National Transportation Safety Board

Washington, D.C. 20594

Safety Recommendation

Date: April 29, 2004

In reply refer to: A-04-36 through -41

Honorable Marion C. Blakey
Administrator
Federal Aviation Administration
Washington, D.C. 20591

Mr. James M. Shannon
President and Chief Executive Officer
National Fire Protection Association
1 Batterymarch Park
Quincy, Massachusetts 02269

Mr. Garry Briese
Executive Director
International Association of Fire Chiefs
4025 Fair Ridge Drive
Fairfax, Virginia 22033-2868

On June 16, 2001, about 1438 central daylight time, a Cirrus Design SR22, equipped with an undeployed ballistic parachute system,[1] was destroyed while landing on runway 20 at the Springfield-Branson Regional Airport (SGF), in Springfield, Missouri. The airplane touched down 1,000 to 1,500 feet beyond the approach end of the runway, bounced several times, and veered off the left side of the runway. The airplane then crossed a sod area, a taxiway, and another sod area before impacting a disabled aircraft used for airport rescue and firefighting (ARFF) training. The private pilot and the passenger in the rear seat received minor injuries; the passenger in the left front seat was seriously injured. Visual meteorological conditions prevailed at the time of the accident. The personal flight was operated under the provisions of 14 *Code of Federal Regulations* (CFR) Part 91.[2]

[1] The ballistic parachute device installed in the accident airplane was a Cirrus Airplane Parachute System (CAPS), components of which are manufactured by Ballistic Recovery Systems, Inc. (BRS). According to Cirrus, CAPS is "a safety system designed to lower the entire aircraft to the ground in extreme emergencies."

[2] The description for this accident, CHI01FA169, can be found on the National Transportation Safety Board's Web site at <http://www.ntsb.gov>.

ARFF personnel arrived at the scene about 2 minutes after the airplane crashed. A firefighter who responded to the scene was later interviewed by the National Transportation Safety Board and stated that emergency workers, at first, did not notice the warning labels on either side of the aft fuselage indicating that the airplane was equipped with a rocket for parachute deployment. However, during fire suppression activities, another worker who recognized the airplane make and model alerted other firefighters to the potential hazard. After the accident, the Assistant Director of Aviation for SGF wrote a letter to the Safety Board investigator-in-charge (IIC) of the accident investigation, expressing concern that existing warning labels on Cirrus airplanes do not provide emergency workers with sufficient notice that "a possible hazardous device [is] located on the aircraft."

CAPS has been installed on all SR20 and SR22 airplanes (Cirrus has delivered about 1,000 to date).[3] In addition, since 1993, BRS (the manufacturer of CAPS components) has installed similar ballistic parachute systems in about 30 Cessna 150 and 172 airplanes under supplemental type certificates (STC).[4] CAPS has been deployed in at least one emergency involving a Cirrus SR22, possibly saving the pilot's life;[5] however, as was the case in the June 16, 2001, accident at SGF, the devices are not always deployed before an aircraft accident. Therefore, as a result of a proliferation of ballistic parachute devices in the general aviation fleet, emergency workers who respond to aircraft accidents are increasingly likely to encounter unfired ballistic parachute systems that could discharge during rescue and recover operations.

CAPS uses a solid-fuel rocket (stored in a compartment in the aft fuselage of Cirrus airplanes) to deploy a 55-pound parachute that allows the airplane to descend in a level attitude at about 26 feet per second. To activate the system, a pilot pulls an overhead handle in the cockpit (after removing a metal pin that secures the handle in a stowed position). The aluminum CAPS rocket, which weighs 1 pound 6 ounces, contains 1 pound of propellant, fires for 1.2 seconds, and accelerates to over 100 miles per hour in the first tenth of a second. It produces peak thrust of about 300 pounds. Under normal conditions, CAPS is well secured and is not prone to accidental firing. The rocket will only fire if the activation handle in the cockpit is pulled with sufficient force (about 35 pounds for Cirrus airplanes[6]). However, the system can be less predictable if an airplane has been in an accident. BRS addresses this safety issue in a publication for emergency workers (available on the company's Internet site), titled "Rocket-Deployed Parachutes on Civilian Aircraft May Pose Hazard to Emergency Personnel." The BRS publication advises that merely moving a damaged airplane could cause the rocket to fire and states the following:

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[3] CAPS is part of the type design approved in the initial type certification of Cirrus SR20 and SR22 airplanes, which were first delivered to customers in 1999. Under the Federal Aviation Administration's (FAA) equivalent level of safety certification policy, described in 14 CFR Section 21.21(b)(1), Cirrus was allowed to forgo spin recovery testing (described in Section 23.221) for its airplanes based on the demonstrated capabilities of CAPS.

[4] BRS has also manufactured about 3,000 ballistic parachute systems installed in experimental and homebuilt airplanes and about 10,000 installed in ultralight aircraft since 1981. Cirrus and Cessna airplanes are the only FAA-certificated aircraft with ballistic parachute systems installed.

[5] The description for this accident, FTW03LA005, can be found on the Safety Board's Web site at <http://www.ntsb.gov>.

[6] BRS does not have data regarding the pull force required to activate the system in other airplane models.

> Should the sections of an airplane be broken apart, the activating housing [a shaft that houses the cable that links the firing handle to the parachute] may become stretched tight. If the parts separate enough, the unit could be detonated even with the blast handle still secured by its safety pin.

Using rescue tools to extricate airplane occupants could also cause the rocket to fire. The activation cable (between the handle in the cockpit and a firing mechanism that ignites the rocket) need only be pulled forward 1/2 inch, with a force of about 35 pounds to activate the rocket. By comparison, hydraulic rescue tools are capable of applying as much as 18,000 pounds of force per square inch to cut or spread aircraft structures. In addition, crimping or snagging the activation cable could move it far enough forward to activate the rocket.

The BRS publication also includes detailed instructions for disabling BRS ballistic parachute units. These instructions direct emergency workers to identify and locate the activation handle, the rocket motor, and the metal housing protecting the cable that stretches from the handle to the rocket activation tube, noting that these components may have shifted during the accident sequence and may not be in their original locations. The instructions then direct emergency workers to cut the activation cable where it attaches to the launch tube, while avoiding the departure end of the rocket, to prevent the rocket's firing mechanism from being activated.

Emergency workers who move or cut airplane wreckage without determining the existence of a ballistic parachute system or who disregard the positioning of the rocket motor as they work with the wreckage risk death or serious injury. The Safety Board considers it critical to these workers' safety that they be able to quickly identify aircraft with these systems installed and take action to ensure that the systems are not accidentally deployed. Training that specifically addresses the hazards of ballistic parachute systems, as well as effective warning labels and markings, would greatly aid emergency workers in the safe completion of their activities.

Emergency Worker Training for the Identification and Disabling of Ballistic Parachute Systems

Current Federal Aviation Administration (FAA) regulations[7] and guidance[8] for ARFF training do not require or recommend training on the hazards associated with ballistic parachute systems. Safety Board informal communications with firefighters at three Part 139-certificated airports suggest that there is little awareness among some ARFF units regarding the hazards of ballistic parachute devices. Anecdotal evidence from Board investigators who have responded to accidents involving ballistic parachute-equipped airplanes supports the stated lack of awareness.

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[7] Title 14 CFR 139.319(j)(2) requires that ARFF personnel at land airports serving certain air carriers be trained in many general areas, including aircraft familiarization, rescue and firefighting personnel safety, emergency aircraft evacuation assistance, and adapting and using structural rescue and firefighting equipment for aircraft rescue and firefighting.

[8] Advisory Circular 150/5210-17, "Programs for Training of Aircraft Rescue and Firefighting Personnel," contains additional information on recommended training subtopics, such as identifying the hazards associated with aircraft and aircraft systems.

The Safety Board's investigation also revealed a lack of any national training guidelines for non-airport emergency personnel on this subject. Although the National Fire Protection Association (NFPA) publishes nationally recognized training standards for non-airport firefighting organizations (in addition to voluntary training standards[9] for ARFF personnel that complement FAA regulations and guidelines), these standards do not address the hazards associated with ballistic parachute systems either. As discussed earlier, the BRS publication about this safety issue is available on the Internet, but there has been no national effort to distribute this information to firefighters or other emergency responders.

To maintain their safety and the safety of any aircraft accident survivors, emergency personnel need to be trained to quickly identify aircraft containing ballistic parachute systems, determine whether the system needs to be disabled, and proceed accordingly. Therefore, the Safety Board believes that the FAA should revise training guidelines for Part 139-certificated airports to ensure that ARFF crews receive training in the recognition and disabling of aircraft ballistic parachute systems during emergency operations. The Safety Board also believes that the FAA should distribute a safety bulletin to all Part 139-certificated airports to raise awareness among ARFF crews regarding the hazards associated with ballistic parachute devices during general aviation rescue and firefighting operations.

Because many first responders to aircraft accidents are non-airport firefighters and to ensure that this population is informed of this safety issue, the Safety Board believes that the NFPA and the International Association of Fire Chiefs should, in cooperation with BRS and Cirrus Design, develop and distribute a safety bulletin to your membership to raise awareness among non-airport fire/rescue organizations regarding the hazards associated with ballistic parachute devices during general aviation rescue and firefighting operations. The Board also believes that the NFPA should update existing firefighter training standards for non-airport firefighting organizations to include information on the recognition and disabling of ballistic parachute systems.

Design for Disabling Ballistic Parachute Systems

In its instructions for disabling ballistic parachute systems, BRS "strongly recommends" using a Felco brand C.16 circular cutting tool (part number 39601-63-00) to cut the activation cable in its protective housing. The company's instructions stress that using the appropriate tool is important because any twisting during the cutting process (such as might occur with standard bolt cutters) could pinch the cable, possibly pulling it far enough to cause the rocket to fire. The instructions state that the ballistic parachute system is relatively safe after the activation cable has been cut, and emergency workers can more safely remove accident victims from the wreckage. After victims have been removed, BRS recommends taking the additional safety step of removing the rocket's fuel and firing the rocket igniters to render the rocket completely incapable of firing.

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[9] Relevant NFPA guidelines include the following: (1) *Recommended Practice for the Recurring Proficiency Training of Aircraft Rescue and Fire Fighting Services.* (1999). Standard 405. Quincy, Massachusetts: National Fire Protection Association. (2) *Guide for Aircraft Rescue and Fire Fighting Operations.* (2002). Standard 402. Quincy, Massachusetts: National Fire Protection Association. (3) *Standard for Aircraft Rescue and Fire Fighting Services at Airports*. (1998). Standard 403. Quincy, Massachusetts: National Fire Protection Association.

The Safety Board notes two shortcomings of BRS' disabling instructions. First, the instructions appear to have been designed with ultralight aircraft in mind. Although ballistic parachute systems are clearly visible on most ultralight aircraft, they are highly concealed on general aviation airplanes, especially the Cirrus models. There are no external markings on Cirrus airplanes revealing the location of CAPS components or identifying the rocket's exit path. The activation cable, which must be cut to disable the system, is concealed under materials inside the aft baggage compartment, with no exterior markings identifying its location. Second, the Felco tool recommended for cutting the activation cable inside its housing is not standard firefighting equipment. Airport firefighters contacted by Safety Board staff at three airports were unfamiliar with the Felco C.16, and one fire official at a major airport stated that firefighters typically carry more common types of bolt and cable cutters.[10] Because of the difficulty in locating the necessary components and the need for a special cutting tool, it is likely that firefighters or emergency workers would have difficulty disabling the ballistic parachute systems that are currently being factory-installed in general aviation airplanes. Therefore, the Safety Board believes that the FAA should develop standards for the design and installation of ballistic parachute systems in future general aviation aircraft to enable emergency responders to quickly and safely disable the system using only common firefighting tools and examine the feasibility of retrofitting aircraft that currently have ballistic parachute systems installed with a system that complies with the new design and installation standards.

Deficiencies of Current Exterior Warning Labels

The type certificate for Cirrus SR20 and SR22 airplanes and the STC for after-market installation of BRS units in Cessna airplanes require that warning labels for the units be affixed to the exterior of these airplanes (labels should be affixed to the aft fuselage on Cirrus airplanes and to the rear window on Cessna 172s[11], for example). However, there are no general FAA requirements or standards pertaining to the design of such labels. Cirrus designed the labels used on its aircraft and BRS designed the labels that are provided with aftermarket ballistic parachute installation kits. As shown in figures 1 and 2, the warning labels designed by Cirrus and those designed by BRS are very dissimilar.

The Safety Board identified several shortcomings with both companies' warning labels. According to the American National Standards Institute's (ANSI) 2002 *American National Standard for Product Safety Signs and Labels* (ANSI Z535.4),[12] warning labels should be subdivided into three panels. The first panel should contain an appropriate signal word,

[10] Personal communication with Lieutenant/FAA Training Specialist, Chicago Fire Department, O'Hare International Airport, August 23, 2002.

[11] The Cessna 172 STC also requires that a label be affixed to the parachute canister, located inside the baggage compartment.

[12] This standard, first published by the National Electrical Manufacturers Association in 1992, provides guidelines for the design of safety signs and labels for application to products and is completely voluntary. For standards to be ANSI-approved, the standards developer must meet ANSI requirements for due process, consensus, and other criteria. A laboratory study conducted by Michael S. Wogalter, Ph.D., at North Carolina State University in 2002 found that warning labels consistent with the ANSI standard were better noticed, more often read, and produced greater understanding and compliance [Wogalter, M.S. (2002). Guidelines for Warning Design: Do they matter? Paper presented at the 46th Annual Meeting of the Human Factors and Ergonomics Society, Baltimore, Maryland.]

accompanied by a safety alert symbol,[13] that advises readers of the hazard and is written in black letters against an orange background. The second panel should contain a message that informs readers of the consequences of not taking precautions to avoid the hazard and provides instructions for avoiding the hazard.[14] ANSI Z535.4 also states that the message panel should be legible from a minimum safe viewing distance. Finally, the third panel should contain a safety pictorial that rapidly conveys information about the nature and consequences of the hazard to people who do not or cannot read the message panel.

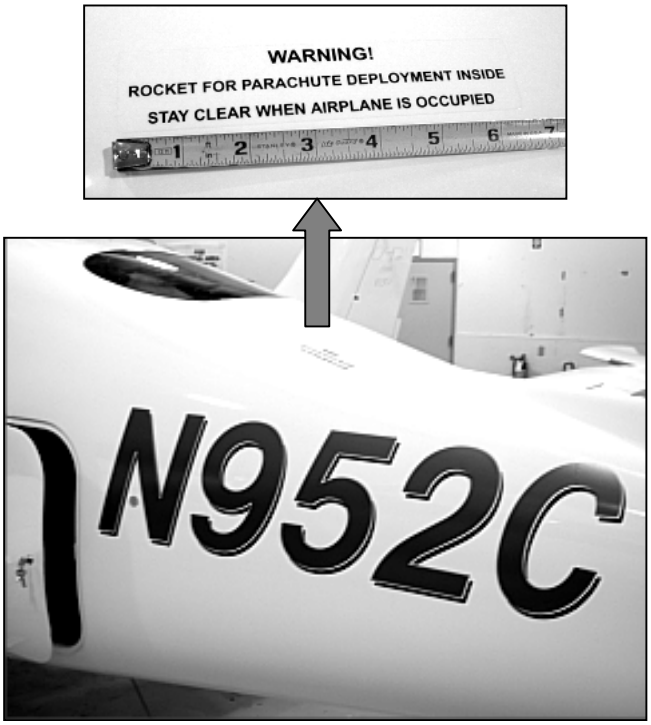

Figure 1. CAPS warning label for Cirrus SR20 and SR22 airplanes

[13] According to the ANSI standard, the signal word "warning" is used to indicate a hazard which, if not avoided, could result in death or serious injury. The ANSI standard safety alert symbol is an exclamation point surrounded by an equilateral triangle.

[14] According to a 1996 study on the effectiveness of signs and labels, failing to provide information about hazard consequences reduces the likelihood of compliance with recommended safety precautions. [Wogalter, M.S., and Laughery, K.R. (1996). WARNING! Sign and label effectiveness. *Current Directions in Psychological Science*, 5, 33-36.]

Label Affixed to Aircraft Rear Window

Label Affixed to Parachute Canister

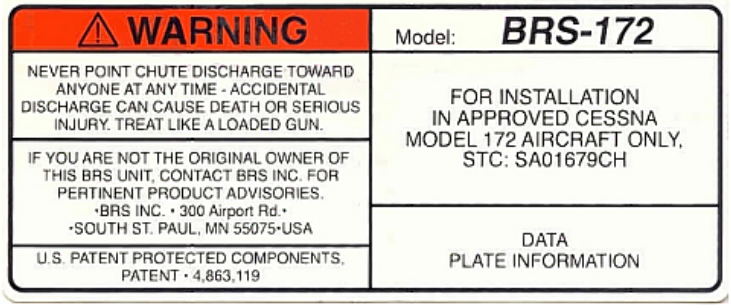

Figure 2. BRS Warning Labels for the Cessna 172

As shown in figure 1, the Cirrus warning label does not use the panel format. Although it contains an appropriate signal word (in this case, "warning"), it does not contain a safety alert symbol, nor does it use the recommended orange background. The label also lacks a message panel that provides information regarding steps that emergency workers can take to avoid the hazard and that explains the potential consequences of failing to avoid the hazard (in this case, that a person struck by the rocket or flying debris or exposed to the blast during an accidental firing could be killed or seriously injured). Although the Cirrus label instructs those outside the airplane to "stay clear when [the] airplane is occupied," there are no markings showing the exit point of the CAPS rocket, or otherwise indicating unsafe areas outside the airplane. Moreover, the instruction to stay clear is not useful information for emergency workers who may need to rescue trapped occupants. It does not explain that moving or cutting the wreckage after an accident could cause the rocket to fire and does not point emergency workers to the appropriate location to cut the activation cable if they need to disable the ballistic parachute system. In addition, the text size on the current Cirrus label does not allow personnel to identify the hazard from a safe viewing distance. The largest letters (in the word "warning") are 1/4 inch high, which requires the reader to get quite close to the rocket exit point to read the label. Furthermore, the label lacks a safety pictorial that warns those who do not or cannot read the written message. Finally, Cirrus does not currently affix any warning label to the rocket canister, which would increase the difficulty of identifying this component if it were to become displaced from its normal position during a crash.

The BRS-designed labels are superior to the Cirrus warning label in some respects. For example, both labels feature an ANSI-style safety alert symbol and the signal word "warning" in black letters against an orange background, as recommended by ANSI Z535.4.[15] In addition, on the canister label, the signal word and safety alert symbol are presented in their own panel, as

[15] BRS referred to a 1991 version of ANSI Z535.4 when designing its warning labels.

recommended by ANSI Z535.4. The canister label also describes the potential consequences of failing to avoid the hazard and provides specific information on how to avoid the hazard. Although the BRS warning labels are an improvement over the Cirrus label, they also have shortcomings. Like the Cirrus warning label, the message panel on the BRS label intended for use on the aircraft exterior contains small lettering that would be difficult to read from a distance. Also like the Cirrus label, the BRS exterior label provides the reader with an instruction to "remain clear," a safety precaution that may not be specific enough to be useful to emergency workers. Information for avoiding the hazard, which is included on the canister label, would not be seen easily from outside the aircraft. Like the Cirrus label, the BRS labels do not provide a safety pictorial illustrating the nature of the hazard and hazard consequences.

The Safety Board is concerned that current warning labels and exterior markings on general aviation airplanes containing ballistic parachute systems are poorly designed. The Board notes that BRS and Cirrus pioneered the development of ballistic parachute systems for general aviation airplanes and, therefore, possess considerable expertise regarding the hazards of these systems. Furthermore, the Board notes that the FAA's ARFF working group has considerable expertise regarding the training and working practices of airport rescue personnel, as does the NFPA with regard to non-airport rescue personnel. Therefore, the Safety Board believes that the FAA should work with BRS, Cirrus Design, the NFPA, and the ARFF working group to establish design requirements for warning labels and exterior markings for airplanes equipped with ballistic parachute systems that meet the ANSI guidelines for conspicuity, coloration, visibility, and content.

Therefore, the National Transportation Safety Board makes the following recommendations:

—To the Federal Aviation Administration:

Revise training guidelines for 14 *Code of Federal Regulations* Part 139-certificated airports to ensure that airport rescue and firefighting crews receive training in the recognition and disabling of aircraft ballistic parachute systems during emergency operations. (A-04-36)

Distribute a safety bulletin to all 14 *Code of Federal Regulations* Part 139-certificated airports to raise awareness among airport rescue and firefighting crews regarding the hazards associated with ballistic parachute devices during general aviation rescue and firefighting operations. (A-04-37)

Develop standards for the design and installation of ballistic parachute systems in future general aviation aircraft to enable emergency responders to quickly and safely disable the system using only common firefighting tools and examine the feasibility of retrofitting aircraft that currently have ballistic parachute systems installed with a system that complies with the new design and installation standards. (A-04-38)

Work with Ballistic Recovery Systems, Inc., Cirrus Design, the National Fire Protection Association, and the airport rescue firefighting working group to establish design requirements for warning labels and exterior markings for airplanes equipped with ballistic parachute systems that meet the American National Standards Institute's guidelines (ANSI Z535.4) for conspicuity, coloration, visibility, and content. (A-04-39)

—To the National Fire Protection Association and the International Association of Fire Chiefs:

In cooperation with Ballistic Recovery Systems, Inc., and Cirrus Design, develop and distribute a safety bulletin to your membership to raise awareness among non-airport fire/rescue organizations crews regarding the hazards associated with ballistic parachute devices during general aviation rescue and firefighting operations. (A-04-40)

—To the National Fire Protection Association:

Update existing firefighter training standards for non-airport firefighting organizations to include information on the recognition and disabling of ballistic parachute systems. (A-04-41)

Please refer to Safety Recommendations A-04-36 through -41 in your reply. If you need additional information, you may call (202) 314-6177.

Chairman ENGLEMAN CONNERS, Vice Chairman ROSENKER, and Members GOGLIA, CARMODY, and HEALING concurred in these recommendations.

Original Signed

By: Ellen Engleman Conners
Chairman