Aviation Investigation Final Report

Location:	Colorado Springs, Colorado	**Accident Number:**	CEN16LA223
Date & Time:	June 18, 2016, 14:11 Local	**Registration:**	N678Z
Aircraft:	CIRRUS DESIGN CORP SR22	**Aircraft Damage:**	Substantial
Defining Event:	Loss of engine power (partial)	**Injuries:**	3 Minor
Flight Conducted Under:	Part 91: General aviation - Instructional		

Analysis

The commercial pilot was conducting a local flight when he noted a lower-than-normal oil pressure indication and engine roughness. The engine subsequently experienced a partial loss of power and the airplane could not maintain altitude. The pilot deployed the Cirrus Airframe Parachute System (CAPS) at an estimated 472 ft above ground level, and the airplane impacted rough terrain under canopy in a nose-low, upright attitude. A test run of the engine and review of recorded data did not reveal the reason for the partial loss of engine power.

Examination of the airframe parachute system revealed that, during deployment of the CAPS, the rocket separated from its lanyard in overstress. Fracture testing of the lanyard revealed that it did not exceed the minimum value in several tests, and the examined lanyard sections did not fully conform to specification; however, it is unlikely that these anomalies resulted in the overstress fracture.

Features observed on the CAPS retaining harness suggested that some resistance was encountered when pulling the incremental bridle from the sleeve during the deployment. The cover flap from the retaining harness had discoloration and heat damage consistent with abnormal exposure to the rocket exhaust, and pulled stitches were noted in the vicinity of the sleeve where the incremental bridle was stowed. It is likely that the incremental bridle was not released immediately from the sleeve, which kept the rocket closer to the retaining harness and placed abnormal loads on the lanyards. At some point, the incremental bridle was released from the sleeve and loaded to separate the stitches in the incremental bridle as designed.

During a nominal CAPS deployment, the airplane enters a nose-low attitude before leveling off, a stage of deployment referred to as "tail drop." For tail drop to occur, the deployment must be initiated to allow adequate time and/or altitude. During the accident, the parachute inflated fully; however, the abnormal CAPS deployment, as well as low deployment altitude resulted in the airplane touching down in a nose-low attitude before tail drop occurred.

Based on static pull tests in the lab, the orientation of the incremental bridle within the sleeve can significantly affect the force required to release the incremental bridle from its stowed position. A review of parachute packing procedures revealed that the orientation of the incremental bridle as it was inserted in its sleeve was not specified. In the absence of any specific procedure for orienting the incremental bridle in the sleeve, it would be possible for the incremental bridle to be inserted in either orientation. The investigation could not determine whether the incremental bridle had been inserted in an unfavorable orientation or if such an orientation would have resulted in the lanyard fracture. Based on review of the parachute deployment and subsequent testing, an exact cause for the abnormal CAPS deployment could not be determined.

Probable Cause and Findings

The National Transportation Safety Board determines the probable cause(s) of this accident to be:

A hard landing on rough terrain due to a faulty deployment of the airplane's airframe parachute system following a partial loss of engine power for reasons that could not be determined, because postaccident examination revealed no malfunctions or anomalies that would have precluded normal operation. Contributing to the accident was the low altitude deployment of the parachute system.

Findings

Not determined	(general) - Unknown/Not determined
Aircraft	Parachute - Malfunction
Environmental issues	Sloped/uneven terrain - Contributed to outcome

Factual Information

History of Flight

Enroute	Loss of engine power (partial) (Defining event)
Enroute	Off-field or emergency landing
Landing	Hard landing

On June 18, 2016, about 1411 mountain daylight time, a Cirrus Design Corporation SR22 airplane, N678Z, descended under the canopy of the cirrus airframe parachute system (CAPS) and impacted terrain near Colorado Springs, Colorado, following an inflight loss of engine power. The pilot, a safety pilot in the right seat, and a pilot rated rear-seated passenger sustained minor injuries. The airplane sustained substantial damage during the impact. The airplane was registered to N678Z LLC and was operated by the pilot under the provisions of 14 Code of Federal Regulations Part 91 as an instructional flight. Day visual meteorological conditions prevailed in the area of the accident and the flight was not operated on a flight plan. The local flight originated about 1345 from the City of Colorado Springs Municipal Airport (COS), near Colorado Springs, Colorado.

The pilot of the accident airplane reported that he was participating in a Cirrus Owners and Pilots Association flying clinic. He departed from COS with two passengers to conduct training in a local practice area located about 15 miles east of COS. The pilot stated that after 20 minutes of air work, at approximately 8,500 feet above mean sea level (msl), he noticed a roughness in the engine and that the oil pressure reading indicated within the green arc but lower than normal. The engine continued to run rough and lose power. Air traffic controllers were advised that the flight was headed back to COS with an engine problem. He said that with the reduced engine power available, the airplane began losing altitude and airspeed. The pilot determined the flight could not make a landing at COS, which was about 11 nautical miles west of the airplane's position, or Meadow Lake Airport, which was about 6 nautical miles north. He indicated that no suitable landing areas were identified and he pulled the CAPS handle. The CAPS rocket fired and separated from its lanyard. The parachute subsequently deployed. The airplane impacted the ground in a nose down attitude. The impact occurred with the aft harness in a snubbed position, prior to tail drop. The airplane subsequently stabilized upright on its main landing gear.

The safety pilot seated in the front right seat of the accident airplane, reported that he flew the accident airplane earlier in the morning during the demonstration phase of training and noted no issues or anomalies with the accident airplane. He indicated that his purpose during the flight was to demonstrate and teach formation-flying techniques. He reported that after a preflight brief he held an additional briefing emphasizing that the airplane owner would be the pilot-in-command and is responsible for all emergencies as he, as a safety pilot, was not familiar with the owner's equipment.

According to the safety pilot, the rear seated passenger noticed the oil light illuminated before the takeoff run when the engine was at idle. However, the light went off during the engine run up so he did not think it was a problem. The safety pilot related that he had observed his oil pressure light illuminated while at idle numerous times with a warm engine.

The safety pilot indicated that the takeoff, rendezvous, and initial formation training were normal. As a wingman, the pilot is usually unaware of the flight's location, altitude, or airspeed. Additionally, he said that a wingman's attention revolves around the lead airplane where you do not have time to monitor engine instrumentation. The safety pilot said, "If you have never flown as a wingman you just don't understand how much you have to trust your plane while keeping your eyes on lead AT ALL TIMES. I even commented on this during the initial 4-hour brief - if you have a weak engine don't fly. When there is a lead change it takes a moment for you to figure out where you are."

The safety pilot reported that this loss of engine power during the flight was extremely subtle. At no time did he notice any indications out of normal parameters. The pilot mentioned his oil pressure looked low at 27 psi. The safety pilot asked what was normal but the pilot did not know. The safety pilot stated that the oil pressure and all other engine indications were within their respective green arcs, showing normal engine parameters. The accident airplane had fallen behind the lead airplane and was five plane lengths away on his right wing. The safety pilot said that a slow "pinging" about every 10 - 15 seconds started and that is when the pilot elected to return to the airport. The formation flew as briefed where the accident airplane took over as the lead airplane. The pilot informed air traffic control of engine problem. An intermediate engine power setting was set and all of the engine indications remained within their green arcs. The safety pilot reported that the pinging interval started to decrease and that the engine did not sputter.

An air traffic controller advised the flight of bearings and distances to three nearby airfields. The safety pilot stated that with the remaining altitude, they immediately knew they could not reach any of them. He noticed and told the pilot the airspeed was low with an indication of 100 knots while the airplane was at 7,100 feet msl. The pilot told him that the throttle was full forward. The safety pilot immediately transmitted a Mayday call and advised the pilot to deploy the CAPS.

The safety pilot reported that the pilot in command would pull the CAPS unless incapacitated, as briefed during preflight briefing. According to the safety pilot, the pilot's previous and overriding training habit kicked as he looked for a place to land. The pilot verified with the safety pilot that he intended to deploy the CAPS and pulled the CAPS handle at the safety pilot's second request. The airplane's altitude was 7,000 feet msl and its indicated airspeed was 80 knots. The handle came out and down. However, it took a strong second pull to get the rocket to fire. The safety pilot estimated that the CAPS deployment occurred about 800 feet above ground level (agl).

The safety pilot said that there was a huge deceleration after the CAPS deployment. There was a moment of weightlessness and then the airplane pitched nose down. The safety pilot, in part, said:

All I saw was the ground rushing up rapidly. ... We violently impacted nose down. I screamed in pain. It felt as if I was stabbed in my neck and lower back, all on the left side. It took a few seconds to access my condition. Wiggle fingers and toes, move head, etc. When I realized I was alive I looked over at [the pilot]. It initially looked like he was slumped over to the left but then observed him move with purpose. He stated his door was jammed, grabbed the hammer and started whacking away at the forward part of his door window. [The rear seated passenger] ... told me to try my door. It opened, I crawled out and went to move the seat forward but [the rear seated passenger] had already slithered out so I went down the wing.

The safety pilot flying in the other formation airplane, in part, said:

I observed N678Z deploy CAPS, and informed Approach that I saw a "good chute". I did not look at the altimeter, but I recall thinking that we were very low. N678Z struck the ground within just a few seconds, in a nose-low attitude that I estimate at about 80 degrees. A large dust cloud was raised; the impact appeared violent to me, and I was not sure that it was survivable by any of the occupants.

The passenger in the rear seat of the accident airplane helped the accident pilot egress out of the right-side door. The safety pilot in the accident airplane reported that first responders helped deflate and wrap up the chute. After that, his neck started hurting again. The three occupants were subsequently transported to a hospital to be evaluated.

Pilot Information

Certificate:	Commercial	**Age:**	64,Male
Airplane Rating(s):	Single-engine land	**Seat Occupied:**	Left
Other Aircraft Rating(s):	None	**Restraint Used:**	4-point
Instrument Rating(s):	Airplane	**Second Pilot Present:**	No
Instructor Rating(s):	Airplane single-engine	**Toxicology Performed:**	No
Medical Certification:	Class 3 With waivers/limitations	**Last FAA Medical Exam:**	June 1, 2015
Occupational Pilot:	No	**Last Flight Review or Equivalent:**	June 13, 2015
Flight Time:	1289 hours (Total, all aircraft), 30 hours (Total, this make and model), 1170 hours (Pilot In Command, all aircraft), 40 hours (Last 90 days, all aircraft), 23 hours (Last 30 days, all aircraft), 2 hours (Last 24 hours, all aircraft)		

The 64-year-old pilot held a Federal Aviation Administration (FAA) commercial pilot certificate with an airplane single engine land and instrument ratings. He held a flight instructor certificate for single engine airplanes. He also held a third-class medical certificate that was issued on June 1, 2016, with a limitation that he must wear corrective lenses. The pilot reported that he had accumulated 1,289 hours of total flight time and accumulated 30 hours in the same make and model as the accident airplane.

Aircraft and Owner/Operator Information

Aircraft Make:	CIRRUS DESIGN CORP	**Registration:**	N678Z
Model/Series:	SR22 NO SERIES	**Aircraft Category:**	Airplane
Year of Manufacture:	2002	**Amateur Built:**	
Airworthiness Certificate:	Normal	**Serial Number:**	0311
Landing Gear Type:	Tricycle	**Seats:**	4
Date/Type of Last Inspection:	November 13, 2015 Annual	**Certified Max Gross Wt.:**	3400 lbs
Time Since Last Inspection:		**Engines:**	1 Reciprocating
Airframe Total Time:	788 Hrs as of last inspection	**Engine Manufacturer:**	CONT MOTOR
ELT:	C91 installed, activated, did not aid in locating accident	**Engine Model/Series:**	IO-550-N
Registered Owner:	On file	**Rated Power:**	310 Horsepower
Operator:	On file	**Operating Certificate(s) Held:**	None

N678Z, a 2002 model Cirrus Design Corporation SR22, serial number 0311, was a four-place single engine low-wing airplane powered by a six-cylinder, Continental Motors model IO-550-N engine with serial number 686307, that drove a three-bladed Hartzell constant speed propeller. According to airplane logbook entries, an annual inspection was completed on November 13, 2015. The airplane accumulated 787.9 hours of total flight time at the time of that inspection. Another entry indicated that a Forced Aeromotive Technologies, Inc. (FAT) supercharger was installed on the engine on June 11, 2016, and the airplane accumulated 817.6 hours of total flight time at the time of that installation.

According to technical information from the supercharger manufacturer's website, the supercharger is belt driven off the accessory drive, similar to the alternator. The supercharger will run much cooler than a turbocharger and should result in much lower maintenance costs. It will add 7 to 8,000 feet of altitude performance to the Cirrus SR-22. The supercharger's impeller speed is a function of engine RPM and therefore over-speed and bootstrapping are not operational considerations. There are no manifold pressure fluctuations while adjusting the throttle, or mixture. Additionally, according to the manufacturer, after landing idle cool down periods are not necessary and the manifold pressure is limited to 29.60 inches at full engine power.

Engine manifold pressure is maintained automatically by an electronic boost controller designed for the SR22 by FAT. The controller reacts to throttle changes in less than one second. The boost controller is not affected by cold oil temperatures or cold take off conditions and will operate quickly to control boost even down to -50° F.

The airplane was equipped with an Avidyne Multi-Function Display (MFD). The MFD unit can display engine information, pilot checklists, terrain/map information, approach chart information and other airplane/operational information depending on the specific configuration and options that are installed. One of the options available is a display of comprehensive engine monitoring and performance data. Each MFD contains a compact flash (CF) memory card. This memory card contains all the software that the MFD needs to operate. Additionally, this card contains checklists, approach charts, and map information that the unit uses to generate the various cockpit displays.

During operation, the MFD display receives information from several other devices that are installed on the airplane. Specifically, the MFD receives GPS position, time and track data from the airplane's GPS receiver. The MFD may also receive information from the airplane concerning altitude, engine and electrical system parameters, and outside air temperature. This data is also stored on the unit's CF memory card.

The MFD generates new data files for each MFD power-on cycle. The oldest file is dropped and replaced by a new recording once the storage limit has been reached. MFD data are sampled every six seconds and recorded to memory once every minute. If an interruption of power occurs during the minute between MFD memory write cycles, data sampled during that portion of a minute are not recorded.

The airplane was fitted with a CAPS designed to recover the airplane and its occupants to the ground in the event of an in-flight emergency. The CAPS contains a parachute (within a deployment bag) located within a fiberglass CAPS enclosure compartment, a solid-propellant rocket contained within a launch tube to deploy the parachute, a pick-up collar assembly and attached Teflon-coated steel cable lanyard and incremental bridle, a rocket activation system that consisted of an activation handle, an activation cable, and a rocket igniter, and a harness assembly, which attached the parachute to the fuselage. Upon deployment by the pilot, a rocket fires from the parachute bay located behind the cabin, knocking the cover panel off the parachute bay in the process. The pickup collar assembly is carried by the rocket for rapid deployment of the parachute.

Meteorological Information and Flight Plan

Conditions at Accident Site:	Visual (VMC)	**Condition of Light:**	Day
Observation Facility, Elevation:	KCOS,6170 ft msl	**Distance from Accident Site:**	11 Nautical Miles
Observation Time:	13:54 Local	**Direction from Accident Site:**	274°
Lowest Cloud Condition:	Few / 7000 ft AGL	**Visibility**	9 miles
Lowest Ceiling:		**Visibility (RVR):**	
Wind Speed/Gusts:	9 knots / 16 knots	**Turbulence Type Forecast/Actual:**	/
Wind Direction:	170°	**Turbulence Severity Forecast/Actual:**	/
Altimeter Setting:	30.36 inches Hg	**Temperature/Dew Point:**	29°C / 11°C
Precipitation and Obscuration:	No Obscuration; No Precipitation		
Departure Point:	COLORADO SPRINGS, CO (COS)	**Type of Flight Plan Filed:**	None
Destination:	COLORADO SPRINGS, CO (COS)	**Type of Clearance:**	None
Departure Time:	13:45 Local	**Type of Airspace:**	

At 1354, the recorded weather at COS was: Wind 170° at 9 knots gusting to 16 knots;

visibility 9 statute miles; sky condition few clouds at 7000 feet; temperature 29° C; dew point 11° C; altimeter 30.36 inches of mercury.

Wreckage and Impact Information

Crew Injuries:	2 Minor	**Aircraft Damage:**	Substantial
Passenger Injuries:	1 Minor	**Aircraft Fire:**	None
Ground Injuries:	N/A	**Aircraft Explosion:**	None
Total Injuries:	3 Minor	**Latitude, Longitude:**	38.797779,-104.461387(est)

The airplane was found upright about 11 miles east of COS. Its engine and cowling were bent upward forward of the firewall. The CAPS parachute was found deployed. A recovery company relocated the wreckage. The CF memory chip from the MFD, the engine, and components of the CAPS system, to include the rocket lanyard, incremental bridle, incremental bridle sheath, deployment bag, and retaining harness, were subsequently shipped for additional examinations. However, the rocket, the pickup collar, pickup collar support, and the cable stop sleeves from the pickup collar assembly were not recovered.

Examination of the wreckage revealed a witness mark on the lower forward left side of the vertical stabilizer. The hour meter indicated 823.0 hours. The electric fuel pump was able to pump a fluid when electric power was applied. Disassembly of the pump did not reveal any anomalies that would have prevented its operation.

Tests and Research

The engine was shipped to and examined at Continental Motors in Mobile, Alabama. Both front engine mounts were damaged and replaced with exemplar mounts. The engine was mounted on a test stand and placed in a test cell. During the initial engine test run, the engine reached an indicated manifold pressure of 35 inches of mercury at 2,700 RPM. The altitude control valve was connected and the indicated engine performance was within the supplemental type certificate holder's specifications and no anomalies were noted.

The CF memory chip from the MFD was shipped to the National Transportation Safety Board (NTSB) Recorder Laboratory. The MFD card was received in good condition and a senior recorder specialist downloaded and examined the card's data. The recorder specialist subsequently produced a report that showed the MFD card contained 138 data files, representing data from 69 electrical power cycles. The last 2 files recorded were identified as the accident flight. The data from the accident flight and the previous 11 engine cycles before the accident were plotted. According to the pilot, some preceding flights were to retrieve the airplane after the installation of the supercharger and then to return back to Centennial Airport (APA), near Denver, from COS for a 2-hour inspection. The engine was reported to have operated nominally on the flights to/from APA, as well as on the first flight on the day of the accident. Some of the recorded engine cycles occurred with the airplane on the ground and were only a few minutes in duration. Although review of the engine operation data showed fluctuations in their values, the recorded data did not reveal any anomalies that could explain the engine power loss.

The occupants of the other airplane in the formation flight collected GPS and photographic data during the accident airplane's power loss and descent. A review of the images revealed the parachute traveled aftward and below the airplane. The parachute subsequently inflated, the airplane descended downward in a nose low attitude, and impacted terrain in a nose low attitude.

The CAPS components were shipped to the NTSB Materials Laboratory. A senior materials engineer examined the components and produced Materials Laboratory Factual Report No. 17-009.

In the accident airplane, the cable for the rocket lanyard (included in the pickup collar assembly) had separated.

As designed, the rocket lanyard from the pickup collar assembly attach to the incremental bridle. The other end of the incremental bridle is attached to lanyard on the parachute deployment bag. The folded parachute is contained within the deployment bag. When stowed, the retaining harness covers the top of the deployment bag and retains the deployment bag in the airplane parachute bay.

During a deployment, the rocket is launched, carrying the pickup collar assembly, incremental bridle, and parachute deployment bag with it. The incremental bridle is positioned between the rocket lanyard and the deployment bag and is designed to absorb the impact associated with the acceleration difference between the rocket and the deployment bag during deployment. As assembled, the middle portion of the incremental bridle is folded to a shorter length, and the folded segment is stitched together. The stitches in the folded segment separate until the velocity of the deployment bag matches the velocity of the rocket. During a typical deployment, some stitches in the incremental bridle remain intact, and a portion of the incremental bridle remains folded. Ten rows of stitches remained intact in the incremental bridle from the accident airplane.

The pickup collar assembly includes a zinc-coated steel pickup collar, aluminum pickup collar support, and rocket lanyard. The rocket lanyard consists of two lengths of a single stainless steel cable that connect the pickup collar to the incremental bridle. The cable for the lanyard loops through and around the pickup collar and pickup collar support, and cable eyes at each end are connected to a loop at one end of the incremental bridle. The cable bends 90° at two locations on either side of the pickup collar support, and the center of the cable is routed around the center tube of the support. Cable stop sleeves made of copper are attached to the cable adjacent to the pickup collar. During manufacturing, each pickup collar assembly is proof tested to a tensile load of 1,000 pounds.

The submitted cable from the accident airplane for the rocket lanyard was separated into two segments that were arbitrarily labeled segments A and B. Teflon tubes, which cover each leg of the lanyard between the pickup collar and the cable eyes, were also included. The Teflon tube that had covered the segment A lanyard was displaced along the length of the cable segment and was covering the separation.

The Teflon tube from segment B was completely separated from the cable. Based on engineering drawings, the calculated total length of the rocket lanyard cable in the pickup collar assembly is 105.1 inches ± 1.0 inch.

The rocket lanyard cable was constructed of 7 strands (6 strands wrapped around a core strand) with 7 wires per strand consistent with manufacturer specifications. The lengths of segment A and segment B were measured from the separation to the end of the cable eye. Segment A was 55.38 inches long, and segment B was 50.50 inches long, for a measured total cable length of 105.88 inches, consistent with the cable length calculated from the engineering drawings.

The cable segments were closely examined visually and using an optical stereomicroscope for contact damage, deformation, and metal transfer. Individual wires showed necking deformation and chisel-type separation features consistent with overstress separation. A material consistent with red grease was present on the surfaces of the cable, and no evidence of corrosion was observed.

Orange metal deposits consistent with copper were observed along the surface of cable segment A between approximately 0.5 inches and 5.3 inches from the separation. The deposits were consistent with material transfer from a copper cable stop sleeve.

On segment B, isolated areas of orange metal deposits consistent with copper were observed on two of the wires approximately 0.28 to 0.34 inch from the separation. Further from the separation on segment B, the outer surfaces of wires on two strands were flattened consistent with sliding contact damage at a location between 0.07 to 0.09 inch from the separation. On most of the wires with the contact damage, gray metal was observed at the edge of the flattened surface on the side furthest from the separation.

The separation end of segment B was examined using a scanning electron microscope (SEM).
The SEM examination revealed portions of the area with sliding contact appeared relatively lighter gray than the surrounding material, consistent with the presence of an element with a higher atomic weight. Analysis of the area using energy dispersive x-ray spectroscopy (EDS) showed the bright areas showed a peak indicating the presence of zinc.

The gray metal adjacent to the sliding contact areas was also examined using SEM and EDS. The EDS analysis of the gray metal at the edges of the sliding contact damage resulted in spectra consistent with stainless steel, matching the spectra obtained from intact areas of the lanyard cable wires.

Two lengths of cables were cut from each rocket lanyard segment to facilitate tension tests to fracture. Four tension specimens were fabricated. The test specimens fractured at peak loads of 905 pounds, 916 pounds, 893 pounds, and 930 pounds. All specimens broke within the crimp for the cable eyes. The specified minimum cable strength as listed in the current Military Standard MIL-DTL-83420N is 920 pounds.

The cover flap of the retaining harness has a pocket on its flap exterior. The clear plastic face of the pocket is intended to observe parachute documents. The plastic pocket face from the accident retaining harness was detached from the fabric border on three of the four sides and was discolored and distorted consistent with exposure to heat. No evidence of abrasion was observed on the plastic surfaces.

Pulled stitches were observed in the fabric of the retaining harness near the sleeve for the incremental bridle. The sleeve was located on the right side of the retaining harness cover flap. Stitches between the cover flap and the side flap were broken just above the sleeve. Pulled stitches were also observed at the upper end of the sleeve where it was attached to the cover flap.

Pull tests were conducted with the exemplar incremental bridle folded and inserted into the sleeve on the retaining harness cover flap in two configurations. In the first pull test, the incremental bridle was inserted so that the rocket lanyard end of the bridle was adjacent to the cover flap. In the second test, the incremental bridle was inserted so that the deployment bag end of the bridle exited the sleeve adjacent to the cover flap. To simulate the shape of a retaining harness installed on a packed parachute, the retaining harness was clamped to a table with wood planks extending into the cover flap cavity, and the cover flap cavity was stuffed with packing paper. For each test configuration, a force gage was attached to the exemplar pickup collar, and the collar was pulled while the restraining harness was held in place by the clamped wood planks. In the test 1 configuration where the lanyard end exited the sleeve adjacent to the cover flap, the incremental bridle pulled out of the sleeve at a load of 9 pounds. In the test 2 configuration where deployment bag end of the bridle exited the sleeve adjacent to the cover flap, the incremental bridle remained within the sleeve up to a load of 90 pounds, at which point the test was interrupted. In Cirrus Design's Packed Parachute Assembly Specification document number 90814, revision J, dated October 7, 2015, the procedure states, "Insert incremental bridle assembly into the pouch of the retaining strap." However, the document does not specify the orientation of the inserted incremental bridle.

Cirrus Aircraft completed tension tests to failure on 5 exemplar pickup collar assemblies. Reported peak loads for the assembly tension tests were 2,080 pounds, 1,838 pounds, 1,802 pounds, 1,927 pounds, and 1,925 pounds. Cirrus Aircraft also completed impact load tests to failure on additional exemplar pickup collar assemblies accomplished by dropping a 3,000-pound weight from a 48-inch height. The fractured pickup collar assemblies from 5 tension tests and 2 impact load tests were then sent to the NTSB Materials Laboratory for examination.

In the 5 tension tests, fractures of the rocket lanyard cable from the collar assembly test specimens occurred in 2 or 3 locations. Three of the test assemblies fractured in 2 locations, and the remaining 2 assemblies fractured in 3 locations. The primary fracture in each case occurred in the lanyard cable at the location where the cable bent around the flange on the pickup collar. Secondary fractures in the lanyard cables occurred at the lower side of the sleeve as the sleeve was loaded against the lower end of the pickup collar. The lower ends of the pickup collars in each test assembly were bent downward and outward consistent with the downward loading from contact with the sleeves.

In tests resulting in 2 fractures, a secondary fracture occurred in the rocket lanyard cable just below the sleeve opposite from the primary fracture, leaving a 4.7-inch to 5.5-inch segment of cable with the sleeve attached. On the other side of the pickup collar in these tests, the sleeve adjacent to the primary fracture slipped off the fractured end as the sleeve was loaded against the lower end of the pickup collar. In tests resulting in 3 fractures, secondary fractures occurred in the lanyard cable at the lower side of both sleeves, leaving a short segment (0.8-inch to 0.9-inch length) of cable within the sleeve adjacent to the primary fracture and an approximately 5-inch to 5.5-inch length of cable with the other sleeve attached.

In the 3 tests with 2 fractures, copper metal transfer was observed adjacent to the primary fracture in the area where the sleeve had originally been installed up to the fracture location. In one of the tests with 2 fractures, copper metal transfer was also observed adjacent to the secondary fracture consistent with sleeve movement prior to cable fracture at the secondary fracture location.

In the 2 impact tests, the rocket lanyard cable from the pickup collar assembly fractured in one location. The location of the fracture in each case corresponded to the location of the 90° bend. The two cable segments measured 50.13 inches and 54.88 inches long on one impact test assembly, and the segments measured 50.38 inches and 54.88 inches long on the other impact test assembly. The lower ends of the pickup collars in each test assembly were bent downward and outward consistent with the downward loading from contact with the sleeves. Copper metal transfer was observed on the cable surfaces between the locations of the stop sleeve installation and the fractured end on each cable segment.

Additional Information

The safety representative from Cirrus Design provided correspondence in reference to the investigation, which, in part, stated:

Prior to this investigation, and part of the development of our 200 lbs increased gross weight project, we had to develop a larger diameter parachute that in turn required a more powerful rocket motor. The trickle-down effect also required a thicker rocket lanyard, new incremental bridle and a new pick-up collar/collar support. As a result, we developed two larger, more powerful rocket motors (known as the 3,600 and 3,400). Both with electronic (top down) ignition. The 3,600 was developed for new production in the SR22 and SR22T (Generation 5, 200 lbs increase gross weight) aircraft. The 3,400 was later developed for new production in the SR20 (Generation 5, 100 lbs increase gross weight) and as an electronic upgrade for older SR20, SR22 and SR22T (Generation 1-3) aircraft. The 3,600 system, with its larger diameter cable lanyard, redesigned bridle and bridle sheath, redesigned pick-up collar and pick-up collar support, entered production in January 2013. The similar 3,400 system entered production in April 2013. ...

There were approximately 5,330 airplanes built prior to the implementation of electronic rocket ignition on the production line in January 2013. (As a reference, approximately 1,490 electronic rocket ignition aircraft have been produced since then.) As of December 5, 2017, approximately 2,600 aircraft in the field (roughly 50%) had already been converted to electronic rocket ignition. We expect an additional 800 aircraft in the field (roughly 15%) to be converted in 2018. By the end of 2018, over 65% of the older airplanes will have been converted to an electronic rocket ignition. The remaining 35% of older airplanes will be converted as they reach their scheduled ten-year repacks between 2019 and mid-2023. Overall, by the end of 2018, nearly 75% of the entire Cirrus fleet will be equipped with electronic rocket ignition and the host of upgrades that system provides.

The safety representative from the Cirrus Owners and Pilots Association (COPA) produced a factual analysis report of images taken from the other formation airplane. The COPA report, in part, indicated the analysis of the images suggests that the accident airplane was approximately 472 ft agl in a photograph taken very shortly after CAPS activation.

In the Cirrus Design correspondence, the safety representative, in part, stated that the CAPS was deployed at a low altitude and touchdown under a fully inflated canopy occurred prior to tail drop. The nose low attitude is a designed stage in the deployment sequence. A subsequent stage, referred to as "tail drop," would occur at a time in the deployment sequence that is dependent on the type of reefing line cutters used (8 or 10 second cutters). To achieve tail drop, requires time and/or altitude. On site photos revealed that at some point, after touchdown, the reefing line cutters fired, and the rear harness became unsnubbed.

Administrative Information

Investigator In Charge (IIC):	Malinowski, Edward
Additional Participating Persons:	Joseph T Walsh; Federal Aviation Administration; Denver, CO Brad Miller; Cirrus; Duluth, MN Borris Popov; BRS Aerospace; Saint Paul, MN Chris Lang; Continental Motors; Mobile, AL Rick Beach; Cirrus Owners & Pilots Association; Las Vegas, NV Peter Schroeder; Wisconsin Aviation; Watertown, WI
Original Publish Date:	July 5, 2018
Last Revision Date:	
Investigation Class:	Class
Note:	The NTSB did not travel to the scene of this accident.
Investigation Docket:	https://data.ntsb.gov/Docket?ProjectID=93408