Ballistic Recovery Systems, Inc.

BRS-182 System Description

This discusses the description, operation and gives an overview of BRS systems for installation in Cessna aircraft (182) a similar installation exists for Cessna 172 but is not specifically discussed here.

BRS-182 INSTALLATION MANUAL

1. SCOPE

This specification establishes the materials, equipment, and processes required to install the BRS-182 Parachute System. The inspection, assembly, and installation procedures outlined in this document are to be performed only by qualified personnel. The components and installation procedures for the BRS-182 will be unique to most certified Airframe and Powerplant mechanics. BRS has therefore provided detailed step by step illustrated instructions to ensure that the system has been installed properly. Exploded views of the installed BRS-182 are included at the end of this section to provide an overview of the installation.

1.1 BRS-182 System Description

The BRS-182 recovery system for the Cessna-182 model aircraft utilizes a rocket deployed parachute to recover the aircraft and its occupants in life threatening emergency situations and lower it to the ground at a safe rate of descent. The design is the result of more than 20 years of BRS experience in designing, manufacturing, and servicing ballistically deployed parachutes for aircraft.

The system's round, non-steerable parachute is pressure packed with a hydraulic ram and special steel packed jigs. It is then stowed inside a deployment bag that has been designed to properly stage the extraction sequence. This packed parachute assembly is enclosed in an aluminum canister along with additional hardware such as rocket motor lanyards and the rear aircraft attachment harness. The canister has a vacuum formed ABS plastic cover that will break away when the system is activated.

The parachute canister is mounted in the baggage compartment as shown in Figure 1. The system's manually activated solid propellant rocket motor is mounted aft of the parachute canister and is protected by a fiberglass shield.

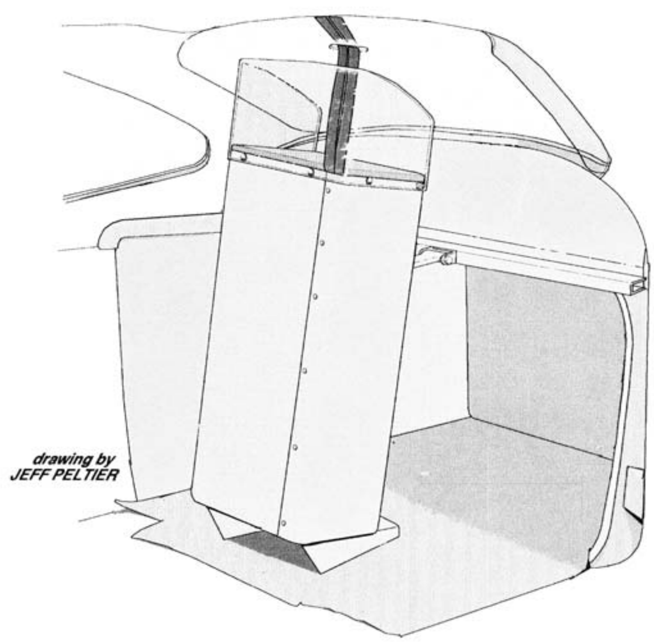


Figure 1.

BRS-182 Parachute Canister Installation

The parachute is attached to the airplane primary structure with a four point harness assembly fabricated of flexible woven Kevlar straps. Two of the harness straps are routed through a slot in the rear window and across the top skin to the front wing attachment points as shown in Figure 2. These front attach straps are protected from the elements by a fiberglass fairing.

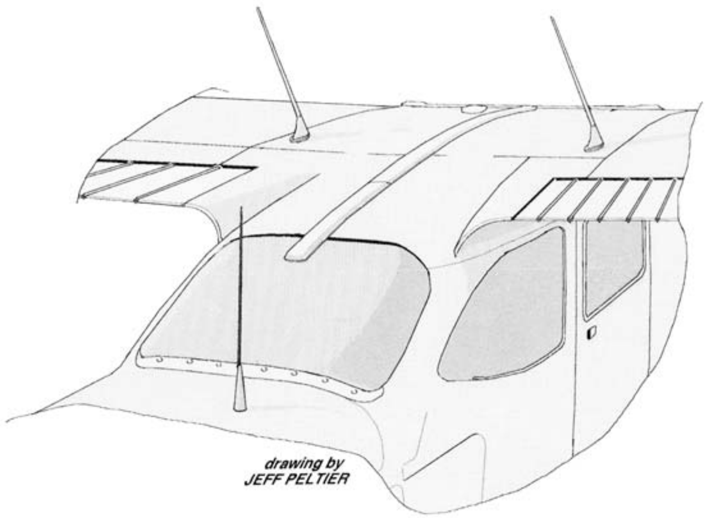


Figure 2.
BRS-182 Aircraft Attachment Harness Installation

The rear harness straps, which are stowed inside the baggage area, are attached to the aft cabin primary structure that has been modified with a custom rear attachment assembly, illustrated in Figure 3, to distribute the parachute inflation loads across this area.

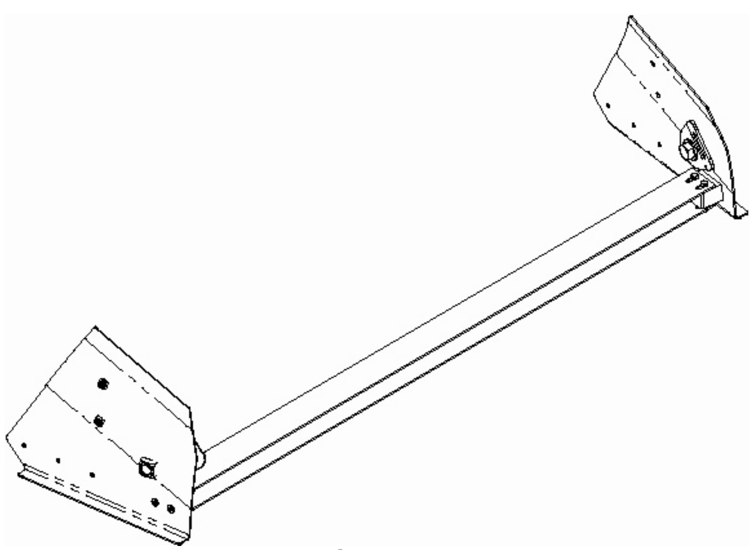


Figure 3.

BRS-182 Rear Attachment Assembly

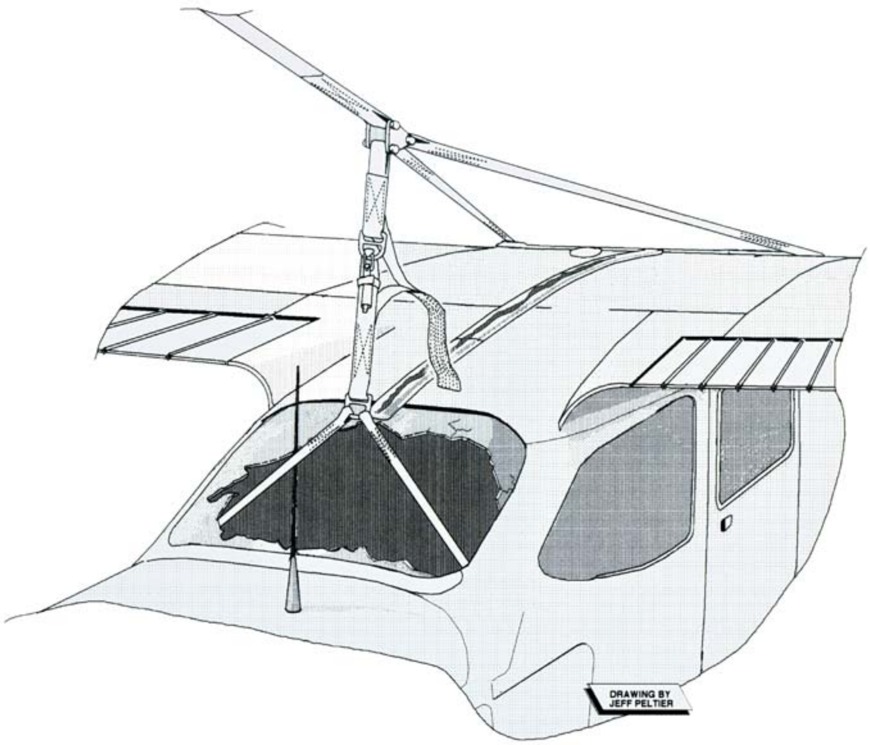


Figure 4.
Aircraft Attachment Harness after Parachute Extraction

When the system is activated, the rocket motor will penetrate the rear window and extract the parachute away from the airplane, peeling the two forward attachment harness straps away from the aircraft top skin and extracting the rear harness straps from inside the aircraft as shown in Figure 4. The BRS-182 harness system is designed to control the pitch dynamics of the airplane during the deployment cycle by limiting the length of the rear harness strap until the deployment cycle is complete.

The rear harness assembly has two sections of different length. The shorter section has a mechanical release mechanism that is activated by a fused pyrotechnic reefing line cutter as shown in Figure 5. This system uses a series of metal rings routed through each other in a manner that provides a significant mechanical advantage. In the BRS release mechanism, a D-ring is attached to one end of the mechanism and a rectangular link and small link are attached to the opposite end. During its assembly the rectangular link is flipped through the D-ring and the small link is flipped through the rectangular link.

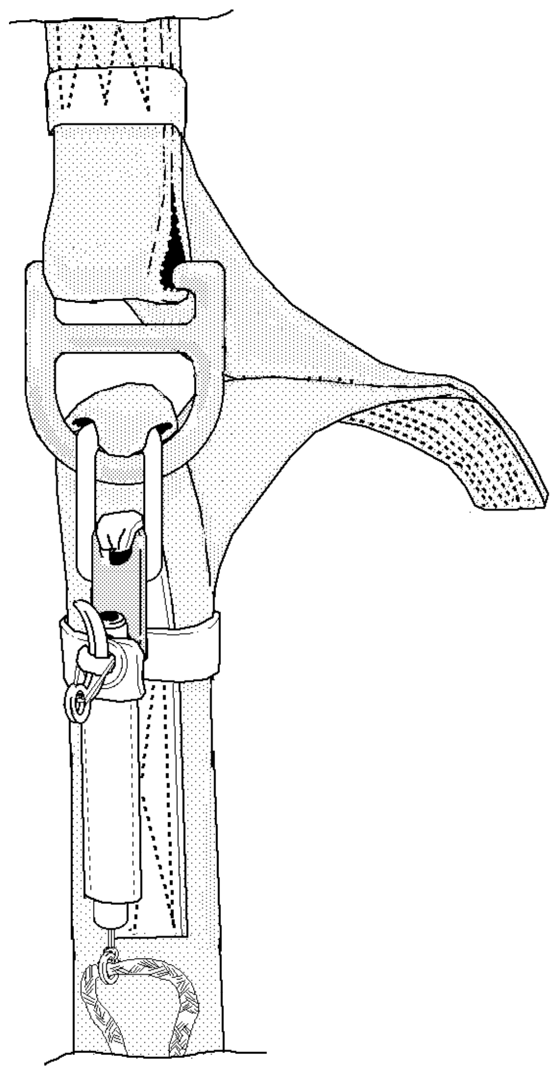


Figure 5.
Rear Harness Release Mechanism

For the mechanism to be released, each link must rotate through its adjacent ring or link. The force necessary to hold the small link in its stowed position is considerably smaller than the force that is being applied as a result of the overall load on the mechanism. The use of two consecutive links in series results in a mechanical advantage of more than 100 to 1. The last link is held in place by a short length of nylon cord which is severed by the line cutter. The eight second fuse on the line cutter is initiated when the line cutter release pin is pulled as the parachute is extracted.

The longer rear harness section has been folded in half and sewn together with several rows of heavy nylon thread. This stitching is peeled away when tension is applied to provide shock absorption. After the line cutter fires and the release mechanism is activated, the longer section of the rear harness takes over and the airplane assumes its touchdown attitude of approximately ten degrees nose down, shown in Figure 6, to optimize occupant protection.

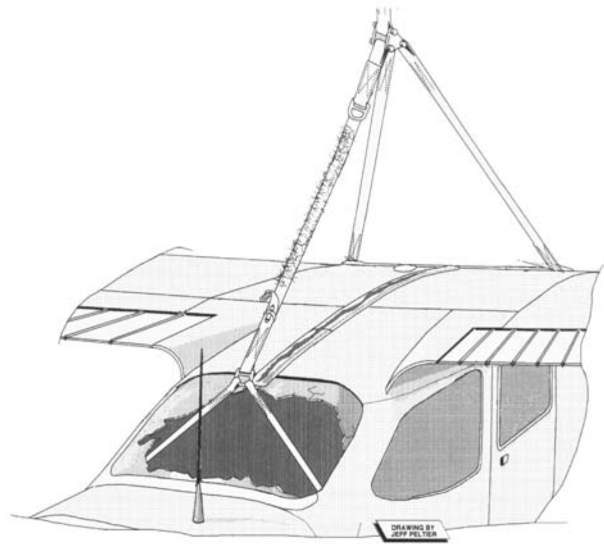
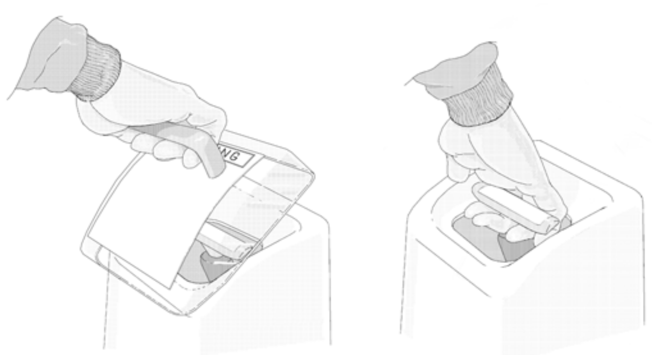


Figure 6.
Aircraft Attachment Harness after Rear Harness Release

The rocket motor is activated by pulling an activation handle mounted in a protective fiberglass box on the floor between and slightly forward of the pilot/copilot as shown in Figure 7. The handle, the only part of the system accessible to the pilot in flight, is protected with a cover to prevent it from being pulled accidentally. This handle is connected to the rocket motor igniter with a flexible, stainless steel aircraft grade cable routed through a Teflon lined cable housing under the carpet.



Removing Cover **Deploying Parachute**

Figure 7.
Activation Handle Box

Two separate and deliberate actions are required for activation. First, the protective cover must be removed from the activation handle box. Second, the handle must be pulled out with at least 40 lbs of force. The first few inches of motion deliberately takes up cable slack within the housing. The remaining motion both arms the rocket motor igniter and fires it. The rocket motor igniter, a mechanical device that requires no electrical source, is unarmed in the normal configuration. Approximately 25 to 30 lbs of force would be required to activate the rocket motor igniter directly. However, additional force required to activate the system at with the handle is due to friction within the cable housing assembly.

The BRS-182 rocket motor uses stored chemical energy in the form of a solid propellant to provide the thrust forces necessary to rapidly remove the enclosure cover and extract the parachute from its enclosure. Vast experience has been gained in solid propellant rocket motor technology over the past 50 years through a wide array of applications. Solid propellants are used in large boosters and second stage motors for space vehicles and high altitude ballistic missiles. Smaller applications of solid propellant rocket motors include tactical missiles for military applications such as antitank, antiballistic, air-to-air, and surface-to-air missiles.

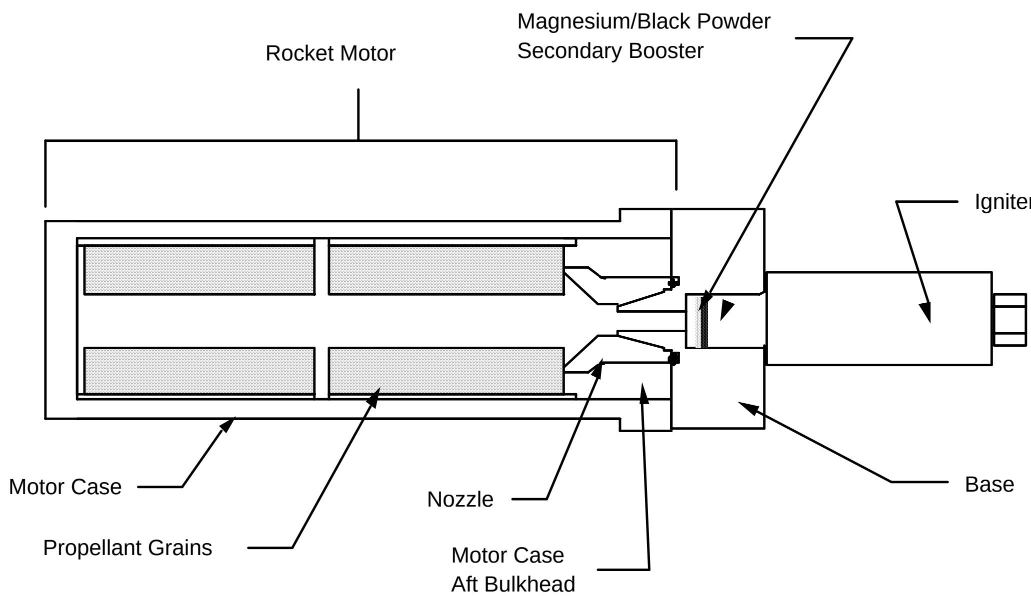


Figure 8.
BRS-900 Rocket Motor Assembly

The BRS-900 rocket motor, illustrated in a cut-away view in Figure 8, consists of the rocket motor, igniter, and rocket motor base. The rocket motor components consist of the motor case, motor aft bulkhead, propellant, and nozzle. The motor case/aft bulkhead contains the propellant and serves as a pressure chamber when the propellant is burning. The composite propellant is cast into grains, or solid shaped masses that fit snugly inside the motor case. To provide consistent dimensional tolerances, the grains are cast inside a filament wound internal liner that also acts as an insulator to limit heat transfer to the motor case.

The igniter, illustrated in a cut-away view in Figure 9, consists of a firing pin actuator to which the activation cable is attached, a steel spring, a plunger, and two firing trains. Each firing train consists of a firing pin and primer which ignites a booster at the end of the igniter. In its normal position the firing pin actuator and plunger are interlocked with two small ball bearings held in place by the inner wall of the igniter body.

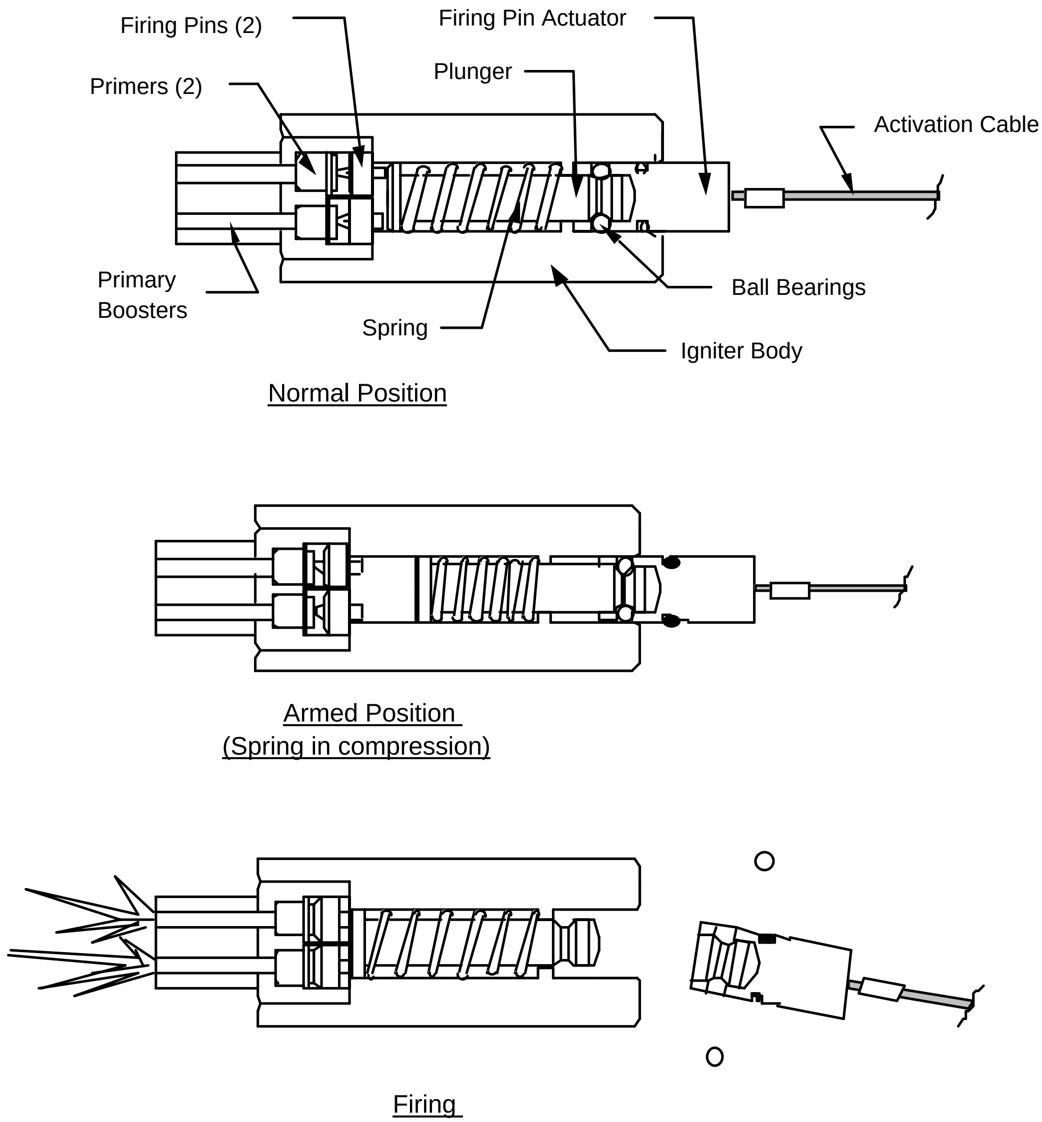


Figure 9.
Percussion Igniter Assembly

Pulling the activation cable compresses the spring and cocks the plunger. One half inch of plunger travel is required to release the ball bearings and allow the plunger to strike the firing pins with the stored energy of the compressed spring. The firing pins then strike the shot-gun primers which ignites a black powder and magnesium primary booster in the end of the igniter. The igniter is unarmed in its normal configuration since the spring is uncompressed and the plunger is separated from the firing pins by a small gap.

The igniter primary booster ignites a secondary black powder and magnesium booster contained in the rocket motor base. The extra booster material is used to insure ignition of the larger rocket motor. The rocket motor base has a conical protrusion which sprays hot particles past the rocket nozzle and across the surface of the rocket motor's solid propellant grains. Once ignited, the grains will burn on all exposed surfaces to form hot gases that are exhausted through the nozzle. The rocket motor nozzle provides for the expansion and supersonic acceleration of the hot gases.

Due to shipping constraints outlined by the U.S. Department of Transportation, BRS cannot ship a completely assembled rocket motor. Final assembly of the rocket motor must therefore be accomplished when the system is installed in the aircraft.

1.2 BRS-182 Parachute

Although the following information is not critical to the personnel responsible for installing the BRS-182 system in the aircraft, it does provide a brief overview of the parachute assembly and its function.

WARNING!
The BRS-182 Parachute Canister must not be opened by anyone other than authorized factory personnel.

Parachutes are the lightest, most cost-effective device for decelerating a vehicle in the atmosphere. They are also very reliable devices when manufactured according to strict quality control procedures, maintained properly and used within their design operating envelope. The long history, widespread use, and many critical applications of parachuting activities have created the necessary high standards of engineering which Ballistic Recovery Systems employs in their design and fabrication.

Present day parachutes have many applications, including sport parachuting, airdrop of troops and supplies, emergency aircrew escape, stabilization of ordnance, and recovery of many other aerospace vehicles. Their configurations range from round non-steerable hemispherical shaped canopies that simply create drag and slow descent to wing shaped gliding parachutes that offer precision control and maneuverability.

Round non-steerable parachutes are used for aircraft recovery because their purpose is simple, to slow an aircraft to a descent speed that is conducive to a safe touchdown. It is this simplicity that enhances their reliability. The following discussion will focus on round parachutes, their materials, and fabrication methods.

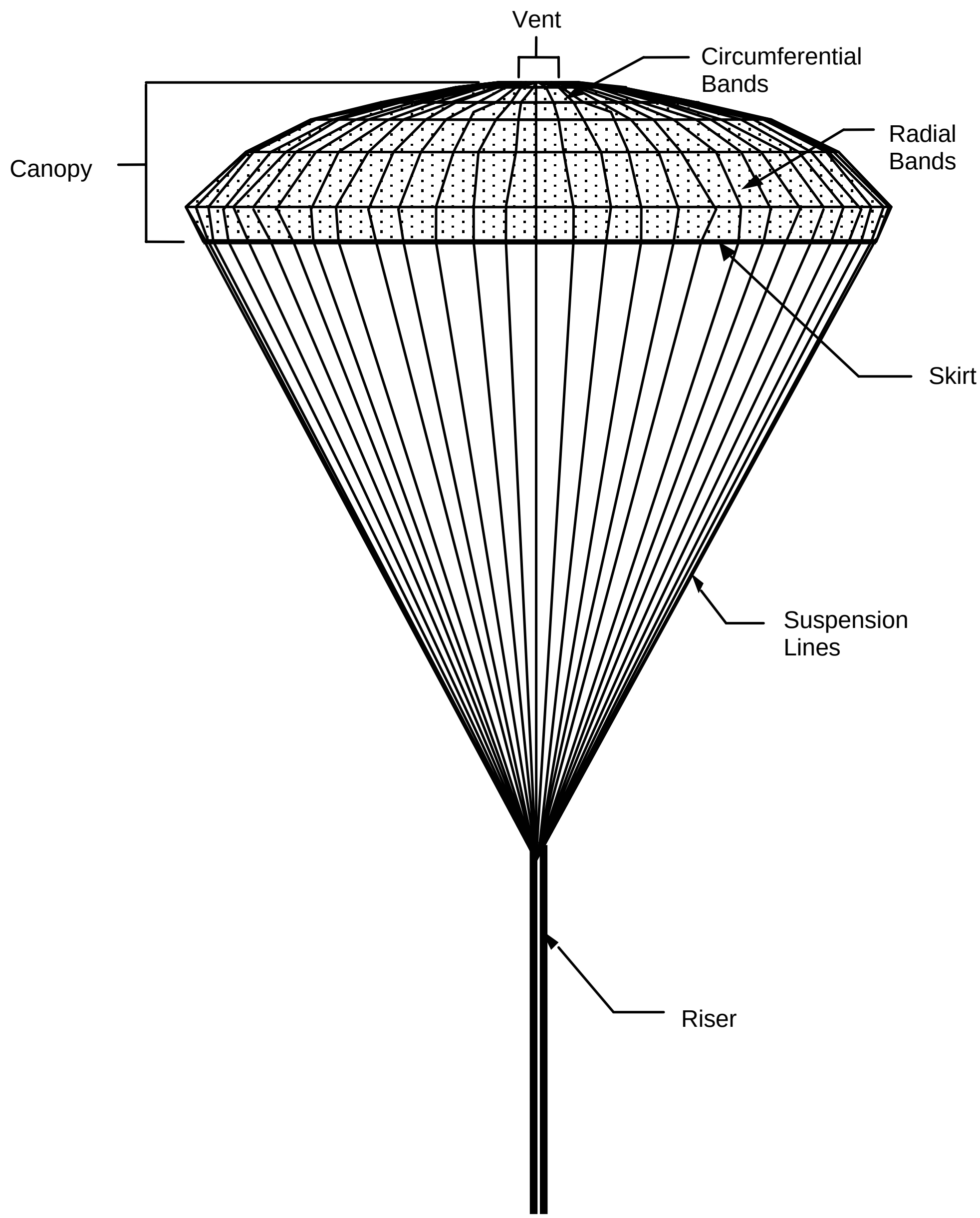


Figure 10.
Typical Round Parachute

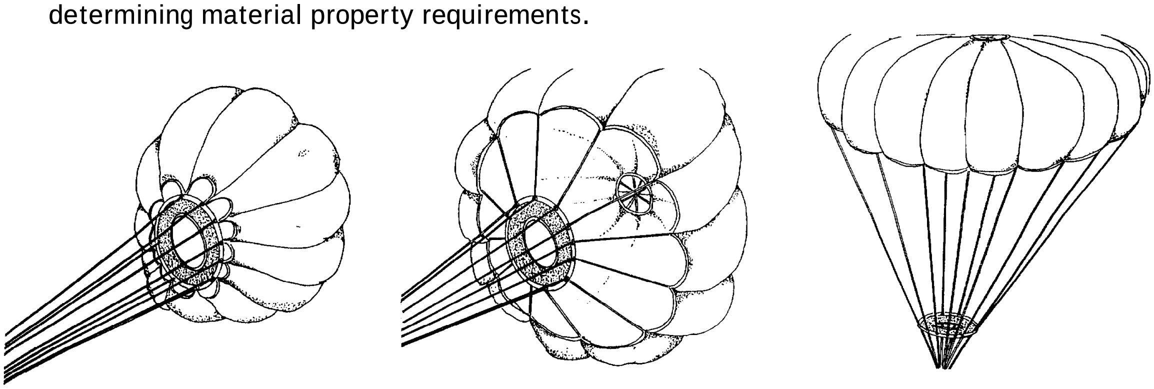
Parachutes are fabricated from woven textiles in the form of fabrics, tapes, webbing, and thread. The basic structure of a round parachute (shown in Figure 10) consists of the canopy and suspension lines. The canopy, which creates the aerodynamic drag, is made up of a series of fabric panels or "gores" sewn together to form its desired shape. The canopy has a vent at its center to allow some air to escape in a controlled manner and thus reduce oscillations and provide a stable descent. Vent lines are attached to the perimeter of the vent and routed symmetrically across its center to provide structural support and maintain its shape.

The suspension lines are attached to the "skirt" of the canopy and converge to a riser or set of risers at the opposite end. The canopy structural integrity is enhanced by a "skeleton" of tapes and webbings sewn nearly perpendicular to each other to the top surface of the canopy fabric. Radial bands run from opposite suspension line attachment points, across the top of the canopy. The skirt band, vent band, and circumferential bands run around the circumference of the canopy.

All of the textile components in the BRS-182 Parachute assembly are fabricated from either Kevlar™ or Nylon. Their properties allow fibers to be formed by forcing the softened material through tiny holes (spinneret) and then hardened. Yarns are formed by twisting two or more fibers together. This keeps un-tensioned fibers together to equalize minor differences in length. The amount of twist depends on the yarn ultimate use, weaving, braiding, etc.

Parachute material strength requirements are ultimately based on deployment characteristics, or specifically, deployment loads. A typical deployment load profile begins with a snatch force which occurs when the parachute assembly is initially extracted from its container and pulled to full line stretch. When air begins to fill the canopy, inflation loads result. The number and magnitude of the peak loads is dependent on airspeed at deployment, payload weight, reefing devices, and atmospheric conditions.

The inflation loads of parachutes for the recovery of manned vehicles, such as general aviation aircraft, must be maintained within the limits of human tolerance to abrupt decelerations. In other words, the parachute must deploy without generating forces high enough to injure the aircraft occupants. This relationship is one of the major guidelines for determining material property requirements.



Maximum Reefed Condition **Disreefing** **Full Canopy Deployment Condition**

Figure 11.
BRS Annular Slider

The BRS-182 Recovery System uses a 2400 sq. ft. round parachute with a slider to aerodynamically reef the parachute and limit inflation loads. The slider, illustrated in Figure 11, is a flat annular shaped fabric panel with metal grommets attached to its perimeter. The parachute suspension lines are routed through the grommets such that the slider is free to move along the suspension lines. The slider, which has a significantly smaller diameter than the fully inflated parachute, is positioned at the top of the suspension lines, next to the canopy skirt, when the parachute is packed. It therefore limits the initial inflated diameter of the parachute and hence the inflation loads. During inflation, the slider remains next to the skirt for a period of time that is dependent on the dynamic pressure acting on the system. This allows the payload to decelerate to a speed at which the parachute can fully inflate without generating excessive loads.