canopy shall be marked to show its approved use as follows:

- 4.2.2.1** "Single Harness Emergency Parachute Canopy"
"Single Harness Reserve Parachute Canopy"
"Single Harness Emergency/Reserve Parachute Canopy"
"Dual Harness Reserve Parachute Canopy"

- 4.2.2.2** Each canopy (single harness types only) that has not been tested in accordance with the breakaway tests of Section 4.3.8.2 shall be marked as follows:

"**LIMITATION:** May not be used with main parachute breakaway device".

4.3 QUALIFICATION TESTS:

The minimum performance standards listed in Tables 2, 3 and 4 shall be met. There shall be no failure to meet any of the requirements during the qualification tests of this section. In case of a failure, the cause must be found, corrected, and all affected tests repeated.

4.3.1 PACKING METHOD:

The packing method must be specified and the identical packing method must be used for all of the functional and structural tests.

4.3.2 PRIMARY ACTUATION DEVICE/RIPCORD TEST:

- (a) The ripcord, including all joints, shall not fail under a straight tension test load of 300-lbf (1337.7 N) applied for not less than 3 seconds.
- (b) If the reserve is to be static line actuated by releasing the main canopy, the reserve static line, if used, must not fail under a straight tension test load of 300-lbf (1334.5 N) applied for not less than 3 seconds.
- (c) If the reserve ripcord is to be static lined from an aircraft the reserve ripcord/static line, must not fail under a straight tension test load of 600-lbf (2668.9 N) applied for not less than 3 seconds.
- (d) Rigid pins, if used, shall not yield under a load of 8-lbf (35.6 N) applied to the cable (or equivalent) perpendicular to the axis of the pin, for not less than 3 seconds. The pin shall be supported for 0.5 in (12.7-mm) maximum at the end farthest from the cable attachment. All 4.3.3 human factors tests shall be performed using a primary actuation device/ripcord that has passed this test

4.3.3 HUMAN FACTORS AND ACTUATION FORCE TESTS:

An anthropometrically diverse group of individuals (typically consisting of a representative group of no less than 3 males and 3 females) from the intended user group shall be employed for all human-factors tests in 4.3.3. All individuals shall be able to operate the subject device without any undue difficulty. Table 2 lists the required test conditions and number of tests for each particular component. Additional information for the component tests is listed below.

TESTS: Under normal design operating conditions, all devices tested under this paragraph shall result in a positive and quick operation of the device within the following load range applied to the handle:

- (a) a load applied at the handle of not less than 5 lbf (22.2 N), applied in the direction giving the lowest pull force,
- (b) a load applied at the handle of not more than 22 lbf (97.9 N), applied in the direction of normal design operation,
- (c) for chest type parachute assemblies, the maximum pull force shall be 15 lbf (66.7 N), (d) the primary actuation device shall be tested in accordance with Table 2,
- (e) the emergency/reserve drogue release (if used) shall be tested in accordance with Table 2.

NOTE: For these tests, the primary actuation device (ripcord or equivalent) shall be equipped with a tamper-indicating device (i.e. seal thread or equivalent) of the same type that will be required for production articles in service.

4.3.4 HUMAN FACTORS TESTS, HARNESS:

Harnesses shall demonstrate that they will perform the basic function of retaining the body at the end of the parachute suspension system in an inherently secure manner.

This requirement shall be demonstrated by passing all live drop tests in Table 3.

4.3.5 ENVIRONMENTAL TESTS:

Three drops shall be made at 60 KEAS except that prior to the test the parachute assembly shall be subjected to the following preconditioning: (These tests may be combined with other tests.)

4.3.5.1 Precondition for 16 h at not less than +200 °F (93.3 °C), stabilize to ambient and test drop.

4.3.5.2 Precondition for 16 h at not greater than -40 °F (-40 °C), stabilize to ambient and test drop.

4.3.5.3 Precondition for not less than 400 continuous hours with a 200 lbf (889.6 N) or greater load applied to compress the pack in a manner similar to that most likely to be encountered in actual use. Test drop within 1 hour after removing the load.

4.3.5.4 **Alternate preconditioning.** The preconditioning requirements for 4.3.5.1 and 4.3.5.3 may be combined as follows: The complete test parachute assembly may be placed in a vacuum bag and preconditioned at +180 °F (82.2 °C) for 18 hours at a constant vacuum of not less than 25" Hg (0.846 bar). Stabilize to ambient and drop.

4.3.6 **STRUCTURAL OVERLOAD TESTS:**

No material(s) or device(s) that attenuates shock loads and is not an integral part of the parachute assembly or component being certified may be used. Tests may be conducted for either a complete parachute assembly or separate components. There shall be no evidence of material, stitch, or functional failure that will affect airworthiness. For reusable items the same items shall be used for all 4.3.6 tests. Peak opening force shall be measured on all 4.3.6 tests. The parachute must be functionally open within the number of seconds calculated for 4.3.8 tests. Parachute assemblies shall be tested in accordance with the following schedule:

- (a) Test weight = Maximum operating weight x 1.2
Test speed = Maximum pack opening speed x 1.2
- (b) Test weight = Maximum operating weight x 1.43 or multiplier from Figure 1
Test speed = Maximum pack opening speed x 1.1 or multiplier from Figure 1

However, the test speed must be not less than 180 KEAS (333.4 km/h) for reserve and emergency parachute assemblies and the weight must be not less than 264 lb. (120 kg).

For dual harness parachute assemblies the test weight must not be less than 600 lb. (272.7 kg) and the test speed must not be less than 200 KEAS (370.4 km/h).

4.3.6.1 **STRENGTH TEST,
COMPLETE PARACHUTE ASSEMBLY:**

Three drops shall be made with weight and speed in accordance with 4.3.6. When using test method (b), in 4.3.6 a 4th drop must be added using the same parachute under the same conditions in the first three drops. Where non-positive locking hardware is used to attach the canopy or riser(s) to the harness, a cross connector must be used and one of the above drops shall be with only one attachment engaged to test the cross connector and hardware.

4.3.6.2 **STRENGTH TEST, ALTERNATE MEANS OF COMPLIANCE
CANOPY (ONLY):**

Three drops shall be made with a gross weight and speed in accordance with 4.3.6. When using test method (b), in 4.3.6 a 4th drop must be added using the same canopy under the same conditions in the first three drops. A test vehicle (e.g., a bomb) may be used. The canopy and any required additional components (i.e., deployment device, pilot chute, and risers) shall be tested as a unit. The connector links (if used) shall be attached to the risers in the same manner as the intended use and the riser(s) should be secured to the test vehicle in a manner appropriate to the test objective. For example, if the parachute risers are to be tested on the bomb drop, it should be arranged in a manner as to duplicate the loading found on the personnel

parachute harness. Where non-positive locking hardware is used to attach the canopy or riser(s) to the harness, a cross connector must be used and one of the above drops shall be with only one attachment engaged to test the cross connector and hardware.

4.3.6.3 **STRENGTH TEST, ADDITIONAL MEANS OF COMPLIANCE HARNESS (ONLY):**

A harness may, at the manufacturer's option, be placarded with a higher average peak opening force than what was measured in 4.3.6 tests by performing additional tower drop tests as outlined below:

The harness shall be drop tested using a torso shaped dummy, three (3) times for each of four (4) different loading conditions.

The dummy weight shall be not less than 75% of harness maximum operating weight and the drop distance shall be as necessary to generate the required forces.

Up to three (3) separate harnesses may be used; however each harness shall be subjected to a minimum of one test at each of the following four test conditions.

Test condition one – All risers loaded to a combined load of at least 100% of placard maximum load.

Test condition two – Only left side harness/canopy attachment point(s) loaded to a combined load of at least 66% of placard load.

Test condition three – Only right side harness/canopy attachment point(s) loaded to a combined load of at least 66% of placard load.

Test condition four – Each unique brake setting shall be tested to a minimum of 16.7% of placard load if applicable.

4.3.7 **FUNCTIONAL TESTS (Twisted Lines):**

A minimum of 5 drops shall be made with a weight not more than the maximum operating weight dummy or person¹ in each harness. The airspeed at the time of pack opening shall be 60 KEAS (111.1 km/h).

Procedural Note: The suspension lines shall be twisted together (360 degrees) three times in the same direction within the upper one third of the suspension line length beginning immediately below the attachment point to the canopy. The twists shall be placed in the lines before the suspension lines are stowed.

Performance Requirement: The parachute must be functionally open within 133% of the time calculated in 4.3.8 from the time of pack opening.

4.3.8 **FUNCTIONAL TESTS (Normal Pack - All Types):**

Opening Time or Altitude Loss: Using the MOW in pounds and the MPOS in knots, for all 4.3.8 tests the maximum allowable opening time or altitude loss shall be determined from either of the following formulas on any drop.

If MOW < 250 lb:

Maximum Allowed Opening Time (s) = $(\text{MPOS}/150)^2 \times 3.00$

Maximum Altitude loss (ft) = $(\text{MPOS}/150)^2 \times 300$

¹ A person's or individual's body weight may be increased to equal the maximum operating weight by using a weight belt or similar device.

If MOW \geq 250 lb:

Maximum Allowed Opening Time (s) = [(MOW-250) x 0.01] + [(MPOS/150)² x 3.00]

Maximum Altitude loss (ft) = (MOW-250) + [(MPOS/150)² x 300]

4.3.8.1 DIRECT DROP TESTS:

There shall be a minimum of 48 drops at weights and airspeeds (at the time of pack opening) as outlined in the Table 3. The test condition airspeeds are in KEAS. From the time of pack opening, the parachute canopy must be functionally open within the allowed time or altitude as calculated in 4.3.8.

NOTE: If a "MARD device" option is offered, one half of the tests at each speed must be done with the device attached.

4.3.8.2 BREAKAWAY DROP TESTS (systems with main canopy release):

Eight drop tests shall be made by breaking away from an open and normally functioning main parachute canopy and actuating the reserve parachute within 2 seconds of the breakaway. These tests shall be conducted by a person (or suitable other devices) weighing not more than the maximum operating weight. The initial vertical velocity shall be less than 20 ft/s (6.1 m/s) and the total velocity less than 36 ft/s at the time of breakaway. From the time of pack opening, the parachute canopy must be functionally open within the altitude or within the allowed time as calculated in 4.3.8.

NOTE: If a reserve static line is part of the assembly, then four of the breakaway drops shall be made with the reserve static line actuating the reserve pack.

4.3.9 RATE OF DESCENT TESTS:

Per Table 3, there shall be not less than 6 drops, with an individual and/or dummy in each harness weighing not less than the maximum operating weight². Either or both of the 4.3.9 tests may be used for compliance with this section.

4.3.9.1 RATE OF DESCENT TESTS (Method 1):

The average rate of descent shall not exceed 24 ft/s (7.3 m/s), and the total velocity shall not exceed 36 ft/s (11.0 m/s), in an unaltered post deployment configuration, corrected to standard sea level altitude conditions. The rate of descent measurement shall be taken over a minimum interval of 100 ft (30.5 m). These tests may be combined with other tests in this section.

4.3.9.2 RATE OF DESCENT TESTS (Method 2):

The average rate of descent corrected to standard sea level altitude conditions shall not exceed 5 ft/sec at touchdown with appropriate control manipulations by the user. These tests may be combined with other tests in this section. When using this method, the manufacturer must identify in the owner's manual the weight where the user will have less than a 24 ft/s rate of descent and 36 ft/s total velocity in an unaltered post deployment configuration corrected to standard sea level altitude conditions.

² A person's or individual's body weight may be increased to equal the maximum operating weight by using a weight belt or similar device.

4.3.10 STABILITY TESTS:

Per Table 3, there shall be not less than 6 drops, with a dummy weighing less than or equal to one half the maximum operating weight. The oscillations shall not exceed 15° from the vertical, in an unaltered post-deployment configuration. These tests may be combined with other tests in this section.

4.3.11 LIVE TESTS:

Per Table 3, there shall be a minimum of 4 live tests with an individual weighing not more than the maximum operating weight in each harness⁴. Two drops shall include a freefall of not more than 3 seconds and 2 drops shall include a freefall of at least 20 seconds. These tests may be conducted in conjunction with functional and/or rate of descent tests when practical. The user(s) must suffer no significant discomfort from the opening shock and must be able to disengage himself (themselves) unaided from the harness after landing. For this test the standard harness may be altered to permit attachment of a certified reserve parachute assembly (less harness) provided that such alteration does not interfere with the normal operation of the parachute assembly being tested. Reserve parachute assemblies shall be tested with the main compartment(s) full and empty, with a minimum of two tests each.

NOTE: Live tests for Dual Harness Reserve Parachute Assemblies may be tested with the parachutist in command and a dummy payload in the passenger harness.

5. COMPONENT QUALIFICATIONS:

Any single component, assembly of components, group of components or group of assemblies may be certified. Table 4 lists the appropriate test paragraphs for each of the major components. Any components not listed in Table 4 shall be tested according to all applicable sections of this document based on the components function.

5.1 COMPONENT COMPATIBILITY:

The component manufacturer shall provide a means of determining compatibility and shall provide specific guidance to ensure that form, fit and function of all components, as assembled, are within acceptable limits for each individual component and the assembly as a whole.

5.2 COMPONENT QUALIFICATION BY GROUP:

Components may be qualified as a group consisting of a range of scaled sizes to a maximum factor of three times the smallest size to the largest size. Separate elements of the component design may be linearly scaled at different rates as specified in the component drawings provided that fit, form, and function are not adversely affected.

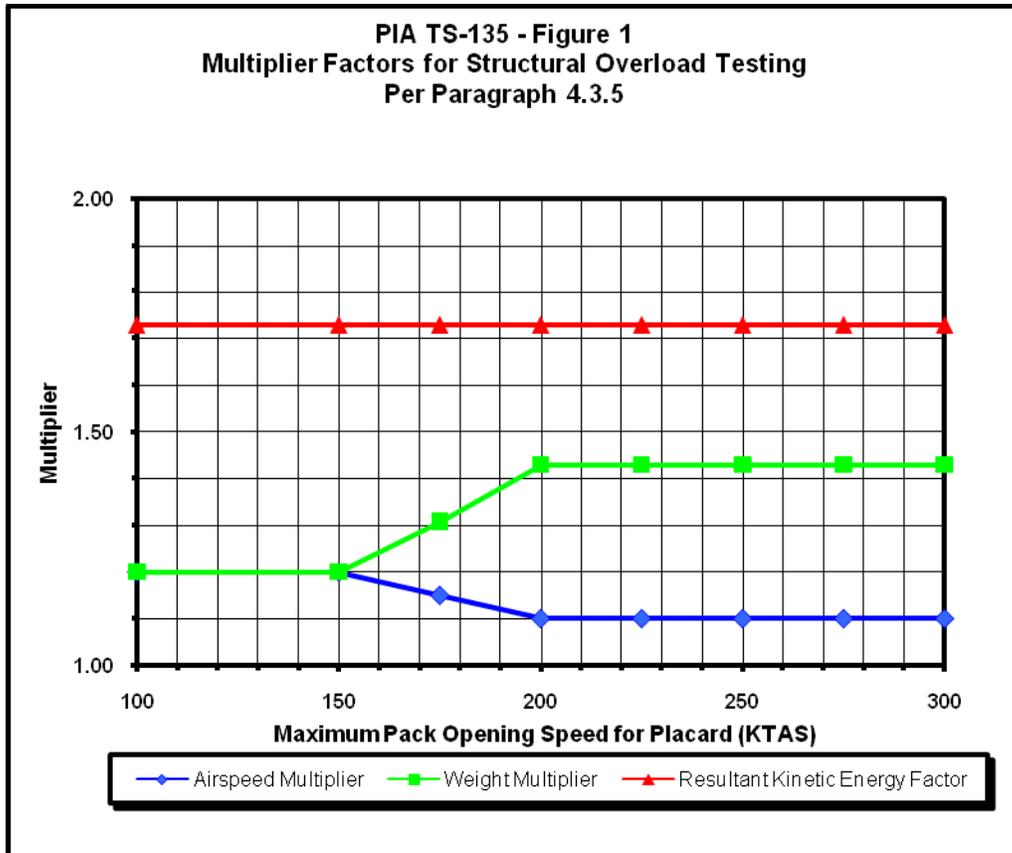
When certifying components as a group, only the largest and the smallest members of the group must be tested in accordance with the appropriate sections of this document.

5.3 MAINTENANCE REQUIREMENTS:

The manufacturer of each component is responsible for developing and disseminating the maintenance requirements for each component, specifically including the inspection interval, repack cycle, service life, criteria for continued airworthiness and the qualifications required of maintenance personnel.

5.4 FITTING REQUIREMENTS:

The manufacturer is responsible for developing and disseminating instructions identifying the correct method of fitting the equipment to the user.



PIA-TS-135 - Table 1.

Data Marking Requirements

	Reference Paragraph	Deployment Initiation Device (Pilot Chute, etc.)	Deployment Control Device (d-bag, etc.)	Reserve Emergency Canopy	Stowage Container	Primary Actuation Device (Ripcord or Equivalent)	Reserve Static Line (if used)	Harness (if not integral with container)	Risers (if not integral with harness)	Reserve/Emergency Drogue Canopy & Riser (if used)	Reserve/Emergency Drogue Release Device (if used)
Marking Data Requirements											
Manufacturers Name, Code or Symbol		X	X	X	X	X	X	X	X	X	X
Part Number (w/dash numbers)		X	X	X	X	X	X	X	X	X	X
Serial or Lot Control Number		X	X	X	X	X	X	X	X	X	
Date of Manufacture (month and year minimum)		X	X	X	X	X	X	X	X	X	
Date to Be Removed from Service (if applicable)		X	X	X	X	X	X	X	X	X	
Maximum Pack Opening Speed (KEAS)	4.3.6	X	X		X			X	X		
Maximum Gross Weight (lb) if applicable	4.3.6							X	X	X	
Average Peak Force Measured during 4.3.6 tests	4.3.6			X				X	X		
Approved for Use Statement	4.2.2			X							
Statement of Authorization Under TSO-C-23e and/or (J) TSO-C-23e if applicable		X	X	X	X			X	X	X	
Operators Warning Label with Maximum Operating Limits	4.3.6			X				X			
Operators Warning Label and location for component operating limitations	4.2.1				X						
Maximum Drogue deployment speed	4.3.6									X	
For ripcords, either lot control number or date of manufacture may be marked provided that tracability is maintained											
At a minimum, Maximum Operating Limitations must include maximum pack opening speed and maximum gross weight. Manufacturer may voluntarily derate operating limitations.											
Redundant marking may be eliminated for components which are permanently joined at the time of manufacture. If this is the case, the marking will be locate the most visible component, normally the container.											

PIA-TS-135 - Table 2

**Human Factors and Actuation Force Tests
Primary Actuation Device / Ripcord**

	Line Reference	Data Required	Test Condition	Load Factor	Second Parachutist	Suspended by	Main Pack Condition	Emergency Parachute Assembly		Single Harness Reserve Parachute Assembly		Dual Harness Reserve Parachute Assembly	
								Male	Female	Male	Female	Male	Female
Primary Actuation Device / Ripcord	A1	P/F Force	Standing Upright	N/A	N/A	N/A	N/A	6	6				
	A2/A2.1	P/F Force	Standing Upright	N/A	none/with	N/A	Full			3	3	3/3	3/3
	A3/A3.1	P/F Force	Standing Upright	N/A	none/with	N/A	Empty			3	3	3/3	3/3
	A4	P/F Force	Suspended Harness	1g	none	Main Risers	Empty			3	3	3	3
	A5	P/F Force	Suspended Harness	1 g	with	Main Risers	Empty					3	3
	Additional tests if emergency/reserve drogue is used:												
	A6	P/F Force	Suspended Harness	4.1.7	N/A	Drogue	N/A	3	3				
	A7	P/F Force	Suspended Harness	4.1.7	none	Drogue	Full			3	3	3	3
	A8	P/F Force	Suspended Harness	4.1.7	none	Drogue	Empty			3	3	3	3
	A9	P/F Force	Suspended Harness	4.1.7	with	Drogue	Full					3	3
	88	P/F Force	Suspended Harness	4.1.7	with	Drogue	Empty					3	3
	Total Tests Required in This Section (drogue / no drogue)								18/12		30/18		60/36
4.1.7 - The drogue release shall be tested at an equivalent (or greater) force to the drag force generated at the MOW and MPOS.													

- Notes:
 1. All tests must be conducted with a reserve/emergency canopy assembly packed for intended use.
 2. N/A = Not Applicable
 3. P/F = Pass/Fail

Required Qualification Tests

Notes on Data Required	Test Description	Reference Paragraph	Speed at Pack Opening (KEAS)	Test Weight	Main Pack Condition	Emergency Parachute Assemblies		Single or Dual Harness Reserve Parachute Assembly	
						Live	Dummy	Live	Dummy
1, 8, 5	Primary Actuation Device/Ripcord	4.3.2	N/A	N/A					
1,2,5	Human Factors Tests	4.3.3	N/A	N/A		Table 2		Table 2	
1,5	Environmental Tests	4.3.5	60	<= MOW					
1, 3	Precondition to +200 F	4.3.5.1					1		1
1, 3	Precondition to -40 F	4.3.5.2					1		1
1, 3	Precondition - compressed pack	4.3.5.3					1		1
1, 3	Precondition - alternate to 4.3.5.1 & 4.3.5.3	4.3.5.4					(alt 1)		(alt 1)
	Structural Overload Tests	4.3.6							
1,2,3,5	Complete Assemblies	4.3.6.1	Fig. 1	Fig. 1	N/S		3	3	
1,2,3,5	Alternate Means of Compliance, Canopy Only	4.3.6.2	Fig. 1	Fig. 1	N/S				
1,2,3,5	Alternate Means of Compliance, Harness Only	4.3.6.3	Fig. 1	Fig. 1	N/S				
1,2,3,5	Drogue (if applicable)	4.3.6.4	Fig. 1	Fig. 1	N/S				
1, 3 (or 4), 5,	Functional Tests, Twisted Lines	4.3.7	60	<= MOW	N/S	5		5	
1, 3 (or 4), 5,	Functional Tests, Normal Pack	4.3.8							
1, 3 (or 4), 5,	Direct Drop	4.3.8.1	60	<= MOW	Empty	14	2	7	2
1, 3 (or 4), 5,	Direct Drop	4.3.8.1	60	<= MOW	Full		<= MOW	7	<= MOW
1, 3 (or 4), 5,	Direct Drop	4.3.8.1	85	<= MOW	Empty	14	2	7	2
1, 3 (or 4), 5,	Direct Drop	4.3.8.1	85	<= MOW	Full		<= MOW	7	<= MOW
1, 3 (or 4), 5,	Direct Drop	4.3.8.1	110	<= MOW	Empty	14	2	7	2
1, 3 (or 4), 5,	Direct Drop	4.3.8.1	110	<= MOW	Full		<= MOW	7	<= MOW
1, 3, 5, 9, 10	Functional Tests, Breakaway	4.3.8.2	< 20 fps Vv	<= MOW	Empty	0		4	4
	Rate of Descent Tests	4.3.9							
1, 5, 7a	Method 1	4.3.9.1	N/A	MOW	N/S	5		5	
1, 5, 7b	Alternate, Method 2	4.3.9.2	N/A	MOW	N/S				
1, 5, 6	Stability Test	4.3.10	N/A	0.5 * MOW	N/S	6		6	
	Live Jumps	4.3.11							
1, 3, 5	Less 3 second delay	4.3.11.1	60	<= MOW		2	0	2	0
1, 3, 5	More than 20 second delay	4.3.11.2	> 85	<= MOW		2	0	2	0

Total Tests Required 74

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Notes on Test Criteria

- 1 P/F
- 2 Riser Force
- 3 Opening Time
- 4 Altitude Loss
- 5 Video Record
- 6 Oscillation Angle
- 7b Rate-of-Descent - Steady state method
- 7a Rate-of-Descent - Alternate (dynamic) method
- 8 Ripcord Pull Force
- 9 If an RSL used, then half of the cutaway test shall be conducted with the RSL - a total of 8 tests is required
- 10 Dummy Use is Optional

PIA-TS-135 - Table 4.													
Performance Test Requirements for Component Qualification													
Description of Test	Reference Paragraph for PIA-TS-135	Complete Parachute Assembly	Deployment Initiation Device (Pilot Chute, etc.)	Deployment Control Device, (dbag, etc.)	Canopy, lines, links, and reefing device (if used)	Stowage Container	Primary Actuation Device (Ripcord or Equivalent)	Reserve Static Line (if used)	Harness	Risers (if not integral with harness)	Main Parachute Breakaway Device (if used)	Drogue, Canopy & Riser (if used)	Drogue Release Device (if used)
Ripcord Strength Tests	4.3.2	X					X	X					
Human Factors	4.3.3	X				X	X				X	X	X
Environmental	4.3.5	X	X	X	X	X			X	X	X	X	X
Strength Tests - Assembly	4.3.6.1												
Strength Tests - Canopy Alternate	4.3.6.2												
Strength Tests - Harness Alternate	4.3.6.3												
Strength Tests - Drogue Canopy and Bridle	4.3.6											X	
Strength Tests - Deployment Devices	4.3.6		X	X									
Functional Tests - Twisted Line	4.3.7	X		X	X								
Functional Tests - Normal Pack, Direct Drop	4.3.8.1	X	X	X	X	X	X	X				X	X
Functional Tests - Normal Pack, Breakaway	4.3.8.2	X	X	X	X	X	X	X					
Rate of Descent	4.3.9.1	X			X								
Rate of Descent - Alternate	4.3.9.2												
Stability	4.3.10	X			X								
Live Drops	4.3.11	X	X	X	X	X	X	X	X	X	X	X	X