



National Transportation Safety Board

Washington, D.C. 20594

Safety Recommendation

Date: November 30, 1998

In reply refer to: A-98-119 through -121

Honorable Jane F. Garvey
Administrator
Federal Aviation Administration
Washington, D.C. 20591

On April 11, 1997, the pilot of a single-seat Glaser-Dirks DG-300 glider, N70644, was killed after he lost control of the aircraft for undetermined reasons and crashed near Minden, Nevada. The National Transportation Safety Board's investigation found that the pilot had jettisoned the glider's canopy in an apparent attempt to parachute from the aircraft but that he was subsequently incapacitated when the canopy struck his forehead during the jettison sequence (the basis for these findings is discussed later in this letter). As a result, he remained with the aircraft and was found in the cockpit with his seat belt restraint system still fastened. The nearly horizontal flightpath of the jettisoned canopy caused it to strike the glider's T-tail, become impaled on the horizontal portion of the T-tail, and remain with the aircraft until ground impact. The glider was destroyed.

The canopy's emergency jettison release knob and pin-latch handle had both been pulled in accordance with the requirements for jettisoning outlined in the DG-300 Pilot's Operating Handbook. The handbook indicates that the jettisoned canopy will then be blown away by the oncoming airstream.

In normal operation, the canopy is latched or unlatched at the aft end, and the front end of the canopy pivots about an airframe-mounted pivot assembly. Pulling the canopy's pin-latch handle withdraws the pin from the latch clevis and unlocks the canopy at the aft end. The canopy's latching pin, on the aft upper part of the canopy, and the latch clevis, on the aft upper part of the cockpit, were found intact and undamaged. Pulling the jettison release knob unlocks the front end pivot assembly and allows a small spring to push the front end of the canopy upward, away from the pivot plate. The Safety Board found that activating the release knob on the ground results in a positive release of the canopy from the pivot plate. However, the spring force does not result in significant upward travel of the front end of the canopy and, therefore, may be insufficient to ensure automatic in-flight separation of the canopy from the fuselage.

The left and right outboard horizontal sections of the glider's T-tail contained impact marks with black paint smears similar to the black paint on the interior of the canopy frame; the

distance between the impact marks approximated the length of the canopy frame. There were several small punctures on the upper surface of the tail; one was round with red material, approximating the shape and color of the jettison release knob. Pieces of the canopy Plexiglas were found up to 300 yards from the glider's main wreckage.

According to the autopsy report, the pilot's face had several large lacerations and abrasions with minimal associated hemorrhage. No blood was observed anywhere on the pilot's face, but the autopsy report described a large bruise on the forehead as follows: "Covering the front of the forehead, almost paralleling the eyebrows, is a 10.0 x 6.0 cm area of confluent purple-gray abrasion superimposing contusion." This was the only contusion¹ noted anywhere on the pilot's head. The contusion was consistent with impact from a solid, hard object with a linear edge. The absence of bleeding, despite large lacerations to the pilot's face, indicates that his death upon ground impact was abrupt, resulting from blunt force trauma.

The contusion (bruise) on the pilot's forehead, however, required a finite period of time after the trauma was inflicted for the injury to accumulate blood. Moreover, blood to this area of the body could not have resulted from gravity flow but had to be provided under pressure. Therefore, the impact force causing the contusion had to have been inflicted before the ground impact that killed the pilot. This fact, together with the shape and location of the contusion, provides compelling evidence that the canopy frame struck the pilot on the forehead during the jettison sequence.

The DG-300 is manufactured in Germany by DG Flugzeugbau GmbH and is type certificated in that country in the utility category, according to Joint Airworthiness Requirements for Sailplanes and Powered Sailplanes (JAR-22).² However, the glider has not been type certificated in the United States but is currently imported, licensed, and operated in the experimental category. According to the manufacturer, jettison of the DG-300 canopy or the canopies on DG-100/200/400/600 series gliders (aircraft configured with a similar canopy and jettison mechanism) was not required to be demonstrated during the course of German certification. However, the manufacturer indicated that, during a flight test of a DG-600, jettison of the canopy became necessary during a spiral dive and was accomplished successfully without injury to the pilot.

Egress from the cockpit and jettisoning of the canopy are addressed in the following excerpts from JAR 22.807, Emergency Exit:

- (a) The cockpit must be so designed that unimpeded and rapid escape in emergency situations during flight and on the ground is possible with the occupant wearing a parachute.

¹ A contusion (bruise) signifies hemorrhage into the skin, the tissues under the skin, or both. It is usually the result of a blow or squeeze that crushes the tissues and ruptures blood vessels but does not break the skin.

² JAR-22 is based on the Federal Republic of Germany's national airworthiness code and was developed through the joint participation of several European countries.

(b) The opening, and where appropriate jettisoning, of each canopy or emergency exit must not be prevented by the presence of the appropriate aerodynamic forces and/or the weight of the canopy at speeds up to V_{df} or by jamming of the canopy with other parts of the sailplane. The canopy or emergency exit attachment fittings must be designed to permit easy jettisoning, where jettisoning is a necessary feature of the design.

Until recently, all Glaser-Dirks gliders imported into the United States, except for the DG-500 model, were certificated in the experimental category. However, the DG-100/400/500/800 models are now type certificated in the standard (utility) airworthiness category, and the Safety Board understands that the Federal Aviation Administration (FAA) has initiated a program aimed at eventual type certification of all Glaser-Dirks gliders in the standard airworthiness category. Even though the Safety Board concurs with the FAA's certification objectives, it is concerned about the extent to which jettison of the canopies of these gliders has been demonstrated for certification purposes. Although the jettison of a DG-600 canopy was apparently accomplished without incident, the Safety Board does not believe that this single event provides a sufficient technical basis for concluding that the canopy can be jettisoned successfully under all conditions throughout the complete airspeed and maneuver operating envelopes of these gliders. For example, flight at high angles of attack or sideslip, as in a spin, might significantly affect a canopy's jettison characteristics and its subsequent flightpath.

In connection with an evaluation of existing glider canopy jettisoning systems, the German Federal Ministry of Transport commissioned the 1991 study "Problems and Improvements of Canopy Jettisoning Systems" in which tests were performed with a glider mounted on the roof of an automobile. Details were presented of the motion and flightpath of the canopy, after its release in an emergency, as well as the influence of airspeed, angle of attack, sideslip, and raising of the front end of the canopy. The study concluded the following:

It is clear that none of the existing mechanisms in today's gliders guarantee a problem-free jettisoning of the canopy and there is a high risk of injury to the pilot by the moving canopy. The main reason for this is the nose-down pitching and nose-inwards yawing moment on the canopy. This is due to the position of the center of pressure which is behind the center of gravity. This nose-down moment can be transformed into a nose-up pitching moment by a rear hinge between the top of the canopy and the fuselage. This hinge can take the form of a simple clasp. In such cases, the hinge must be released at an angle of approximately 40 degrees between the canopy and the cockpit. This simple improvement means that after the release, the canopy rotates with a nose-up pitching moment, separates quickly from the cockpit and passes high above the rudder. There is no risk of injury to the pilot.

An automatic jettisoning assumes a raising of the front part. At low speeds and a low angle of attack, the raising does not initiate the separation of the canopy. For this reason, there should be two handles on the right and left frame of the canopy which the pilot can use to assist jettisoning. These handles should also be used to release the canopy. This is why there should be two handles in any canopy jettisoning system.

The relatively shallow, almost horizontal flightpath of the jettisoned canopy from N70644, causing it to strike both the pilot and the glider's T-tail, contrasts sharply with the study's test results based on a canopy with a rear hinge that releases from the cockpit at about 40°. For example, in one such test conducted at 70 knots, the canopy rotated upward around the hinge, separated from the fuselage at the proper angle, ascended steeply, and passed over the glider's tail at a height of about 13 feet.

There are about 88 aircraft of the DG-300/400/500/600/800 series currently operating in the United States. The Safety Board believes, based on the FAA's program to eventually certificate all Glaser-Dirks gliders in the standard airworthiness category, that the models and their numbers may increase significantly. Therefore, the Safety Board believes that the FAA should require DG Flugzeugbau GmbH to conduct testing of the canopy jettison system used on all Glaser-Dirks gliders certificated in the United States to determine the design changes, conditions, or limitations necessary to ensure that the canopies can be reliably jettisoned throughout the airspeed and maneuver operating envelopes of the aircraft without striking the pilot. The Safety Board also believes that the FAA should issue an airworthiness directive, applicable to all Glaser-Dirks gliders certificated in the United States in the standard airworthiness category, requiring the implementation of any appropriate design changes and/or operational procedures. Further, The Board believes that the FAA should issue a special airworthiness information bulletin, applicable to all Glaser-Dirks gliders certificated in the United States in the special (experimental) airworthiness category, advising owners of the need to implement any appropriate design changes and/or operational procedures.

Therefore, the National Transportation Safety Board recommends that the Federal Aviation Administration:

Require DG Flugzeugbau GmbH to conduct testing of the canopy jettison system used on all Glaser-Dirks gliders certificated in the United States to determine the design changes, conditions, or limitations necessary to ensure that the canopies can be reliably jettisoned throughout the airspeed and maneuver operating envelopes of the aircraft without striking the pilot. (A-98-119)

Issue an airworthiness directive, applicable to all Glaser-Dirks gliders certificated in the United States in the standard airworthiness category, requiring the implementation of any appropriate design changes and/or operational procedures. (A-98-120)

Issue a special airworthiness information bulletin, applicable to all Glaser-Dirks gliders certificated in the United States in the special (experimental) airworthiness category, advising owners of the need to implement any appropriate design changes and/or operational procedures. (A-98-121).

Chairman HALL, Vice Chairman FRANCIS, and Members HAMMERSCHMIDT, GOGLIA, and BLACK concurred in these recommendations.

By: Jim Hall
Chairman