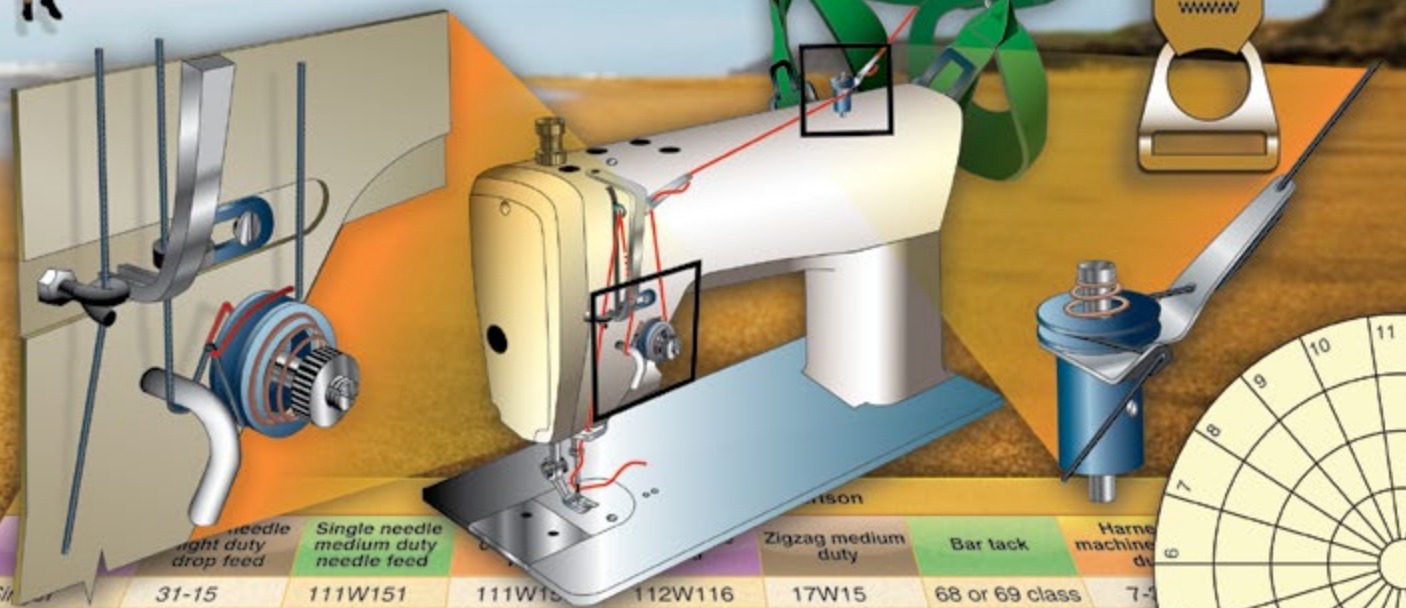


Parachute Rigger Handbook



U.S. Department
of Transportation
Federal Aviation
Administration



	Single needle light duty drop feed	Single needle medium duty needle feed		Zigzag medium duty	Bar tack	Harness machine duty
Singer	31-15	111W151	111W151	112W116	17W15	68 or 69 class
Consiew	292R	N/A	206RB-4	333RB-1	199R-2A	N/A
Juki	DLN-415		LU-563	LH-515		
Brother		B-791				
Mitsubishi	DB-130	DY-340-12	LU2-400	LT2-220	LZ-780-11	
Pfaff					138	3334



Parachute Rigger Handbook

August 2015

Change 1 (December 2015)

U.S. Department of Transportation
FEDERAL AVIATION ADMINISTRATION
Flight Standards Service

Record of Changes

Change 1 (December 2015)

This is an updated version of FAA-H-8083-17A, Parachute Rigger Handbook, dated August 2015. This version contains error corrections, revised graphics, and updated performance standards. All pages containing changes are marked with the change number and change date in the page footer. The original pagination has been maintained so that the revised pages may be replaced in lieu of repurchasing or reprinting the entire handbook. The changes made in this version are as follows:

- Updated Table of Contents page numbers (page ix).
- Replaced Figure 2-12 (page 2-8) with version from previous version of the handbook (FAA-H-8083-17, Figure 2-10).
- Revised the third sentence in the second paragraph in the left column of page 2-14: changed “ $\frac{3}{8}$ ” to “ $\frac{1}{2}$.”
- Revised the caption for Figure 3-17 (page 3-7): changed “Tape” to “Webbing.”
- Revised the caption for Figure 3-18 (page 3-7): changed “Tape” to “Webbing.”
- Revised the last sentence in the first paragraph in the right column of page 7-2: changed “FAA-licensed” to “FAA-certificated.”
- Revised the third bullet under Square Canopy – Rib Repair in the right column of page 7-25: added “—mains and reserves; FAA Senior Parachute Rigger—mains.”
- Revised Figure G at the bottom of page 7-82: removed “+2” after “X = Required length.”
- Revised Appendix A Table of Contents (page A-1): revised titles of new documents and updated page numbers.
- Revised Appendix A: replaced *PIA TS-100—Standardized Nomenclature for Ram-Air Parachutes* with latest version (pages A-3 – A-10).
- Revised Appendix A: replaced *SAE AS 8015B—Minimum Performance Standards for Parachute Assemblies and Components* with *Personnel PIA TS 135—Performance Standards for Personnel Parachute Assemblies and Components* (pages A-26 – A-43)
- Revised Appendix A: updated page numbering for all documents (pages A3 – A-65).

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most influential concept in the evolving container design. Cones were replaced by fabric closing loops, and main ripcords and pins were replaced by hand deploy bridles and locking pins. It was no longer necessary to compress the spring-loaded pilot chute inside the container. Thru closing loops were used to compress the pack and make it thinner to conform to the body shape. The use of deployment bags and other devices helped provide shaping to the container. This was true for both square and round canopies.

Today, most modern container designs have completely done away with frames and bow stiffeners. This has resulted in smaller, more flexible, more comfortable, and more efficient container designs. Instead of metal stiffeners, nylon plastic is used to reinforce the container flaps for backing the grommets. The nylon is lighter, easier to work with, and cheaper. Many of the modern military designs now follow the design concepts pioneered by the sport industry as they have proven better and more cost effective. *Figure 2-10* shows a modern military container.



Figure 2-10. *Modern military container.*

Modern Design Concepts

The containers of today do more than simply enclose the canopy and deployment device. Sport containers in particular need to be designed so that they contribute to the deployment needs of the specific parachute. Piggyback designs have separate requirements for the main and reserve containers.

The reserve container is generally small, tight, and mostly wedge-shaped. Virtually all popular sport systems are designed around the use of a ram-air canopy. The deployment method of choice is a Type 5 deployment bag. In the early days of the ram-air reserve, there were certain container design requirements specified by the manufacturers which are listed below:

1. A hesitator loop configuration secures the bridle and holds the bag in until the reserve pilot chute is deployed and under drag. *[Figure 2-11]*



Figure 2-11. *Square reserve hesitator loop configuration.*

2. Nonrestrictive corners to allow the bag to be lifted off by the bridle in the event of a horseshoe-type malfunction. *[Figure 2-12]*

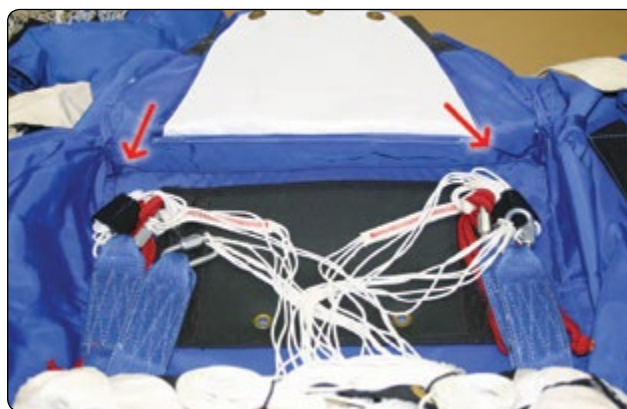


Figure 2-12. *Non-restrictive container corners.*



Figure 2-27. Tail pocket.

Securing the Deployment Device

With all deployment methods, it is necessary to properly fold or stow the canopy and secure the deployment device with the lines. The early parachutes utilized hesitator loops to secure the lines. [Figure 2-28] This method is still used today in many military systems.



Figure 2-28. Hesitator loops.

In modern designs that utilize types 1 through 4 and 6, the preferred method of locking the deployment device is rubber bands. The specification for standard rubber bands is MIL-R-1832. Type 1 are made of natural rubber and are ½" x 2". These were designed for use with the thicker Type III nylon lines such as on the 28' C-9 canopy. Many of the newer lightweight, round canopies use smaller diameter and fewer lines. Consequently, the standard rubber bands do not work well. Some manufacturers supply smaller, 1¼" diameter rubber bands to be used with their canopies. It is extremely important to utilize the correct size rubber bands.

With the introduction of the free bag system in 1977, Para-Flite, Inc., used a BUNA-N "O" ring to secure the locking stows. [Figure 2-29] During testing of the free bag system, they found inconsistent holding and breaking strengths of rubber bands. They wanted the locking stows to release at a consistent force to prevent bag lock. The "O" rings provided this. A couple of years later, the "O" rings were upgraded to a thicker diameter model. In 1983, Para-Flite, Inc. replaced



Figure 2-29. Para-Flite O-rings.

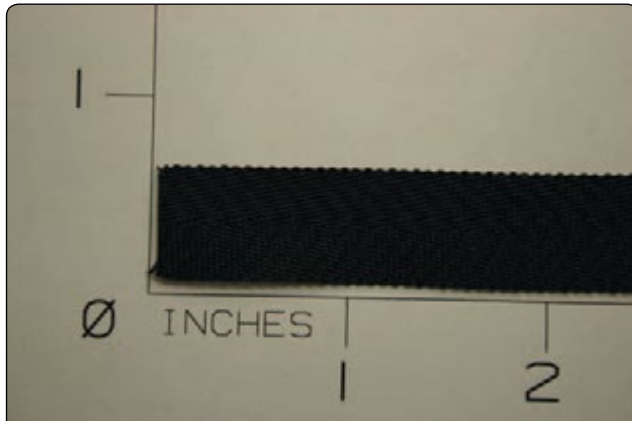
the "O" rings with the Safety Stow®. The Safety Stow® is a continuous loop of elastic shock cord that runs through a webbing channel and through two grommets to secure the first two locking stows. [Figure 2-30] In the event of any restriction on the locking stow, as the loop stretches, it allows first one side to release and then the opposite side.



Figure 2-30. Safety Stow®.

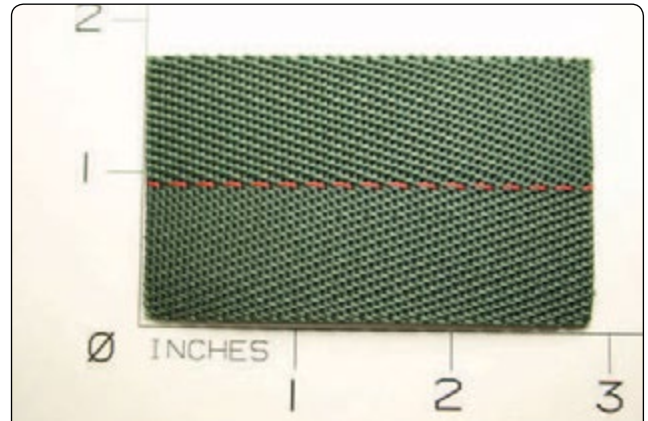
It is important to maintain the rubber bands or Safety Stow®. Rubber bands are susceptible to heat degradation and may dry out. If they break prematurely during use, the parachute may malfunction. Non-mil. specification rubber bands may react to natural brass grommets and may become gummy and sticky, causing the lines to stick to the diaper or bag. Rubber bands should be replaced during routine Inspection and Repack. [Figure 2-31A and B] The BUNA-N "O" rings should be replaced with the Safety Stow®. The Safety Stow® should be inspected for broken stitching or internal rubber strands. [Figure 2-32]

In response to occasional violent openings on ram-air canopies, Parachute Labs (Jump Shack) in 2003 introduced the "speed bag" to eliminate "line dump" (line strip). The lines are retained in rubber bands 25 percent in from the edge of the bag. This balances the mass of the stows between the



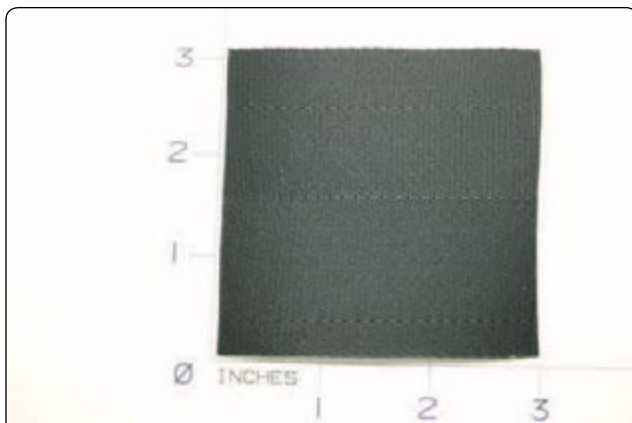
Specification:	PIA-W-4088
Strength:	500 lb
Identification:	2/2 HB twill, 1/16" width, no color code
Common Use:	Stow band retainer loops on main deployment bags
Comment:	N/A

Figure 3-17. 1/16" Type-1 Webbing.



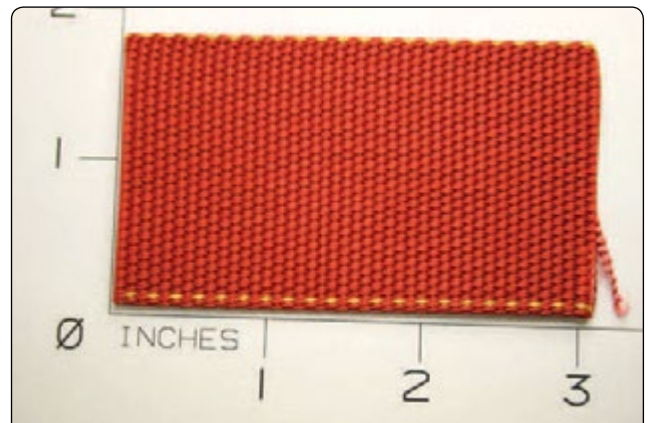
Specification:	PIA-W-4088
Strength:	2,500 lb
Identification:	2/2 HB twill, 1 23/32" width, red centerline
Common Use:	Buffer strips, harness attachment straps on Navy containers
Comment:	N/A

Figure 3-19. Type-6 Webbing.



Specification:	PIA-W-4088
Strength:	1,800 lb
Identification:	2/2 HB twill, 3" width, some slider edge tapes
Common Use:	Confluence wraps, container reinforcing
Comment:	Not to be confused with 5038 Ty-4 square weave.

Figure 3-18. 3" Type-4 Webbing.



Specification:	PIA-W-4088
Strength:	6,000 lb
Identification:	Double plain weave, 1 23/32" width, 1/16" thick, with yellow tracer thread at each selvage edge
Common Use:	Modern sport harness, risers
Comment:	Originally intended for cargo netting use; also used in sport harnesses

Figure 3-20. Type-7 Webbing.

As stated in Chapter 1 of this handbook, Regulations and Human Factors, it is imperative that riggers be able to distinguish between minor and major repairs. This ensures that riggers do not exceed the limitations of their certificate or endanger the parachute user. The basic rule for repairs is to return the damaged parachute or component to its original airworthy configuration. However, in many instances, the remanufacture of the parachute may not be practical or cost effective. In these cases, there are approved repair techniques riggers can use to return the parachute to service. These techniques form an important part of the rigger's store of knowledge. To make a decision as to the confirmation for the possible need for repairs, we must first understand the Federal Aviation Administration (FAA) requirement of inspection.

Inspection Process

Chapter 5 of this handbook, Inspection and Packing, addresses the purpose of the 180-day cycle as required by the FAA. This action insures that the approved/certificated parachute assembly meets the standards and conditions for safe return to service; it also become the cornerstone of the maintenance and repair process.

The confirmation of wear or damage is critical in the determination of actions that may be needed as set forth in Title 14 of the Code of Federal Regulations (14 CFR) part 43 and key in the assessment of actions and clarity of the repair that may need to be performed.

As is the character of any device or object, use and physical location conditions (heat, moisture, sand, dirt) over time cause wear to an item and, on occasion, misuse or improper actions during use result in damage. Certain parts or areas of a device incur more wear or damage according to use, action of handling, and contact with other components. Knowledge of this aspect should require increased or location specific consideration during the inspection process.

This recognition possibility of high-wear components or areas does not decrease or eliminate the inspection of any other part of the parachute assembly. It only identifies that the wear or damage probabilities are greater at these locations. These areas are referred to as common wear or damage patterns and apply to both round and square parachutes and parachute assemblies. These types of common wear/damage pattern applies in greater detail to the parachute that is utilized as the main parachute and deployed on each jump in sport use.

The inspection of a reserve canopy after deployment should be very concise and complete. Much care should be taken for a very thorough inspection of the parachute and related components. Parachutes are manufactured in two categories: approved (certificated) and non-approved

(non-certificated). All reserve emergency use parachutes are approved (certificated) and are tested to FAA-required Technical Standard Order (TSO) standards. They are used and maintained by FAA standards (inspection and repaired by FAA-certificated rigger or the manufacturer) as airframe and powerplant (A&P) mechanics are used.

Non-approved or non-certificated parachutes are generally main parachutes, and related components, which can be packed, used, and repaired outside of FAA maintenance and repair requirements. Rigger inspections and rigger repairs are highly recommended but not required. Inspection of and approved (certificated) parachute calls for inspection of all related components, which are listed below. Related components are parts of the parachute, deployment system, harness, and container system, and any item that has responsibility for containment, deployment, or operation of an approved (certificated) parachute and are a critical part of the assembly. They must be inspected for use the same as the reserve parachute.

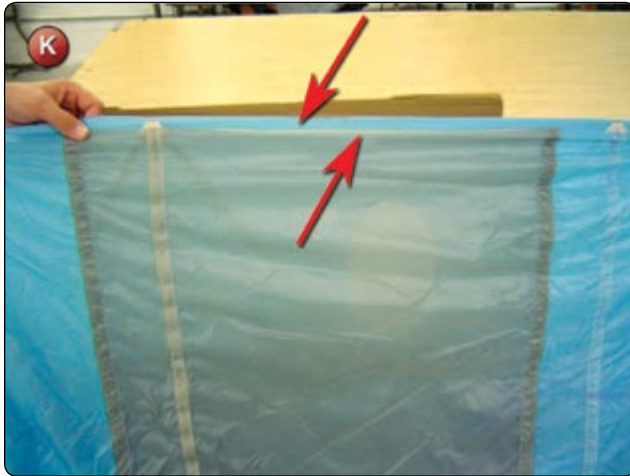
- Deployment bag (freebag, safety stow)
- Bridle and pilot chute
- Slider, slider fabric, and grommets
- Rapid links (soft links)
- Rapid link covers (soft link covers)
- All seams and seam fabric
- Suspension lines and line attachments
- Ripcord housing and attachments
- Ripcord assembly
- Upper and lower skins of canopy, all load and non-load bearing ribs, all cross ports

All of these areas can sustain wear or damage during normal use. The event of use at very high speeds can be contributed to the possibility of increased damage from exceeding the maximum speed allowed during deployment.

During inspection of certificated/approved parachutes, it is advisable to map related damage found on a chart which is shown in *Figure 7-1*. This chart can be used to describe the location of needed repair to a customer, assist in quickly locating the damage, and answer questions that the manufacturer may have relating to possible repair. *[Figure 7-1]*

If a rigger were to receive a damaged sport main canopy for repair, it would be advantageous to gain as much information as possible as to the cause and situation that created the damage. Inspection of the canopy should be as follows:

11. Check the tension of the new partial panel piece against the edges of the other panels that formed the original seam. They should all be equal. [Figure K]



12. Refold the original seam with the three panel edges and stitch as per the original seam. [Figure L] Overstitch a minimum of 2 inches on each end.



13. If a line attachment has been removed for the repair, the tab must be replaced. Make sure that the line/tab does not have a twist in it. Locate it at the correct location and reattach as per original.

Inspection

- Check the fabric tension of the replaced panel. It should be equal to that in the remainder of the cell.
- Spanwise reinforcing tape should be straight and sewn.
- Seams should be folded correctly and thread tension even along both rows of stitching.
- Line should be attached correctly and have no twists.

Square Canopy—Rib Repair

- Applicable products: square canopies; main and reserve
- Description: Rib repair on a square canopy
- Authorized repairmen: FAA Master Parachute Rigger —mains and reserves; FAA Senior Parachute Rigger—mains
- Materials: E thread; fabric—type and color to match, reinforcing tape—type and color as per original
- Machines: 301 dtraight dtitch—medium duty 7–11 SPI, 1 inch × 42 stitch bar tack, double needle with puller attachment (optional) and SPI to match original
- Equipment: Scissors, seam ripper, marking pencil, ruler, pin board, straight pins, and patching square

Procedure

Repairing a rib of a square canopy is similar to doing a partial panel repair. The biggest difference comes when the rib is either:

1. A “loaded” rib or one with support tapes for the line attachment points, or
2. A crossport is damaged and needs to be repaired and recut. In this case, the crossport area needs replacement. [Figure A]



Disassembly

1. Determine the extent of the damaged area and unpick the top and bottom seams to access the rib. [Figure B] In most cases, restitching the rib to the top and bottom panels is fairly straightforward. Because of this, opening up the seam for a good distance (18 inches plus either side of the proposed patch) allows easier access and sewing.
2. Pin the damaged rib to the pin board to stabilize the material for marking. Mark out the damaged portion of the panel, following the weave of the fabric.

Appendix A

Technical Documents

PIA TS-100—Standardized Nomenclature for Ram-Air ParachutesA-3

PIA TS-108—Parachute Canopy Fabric Pull Test, Non-Destructive MethodA-16

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PIA Technical Standard 100
Parachute Industry Association Publications
March 27, 2015

Standardized Nomenclature for Ram-Air Parachutes

Introduction

This Technical Standard was adopted by the Parachute Industry Association (PIA) on March 27, 2015. Input concerning revisions and additions should be submitted to:

Parachute Industry Association, Inc.

Attention: Technical Committee Chair
3833 West Oakton Street
Skokie, IL 60076
Telephone: 847-674-9472
Fax: 847-674-9743
Email: TechComChair@pia.com

Definitions

Airlock: On a canopy, a valve which permits air flow more easily in one direction, and restricts airflow in the opposite direction. In most case, airlocks are installed in the nose of the canopy to permit air to enter during deployment and flight, and restrict air from flowing out the nose to ensure better pressurization in turbulent air.

Angle of

Attack: The angle formed between the flight path and the chord line. The Greek letter alpha (α) is used to denote the angle of attack. See Figure 3.

Trim: The angle formed between the horizontal reference line and the trim line. The Greek letter theta (θ) is used to denote the angle of trim. Used instead of the somewhat analogous aircraft term "angle of incidence." See Figure 1b.

Area,

Airfoil Section: The finished cross sectional area of a given rib (airfoil) section. When ribs are not identical, the specific rib must be identified. Used for calculations of pack volume and internal volume of canopy.

Planform: The product of the average chord times the average span of the canopy.

Projected: The area of an inflated canopy as viewed from above, perpendicular to the chord line at the centerline of the parachute. Due to canopy curvature and cell inflation bulging the projected area is always smaller than the planform area.

Aspect Ratio: $\text{Span}^2/\text{Area}$, which for a rectangular planform reduces to Span/Chord .

Attachment Point: A loop of tape, webbing, or the functional equivalent, for attaching something to the surface of the canopy.

Pilot Chute. An attachment point for the pilot chute or pilot chute bridle, including any reinforcement to reduce the effects of abrasion, and also including any additional rib- or canopy-reinforcing tapes intended to distribute the load from the pilot chute to the canopy.

Suspension Line. An attachment point for a suspension line or control line. Some canopies use extensions of rib-reinforcing or flare-reinforcing load tapes to form line attachment points. See also **Flare, Suspension Line Attachment**.

Cell: The chamber formed by upper and lower surfaces and two adjacent loadbearing ribs.

Channel,

Drawstring: A fabric or tape channel that encloses a drawstring, most often found on main canopy sliders.

Pilot Chute Reefing: A channel that runs through the center of the canopy, from upper surface to the lower surface, to allow the pilot chute bridle to connect to the slider.

Chord: The distance from the farthest forward point to the farthest aft point on an airfoil section. If the canopy airfoil sections are not identical, an average chord may be specified. Airfoil dimensions are assumed to be finished dimensions unless otherwise specified. See also **Span**, and **Line (Design), Chord**.

Construction,

Chordwise: A construction method in which upper and lower surfaces are assembled from panels which run from front to rear (chordwise) and are joined to the ribs and each other using a variety of sewn seams. The most common type of ram-air parachute construction.

Spanwise: A construction method in which the upper and lower surfaces are assembled from panels that run from side to side (spanwise) across the full width of the canopy. Personnel parachutes usually require three or four panels each for the upper and lower surfaces.

Crossports: Holes cut in the rib sections to balance the air pressure between adjacent chambers.

Drawstring, Slider: A length of tape or line which may be pulled to collapse or remove a slider after deployment.

Flare, Suspension Line Attachment: An extension of a load bearing rib used on some canopies to distribute suspension line loads along the lower rib seams. A suspension line attachment flare may be integral with the rib or may be sewn to it.

Line (Design),

Chord: A line drawn through the farthest forward point and the farthest aft point on an airfoil section. See Figure 3.

Reference, Horizontal: A line drawn at a right angle to the Vertical Reference Line. Usage is equivalent to the practice of using the aircraft longitudinal axis as an aircraft reference line. See Figure 3.

Reference, Vertical: A line drawn through the links and the quarter chord point.

Trim: A line drawn through the farthest forward and farthest aft line attachment points (excluding control line attachment points). See Figure 1b.

Line (Rigging),

Cascade: A line attached with one end at the canopy and the other end to an intermediate point of an adjacent line. Contrast with **Continuous**.

Continuous: A line attached with one end at the canopy and the other end at the riser of connector link. Contrast with **Cascade**.

Control: A line fastened to the trailing edge of the canopy, used to steer and modulate the forward speed and descent rate of the parachute. Also known as steering or brake line.

Flare: A control line intended primarily for flaring the canopy for landing, but which may also for steering. Also known as **Secondary** control lines, in which case the remaining control lines are known as **Primary** control lines.

Brake-Toggle: When a control line is constructed in sections, that portion of the line between the toggle and the deployment set eye ("cat-eye").

Lower: When a control line is constructed in sections, that portion of the line between the deployment set eye and the upper portion.

Upper: When a control line is constructed in sections, that portion of the line between the canopy and where it converges with other lines attached to the canopy.

Identification System for:

Suspension lines: lettered "A," "B," "C," . . . from front to rear along each load-bearing seam. Numbered from outboard to inboard (outboard lines numbered "1"; see Figure 2a) or inboard to outboard (lines on center load-bearing seams numbered "1"; see Figure 2b).

Control lines: numbered by rib seam, including non-load-bearing ribs, from outboard to inboard. See Figures 2a and 2b.

Suspension: One of the lines that carries the load from the canopy surface to the risers. Control lines are usually not considered suspension lines.

Pilot Chute Controlled Reefing (PCR): A parachute reefing system that uses the drag of the pilot chute to modulate the opening rate of the canopy.

Planform: The overall shape of the wing as viewed from above, perpendicular to the chord line.

Quarter Chord Point: a point on the chord line one quarter of the distance from the nose to the tail of an airfoil.

Removable Deployment System (RDS): A slider variation that permits the slider to be removed and stowed separately after deployment. "Full RDS" is a further variation that also permits the pilot chute, bridle, and deployment bag to be removed and stowed after deployment.

Rib: A section of fabric installed between the upper and lower surfaces of a canopy. Used to establish the airfoil shaped of the canopy. Rib numbering systems (for example, from outboard to inboard, or from inboard to outboard) vary from manufacturer to manufacturer.

Rib, crossbrace: A rib or partial rib installed at an angle other than a 90° angle to the upper and lower surfaces of a canopy.

Rib, loadbearing: A rib to which suspension lines are attached, installed at a 90° angle to the upper and lower surfaces of a canopy.

Rib, non-loadbearing: A rib without attached suspension lines, installed at a 90° angle to the upper and lower surfaces of a canopy.

Rib, stabilizer: A stabilizer-end rib assembly with line attachments along the lower edge.

Rigging,

Crown: A suspension line length pattern in which all “A” lines are the same length across the span of the canopy, all “B” lines are the same length across the span of the canopy, and similarly all “C” and “D” lines, etc.

Flat: A suspension line length pattern in which the lines in the center of the canopy are shorter than the lines farther outboard. In flight, the center part of the airfoil is flatter and creates more vertical lift than a crown-rigged canopy, which generates lift along the radius of the spanwise arc.

Setting,

Deployment: The position of the trailing edge when the control lines are pulled down to their deployment position.

Full-Flight: The position of the trailing edge when the control lines are fully extended.

Slider: A parachute reefing device usually consisting of a rectangular section of canopy cloth reinforced on the edges with lightweight webbing or tape, and with a large grommet or D-ring installed at each corner. Sliders may have fabric removed from the rectangular section or may have fabric edge extensions installed to change opening characteristics. Slider variations include:

- Domed, with a planform similar to a flat rectangular slider, but with fabric pleated along the edges.
- Split, capable of being disassembled into halves after deployment.
- Spider, made of two lengths of webbing sewn in an “X,” and usually used with pilot chute controlled reefing. See **Pilot Chute Controlled Reefing (PCR)**.
- Removable. See **Removable Deployment System**.

Slider Bumper: A small device, typically made from vinyl/silicon tubing, Type-4 tape, or Type-12 webbing, installed at the lower end of the suspension lines to prevent damage to the slider grommets caused by the slider contacting the connector links.

Slider Stop: A small piece of rigid material (metal, plastic, phenolic, etc.) normally covered in tape or light webbing, installed on the lower edge of a stabilizer panels to prevent a slider grommet from riding up over the stabilizer material and damaging the stabilizers or the slider.

Slider Stop Chafing Pad: A tape or fabric reinforcement installed on a stabilizer at a slider stop to reduce wear from abrasion.

Soft link: A connector link constructed primarily of fabric or tape.

Span: The distance from one side of a canopy to the opposite side. Measurements taken at various distances aft of the nose will yield different results, Measurements taken across the upper surface will typically be longer than those taken across the lower. An average span, or separate leading and trailing edge dimensions, may be specified. Airfoil dimensions are assumed to be finished dimensions unless otherwise specified. See also **Chord**.

Stabilizer: A fabric panel installed at the end of a canopy, intended primarily to reduce wingtip vortices (much as an end plate on an aircraft wing), and to provide some directional stability. Some stabilizer designs are ram-air pressurized for additional rigidity.

Tapes, Reinforcement: A tape installed in the canopy to provide additional strength or dimensional stability. Tapes are identified by location.

Cross Tapes: A reinforcing tape that runs spanwise on the upper or lower surface to distribute loads through the canopy. With chordwise construction, a cross tape typically runs from a line attachment point to laterally adjacent line attachment point, although some may run from a suspension line attachment point diagonally to a control line attachment point. With spanwise construction, a cross tape may be rolled into a seam joining spanwise panels.

Leading Edge Tape: A tape applied to or rolled into the leading edge of a upper or lower panel. May be continuous across the span of the canopy.

Line Attachment Reinforcement Tape: A tape sewn chordwise into a seam at a line attachment point.

Load Tape: A tape applied to a rib section and used to distribute the load from a line attachment to the canopy. When applied in a “V” may also be known as a “**V-tape**.” In some canopies, load tapes may extend through the lower seam to become line attachment points.

Rib Leading Edge Tape: A tape applied to or rolled into the leading edge of a rib section.

Trailing Edge Tape: A tape applied to or rolled into the trailing edge seam. Usually continuous across the span of the canopy.

Toggle, Control: A grip attached to the end of the control line to allow the user an adequate handhold on the line. Most commonly consists of a tape/webbing loop or a hard plastic dowel. Typically supplied as part of the container assembly.

Trim: The arrangement of differential line lengths to produce a desired trim angle and anhedral. See also **Angle of Trim**. See Figures 1a and 1b.

Vent, Lower Surface: An opening in the lower surface to provide an alternate path for pressurization during deployment (“inflation vent”) or depressurization during flight (“accuracy vent”).

All lines measured pulled to equal tension (5 -35 pounds typical, varies by manufacturer and line type) parallel to the "A" line, and secured to the same connector link or peg.

When measuring control line trim, secure the deployment setting eye to the connector link or peg.

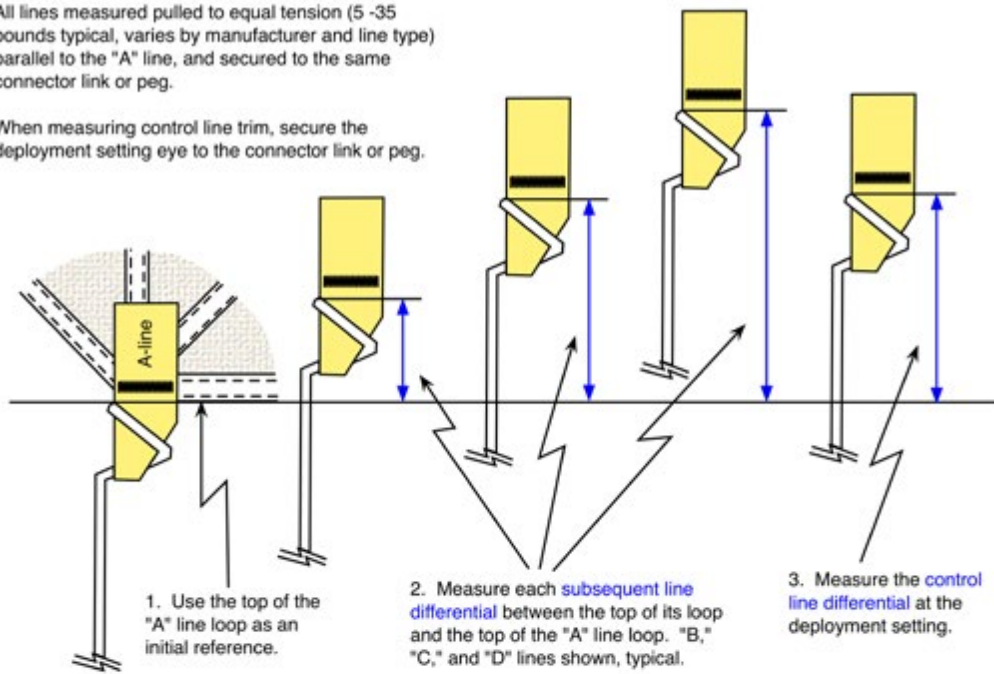


Figure 1a. Measuring line length trim.

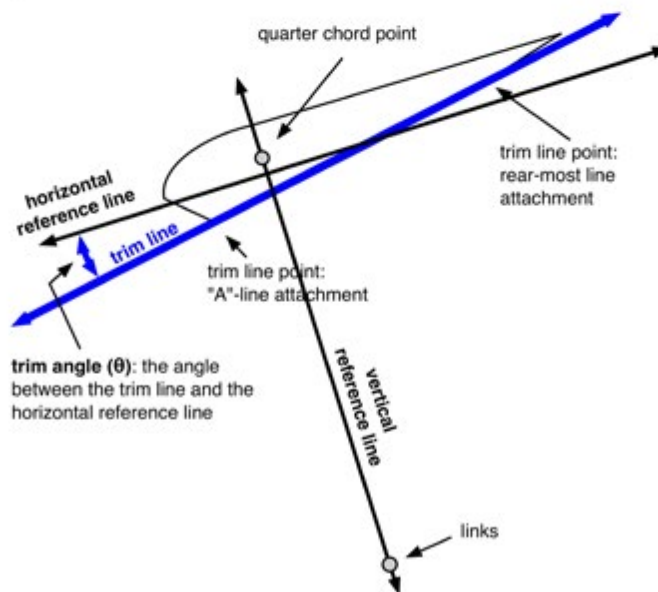


Figure 1b. Measuring trim angle.

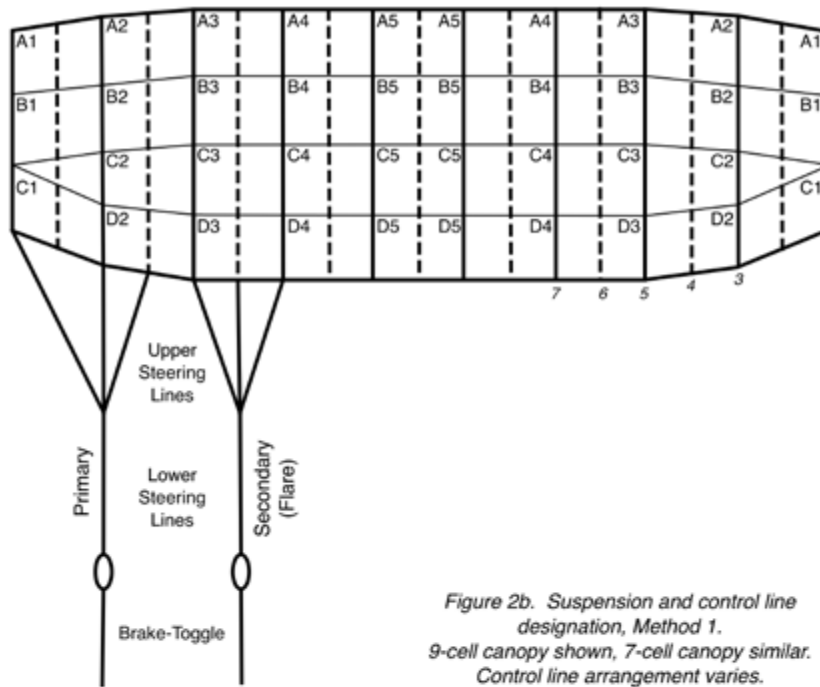


Figure 2b. Suspension and control line design, Method 1. 9-cell canopy shown, 7-cell canopy similar. Control line arrangement varies.

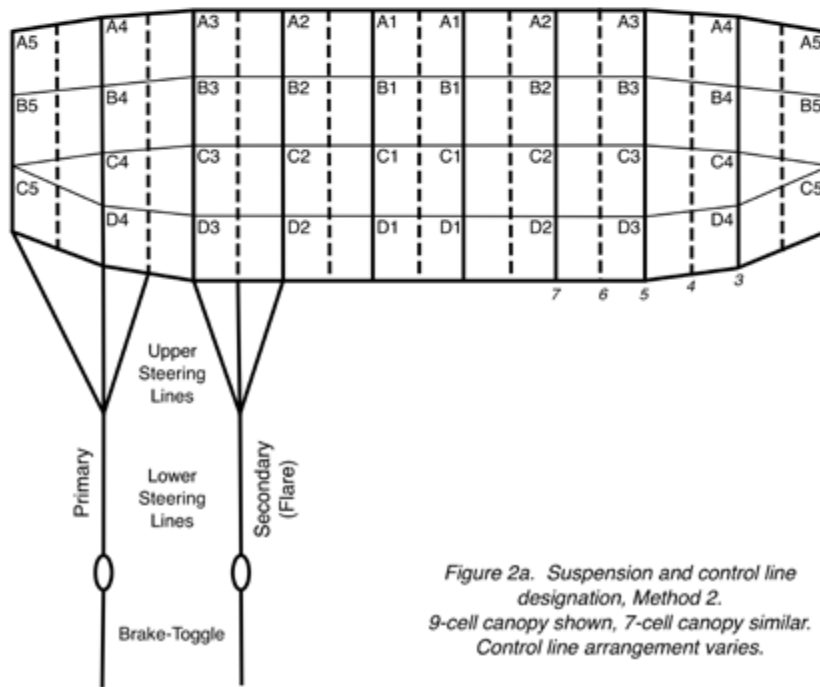


Figure 2a. Suspension and control line design, Method 2. 9-cell canopy shown, 7-cell canopy similar. Control line arrangement varies.

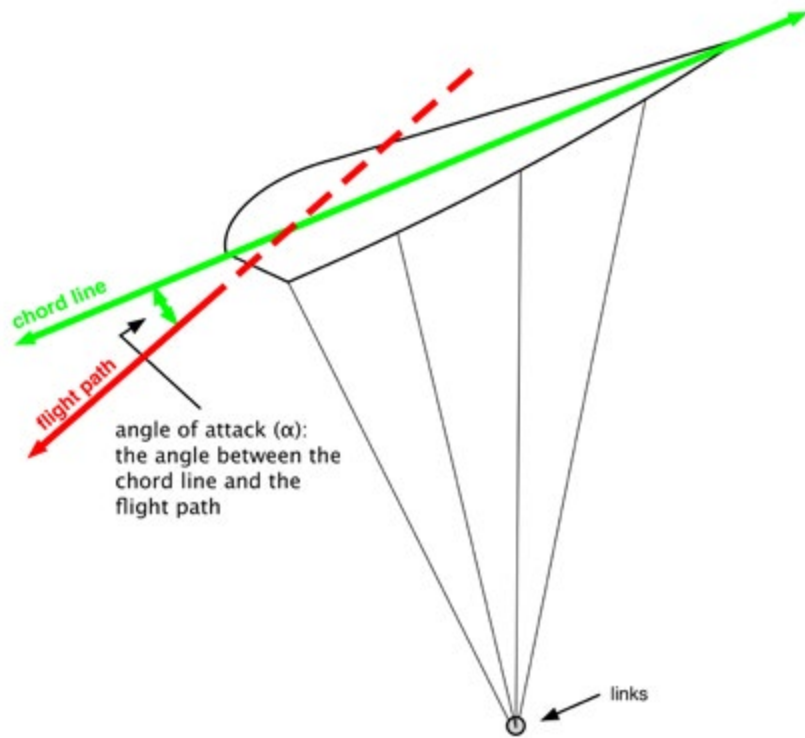


Figure 3. Angle of attack.

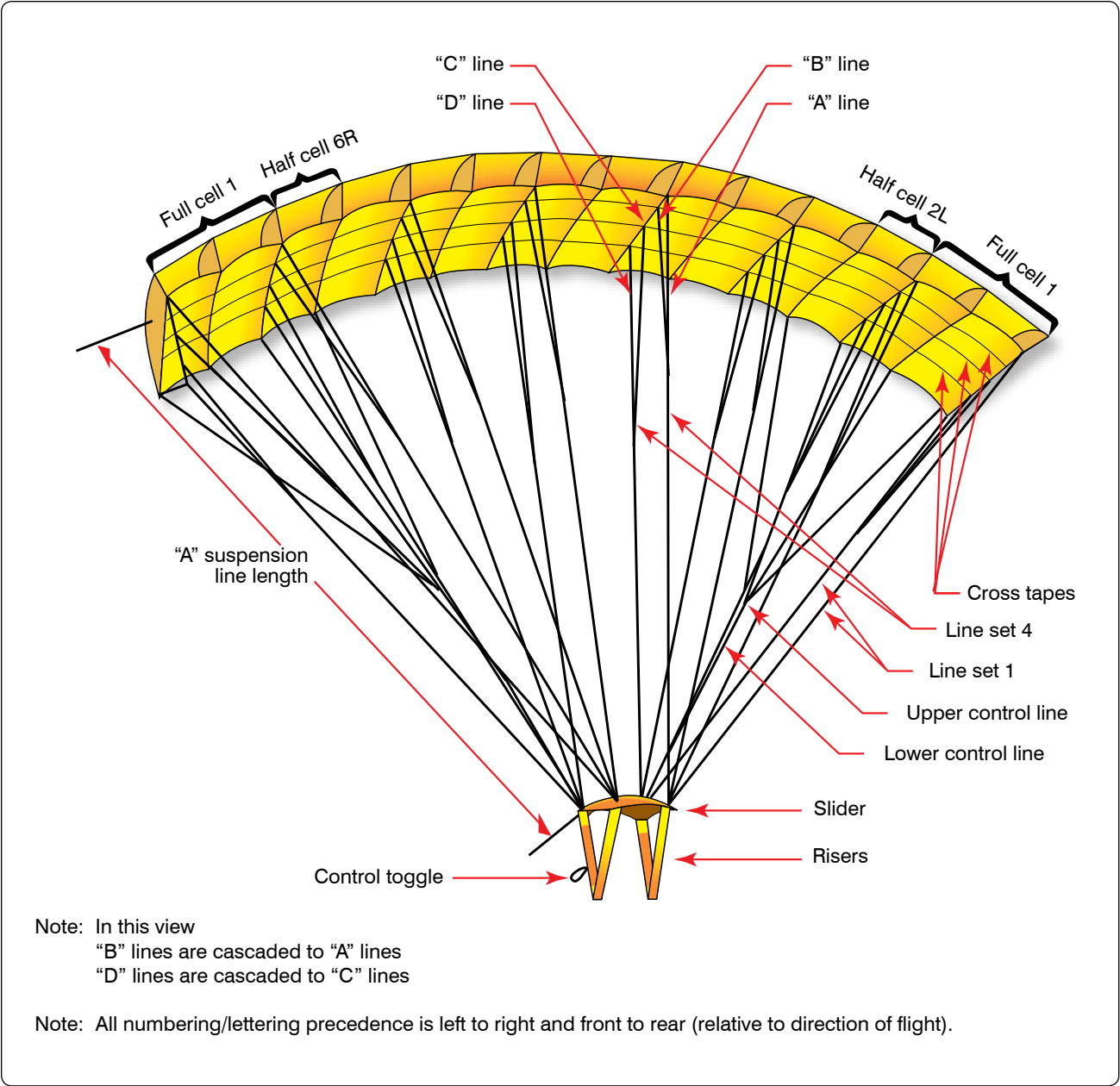


Figure 1.

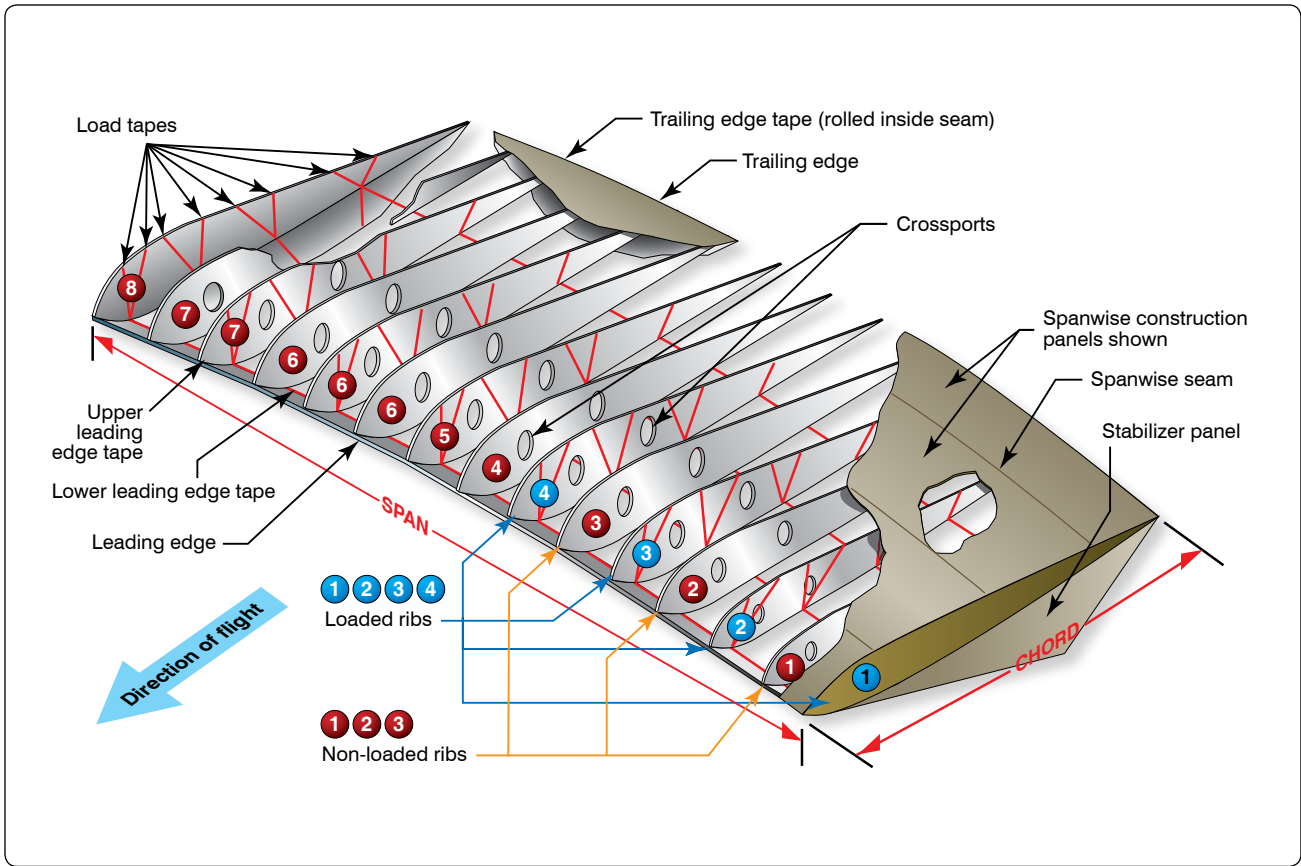


Figure 2.

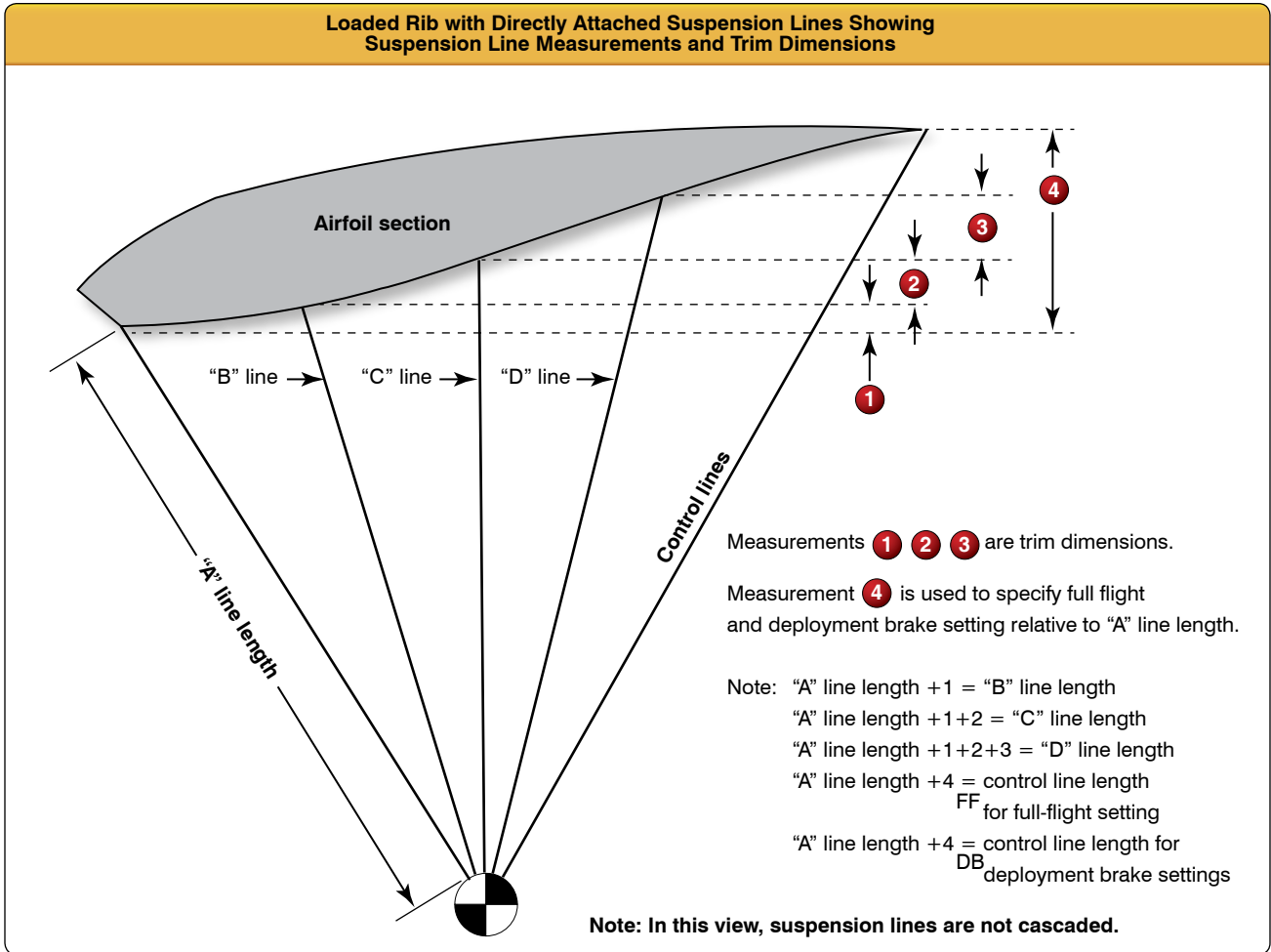


Figure 3A.

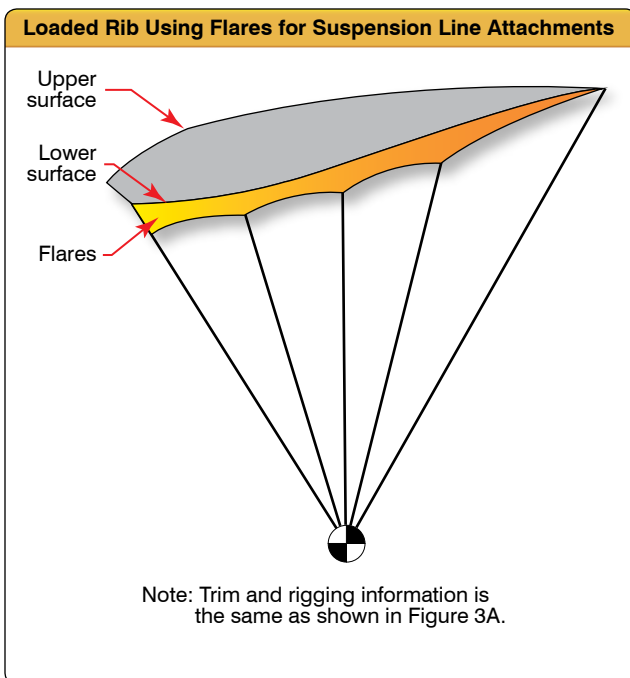


Figure 3B.

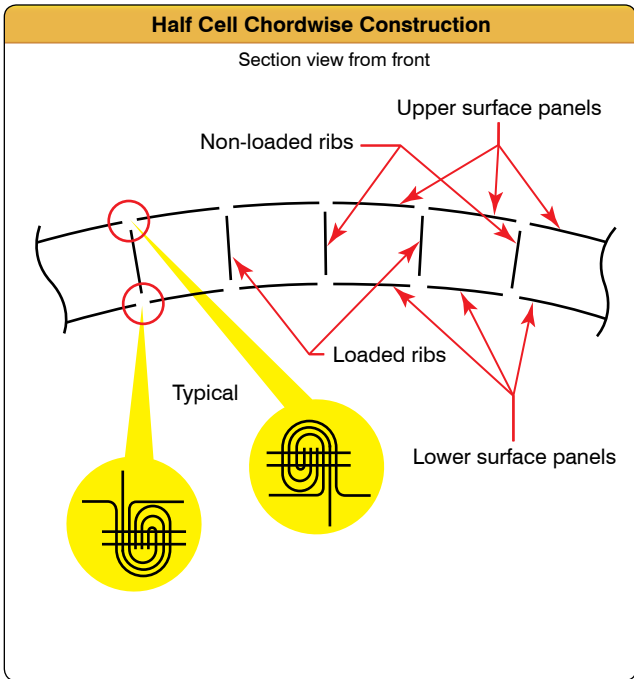


Figure 4A.

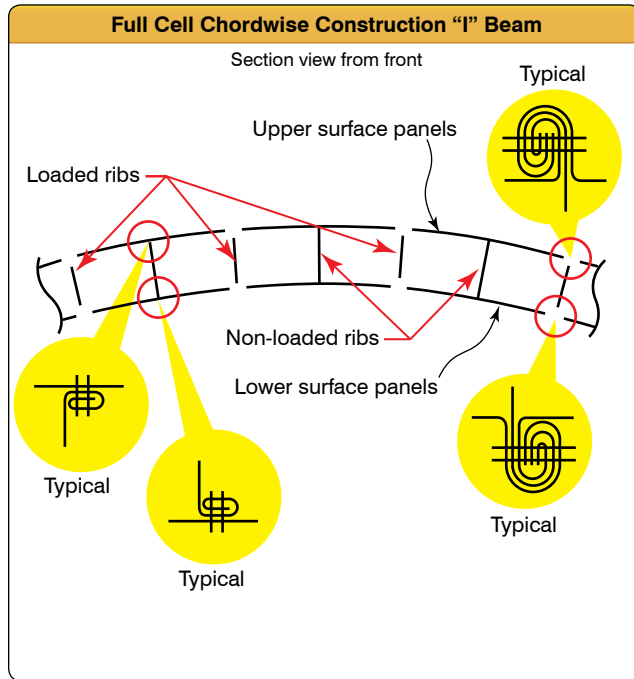


Figure 4B.

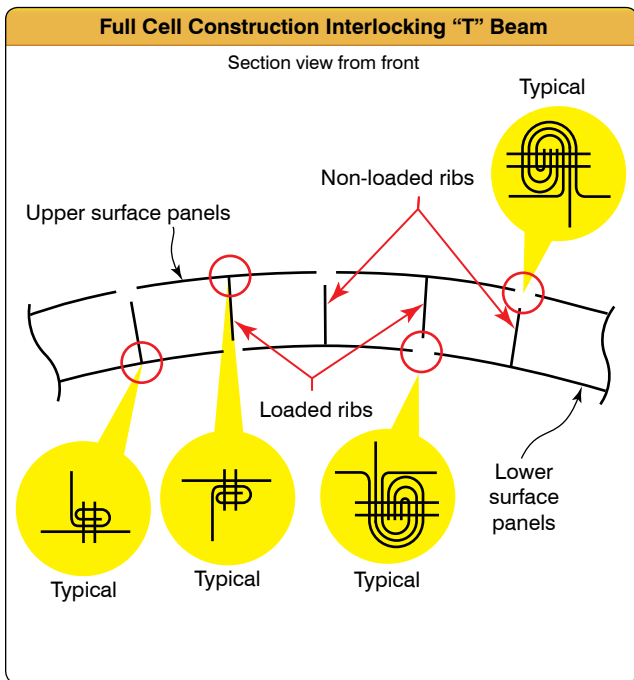


Figure 4C.

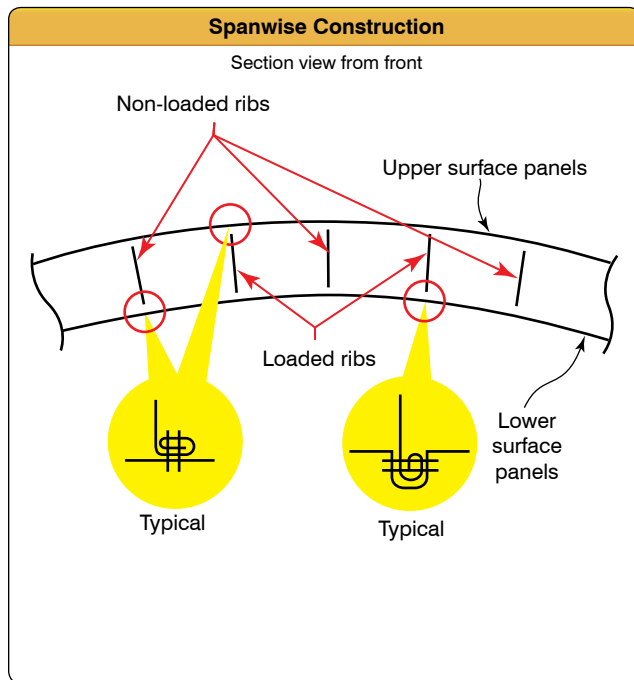


Figure 4D.

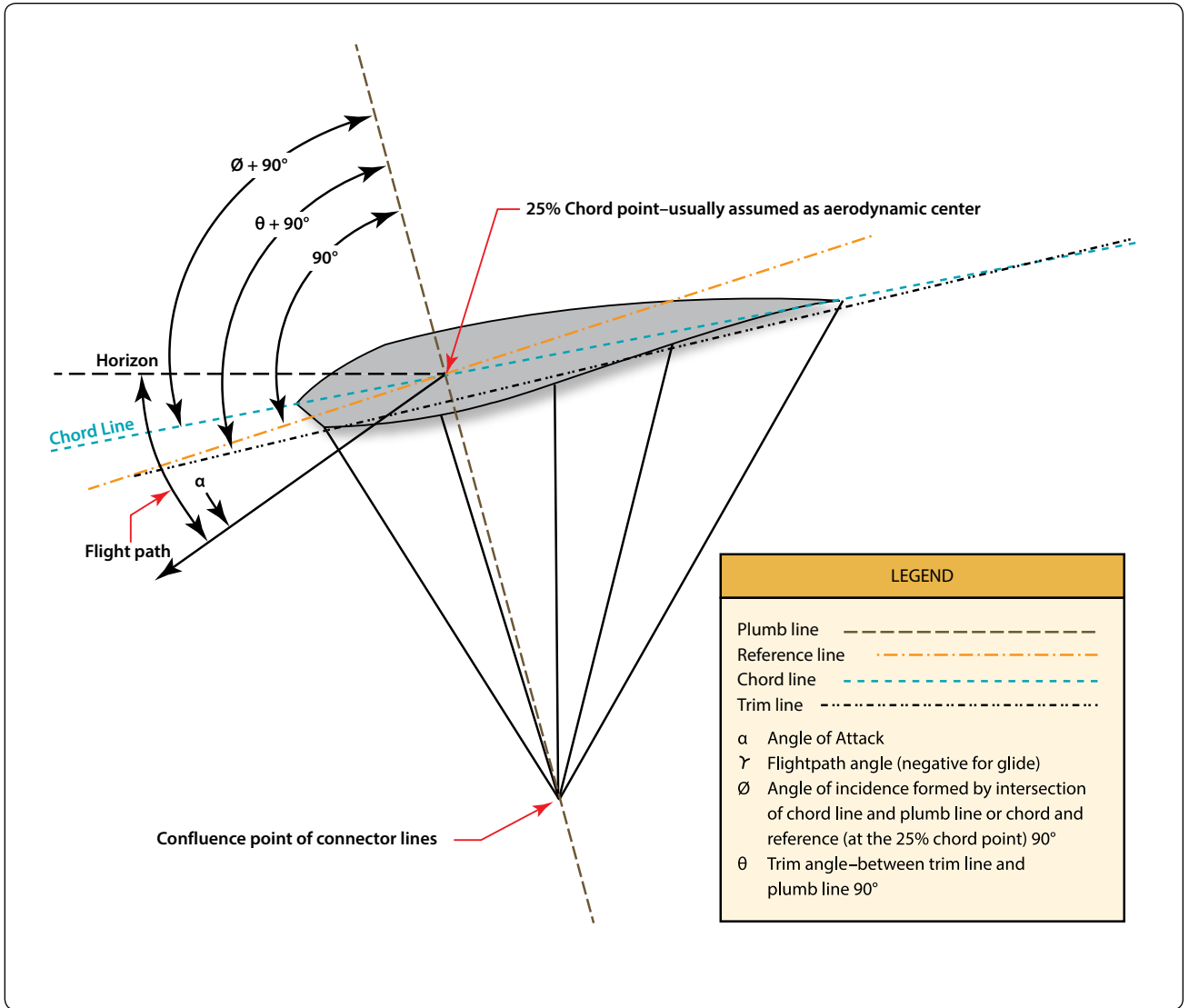


Figure 5.



PIA-TS-108.1
15 January 2010

Superseding
PIA-TS-108
12 December 1992

PIA Technical Standard

Parachute Canopy Fabric Pull Test Non-Destructive Method

Disclaimer: Parachute canopy manufacturers may have pull test requirements that differ in methods, procedures, and loads applied. Test procedures specified by the canopy manufacturer takes precedence over the test procedures described in this document. The person performing the pull tests must determine if the canopy manufacturer has a specific method of pull testing their canopy fabric.

Background: The purpose of this test method is to provide a simple, standardized, non-destructive method of verifying the strength of parachute canopy fabric. **This test method may be used when no other procedure is specified by the manufacturer.** Although this test is intended to be non-destructive, caution should be exercised as this test could damage the fabric, if the fabric is not positioned correctly or is not secured tightly. It may also affect the fabric permeability.

This method is designed to replace the old "Riggers' Thumb Test", first devised in response to the "canopy acid-mesh" discovery in the mid-1980's. It is now the accepted method for all parachutes requiring canopy fabric strength tests. Reasons for testing may include: Manufacturer's Service Bulletins (SBs), Airworthiness Directives (AD's), aging material, chemical contamination, UV exposure or discoloration of a suspicious origin, such as grease.

Tools required and possible sources are as follows:

2 ea. Locking Fabric Clamps

Figure 1

Para-Gear Equipment Co. 800-323-0437 (P/N S7989)
3839 W. Oakton St. www.para-gear.com

Aerostar International, Inc. 605-331-3500 (P/N 51406M)
1814 N. www.aerostar.com
Sioux Falls, SD 57117-5057

Ink, Marking (for parachutes and other textile items)
A-A-59211 (21Jul/98) Supersedes MIL-I-6903C (5Mar/68)

American Writing Ink Co. 781-762-0026
33 Endicott St.
Norwood, MA 02062

PIA-TS-108.1

Strata Blue P/N 7510-00-286-5362 Available in 1 pint container
Orange-Yellow P/N 7510-00-634-6583 Available in 1 pint container

Hitt Marking Devices, Inc. 714-979-1405
3231 W. MacArthur Blvd. 800-969-6699 (toll free)
Santa Ana, CA 92704 www.hittmarking.com

Sharpie Pen- black

1 ea. Calibrated Spring Scale, 50 lb. (23 kg.) minimum capacity

This scale should be calibrated at least once a year to an accuracy of +/- 3 lbs. It should be identified with a serial number and written verification of calibration must be kept on file. An adhesive label (or similar) should be affixed to the scale showing the date calibrated and the date next calibration is due. If the scale is damaged in any manner, such as dropping, it must be pulled from service and tagged as unserviceable until its recalibration.

Test Procedures: The following procedures do not take precedence over a manufacturer's test procedures for their products. Before testing make sure you have the manufacturer's most current test procedures.

A minimum of 2 areas should be tested on a canopy, but not less than 2 pull tests on each separate color (1 in the warp direction and 1 in the fill direction). When testing look for areas of contamination and/or discoloration. If possible remain approximately 6 inches (150mm) from any seam.

Proceed as follows:

NOTE: Steps 1 and 2 apply to cases involving acid-mesh pull testing.

1. Locate the mesh vents in the canopy and determine the fabric areas which are in contact with the mesh when the canopy is packed. These areas are shown as the diagonally shaded lines in typical tri-vent canopies (see FIGURE 2).

2. Perform one 40 lb. (18 kg.) pull test on each panel of material that comes in contact with the mesh when the canopy is packed. Alternate tests from the warp to fill direction on the panels. This could be as few as four tests or as many as twelve tests on some bias constructed canopies.

CAUTION: Never attach fabric clamps or perform pull tests on the mesh covered areas of any canopy. Extensive damage will result.

NOTE: Steps 3 through 6 apply to all pull tests (not just acid-mesh).

3. The area to be tested must be visibly marked for future reference. Refer to FIGURE 3 for examples of how to mark the parachute to be tested.

4. After the marking ink has dried, attach the locking fabric clamps to the ripstop fabric as shown in FIGURE 4. The distance between the clamps should be 3 inches (76.2mm) plus or minus ¼

PIA-TS-108.1

inch (6.35mm) and the clamps must be aligned so that the ripstop pattern is parallel (not on bias) to the edge of the jaws. Lock the clamps **VERY SECURELY**. This will prevent slippage and possible damage to the fabric.

NOTE: If the area to be tested is too small to allow 3 inches (76.2mm) plus or minus ¼ inch (6.35mm) between the jaws of the fabric clamps (such as the apex area of a round canopy), the distance between the jaws may be reduced to 2 inches (50.8mm) plus or minus ¼ inch (6.35mm).

5. Secure one clamp to the packing table or other object which will allow a sufficient load to be applied without movement of the fabric clamp. Attach the spring scale hook to the other fabric clamp and apply the load very smoothly and steadily. Hold the load for 3 seconds.

6. Record test results on the tested areas in contrasting ink as shown in FIGURE 5. Information should include the following:

- The amount of loading pulled to in pounds or kilograms
- The date tested
- The word PASS or FAIL
- The name and certificate number of the individual performing the test.

After completing the tests record the information in your rigger logbook and on the packing data card.

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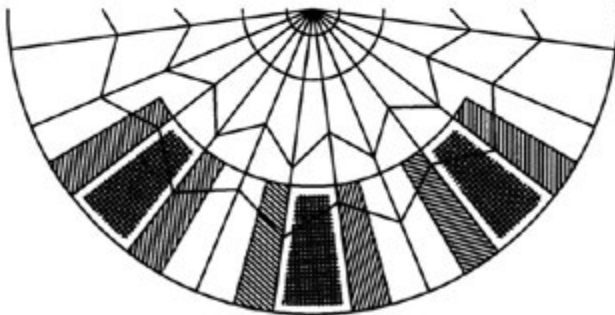
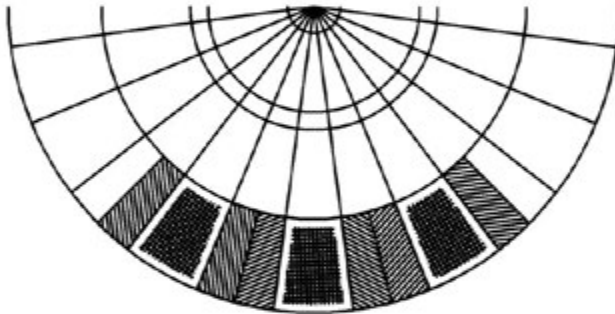
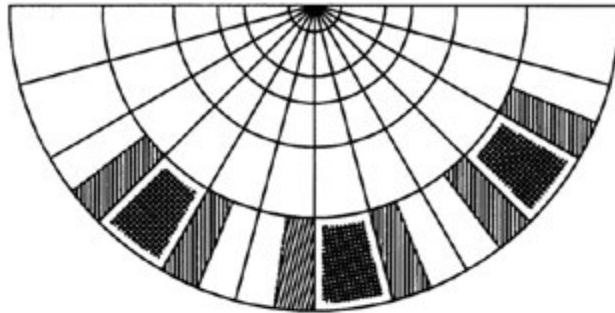


Fabric clamp (rubber padded/square jaw)

FIGURE 1

NOTE: Use only approved fabric clamps. Improvised or homemade clamps may increase the chances of damaging the area to be tested.

Below are diagrams of typical tri-vent modifications.



NOTE: Diagonally shaded areas show examples of fabric that comes in contact with mesh or may contact mesh.

FIGURE 2

<p>___LB/KG PULL TEST: DATE: RIGGER'S NAME AND CERTIFICATE NUMBER</p>

NOTE: This method uses either the corners of the box (above) or the dots (below) as guides for the fabric clamps.

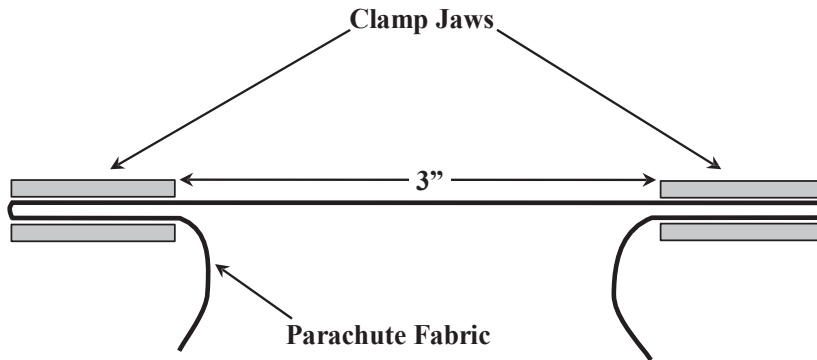
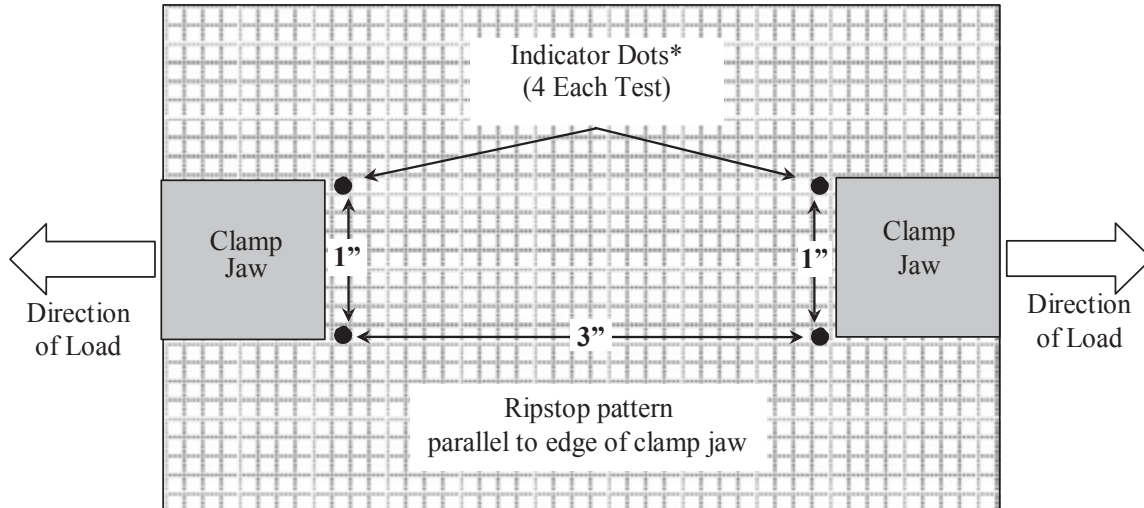
●	___LB/KG PULL TEST: DATE: RIGGER'S NAME AND CERTIFICATE NUMBER	●
●		●



Examples of canopy markings

FIGURE 3

NOTE: Use only a rubber stamp and approved ink or a black Sharpie™ pen to mark the areas to be tested. Do not use a ballpoint pen, pencils or similar items to mark the test area. This could result in damaging the fabric being tested.



How to attach clamps

FIGURE 4

40 LB PULL TEST: PASSED
DATE: 14 JUN 2009
MASTER RIGGER: JOE RIGGER 1234567

Example of completed test

FIGURE 5



Technical Standard Order

Subject: TSO-C23d, PERSONNEL PARACHUTE ASSEMBLIES

a. Applicability.

(1) Minimum Performance Standards. This technical standard order (TSO) prescribes the minimum performance standard that personnel parachute assemblies must meet in order to be identified with the applicable TSO marking. New models of personnel parachute assemblies that are to be so identified and that are manufactured on or after the date of this TSO must meet the standards set forth in Society of Automotive Engineers, Inc. (SAE) Aerospace Standard (AS) Document No. AS 8015B, "Minimum Performance Standards for Parachute Assemblies and Components, Personnel," dated July 7, 1992.

b. Marking. Each personnel parachute assembly or separate sub-assembly must be marked in accordance with 14 CFR part 21, section 21.607(d) and paragraph 4.2 of SAE AS 8015B. This marking requirement applies to any previously approved major component/sub-assembly used in this TSO.

c. Data Requirements.

(1) In addition to the requirement in part 21, section 21.605, the manufacturer shall furnish the manager of the Aircraft Certification Office (ACO), FAA having geographical purview of the manufacturer's facilities, one copy each of the following technical data:

(i) A complete description of the personnel parachute assemblies, including detail drawings, material identification and specifications.

(ii) Operating instructions and limitations, to include donning, retention, adjustment, and deployment.

(iii) Installation instructions and limitations.

(iv) A report of the tests conducted in accordance with SAE AS 8015B for qualification and approval of personnel parachute assemblies.

DISTRIBUTION: ZVS-326; A-W(IR)-3; A-X(CD)-4; A-FFS-7, 8(LTD); A-X(FS)-3;
AFS-600 (2 cys); A-FAC-0(MAX)

(v) Detailed maintenance instructions, including specific guidance on the limits of wear and damage permissible to webbing material that would warrant replacement.

(vi) The quality control inspection and functional test specification to be used to ensure each production article complies with this TSO, as required by part 21, section 21.605(a)(3) and part 21, section 21.143(a)(3).

(2) The manufacturer must furnish to the user of the article one copy of the data and information specified in paragraphs c(l)(ii) and c(l)(v). This data and information is necessary for proper installation and use and for continued airworthiness of the product or article.

“The conditions and test required for TSO approval of this article are minimum performance standards. It is the responsibility of those desiring to install the article either on or within a specific type or class of aircraft to determine that the aircraft installation conditions are within the TSO standards. The article may be installed only if further evaluation by the applicant (user/installer) documents an acceptable installation and is approved by the Administrator.”

d. Availability of Referenced Documents.

(1) Copies of SAE AS 8015B may be purchased from the Society of Automotive Engineers, Inc., Department 331, 400 Commonwealth Drive, Warrendale, PA 15096.

(2) Federal Aviation Regulations, part 21, subpart O, may be purchased from the Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402-9325.

(3) Advisory Circular 20- 110, “Index of Aviation Technical Standard Orders,” may be obtained from the U.S. Department of Transportation, General Services Section, M-443.2, Washington, DC 20590.

/S/ John K. McGrath
Manager, Aircraft Engineering Division
Aircraft Certification Service

PIA TS 135

Parachute Industry Association (PIA)

TECHNICAL STANDARD 135

PERFORMANCE STANDARDS FOR PERSONNEL PARACHUTE ASSEMBLIES AND COMPONENTS

1. SCOPE:

This document defines the 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.

PIA TS 135

1.3 LIST OF TECHNICAL STANDARDS, TABLES AND FIGURES:

Figure 1	Multiplier Factors for Structural Overload Testing
Figure 2	Functional Direct Drop Tests Required per 4.3.8.1
Table 1	Data Marking Requirements
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2. DEFINITIONS AND GENERAL REQUIREMENTS

2.1 GENERAL DEFINITIONS:

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

- a. "Administrator" – The FAA Administrator or equivalent 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 relative to undisturbed air. True airspeed is equal to equivalent airspeed multiplied by $(\rho_0/\rho)^{1/2}$ where ρ_0 is the air density at standard day conditions and ρ is the air density at the local altitude.
- f. "Approved", unless used with reference to another person, means approved by the Administrator for use within the limits specified by the manufacturer and verified by compliance with the requirements of this standard.
- g. "Canopy" - The part of the parachute that opens up and fills with air and provides the lift and/or drag required to decelerate the payload to the desired value.
- 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 person (or business/corporate entity) who controls the design and quality of the article produced including the parts of them, and any processes or services related to them that are procured from an outside source.
- l. "Main Assisted Reserve Deployment (MARD) device" – An automatically releasable connection between the main parachute and the reserve deployment system which uses a malfunctioned main canopy to speed reserve deployment upon breakaway.

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- 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 making a tandem jump 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. Drogue canopy and bridle (if used with reserve and/or emergency parachutes).
- j. Drogue release device (if used with reserve and/or emergency parachutes).

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 and 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.

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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 rate of descent of not more than 24 ft/s (7.3m/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 (reserve/emergency) parachute pack (container) is designed to 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 MINIMUM OPERATING WEIGHT (MinOW)

The minimum operating weight is the lowest allowed total (gross) weight of an individual or dummy (or all individuals or dummies in the case of a tandem) and their equipment including the parachute assembly itself. The **MinOW** shall be specified by the manufacturer and may be any weight demonstrated to be appropriate by the manufacturer for the system.

2.1.13 SERVICE LIFE RESTRICTED ITEMS:

Materials or products that, by design, are service life restricted 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 serviceable status of the part.

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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 is not required for 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/RIPCORD:

The primary actuation device/ripcord, including all joints, shall withstand the test loads of 4.3.2 without failure. The primary actuation device/ripcord shall meet the human-factors requirements of 4.3.3., if applicable.

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:

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

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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:

The minimum and maximum operating limits in Table 1 shall be marked/placarded on or attached to the outside of the parachute stowage container (pack). The marking/placard may refer to the owner's manual for the minimum operating weight. 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 minimum 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:

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.

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- (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 (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 hours 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.

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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

-OR-

- (b) Test weight = Maximum operating weight multiplied by the factor from Figure 1
Test speed = Maximum pack opening speed multiplied by the factor from Figure 1

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

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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.

- (a) Test condition one – All risers loaded to a combined load of at least 100% of placard maximum load.
- (b) Test condition two – Only left side harness/canopy attachment point(s) loaded to a combined load of at least 66% of placard load.
- (c) Test condition three – Only right side harness/canopy attachment point(s) loaded to a combined load of at least 66% of placard load.
- (d) Test condition four – Each unique brake setting shall be tested to a minimum of 16.7% of placard load if applicable.

4.3.6.4 STRENGTH TESTS, ALTERNATE MEANS OF COMPLIANCE, DROGUE CANOPY (ONLY)

For parachute assemblies in which a drogue parachute canopy is an integral part of the reserve or emergency parachute assembly, the drogue may be separately tested at the conditions determined in 4.3.6. The drogue canopy itself and all related components of the drogue assembly must be tested as a functional subsystem of the parachute assembly.

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 KTAS for all 4.3.8 tests the maximum allowable opening time and the maximum allowable altitude loss on any drop shall be determined from the following formulas..

- (a) The greater of 3.00 seconds or the value determined as follows:

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.

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$$\text{Opening Time Allowed (sec.)} = (\text{MOW} - 250) * 0.01 + (\text{MPOS}/150 * 3.0)$$

-OR-

(b) The greater of 300 feet or the value determined as follows:

$$\text{Altitude Loss Allowed (ft)} = (\text{MOW}-250) + (\text{MPOS}/150 * 300)$$

4.3.8.1 DIRECT DROP TESTS:

There shall be a minimum of 48 tests at weights and airspeeds (at the time of pack opening) as outlined in 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.

- (a) The manufacturer shall specify the Maximum Operating Weight and the Minimum Operating Weight.
- (b) The Maximum Pack Opening Speed (MPOS) shall not be less than 150 knots.
- (c) The MPOS and MOW shall be established by successful completion of the structural overload testing in Paragraph 4.3.6
- (d) The manufacturer will be allowed to select whether to measure altitude loss or opening time, but within each block on the test grid the same method must be used.
- (e) The maximum allowable opening time shall be calculated using the formula in 4.3.8(a): there shall be a minimum of 4 successful tests for each block; the opening times will be averaged and presented to the Administrator in the format shown in Figure 2.
- (f) The maximum allowable altitude loss shall be calculated using the formula in 4.3.8(b): there shall be a minimum of 4 successful tests for each block; the altitude loss must be averaged and presented to the Administrator in the format shown in Figure 2.
- (g) The opening times and/or altitude loss for each test block will be averaged and published in the format shown in Figure 2 in the owner's manual or in some other readily available location.

NOTE:

If a "MARD device" option is offered, an additional 8 drops at weights and airspeeds (at the time of pack opening) must be performed as outlined in the Table 3 with the MARD 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:

- (a) If a reserve static line is part of the assembly, then 4 of the breakaway drops shall be made with the reserve static line actuating the reserve pack.
- (b) If a "MARD device" option is offered, an additional 16 drops at weights and airspeeds (at the time of pack opening) must be performed as outlined in the Table 3 with the MARD attached.

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4.3.9 RATE OF DESCENT TESTS (METHOD 1):

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. 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 day 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.

4.3.9.1 RATE OF DESCENT TESTS (METHOD 2):

The rate of descent corrected to standard day sea level altitude conditions shall not exceed 5 ft/sec (1.5m/sec) at touchdown with appropriate control manipulations and the average rate of descent shall not exceed 24 ft/sec (7.3 m/s) in the unaltered post deployment configuration over a minimum interval of 100 ft (30.5m). These tests may be combined with other tests in this section.

NOTE: If the total velocity exceeds 36 ft/sec at maximum certified weight, the container or harness (if integral to the container) must be marked in an area readily visible to the user: "For experienced parachutists only. The owner's manual contains experience requirements."

4.3.10 STABILITY TESTS:

Per Table 3, there shall be not less than 6 drops, at the minimum 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 harness. 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.

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.

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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. 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. For canopies, the range may consist of scaled sizes to a maximum area of three times the smallest size.

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:

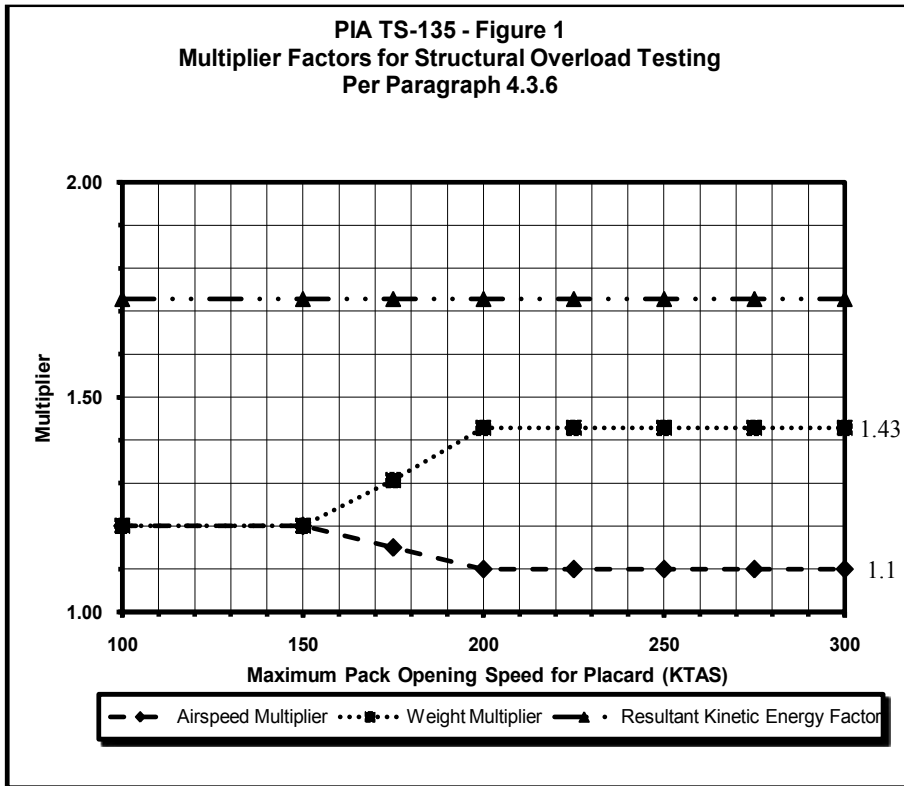
The manufacturer of each component is responsible for developing and disseminating the maintenance requirements for each component, specifically including the inspection interval, repack cycle, service life, criteria for continued airworthiness and the qualifications required of maintenance personnel.

5.4 FITTING REQUIREMENTS:

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

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**PIA TS-135 - Figure 1
Multiplier Factors for Structural Overload Testing
Per Paragraph 4.3.6**



**PIA TS-135 Figure 2
Direct Drop Tests
Per Paragraph 4.3.8.1**

Test Weight	Test Speed			
	60 KEAS	85 KEAS	MPOS x 80%	MPOS x 100%
Minimum Operating Weight	4	4	4	4
Averaged Operating Weight*	4	4	4	4
Maximum Operating Weight	4	4	4	4
Minimum Total (direct drop) Functional Tests Required				48

*Averaged Operating Weight is defined as (Maximum Operating Weight + Minimum Operating Weight)/2
 Average test weights shall be +/- 5%
 Minimum test weights shall be +1%/-10%.
 Maximum test weights shall be +10%/-1%

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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	
Minimum Gross Weight (lb)	4.2				X							
Average Peak Force Measured during 4.3.6 tests	4.3.6				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						
Operators Warning Label with Maximum Total Velocity for intended use (Student, Tandem, Emergency Air Crew or Other).	4.3.9				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 located on the most visible component, normally the container.												

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PIA-TS-135 - Table 2

Human Factors and Actuation Force Tests

Primary Actuation Device / Ripcord

	Data Required	Test Condition	Load Factor	Second Parachutist	Suspended by	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	P/F Force	Standing Upright	N/A	N/A	N/A	N/A
P/F Force	Standing Upright	N/A	none/with	N/A	Full				3	3	3/3	3/3	
P/F Force	Standing Upright	N/A	none/with	N/A	Empty				3	3	3/3	3/3	
P/F Force	Suspended Harness	1g	none	Main Risers	Empty				3	3	3	3	
P/F Force	Suspended Harness	1 g	with	Main Risers	Empty						3	3	
Additional tests if emergency/reserve drogue is used:													
P/F Force	Suspended Harness	4.1.7	N/A	Drogue	N/A	6		6					
P/F Force	Suspended Harness	4.1.7	none	Drogue	Full				3	3	3	3	
P/F Force	Suspended Harness	4.1.7	none	Drogue	Empty				3	3	3	3	
P/F Force	Suspended Harness	4.1.7	with	Drogue	Full						3	3	
P/F Force	Suspended Harness	4.1.7	with	Drogue	Empty						3	3	
Total Tests Required in This Section (drogue / no drogue)								24/12		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

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PIA TS-135 Table 3

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		
						Dummy	Live	Dummy	Live	
1, 8, 5	Primary Actuation Device/Ripcord Test	4.3.2	IAW 4.3.2 (a) through (d)							
1,2,5	Human Factors and Actuation Force Tests	4.3.3	IAW Table 2 and as described in paragraphs 4.3.3(a) through (e)							
	Human Factors Tests, Harness	4.3.4	Demonstrated by successful completion of five jumps per paragraph 4.3.11							
	Environmental Tests	4.3.5								
1, 3, 5	Precondition to +200 F	4.3.5.1	60 KEAS	<= MaxOW		1		1		
1, 3, 5	Precondition to -40 F	4.3.5.2	60 KEAS	<= MaxOW		1		1		
1, 3, 5	Precondition - compressed pack	4.3.5.3	60 KEAS	<= MaxOW		1		1		
1, 3, 5	Precondition - alternate to 4.3.5.1 & 4.3.5.3	4.3.5.4	60 KEAS	<= MaxOW		1		1		
	Structural Overload Tests	4.3.6								
1,2,3,5	Complete Assemblies	4.3.6.1	Fig. 1	Fig. 1	N/S	3	N/A	3	N/A	
1,2,3,5	Alternate Means of Compliance, Canopy Only	4.3.6.2	Fig. 1	Fig. 1	N/S	3		3		
1,2,3,5	Alternate Means of Compliance, Harness Only	4.3.6.3	Fig. 1	Fig. 1	N/S	3		3		
1,2,3,5	Drogue (if applicable)	4.3.6.4	Fig. 1	Fig. 1	N/S	3		3		
1, 3 (or 4), 5,	Functional Tests, Twisted Lines	4.3.7	60 KEAS	<= MOW	N/S	5		5		
1, 3 (or 4), 5,	Functional Tests, (Normal Pack all types)	4.3.8	Opening Time allowed shall be calculated IAW paragraph 4.3.8 (a). Opening Altitude allowed shall be calculated IAW paragraph 4.3.8 (b)							
1, 3 (or 4), 5,	Direct Drop	4.3.8.1	60 KEAS	MinOW	Empty	4		2		
1, 3 (or 4), 5,	Direct Drop	4.3.8.1	60 KEAS	AvOW	Full	N/A		2		
1, 3 (or 4), 5,	Direct Drop	4.3.8.1	60 KEAS	MaxOW	Empty	4		2		
1, 3 (or 4), 5,	Direct Drop	4.3.8.1	60 KEAS	MinOW	Full	N/A		2		
1, 3 (or 4), 5,	Direct Drop	4.3.8.1	60 KEAS	AvOW	Empty	4		2		
1, 3 (or 4), 5,	Direct Drop	4.3.8.1	60 KEAS	MaxOW	Full	N/A		2		
			Total Drops at 60 KEAS				12		12	
1, 3 (or 4), 5,	Direct Drop	4.3.8.1	85 KEAS	MinOW	Empty	4		2		
1, 3 (or 4), 5,	Direct Drop	4.3.8.1	85 KEAS	AvOW	Full	N/A		2		
1, 3 (or 4), 5,	Direct Drop	4.3.8.1	85 KEAS	MaxOW	Empty	4		2		
1, 3 (or 4), 5,	Direct Drop	4.3.8.1	85 KEAS	MinOW	Full	N/A		2		
1, 3 (or 4), 5,	Direct Drop	4.3.8.1	85 KEAS	AvOW	Empty	4		2		
1, 3 (or 4), 5,	Direct Drop	4.3.8.1	85 KEAS	MaxOW	Full	N/A		2		
			Total Drops at 85 KEAS				12		12	
1, 3 (or 4), 5,	Direct Drop	4.3.8.1	80% MPOS	MinOW	Empty	4		2		
1, 3 (or 4), 5,	Direct Drop	4.3.8.1	80% MPOS	AvOW	Full	N/A		2		
1, 3 (or 4), 5,	Direct Drop	4.3.8.1	80% MPOS	MaxOW	Empty	4		2		
1, 3 (or 4), 5,	Direct Drop	4.3.8.1	80% MPOS	MinOW	Full	N/A		2		
1, 3 (or 4), 5,	Direct Drop	4.3.8.1	80% MPOS	AvOW	Empty	4		2		
1, 3 (or 4), 5,	Direct Drop	4.3.8.1	80% MPOS	MaxOW	Full	N/A		2		
			Total Drops at 80% MPOS				12		12	

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PIA TS-135 Table 3 continued

Required Qualification Tests

1, 3 (or 4), 5,	Direct Drop	4.3.8.1	100% MPOS	MinOW	Empty	4	2
1, 3 (or 4), 5,	Direct Drop	4.3.8.1	100% MPOS	AvOW	Full	N/A	2
1, 3 (or 4), 5,	Direct Drop	4.3.8.1	100% MPOS	MaxOW	Empty	4	2
1, 3 (or 4), 5,	Direct Drop	4.3.8.1	100% MPOS	MinOW	Full	N/A	2
1, 3 (or 4), 5,	Direct Drop	4.3.8.1	100% MPOS	AvOW	Empty	4	2
1, 3 (or 4), 5,	Direct Drop	4.3.8.1	100% MPOS	MaxOW	Full	N/A	2
Total Drops at 100% MPOS						12	12
Total Direct Drop Tests						48	48

1, 3 (or 4), 5, 10, 11	Direct Drop "MARD device"	4.3.8.1	60 KEAS	<= MaxOW	Full	N/A	4
1, 3 (or 4), 5, 12	Direct Drop "MARD device"	4.3.8.1		<= MaxOW	Full	N/A	4
1, 3, 5, 9	Functional Tests, Breakaway	4.3.8.2	< 20 fps Vv	<= MaxOW	Empty	N/A	8
1, 3, 5, 9, 13	Functional Tests, Breakaway "MARD device"	4.3.8.2		<= MaxOW	Empty	N/A	4
1, 3, 5, 9, 14	Functional Tests, Breakaway "MARD device"	4.3.8.2		<= MaxOW	Empty	N/A	4
1, 3, 5, 9, 15	Functional Tests, Breakaway "MARD device"	4.3.8.2		<= MaxOW	Empty	N/A	4
1, 3, 5, 9, 12, 16	Functional Tests, Breakaway "MARD device"	4.3.8.2		<= MaxOW	Empty	N/A	4
1, 5, 7	Rate of Descent Tests	4.3.9	N/A	MaxOW	N/S	6	6
1, 5, 6	Stability Test	4.3.10	N/A	MinOW	N/S	6	6
1, 3, 5, 11	Live Jumps	4.3.11	< 60 knots	<= MaxOW	N/S	2	2
1, 3, 5, 12	Live Jumps	4.3.11	> 120 knots	<= MaxOW	N/S	2	2

Abbreviations used above:

- IAW In accordance with
- MPOS Maximum pack opening speed
- MaxOW Maximum operating weight
- AvOW Average operating weight
- MinOW Minimum operating weight
- N/A Not Applicable
- N/S Not Specified

Notes on Test Criteria

- 1 Record Pass/Fail
- 2 Record Riser Force
- 3 Record Opening Time
- 4 Record Altitude Loss
- 5 Video Record
- 6 Record Oscillation Angle
- 7 Record Rate-of-Descent
- 8 Record 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 Jumps may be performed concurrently with similar direct drops outlined in table 3
- 11 Shall include a freefall of not more than 3 seconds
- 12 Shall include a freefall of at least 20 seconds
- 13 Breakaways from stable main
- 14 Breakaways from forward spinning main. Half left spin, half right spin
- 15 Breakaways from BACKWARDS spinning main. Half left spin, half right spin
- 16 Breakaways from bag lock malfunction

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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, Except Static Line)	Primary Actuation Device (Static Line)	Reserve Static Line (if used)	Harness	Risers (if not integral with harness)	Drogue, Canopy & Riser (if used)	Drogue Release Device (if used)	MARD (if used)
Ripcord Strength Tests	4.3.2	X					X	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
Structural Overload Test	4.3.6	X	X	X	X	X				X	X	X	X	*1
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	
Functional Tests - Normal Pack, Breakaway	4.3.8.2	X	X	X	X	X	X		X					X
Rate of Descent	4.3.9	X			X									
Stability	4.3.10	X			X									
Live Drops	4.3.11	X	X	X	X	X	X	X	X	X	X	X	X	X

*1 MARD installation shall not degrade strength or tensile loads on any reserve deployment devices or subassemblies on which it is installed. The manufacturer shall prove equivalent strength between similar devices or subassemblies with and without the MARD installed. This can be done with a bench/pull test or tensile test. For example, the strength of a free bag bridle with MARD parts installed but not hooked up should not be less than a bridle without a MARD installation.



Department of Transportation
Federal Aviation Administration
Office of Airworthiness
Washington, D.C.

TSO-C23c

Date 4/25/84

Technical Standard Order

Subject: TSO-C23c, PERSONNEL PARACHUTE ASSEMBLIES

(a) Applicability

(1) Minimum Performance Standard. This Technical Standard Order (TSO) prescribes the minimum performance standard that personnel parachute assemblies must meet in order to be identified with the applicable TSO marking. This TSO has been prepared in accordance with the procedural rules set fourth in Subpart O of the Federal Aviation Regulations, Part 21. Personnel parachute assemblies that are to be so identified and that are manufactured on or after the date of this TSO must meet the standard set fourth in society of Automotive Engineers, Inc. (SAE), Aerospace Standard (AS) 8015A, Minimum Performance Standard for Parachute Assemblies and Components, Personnel, dated September 30, 1982, as amended and supplemented by this TSO.

(b) Markings. None in addition to the marking specified in Federal Aviation Regulations (FAR)/21.607(d).

(c) Data Requirements.

In addition to FAR/21.605, the manufacturer must furnish the Manager, Aircraft Certification Office (ACO), Federal Aviation Administration (FAA), having purview of the manufacturer s facilities, one copy each of the following technical data:

- (1) Operating instructions.
- (2) Equipment limitations.
- (3) Inspection and test procedures applicable to this product.
- (4) Specifications.
- (5) Maintenance procedures.
- (6) Manufacturer's TSO qualification test report.

(d) Previously Approved Equipment. Personnel parachute assemblies approved prior to the date of this TSO may continue to be manufactured under the provisions of the original approval.

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(e) Availability of Reference Documents.

(1) Copies of SAE AS 8015A may be purchased from the Society of Automotive Engineers, Inc., Department 331, 400 Commonwealth Drive, Warrendale, Pennsylvania 15096.

(2) Federal Aviation Regulations, Part 21, Subpart O and Advisory Circular 20-110, Index of Aviation Technical Standard Orders, may be reviewed at the FAA Headquarters in the Office of Airworthiness, Aircraft Engineering Division (AWS-110) and at all ACO s.

M.C. BEARD
Director of Airworthiness

FEDERAL AVIATION AGENCY

Washington 25, D. C.

TECHNICAL STANDARD ORDER

Regulations of the Administrator

Part 514

SUBJECT: PARACHUTES

TSO-C23b

Technical Standard Orders for Aircraft Materials,
Parts, Processes, and Appliances

Part 514 contains minimum performance standards and specifications of materials, parts, processes, and appliances used in aircraft and implements the provisions of sections 3.18, 4a.31, 4b.18, 6.18 and 7.18 of the Civil Air Regulations. The regulation uses the Technical Standard Order system which, in brief, provides for FAA-industry cooperation in the development of performance standards and specifications which are adopted by the Administrator as Technical Standard Orders, and a form of self-regulation by industry in demonstrating compliance with these orders.

Part 514 consists of two subparts. Subpart A contains the general requirements applicable to all Technical Standard Orders. These provisions are summarized below for the convenient reference of the public. Subpart B contains the technical standards and specifications to which a particular product must conform, and each Technical Standard Order is set forth in the appropriate section of Subpart B. The subject Technical Standard Order is printed below. ANY TECHNICAL STANDARD ORDER MAY BE OBTAINED BY SENDING A REQUEST TO FAA, WASHINGTON 25, D. C.

SUBPART A--GENERAL

This subpart provides, in part, that a manufacturer of an aircraft material, part, process, or appliance for which standards are established in Subpart B, prior to its distribution for use on a civil aircraft of the United States, shall furnish a written statement of conformance certifying that the material, part, process, or appliance meets the applicable performance standards established in this part. The statement of conformance must be signed by a person duly authorized by the manufacturer, and furnished to the Chief, Engineering and Manufacturing Division, Bureau of Flight Standards, Federal Aviation Agency, Washington 25, D. C.

Subpart A also requires appropriate marking of materials, parts, processes, and appliances as follows:

- (a) Name and address of the manufacturer responsible for compliance,
- (b) Equipment name, or type or model designation,
- (c) Weight to the nearest pound and fraction thereof,
- (d) Serial number and/or date of manufacture, and
- (e) Applicable Technical Standard Order (TSO) number.

In addition, Subpart A provides that no deviation will be granted from the performance standards established in Subpart B, and that the Administrator may take appropriate action in the event of noncompliance with Part 514.

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SUBPART B

§ 514.33 Parachutes - TSO-C23b--(a) Applicability--(1) Minimum performance standards. Minimum performance standards are hereby established for parachutes which are to be used in civil aircraft of the United States. New models of parachutes manufactured for use in civil aircraft of the United States on or after March 29, 1962, shall meet the minimum performance standards of National Aircraft Standards Specification 804 dated August 24, 1949,^{1/} with the exceptions covered in subparagraph (2) of this paragraph. Parachutes approved prior to March 29, 1962, may continue to be manufactured under the provisions of the original approval.

(2) Exceptions. (i) The auxiliary parachute used in combination with a standard parachute shall be designed for use in combination with the specific main parachute.

(ii) For the purpose of testing an auxiliary type parachute used in combination with a standard parachute the speed specified in Section 4.3.8 of NAS Specification 804 shall be 25 feet per second instead of 21 feet per second.

(b) Marking. The auxiliary parachute and its pack shall be marked "Auxiliary Parachute" in addition to the other marking requirements contained in Subpart A.

(c) Data requirements. (1) The manufacturer shall maintain a current file of complete design data.

(2) The manufacturer shall maintain a current file of complete data describing the inspection and test procedures applicable to his product. (See paragraph (d) of this section.)

(d) Quality control. Each parachute shall be produced under a quality control system, established by the manufacturer, which will assure that each parachute is in conformity with the requirements of this section. This system shall be described in the data required under paragraph (c)(2) of this section. A representative of the Administrator shall be permitted to make such inspections and tests at the manufacturer's facility as may be necessary to determine compliance with the requirements of this section.

(e) Effective date. March 29, 1962.

^{1/}Copies may be obtained from the National Standards Association,
616 Washington Loan and Trust Building, Washington 4, D. C.



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

TSO-C23f

Effective
Date: 09/21/2012

Technical Standard Order

Subject: Personnel Parachute Assemblies and Components

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 (FAA), tell you what minimum performance standards (MPS) your personnel parachute assembly and components 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. All prior revisions to this TSO are no longer effective. Generally, we will not accept applications for the previous revision after the effective date of this TSO. We may do so, however, up to six months after it, if we know that you were working against the prior MPS before the new change became effective.

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

3. REQUIREMENTS. New models of personnel parachute assemblies and components 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 135 TS-135 Revision 1.4 issued April 22, 2010 "*Performance Standards for Personnel Parachute Assemblies and Components*" as modified by appendix 1 of this TSO.

a. Functionality. This TSO's standards apply to equipment intended to be used as a reserve or emergency parachute.

b. Failure Condition Classifications.

(1) Lose of the function defined in paragraph **3.a** is a catastrophic failure condition.

c. Functional Qualification. Demonstrate the required performance under the test conditions in Appendix 1 of this TSO.

d. 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 the provision of 14 CFR § 21.618.

4. MARKING.

a. Mark at least one major component permanently and legibly with all the information in CFR § 45.15(b). The marking must include the 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), and
- (2) Each subassembly of the article that you determined may be interchangeable.

5. APPLICATION DATA REQUIREMENTS. You must give the FAA aircraft certification office (ACO) manager responsible for your facility a statement of conformance, as specified in 14 CFR § 21.603(a)(1), and one copy each of the following technical data to support your design and production approval. LODA applicants must submit the same data (excluding paragraph 5.f) through their civil aviation authority.

a. A manual(s) containing the following:

- (1) Operating instructions and equipment limitations sufficient to describe the equipment's operational capability.
- (2) Describe in detail any deviations.
- (3) Installation procedures and limitations sufficient to ensure that the personnel parachute assembly and component, when installed according to the installation procedures, still meets this TSO's requirements. Limitations must identify any unique aspects of the installation. The limitations must include a note with the following statement:

“This article meets the minimum performance and quality system standards required by a technical standard order (TSO). Installation of this article requires separate approval.”

b. Schematic drawings, wiring diagrams, and any other documentation necessary for assembly, installation, donning, and operation of the personnel parachute assembly and component

c. Instructions covering periodic maintenance, calibration, and repair, for the continued airworthiness of personnel parachute assemblies and components. Include recommended inspection intervals and service life, as appropriate.

d. A drawing depicting how the article will be marked with the information required by paragraph 4 of this TSO.

e. Identify functionality or performance contained in the article not evaluated under paragraph 3 of this TSO (that is, non-TSO functions). Non-TSO functions are accepted in parallel with the TSO authorization. For those non-TSO functions to be accepted, you must declare these functions and include the following information with your TSO application:

(1) Description of the non-TSO function(s), such as performance specifications, failure condition classifications, software, hardware, and environmental qualification levels. Include a statement confirming that the non-TSO function(s) do not interfere with the article's compliance with the requirements of paragraph 3.

(2) Installation procedures and limitations sufficient to ensure that the non-TSO function(s), meets the declared functions and performance specification(s) described in paragraph 5.e.(1).

(3) Instructions for continued performance applicable to the non-TSO function(s) described in paragraph 5.e.(1).

(4) Interface requirements and applicable installation test procedures to ensure compliance with the performance data defined in paragraph 5.e.(1).

(5) Test plans, analysis and results, as appropriate, to verify the function and performance of the hosting TSO article is not affected by the non-TSO function(s).

(6) Test plans, analysis and results, as appropriate, to verify the function and performance of the non-TSO functions(s) as described in paragraph 5.e.(1).

f. The quality system description required by 14 CFR § 21.608, including functional test specifications. The quality system should ensure that you will detect any change to the approved design that could adversely affect compliance with the TSO MPS, and reject the article accordingly. (Not required for LODA applicants.)

g. Material and process specifications list.

h. List of all drawings and processes (including revision level) that define the article's design.

i. Manufacturer's TSO qualification report showing results of testing accomplished according to paragraph 3.c of this TSO.

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

- a. Functional qualification specifications for qualifying each production article to ensure compliance with this TSO.
- b. Equipment calibration procedures.
- c. Schematic drawings.
- d. Wiring diagrams.
- e. Material and process specifications.
- f. If the article contains non-TSO function(s), you must also make available items **6.a** through **6.e** as they pertain to the non-TSO function(s).

7. FURNISHED DATA REQUIREMENTS.

a. If furnishing one or more articles manufactured under this TSO to one entity (such as an individual jumper or a drop zone operator), provide one copy or on-line access to the data in paragraphs **5.a** through **5.c** of this TSO. Add any other data needed for the proper installation, certification, use, or for continued compliance with the TSO, of the personnel parachute assembly and components.

b. If the article contains declared non-TSO function(s), include one copy of the data in paragraphs **5.e.(1)** through **5.e.(6)**.

8. HOW TO GET REFERENCED DOCUMENTS.

a. You can download a free copy of PIA TS-135 Revision 1.4 issued April 22, 2010 *Performance Standards for Personnel Parachute Assemblies and Components* at:

<http://www.pia.com/piapubs/TSDocuments/TS-135v1.4.pdf>

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

/S/

Susan J. M. Cabler
Assistant Manager, Aircraft Engineering Division

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

This appendix prescribes the MPS for a personnel parachute assembly and component. The applicable standard is PIA TS-135 Revision 1.4 issued April 22, 2010 *Performance Standards for Personnel Parachute Assemblies and Components*, as modified for this TSO:

1. Page 2, replace Para, 2.1.i. to read as follows:

“Cognizant Agency” - The Federal Aviation Administration (FAA) or civil aviation authorities recognized in bilateral agreements by the FAA,

2. Page 5, Para. 4.1.2. delete: “generally”.

Stitching should not ravel when broken. “Generally” reduces the requirement for stitch choice, and adversely impacts the current standard.

3. Page 5, Para. 4.1.3. delete: “Ref: Table 2”.

Table 2 is not relevant to this requirement. Testing of a packed assy will show if the main parachute will interfere with the proper function of the reserve parachute.

4. Page 9, Para. 4.3.7. in first sentence delete: “a weight not more than”.

The worst case is the maximum operating weight.

5. Page 11, disregard paragraph 4.3.9.1., Rate of Descent Tests (Method 2).

We omitted the Method (2) testing, for not providing an equivalent level of safety to current standard. This method is directed at high performance and experience parachutists in sport and skydiving activities. Novice or less experienced parachutists in emergency conditions due to incapacitation, panic, etc., may not be able to safely deploy and land.

We have to consider the safety of all jumpers, not just the highly skilled, highly experienced. It is argued that the risks the experienced jumpers are exposing themselves to, are mitigated by their skill and experience.

To allow the increased velocity may improve the safety of highly skilled, highly experienced jumpers, but it erodes the safety for the beginner, incapacitated, panicked, or a jumper who has gotten himself into a treacherous landing area.

We do not agree that a canopy manufacturer can demonstrate that a jumper can safely land with an appropriate control manipulation while performing a flare before touchdown. This approach relies on jumper's experience to meet the MOPS that parachutes have been certified to. This approach does not provide an equivalent level of safety.

6. Page 14, Table 1, under Marking Data Requirements, replace:

Statement of Authorization under TSO-C-23e and/or (J) TSO-C-23e if applicable.

With

Statement of Authorization. Under TSO-C23f and/or ETSO-C23f if applicable.

TSO-C23e has been cancelled

NATIONAL AIRCRAFT STANDARDS COMMITTEE

AIRCRAFT INDUSTRIES ASSOCIATION OF AMERICA, INC., 610 SHOREHAM BUILDING, WASHINGTON 5, D. C.

SPECIFICATION - PARACHUTES

This specification defines the minimum performance and safety standards for parachutes to be used in certificated aircraft.

1. APPLICABLE SPECIFICATIONS

1.1 None.

2. TYPES

2.1 This specification covers two types of man-carrying parachutes for use in certificated civil aircraft

Standard Type Parachute
Low Speed Type Parachute (Up to 150 miles per hour).

3. MATERIAL AND WORKMANSHIP

3.1 Materials shall be of a quality which experience and/or tests have conclusively demonstrated to be suitable for use in parachutes. Workmanship shall be consistent with high-grade parachute manufacturing practice.

3.1.1 Canopy Material: The fabric used in the canopy construction shall be free from harmful gums, starches and other foreign material. It shall also be free from avoidable imperfections in manufacture and from defects or blemishes affecting its strength or durability and shall have been finished without application of excessive heat. The canopy material shall have sufficient resilience to insure proper opening of the canopy under conditions outlined in 4.3.5.

3.1.2 Fitting Materials: Fittings shall be fabricated from carbon steel, alloy steel, or corrosion-resisting material. Fittings made from metals that are not corrosion-resisting shall be plated or otherwise protected, to resist corrosion during the normal life of the parachute. The use of dissimilar metals, especially brass, copper, or steel in intimate metal-to-metal contact with aluminum or aluminum alloy, shall be avoided, wherever possible.

4. DETAIL REQUIREMENTS

4.1 Design and Construction

4.1.1 Fittings: All fittings shall be designed to carry their full rated load without yielding.

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TITLE	CLASSIFICATION SPECIFICATION
SPECIFICATION - PARACHUTES	NAS 804 Sheet 1 of 5

THIS DRAWING SUPERCEDES ALL ANTECEDENT STANDARD DRAWINGS FOR THE SAME PRODUCT, AND SHALL BECOME EFFECTIVE FOR VENDOR MANUFACTURERS NOT LATER THAN 6 MONTHS AFTER THE LATEST DATE OF APPROVAL SHOWN.

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- 4.1.2 Suspension Lines: All suspension lines of a given model parachute shall be marked under equal tension to show points of attachment.
- 4.1.3 Stitching: Stitching shall be of a type that will not ravel when broken.
- 4.1.4 Rip Cord: The rip cord, including joints between the handle and the release, shall be designed to withstand the tension test load of 4.3.1.
- 4.1.5 Pack Opening Device: No more than 22 pounds pull shall be required to cause the positive and quick functioning of the pack opening device.
- 4.1.6 Harness Release: The harness shall be so constructed that the rider can release himself and drop clear in case of a water landing, but a quick-attachable or quick-releasing device between the harness and the parachute is not mandatory.

4.2 Marking

- 4.2.1 Pack: The following information shall be legibly and permanently marked on or attached to the outside of the parachute pack by use of a name plate, identification label or stenciled letters.

Manufacturer's name
 Model number or model name*
 Parachute serial number
 Date of manufacture
 National Aircraft Standard Number (NAS804)

*Note: Special designation or identification of low speed type parachutes must be indicated on the outside pack by stenciling in red letters one inch high the following: "Low Speed Parachute" and in red letters one-half inch high, "Limited to Use in Airplane Under 150 MPH."

- 4.2.2 Canopy: Each parachute canopy shall be legibly and permanently marked, preferably adjacent to the skirt, with the same information as in 4.2.1.
- 4.2.3 Harness: The parachute model number or model name and date of manufacture shall be stenciled on all harnesses. This marking shall be placed inside the back strap of the harness or other suitable location where it will be subject to minimum of obliteration.

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TITLE	<small>CLASSIFICATION</small> SPECIFICATION
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THIS DRAWING SUPERCEDES ALL ANTECEDENT STANDARD DRAWINGS FOR THE SAME PRODUCT AND SHALL BECOME EFFECTIVE FOR VENDOR MANUFACTURERS NOT LATER THAN 6 MONTHS AFTER THE LATEST DATE OF APPROVAL SHOWN.

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4.2.4 Inspection Data Pocket: Each parachute outfit shall be provided with an inner and an outer pocket for keeping a record card containing space for recording the date of repacking or repair and the rigger's name and serial number. The inner pocket shall be located in the center of the packed container, tray or frame and the outer pocket placed externally in an easily accessible position. If the inner record card can be read from the outside of the pack because of the use of transparent materials, only the inner pocket need be provided.

4.3 Qualification Tests: 100% performance in qualification tests 4.3.1 through 4.3.8 is required.

4.3.1 Rip Cord Tension Test: The rip cord, including joints between the handle and the release, shall not fail under a straight tension test load of 300 pounds applied for not less than three seconds.

4.3.2 Pull Test - Pack Opening Device: The pack opening device shall be tested by use of an accurate spring balance to indicate its positive and quick-functioning with no more than 22 pounds pull.

4.3.3 Functional Test (Normal Pack): Twelve drops at least six of which shall be from an airplane with a 170-pound dummy man, from an altitude of not more than 500 feet. The indicated air speed at the time of release shall be 70 miles per hour. No twists shall purposely be packed in the suspension lines. The parachute must be fully open within three seconds from time of release.

4.3.4 Functional Test (Twisted Lines): Five drops with a 170-pound dummy man, from an altitude of not more than 500 feet. The indicated air speed at the time of release shall be 70 miles per hour. Three twists shall purposely be packed in the suspension lines near the skirt. The parachute must be fully open within four seconds from time of release.

4.3.5 Compressed Pack Test: This test is required only when canopy materials other than pongee, silk or nylon are used (Ref. 3.1.1). Three drops with the conditions stated in 4.3.3 except that prior to the tests the parachutes completely packed shall be subjected continuously to a 200-pound weight for 400 hours and then dropped without being repacked.

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TITLE SPECIFICATION - PARACHUTES	CLASSIFICATION SPECIFICATION NAS 804 Sheet 3 of 5
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4.3.6 Strength Test

4.3.6.1 Standard Type Parachute: Three drops with a parachute of the same type at an altitude of not more than 500 feet shall be made with a dummy weight and indicated air speed to give the equivalent of 5000 lbs. shock load. (See Table I.) No twists shall purposely be packed in the suspension lines. The weight shall be attached to the harness. No external shock absorbers or material which may act as such shall be permitted. The parachute shall show no failure of any material.

Table I

Launching Speeds & Total Weights for Approx. 5000# Shock Load *

<u>Speed - MPH</u>	<u>Total Weight (Incl. Chute) - lbs.</u>
150	660
175	500
200	400
225	325
250	275
275	225
300	200
325	175
350	160
375	150

* Data computed for 28 ft. Standard Flat-Type Parachute based on USAF Parachute Handbook Section V.

4.3.6.2 Low Speed Type Parachute: Three drops with a parachute of the same type at an altitude of not more than 500 feet shall be made with a dummy weight and indicated air speed to give the equivalent of 3000 lbs. shock load. No twists shall purposely be packed in the suspension lines. The weight shall be attached to the harness. No external shock absorbers or material which may act as such shall be permitted. The parachute shall show no failure of any material.

Table II

Launching Speeds & Total Weights for Approx. 3000# Shock Load *

<u>Speed - MPH</u>	<u>Total Weight (Incl. Chute) - lbs.</u>
100	750
125	525
150	375
175	300
200	235
225	200

* Data computed for 28 ft. Standard Flat-Type Parachute based on USAF Parachute Handbook Section V.

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- 4.3.7 Live Drop Tests: Two live drop tests from an airplane with a man weighing approximately 170 pounds, including the weight of an additional certificated auxiliary parachute, from an altitude of 2000 feet on a comparatively still day. The rider must suffer no discomfort from the opening shock and must be able to disengage himself unaided from the harness after landing. For this test the standard harness may be altered to permit attachment of an auxiliary parachute provided that such alteration does not interfere with the normal operation of the parachute and harness equipment being tested.
- 4.3.8 Rate of Descent Test: At least six drops from an airplane with a 170-pound dummy man. The average rate of descent shall not exceed 21 feet per second for the last 100 feet under standard sea level altitude conditions. A method shall be employed for direct and accurate measurement of rate of descent for the last 100 feet, such as the use of a weighted cord or cable by which the descent may be timed from the time of ground impact of the weight to ground impact of the parachute.

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EXAMPLE OUTLINE FOR SENIOR RIGGER TRAINING, CLASSES, DEMONSTRATIONS AND PROJECTS.

A. Introduction

1. FAA rules and regulations
2. Part 105, 91, 65, and basic facilities to practice rigging, (packing table, inspection, drying area)
3. Responsibility as a licensed rigger, privileges, and rating limitations
4. Paperwork, FAA, logbook, datacard, ADs, service bulletins, (binder with all ADs and SBs)
5. Filling out inspection log book, filling out data cards

B. Rigging Techniques and Tools (VIDEO)

1. Modern rigging technics and methods
2. Packing tapes (Square reserves)
3. Vector
4. Racer
5. Javelin
6. Talon
7. Vector tandem, strong, racer

C. Round Canopy

1. Construction and materials
2. Aerodynamics
3. Inspection procedures, (bridle attaching methods)
4. Line continuity (two and four riser systems) (round to riser assembly)
5. Canopy layout (on packing table)
6. Canopy sections, gore numbers, panel designations.
7. Data panel information
8. Alterations or repairs listed on data panel (is it approved? where do we look?)
9. Diapers, full stow, two stow, vertical stow, etc.
10. Flaking the canopy for packing
11. Diaper and line stowing
12. Acid test and inspection

D. Square Canopy

1. Construction and materials
2. Aerodynamics
3. Inspection procedures, (layout on carpet) (hanging by tail)
4. Line continuity (cascaded and continuous lines) (assembly to risers)
5. Canopy sections (nose, tail, upper and lower skins, ribs, load bearing ribs, crossports)
6. Data panel information
7. Steering toggles (types installation and stowing methods)
8. Deployment systems (freebags, etc.) (inspection of these systems)
9. Packing methods (side pack, stack pack, pro pack, hanging pro pack)
10. Folding canopy (to place indeployment bag) (freebag types, vector, racer, molar, etc.)
11. Line stowing (methods and tools)

E. Harness and Containers

1. Construction and materials
2. Hardware (types, inspection, values of types, ADs or SBs, proper installation)
3. Gromets (types, inspection)
4. Snaps (types, inspection)
5. Cable housings (types, inspection)
6. Attachment links (types, inspection, main and reserve)
7. Pilot chute (types, inspection, both main and reserve, including retract and collapsible)
8. Hand tacking (materials, methods, inspections)
9. Ripcords and release handles (types, materials, inspection procedures)
10. Pins and cones (types, inspection)
11. Harness and container inspection (as a unit)

F. Sewing Machines

1. Manufactures and types (uses of different types) (straight locking, zig zag, bar tack, harness)
2. Sewing machine components (table, head, motor, clutch/brake, bobbin winder, etc.)
3. Threading the machine (needle and bobbin) (thread types and values)
4. Basic operating of machine (foot, knee, hands, and effects, sew, brake, lift foot, set needle, etc.)
5. Types of sewing stitches (301-304-308)

G. Tools (Demonstrations and Applications for all Types)

1. Pull up cords
2. Packing weights
3. Line separator (round/square)
4. Through the bag cord with friction lock
5. Molarstrap
6. Rifle cleaning rod
7. Velcro covers
8. Temporary pins
9. Knee plate
10. T-Bar
11. Packing paddles (long/short)
12. Bodkins
13. Seam ripper
14. Scissors (nippers)
15. Finger trap fids
16. Positive closing device
17. Hand sewing needles
18. Razor knife
19. Tailoring pencils (correct type dixon)
20. Seal press
21. L-Bar separator
22. Weight scale (pull test)
23. Pull test clamps
24. Hot knife
25. Gromet hole cutters
26. Gromet sets
27. Snap setting tools
28. Hot glue gun

H. Automatic Activation Devices

1. Makes models and applications
2. Setting and calibration (all makes and models)
3. Discription of activation types (ballistic, spring, etc.)
4. Care and maintainence (testing operations, replacing batterys, replacing cutters, cocking unit, changing catridges, etc.)
5. Installations (different applications using optional numbers of cutters, pinpullers, powerplates, pull cables, etc.)
6. Responsibility (who can install, remove, replace, maintain, and what are the liabilities connected with these situations?)

I. Materials

1. Presentation of all types, with reference to idertification and strength values (material sample book)
2. Cordura, parapak (denier weights)
3. Suspension line (dacron, spectra, kevlar)
4. F-111, zero porosity, different weight ripstops 1.5, etc.
5. Marquisette netting, high drag netting
6. Velero ($\frac{1}{2}$ - $\frac{3}{4}$ -1 $\frac{1}{2}$ -2 inch)
7. Elastics (1 inch, 1 $\frac{1}{2}$ -inch)
8. Shock cord ($\frac{1}{8}$ - $\frac{3}{16}$ - $\frac{1}{4}$)
9. Tubular nylon ($\frac{1}{2}$ - $\frac{9}{16}$ - $\frac{5}{8}$ - $\frac{3}{4}$ -1 inch)
10. Kevlar tape
11. Nylon stiffener plate
12. Nylon binding tape ($\frac{3}{8}$ - $\frac{3}{4}$ -1 inch)
13. Nylon support tape (1 inch square weave)
14. Webbing (type4, type6, type7, type8 , type9, typel2, type 13, type17, type24)
15. Threads and cords (nylon and cotton)

J. Demonstrations

1. Packing B-12
2. Packing NB-6
3. Packing wonderhog (2 stow)
4. Packing centarus (wide full stow para-innovators)
5. Packing vector II (full stow vertical strong lopo)
6. Packing javelin (national full stow)
7. Packing racer square (side and pro)
8. Packing vector I square (side and pro)
9. Packing talon square (side and pro)
10. Packing flex on square (pro)
11. Packing javelin square (pro)
12. Packing vector tandem
13. Packing strong tandem
14. Packing racer tandem
15. Packing security back pack
16. Packing softie back pack
17. Packing briefcase
18. Packing sprint
19. Packing strong hawk
20. Packing EOS

J . Demonstrations (continued)

21. Tangled round
22. Tangled square
23. Complete inspection (round reserve)
24. Complete inspection (square reserve)
25. Assembly complete (round)
26. Assembly complete (square)
27. Hand sewing and tacking (comfort pads, connector links, cones, reserve cable housing, eyelets)
28. Needle fold (reserve bridles)
29. Installing toggles (main and reserve)
30. Installing gromets and snaps
31. Finger trapping suspension line
32. 4-line release systems
33. Nylon mesh acid test
34. Pull test (description warp and fill thread to selvege edge)
35. Pull test (using scale check pull tension on reserve ripcord)
36. Installing a 6-inch patch in F-111

K. Projects

1. Install to airworthy standards around reserve
2. Install to airworthy standards a square reserve
3. Round canopy inspection locate and verify defects
4. Square canopy inspection locate and verify defects
5. Square reserve side pack
6. Square reserve pro pack
7. Harness and container inspection locate and verify defects
8. Pack B-12
9. Pack NB-6
10. Pack round reserve with 2 stow diaper
11. Pack round reserve with vertical full stow diaper
12. Pack round reserve with full stow diaper
13. Pack round reserve with vertical full stow diaper parallel to bottom of pack tray
14. Pack square reserve in Vector-type freebag (using through bag cord)
15. Pack square reserve in Javelin-type free bag (molar)
16. Untangle round reserve using proper technique
17. Untangle square reserve using proper technique
18. Demonstrate knowledge of 4-line release systems
19. Hand sew ripcord housing, tack comfort pad, Hand sew cone and eyelet
20. Tie knots, overhand, square, clove hitch, double half hitch, slip loop, bowline, surgeon's & locking.
21. Install proper seal on closing pin
22. Perform proper needle fold
23. Machine sewing 1 (build shot bags using templates and perform sewing/practise drills)
24. Machine sewing 2 (install a six inch patch to acceptable and airworthy standards)
25. Using proper tools (cut hole and set gromets in parapack and install snaps)
26. Install steering toggles using recognized methods
27. Finger-trap suspension line to a finished length by calculating shrinkage of traped area
28. Perform dryrun reserve inspection and repack to airworthy standards meeting all FAA requirements
29. Locate correct information for compatability, assembly and inspection of a sport rig and reserve
30. Perform at least 20 complete inspections and repacks to standards of back type reserves

Example Training Syllabus for Master Rigger Training, Classes, Demonstrations, and Projects

A. Introduction

1. Federal Aviation Administration (FAA) regulations and rating privileges
2. Review Title 14 Code of Federal Regulations (CFR) parts 105, 91, detail part 65 required facilities, equipment, tools, materials, record keeping, repair testing
3. Mil-Spec materials and values
4. Technical Standard Order (TSO) standards and who creates them. Current standards, categories, and limitations and who maintains them
5. Skills, responsibilities, and ethics of a master parachute rigger
6. Record keeping
7. Alterations, manufactures, FAA authorization process, records and documentation

B. The Parachute Loft

1. Facilities
2. Work areas, round canopies, square canopies, suspended, table
3. Material storage, and support, conditions for material quality
4. Inspection areas and lighting
5. Hand tools, types, uses, control, maintenance
6. Sewing machines
7. Parachute equipment storage, short and long term
8. Project tables, layout and cutting

C. Harness & Container Systems

1. Reserve system deployment types, (internal pilot chute) (external pilot chute)
2. Harness types, (standard harness) (partial articulated harness) (fully articulate harness)
3. Hardware, current manufactures, (standard cadmium plated) (stainless steel) (rapide links, “galvanized” “stainless”) (Slinks – Manufactured by Performance Design and Precision Aerodynamics)
4. 3-ring release systems, ring sizes, maintenance, riser sizes, lengths, construction
5. Reserve ripcord systems, types, housings, ripcords
6. Main canopy deployment systems, ripcord, throwout, pullout, bottom of container (BOC), PUD system
7. Freebag systems, deployment bag types and cuts, line stow types, bridles and bridle assists, reserve pilotchute types
8. Main canopy release systems, housing types, duel action systems (student equipment)

D. Square Parachute Systems

1. Modern construction
2. Materials
3. Airfoil types (elliptical, semi elliptical, tapered, multi cell)
4. Cell construction types (I-beam, interlocking T-beam, half cell, spanwise)
5. Suspension line types and line attachments types (Spectra, Kevlar, Vectran, HMA, Dacron)
6. Canopy suspension line trim
7. Modern canopy repair methods and limitations (Chapter 7 FAA Parachute Rigger Handbook) (RD Raghanti repair method)
8. Square canopy design and flight definitions
 - (A) Airfoil section area
 - (B) Angle of attack
 - (C) Angle of trim
 - (D) Angle of incidence
 - (E) Aspect ratio
 - (F) Cascade line
 - (G) Cell
 - (H) Chord
 - (I) Control line
 - (J) Control line deflection

- (K) Construction chordwise
- (L) Construction full-cell chordwise
- (M) I-beam
- (N) Interlocking T-beam
- (O) Half-cell chordwise
- (P) Construction spanwise
- (Q) Cross ports
- (R) Deployment brakes
- (S) Flares, suspension line attachments
- (T) Full flight settings
- (U) Glide path (flightpath) angle
- (V) Pilot chute controlled reefing
- (W) Planform
- (X) Planform area
- (Y) Plumblines
- (Z) Projected area
- (AA) Quarter chord area
- (BB) Reference line
- (CC) Ribs
- (DD) Riser specs
- (EE) Slider
- (FF) Slider stops
- (GG) Stabilizer panels
- (HH) Span
- (II) Suspension lines (A) (B) (C) (D)
- (JJ) Suspension line length
- (KK) Trim line
- (LL) Toggles control
- (MM) Final trim measurements

E. Authorized/Certificated Parachute Components and Compatibility

1. Manufactures inspection and packing instructions
2. Approved data
3. Acceptable data
4. Methods to confirm compatibility

F. Automatic Activation Devices

1. Types
2. Service requirements (life, battery service, trouble codes, inspections)
3. Control and calibration
4. Installation
5. Service during FAA 180-day inspection cycle
6. Compatibility to TSOed equipment
7. Airworthiness Directives (AD) or Service Bulletins (SB)

G. Commercial Sewing Machines

1. Machine types and stitch requirements for production of components and major repairs
2. Sewing machine maintenance
 - (A) Tools
 - (B) Lubrication
 - (C) Needles, sizes, types, uses
 - (D) Inspections
 - (E) Thread pick-up types (oscillating, rotating vertical, and rotating horizontal)

- (F) Shuttle timing
 - (G) Feed dog, tooth type and feed adjustment
 - (H) Walking foot feed
 - (I) Stitch length adjustment
 - (J) Thread tension adjustment
 - (K) Thread tension disk adjustment
 - (L) Motor type, speed, clutch adjustment and application
 - (M) Double needle applications and stitch width
 - (N) Setting up machine to run .75 inch nylon binding tape and double and single needle installation
 - (O) Bar tack machines, stitch patterns and lengths
 - (P) Free arm machines, operation and uses
3. Harness geometry and junctions
 4. Harness machine use and operation (7 class)
 - (A) 3 and 4 point harness junction stitch patterns
 - (B) Calculating pattern and stitch numbers to exceed webbing strength
 - (C) Chaffing strip uses and installation in harness junctions
 - (D) Main lift web confluence wrap at 3 ring
 5. Double needle binding tape machine use and operation
 - (A) Applying binding tape to component edge
 - (B) Turning 90 degree corner applying tape
 6. 304 zig zag stitch machine use and operations
 - (A) Stitch length adjustment
 - (B) Stitch width adjustment
 7. Bar tack machine use and operation
 - Stitch width and length adjustment

H. Master Parachute Rigger Applicant Projects

Listed below are possible, projects or tasks you may be required to perform, during the master rigger practical test phase. They may require only the repair or replacement of a single item, or possible construction and replacement of the entire assembly. All projects are to be performed to return to service safety and manufacture standards.

1. Webbing joint construction / replace main lift web
2. Chest strap replacement
3. Partial top/bottom skin replacement (ram air canopy)
4. Line set repair or replacement, (round or ram air)
5. Complete panel replacement (round reserve canopy)
6. Main parachute riser, major repair or construction
7. Main parachute deployment bag construction
8. Installation of AAD in container system not factory ready
9. Construction of slider ram air canopy
10. Construct replacement leg pads for container system
11. Alter riser from I-bar to rapide link
12. Construct lower steering line assemblies and replacement toggles
13. Construct 32-inch hand deploy pilotchute
14. Construct and replace main side flap on container
15. Replace plastic stiffener and grommet reserve flap assembly
16. Build and install BOC pocket on container
17. Construct pull lines and channel for collapsible slider
18. Construct and replace lower leg straps on articulated harness
19. Replace parcel rib ram air
20. Construct collapsible pilotchute bridle assembly

These are just a few of the possible projects or task you may be required to perform during the practical portion of the master parachute rigger test. It is important that you learn use of the proper machines, materials, construction methods, obtain the skills, and knowledge to complete these projects to a return to service standard for safe use.

