

III. INFORMATION ON BRS SYSTEM IN ACCIDENT AIRCRAFT

A – Description of BRS-1350HS

The BRS-1350HS is a rocket deployed emergency parachute system designed for use on aircraft, such as the Flight Design CTLS LSA aircraft. It is designed to recover the aircraft in life threatening emergency situations, lowering the aircraft and occupants to the ground in a controlled descent.

The BRS-1350HS Parachute is enclosed in an aluminum Canister mounted in the baggage compartment aft of the cabin area. The Parachute is attached to the airplane primary structure with a 4-point Harness Assembly fabricated of flexible woven Kevlar straps. Two of the Harness Straps are routed forward over the top of the cabin, down the front door posts, and attach to structure on the front side of the firewall. The aft Harnesses attach to hard-points on the aft side of the aft cockpit bulkhead. When the system is activated, the Rocket will blow off the fiberglass Egress Panel and extract the Parachute away from the airplane. The deploying parachute peels the two forward attachment Harness Straps through the aircraft top skin, extracting the aft Harness Strap from inside the aircraft.

The system is activated by pulling an Activation Handle mounted in a recessed area at the aft end of the center console between and slightly behind the aircraft occupants. The Handle Assembly

is the only part of the system accessible to the pilot in flight. A Safety Pin and “Remove Before Flight” flag is supplied to safety the system when not in use or in maintenance.

A single, deliberate action is required for activation, assuming the Safety Pin and Flag had already been removed as required for flight. The Handle activates the Rocket Motor via a braided stainless steel cable routed through a Teflon, lined Housing. The first few inches of motion deliberately take up slack within the cable housing. The remaining motion simultaneously arms the Igniter and fires it. The Rocket Motor Igniter, a mechanical device that requires no electrical source, is unarmed in the normal configuration.

B – Relevant Sections from BRS-1350HS Owner’s Manual

The BRS Owners Manual provides important safety information to the owners and users of the BRS system and it is delivered with every BRS system. BRS instructs owners it is mandatory they read the entire Owners Manual before using the BRS system. The BRS Owners Manual warns that failure to follow the procedures and directions set forth in the manual can result in deployment failure and personal injury or death to the pilot and any passengers aboard the aircraft.

The BRS Owners Manual warns owners that the rocket and parachute must have a clear path to exit the aircraft. The egress path must be clear of structure, tubing, control linkages, cables, and wiring. The only items in the path of egress should be items that are predictably frangible or easily torn material.

The BRS Owners Manual also contains a Pre-Flight Checklist that owners are able to remove from the manual and carry with them to the aircraft for use before each flight. Relevant items from the BRS Pre-Flight Checklist include:

1. Check routing of airframe bridle
 - a. The pilot is instructed to check that the parachute harnesses do not interfere with the firing of the rocket or the extraction of the parachute.
2. Check parachute container and rocket mounts
 - a. The pilot is instructed to check the parachute container and rocket mounts to ensure they are still positioned and aimed correctly towards the egress opening.
3. Check all bolts and nuts
 - a. The pilot is instructed to check and ensure the nuts and bolts that connect the parachute canister and rocket to airframe are tight and secured.
4. Check stainless steel link security
 - a. The pilot is instructed to check and ensure that the stainless steel Quick-link that attaches the parachute harnesses to the airplane is tight and secured.

The Owners Manual also warns customers that if the BRS system is not installed correctly the system may fail to work properly, which could cause injury or even death as well as damage to the aircraft.

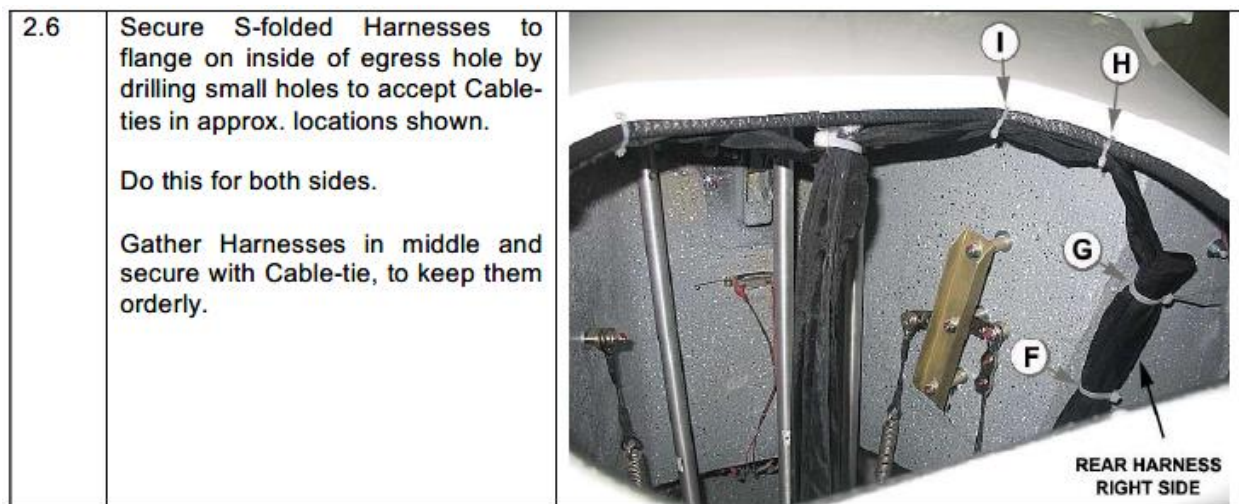
BRS encourages owners to send photos of any installed system to BRS so it can inspect and verify the installation. These services are provided free of charge. BRS owners are also able to schedule an inspection of the actual aircraft if desired.

BRS has no record that anyone ever requested for BRS to review the installation for the aircraft involved in this accident, tail number N81KK, at any time, either through photograph or in person. BRS never reviewed or inspected the installation of the BRS system on N81KK.

C – Relevant Sections from Parachute Installation Manual

The BRS Parachute Installation Manual for the BRS 1350HS was created in cooperation with Flight Design GmbH. These instructions provide guidance on how to properly install the BRS 1350HS, and serve to supplement the BRS Owners Manual, and the BRS General Installation Guide. It provides additional direction relating specifically to the BRS-1350 HS parachute system installed in the Flight Design CTLS series aircraft.

Section 2.6: Secure S Folded harnesses. Note that the harness should not block any part of the egress opening.



Section 4.1: Alignment of Canister.

4.1	Install BRS Canister unit to aircraft parachute frame. Check alignment of Canister and Rocket with egress hole and ensure outer edge of Rocket Pick-up Collar is clear of upper frame tube. Use washers between mounting bracket to shim parachute for better alignment, if necessary.	
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4.2: Use of Lock Tight

4.2	Use 6 Nylon Lock Nuts (unit 22) and 6 Washers (unit 23) to secure unit to frame.	
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4.4: Again reminding mechanic to make sure all Harness material is routed to the outside of all structural frame tubes to ensure clear egress of Harnesses.

4.4	Attach Rear Harness to upper frame tube on the left hand side of the aircraft using one Cable Tie (item 19) in position U. Make sure that all Harness material is routed to the outside of all structural frame tubes to ensure clear egress of Harnesses.	
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4.5: Connecting and securing Quick Link, and applying Loctite.

4.5	Connect all four Harnesses to #12 Quick-link. (item 17) attached to Canister Cover. Apply Loctite 242 to Link threads and close the gate until snug. Do Not Over Tighten. WARNING: Ensure that no Harnesses pass over top of Canister, Rocket or Rocket Lanyards!	
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D – BRS Annual / 100 HR Inspection Procedures

The BRS Instructions for Continued Airworthiness for the BRS-1350HS contain a published Annual/100HR Inspection Procedure. The procedure provides for inspection of both internal and external components of the system. The Annual/100HR inspection must be performed by a maintenance professional.

E – Relevant Sections from Flight Design Aircraft Operating Instructions

The Flight Design Aircraft Operating instructions for the CTLS series aircraft provide the pilot with important safety information.

Section 1.4 clarifies that for Light Sport Aircraft, unlike other aircraft for which the FAA is responsible for the continued certification compliance, the burden of continued certification compliance rests on a cooperative effort between the manufacturer and the Owner/Operator of the aircraft. To this end, certain Manufacturer and Owner/Operator responsibilities are outlined in ASTM F 2295, Standard Practice for Continued Operational Safety Monitoring of a Light Sport Aircraft.

Federal Aviation Regulation 91.327(4) provides that no person may operate an aircraft that has a special airworthiness certificate (such as a Light Sport Aircraft) unless the owner or operator complies with **each Safety Directive applicable to the aircraft** that corrects an existing unsafe condition. Information available from the Flight Design website (www.flightdesignusa.com/support/safety_directives) explains that Service Bulletins are one three different types of Safety Directives issued for continued certification compliance for Flight Design aircraft.

Pursuant to the above authority, owners of Flight Design CTLS aircraft must comply with Flight Design issued Service Bulletins for continued compliance with their Special Airworthiness Certificate.

Other relevant sections of the Flight Design Aircraft Operating Instructions include:

- Section 1.1 – States that the pilot must familiarize themselves not only with the Flight Design Aircraft Operating Instructions, but also the operating handbooks and manuals of the ballistic recovery system, and other components of the aircraft.
- Section 1.4.2 – Advises that owner/operator responsibilities and instructions include reading and complying with the maintenance and continued airworthiness information and instructions provided by the manufacturer, and provides information on how such information can be easily obtained.
- Section 3.6 – Provides instructions for deploying the ballistic recovery system. Warnings are provided, and include instructions for the operator to refer to the operating handbook published by the manufacturer of the recovery system for operating details.

F – Flight Design Maintenance and Inspection Procedures Manual

Section 3.1 of the Flight Design Maintenance and Inspection Procedures Manual provides that during each Conditional Annual Inspection the aircraft maintenance service provider shall check and confirm that all Safety Directives, Airworthiness Directives, and Service Bulletins are complied with, in the following line item:

Safety Directives (SD's), Airworthiness Directives (AD's) and Service Bulletins. Check SD's, AD's, and Service Bulletins which may need to be complied within the inspection.		☐	RLSA-M
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G – Flight Design Service Bulletin SB-ASTM-CTLS-11

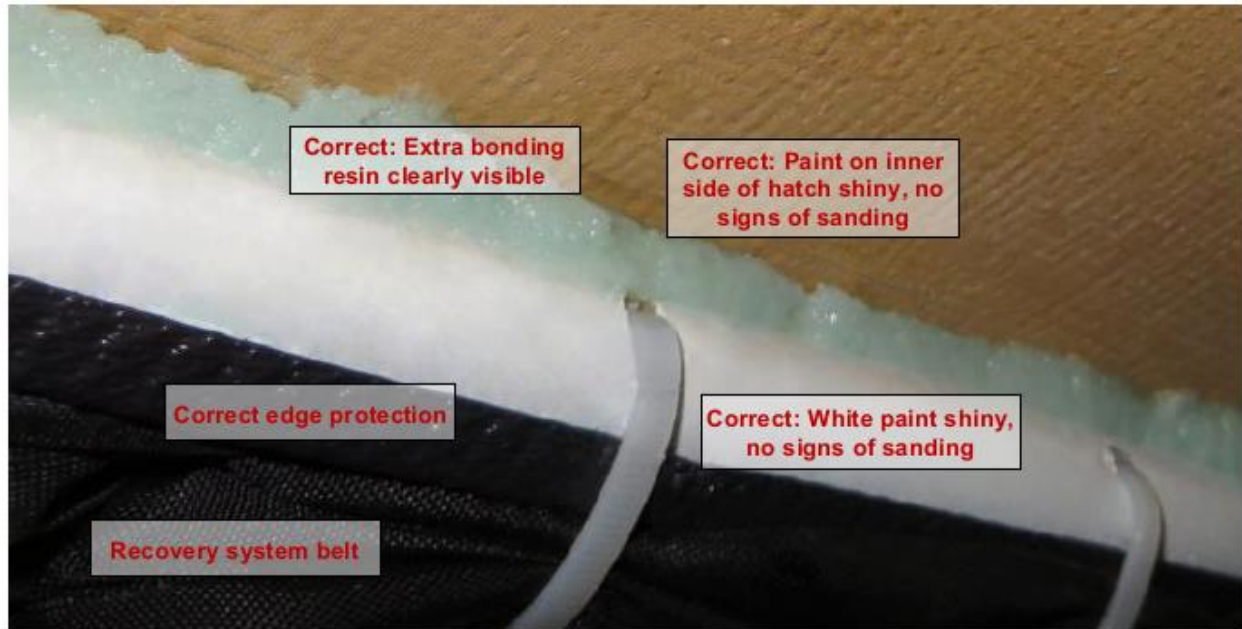
On October 2, 2015 Flight Design issued SB-ASTM-CTLS-11. The reason for issuance states:

As part of the investigation of an accident with a CTSW aircraft it was noticed that the hatch that covers the egress opening of the Airframe Emergency Parachute system had not been installed in line with the manufacturer's installation process. As a consequence the hatch was not immediately and fully removed when the Emergency Parachute was activated. In the investigated case the parachute was extracted and opened as intended. As it cannot be ensured that the observed non-conforming installation will always allow proper parachute extraction, Flight Design has decided to mandate inspection of the installation of all similar type covers on all CT series aircraft.

Section 3.3.2 of the Service Bulletin describes the process for inspection of the egress panel installation. Some of the relevant items to identify during the inspection include:

- In a correct installation, the thickened resin is non-transparent and has a more white color.

- In a correct installation, the lower edge of the fuselage flange that forms the extraction opening is covered with black plastic edge protection, and the black plastic edge protection cannot be easily slipped of the edge of the flange.
- In a correct installation, the surface of the inside of the egress panel, and inside of the hatch, should be painted and installed as shown:



- An example of incorrect paint, finish and installation is provided as shown:



The Service Bulletin warns that failure to comply with the Service Bulletin “may cause serious injury or even death.”

IV. SUBSTANTIVE FINDINGS FROM REVIEW OF AIRCRAFT RECORDS

A. System installed on aircraft

The BRS-6 1350HS parachute installed on N81KK was Serial Number 19944. BRS first packed the parachute on July 16, 2007. The parachute bag was marked PO12220 Lot 8. The system was then shipped to Flight Design. Flight Design then installed the system into N81KK at the Flight Design facility.

The BRS-6 1350HS requires a parachute repack every 6 years. BRS Sales Order No. 10204 indicates that parachute Serial Number 19944 was returned to BRS for repack on or about January 23, 2014. BRS completed the parachute repack on or about January 29, 2014 and thereafter shipped the parachute to the aircraft service provider.

The airframe logbook contains an entry dated February 23, 2014 indicating the parachute repack was accomplished, and the BRS parachute was reinstalled on the aircraft at that time. The sign off states that the aircraft was inspected in accordance with the manufacturer's maintenance and inspection procedures and was found to be in condition for safe operation.

B. Aircraft Airframe Logbooks

The airframe logbook further indicates that Conditional Annual Inspections were completed on January 27, 2015, January 27, 2016, February 7, 2017, March 7, 2018, and November 28, 2018.

Pursuant to the Section 3.1 of the Flight Design Maintenance and inspection Procedures Manual, during each of these Conditional Annual Inspection, the service provider should have checked for compliance with all Service Bulletins applicable to the subject aircraft and its component parts. The aircraft maintenance records fail to indicate compliance with Flight Design Service Bulletins.

Specifically, the aircraft maintenance records fail to indicate the aircraft was in compliance with Flight Design Service Bulletin SB-ASTM-CTLS-11. As a result, the aircraft was returned to service in unairworthy condition following the January 27, 2016 and later annual inspections.

The aircraft maintenance records also fail to indicate the BRS Annual or 100/HR Inspection Procedure was ever complied with.

V. SUBSTANTIVE FINDINGS FROM AIRCRAFT WRECKAGE INSPECTION

On April 24, 2019, the NTSB and the parties to the NTSB investigation participated in the post-accident wreckage inspection of aircraft N81KK. The following information was obtained during the post-accident wreckage inspection.

A. Condition of System at time of April 24, 2019 Inspection

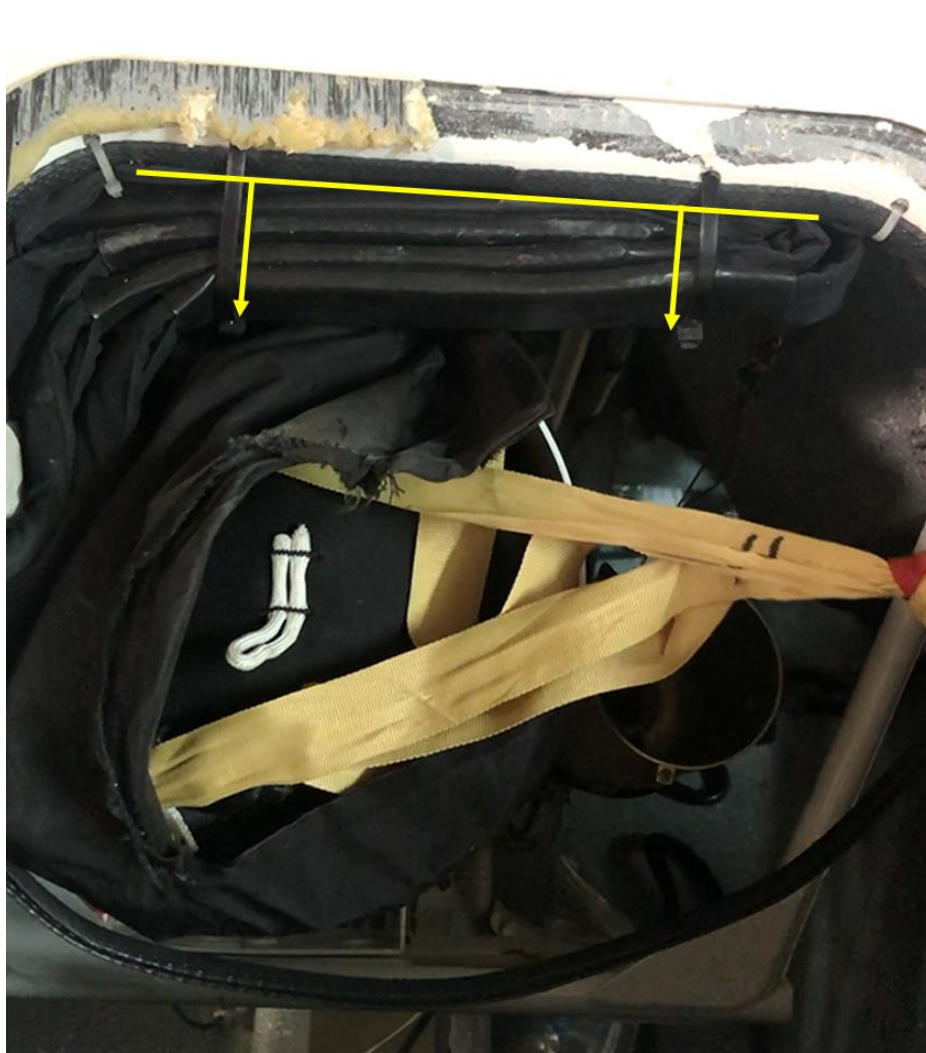
At the time of inspection, the packed parachute was located inside the canister. The fabric cover was affixed to the top of the canister with Velcro. The Velcro was partially removed on the side facing the rocket motor. The fabric cover was also torn on the right side. The Kevlar extraction bands exhibited tension marks on the left 2 straps and folding marks on the right 2 straps. The tension marks on the left 2 straps was consisted with indications of pull stress.



B. Improperly Secured S-folded Harnesses

The S-folded Harnesses were improperly secured to the inside of the egress panel. The S-folded Harnesses improperly protruded into and blocked the egress opening. The S-folded Harnesses also improperly protruded into and blocked the opening of the parachute canister.

This condition fails to comply with BRS Parachute Installation Manual sections 2.6, 4.4, or 4.5. Similarly, this condition fails to comply with the BRS Pre-Flight Checklist advising that pilots should check that the parachute harnesses do not interfere with the firing of the rocket or extraction of the parachute.



C. Egress Panel Failed to Detach

A significant portion of the egress panel remained attached to the airframe. The resin underneath the attached portion of egress panel remained intact. The remaining portion of egress panel did not release when the rocket motor struck the panel. The remaining portion of egress panel protruded into and blocked the opening of the parachute canister.

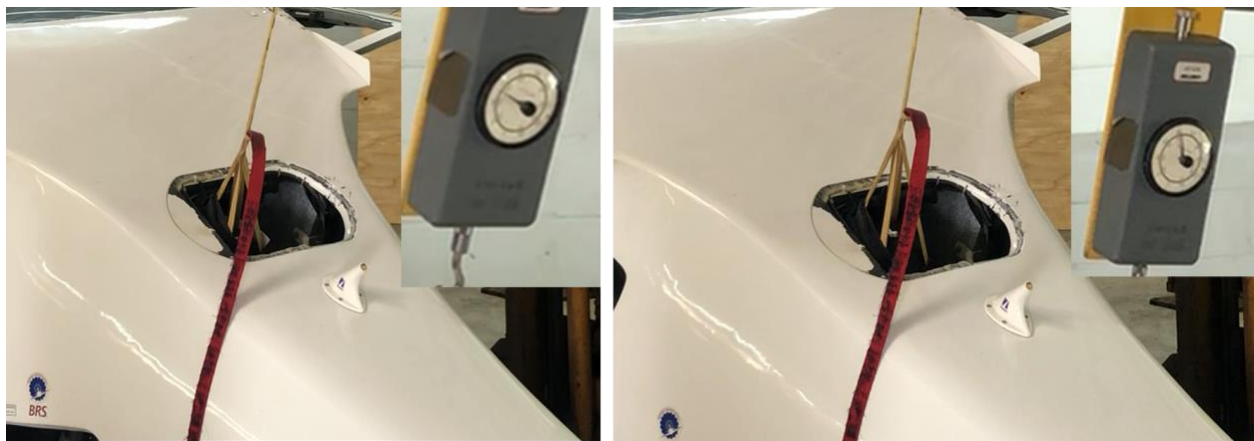


D. Extraction Test

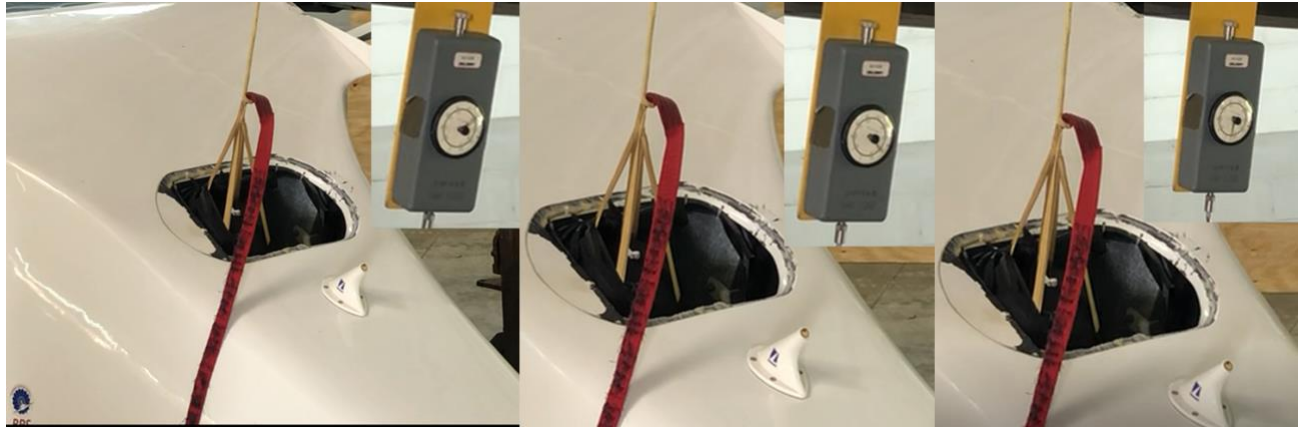
An extraction test was administered to measure the pull-force necessary to extract the parachute from the canister. A calibrated pull tester was suspended above the egress opening from a forklift. The Kevlar extraction bands were attached to the pull tester and the forks were raised.



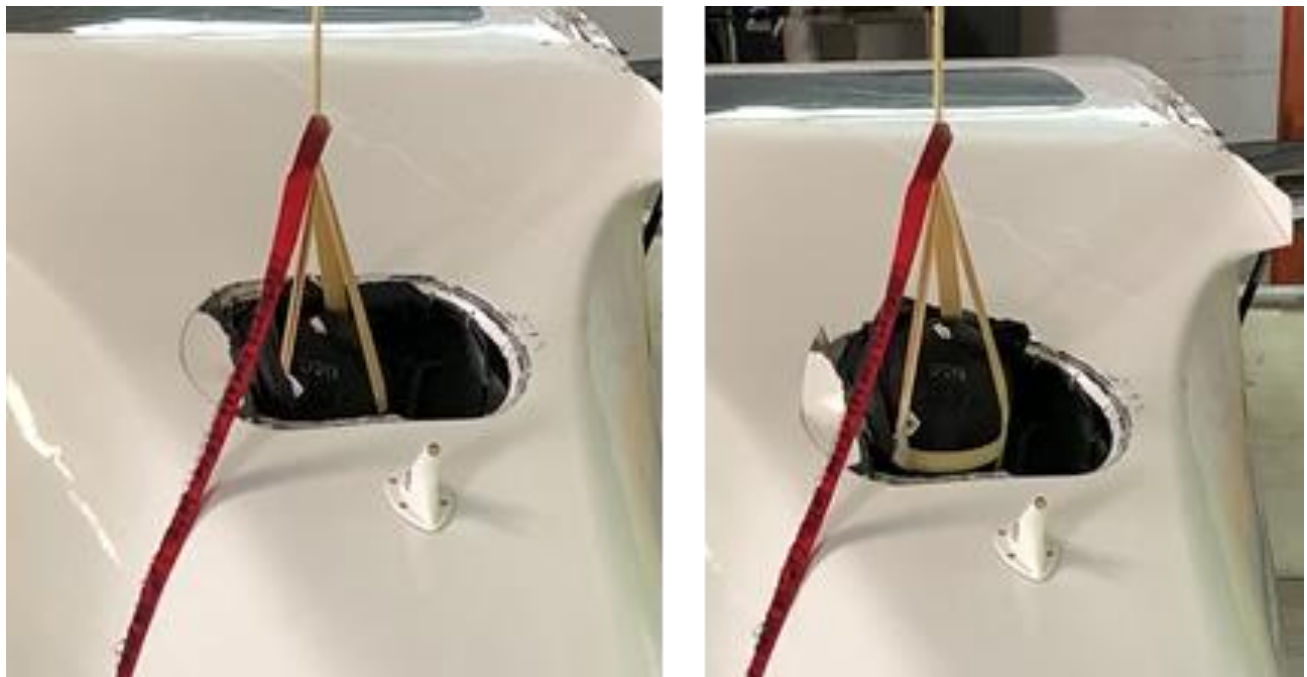
Initial movement of the parachute bag started at 55 pounds of pull-force. The bag continued moving up through 80 pounds of pull force. This value matched bench-testing of the system which showed pull force values at between 50-80 pounds.



The parachute bag then contacted the improperly secured S-folded Harnesses stowed on the inside of the egress panel. The Harnesses blocked the opening of the parachute canister and exerted pressure on the parachute bag. The pull-force continued to increase to over 200 pounds and exceeded the tolerance of the pull-gauge used for this test.



The parachute bag also made contact with the remaining section of egress panel.



The remaining section of egress panel blocked the opening of the parachute canister and also exerted pressure on the parachute bag. The pull-force continued to increase until the hook on the pull-tester actually failed.



At the time the hook on the pull-tester failed, the parachute bag was wedged between the improperly stowed S-folded Harnesses and the remaining portion of egress panel.



The hook on the pull-tester was replaced and the straps on the parachute bag were then re-attached to the pull-tester. The parachute bag was then fully extracted from the canister without the use of a gauge.



E. Observations after Extraction Test

With the parachute bag fully extracted, the S-folded Harnesses returned to their pre-extraction position and continued to protrude into and block both the egress opening and the parachute canister opening.



F. Observations after Extraction Test

The ½ inch Quick-link that connected all four Harnesses to the parachute riser was improperly fastened. The nylon sheathing from the aircraft harness was caught in the threads and the barrel was improperly threaded. The barrel was only secured by about two rotations of threading. There was no Loctite 242 applied to the threads.

This condition fails to comply with BRS Parachute Installation Manual section 4.5. Similarly, this condition fails to comply with the BRS Pre-Flight Checklist advising that pilots should check that the Quick-link is properly secured.



G. The Adhesive for the Egress Panel was Yellow in Color and Brittle

The adhesive attached the egress panel to the airframe was yellow in color and brittle to the touch.

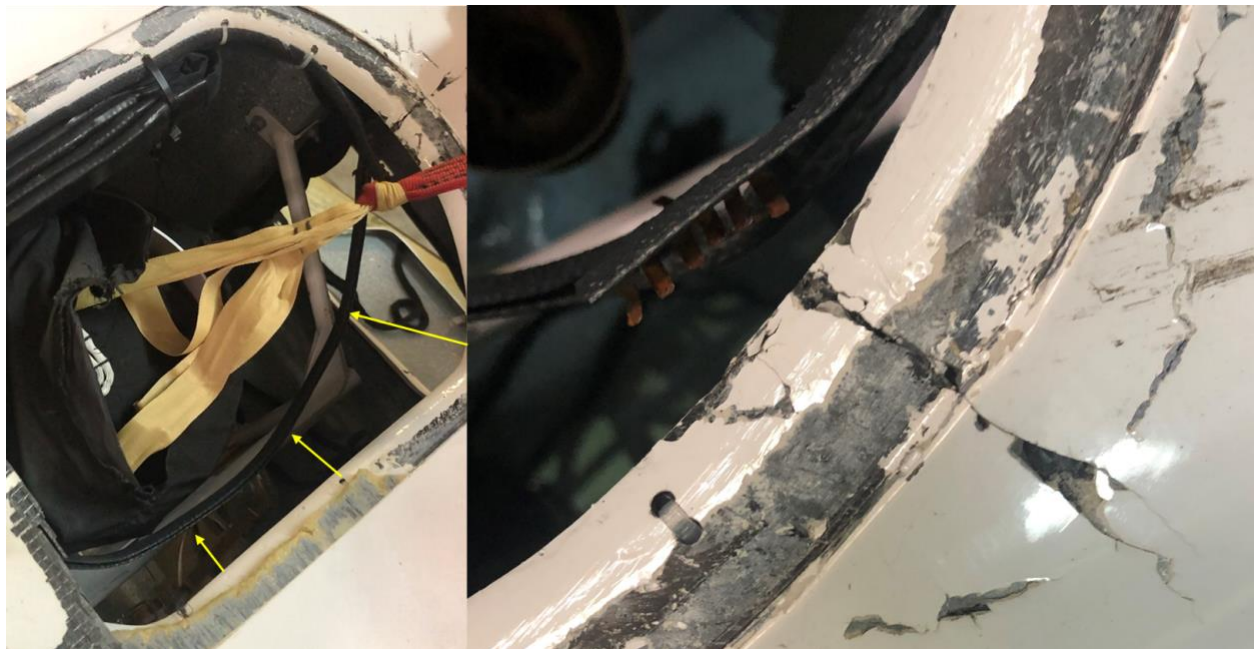
The adhesive did not conform with the manufacture specifications contained within Section 3.3.2 of SB-ASTM-CTL5-11.



H. Black Plastic Edge Protection was missing and easily displaced

The edge of the extraction opening was no longer covered with the black plastic edge protector. The black plastic edge protection was easily removed from the edge of the flange.

These conditions did not conform with the manufacture specifications contained within Section 3.3.2 of SB-ASTM-CTLS-11.



I. The inside surface of egress panel matches the incorrect example from the Service Bulletin

The inside surface of the egress panel matches the incorrect example from the Service Bulletin.

This condition did not conform with the manufacture specifications contained within Section 3.3.2 of SB-ASTM-CTLS-11.



J. Parachute Bag Markings

The parachute bag was marked PO1220 Lot 8.

These markings are consistent with the parachute bag information on record with BRS.



K. Parachute Canister Markings

Markings on the parachute canister indicated Serial Number 19944 and the repack date of 02-14. The markings are consistent with the serial number and repack date on file with BRS.

