# National Transportation Safety Board

Washington, D.C. 20594

## Safety Recommendation

**Date:** March 31, 2008

**In reply refer to:** A-08-10 through -13

The Honorable Robert A. Sturgell
Acting Administrator
Federal Aviation Administration
Washington, D.C. 20591

On August 28, 2006, about 1506 Pacific daylight time,[1] a Raytheon Aircraft Company Hawker 800XP airplane, N879QS, and a Schleicher ASW27-18 glider, N7729, collided in flight about 42 nautical miles (nm) south-southeast of the Reno/Tahoe International Airport (RNO), Reno, Nevada, at an altitude of about 16,000 feet above mean sea level (msl). The airline transport-certificated captain and first officer in the Hawker received minor injuries, and the three passengers were not injured. The private pilot in the glider received minor injuries, and both aircraft sustained substantial damage. Visual meteorological conditions (VMC) prevailed at the time of the collision. The Hawker, which was fractionally owned by multiple corporations and managed by NetJets Aviation, Inc., was operating under the provisions of 14 *Code of Federal Regulations* (CFR) Part 91, Subpart K, as an executive/corporate flight. It departed from Carlsbad, California, about 1400 and was en route to RNO with an instrument flight rules (IFR) flight plan filed. The glider was registered to a private owner and was operated by the pilot under the provisions of 14 CFR Part 91 as a personal flight. It departed from Minden, Nevada, about 1300 for a local flight with no flight plan filed.[2]

### Background

The collision occurred in an area that is frequently traversed by air carrier and other turbojet airplanes inbound to RNO and that is also popular for glider operations because of the thermal and mountain wave gliding opportunities there.[3] The glider pilot, who intended a 5-hour flight in the local area to familiarize himself with the glider, was not communicating with air

[1] All times are in Pacific daylight time unless otherwise noted.

[2] The factual report for this accident, LAX06FA277A/B, can be found on the National Transportation Safety Board's Web site at <http://ntsb.gov/ntsb/brief2.asp?ev_id=20060906X01297&ntsbno=LAX06FA277A&akey=1>.

[3] The area surrounding RNO is known for its world-class gliding and hosts a number of gliderports and glider clubs. Three airports surrounding RNO service glider operations: Minden-Tahoe Airport (35 nm south of RNO), Reno/Stead Airport (14 nm north-northwest of RNO), and Truckee-Tahoe Airport (23 nm southwest of RNO).

traffic control (ATC) and was not required to do so.[4] The Hawker flight was in radar and radio contact with an ATC facility. Before the collision, the Hawker had been descending toward RNO on a stable northwest heading for several miles, and the glider was in a 30º, left-banked, spiraling climb. According to statements from the Hawker's captain and the glider pilot, they each saw the other aircraft only about 1 second or less before the collision and were unable to maneuver to avoid the collision in time. Damage sustained by the Hawker disabled one engine and other systems; however, the flight crew landed the airplane. The damaged glider was uncontrollable, and the glider pilot bailed out and parachuted to the ground.

Because of the lack of radar data for the glider's flight, it was not possible to determine at which points in each flight each aircraft may have been in the other's available field of view. Although Federal Aviation Regulations (FARs) require all pilots to maintain vigilance to see and avoid other aircraft (this includes pilots of flights operated under IFR, when visibility permits), a number of factors that can diminish the effectiveness of the see-and-avoid principle were evident in this accident. For example, the high-speed closure rate of the Hawker as it approached the glider would have given the glider pilot only limited time to see and avoid the jet. Likewise, the closure rate would have limited the time that the Hawker crew had to detect the glider, and the slim design of the glider would have made it difficult for the Hawker crew to see it. Although the demands of cockpit tasks, such as preparing for an approach, have been shown to adversely affect scan vigilance, both the Hawker captain, who was the flying pilot, and the first officer reported that they were looking out the window before the collision. However, the captain saw the glider only a moment before it filled the windshield, and the first officer never saw it at all.

The Hawker was equipped with a traffic alert and collision avoidance system (TCAS)-II capable of generating vertical resolution (collision avoidance) advisories (RA). However, the glider's Mode C transponder was turned off and, therefore, was not detectable by the Hawker's equipment.[5] Although transponder installation is not required on gliders, FARs require that any person operating a transponder-equipped aircraft must use the transponder.[6] Had the glider pilot turned on his transponder, the Hawker's TCAS-II likely would have depicted the glider on the flight crew's monitor and, at a minimum, would have generated an RA to alert the crewmembers and prompt them to deviate their course in time to prevent the accident. In addition, had the glider's transponder been turned on, it would have provided position and altitude information to ATC personnel who could have used that information to provide separation services and traffic advisories to the Hawker crew.

According to Reno Terminal Radar Approach Control (TRACON) personnel, it is not uncommon for arriving and departing air traffic to receive TCAS RAs because of transponder-equipped gliders operating in the area. For example, in a 30-day interval before the accident, the

[4] The collision occurred in Class E airspace that has no requirements for two-way radio communication.

[5] The glider pilot turned off the transponder because he wanted to reserve battery power for radio use.

[6] According to 14 CFR 91.215(c), "each person operating an aircraft equipped with an operable ATC transponder . . . shall operate the transponder, including Mode C equipment, if installed."

facility recorded four such TCAS RA events reported by pilots.[7] Each event involved a conflict between a transport-category airplane operated under 14 CFR Part 121 and a glider.

The National Transportation Safety Board determined that the probable cause of this accident was the failure of the glider pilot to utilize his transponder and the high closure rate of the two aircraft, which limited each pilot's opportunity to see and avoid the other aircraft.

The investigative findings from this accident revealed safety issues related to limitations of the see-and-avoid concept in preventing midair collisions, especially when one or more high-speed aircraft are involved, and the regulatory exemption that allows gliders to operate without transponders. The Safety Board also noted that glider design and electrical power limitations present unique challenges for the installation and operation of transponders. Following this accident, members of the local glider groups and the Reno TRACON facility met and formed working groups to establish interim policies and procedures, improve communications between glider pilots and ATC, and educate glider pilots on the midair collision potential and what they can do to mitigate the risk.[8]

**Benefits of Transponders in Collision Avoidance**

The limitations of the see-and-avoid concept for collision avoidance have long been recognized and acknowledged by the Safety Board and other aviation safety advocates. Following four midair collisions in 1986 and 1987, all of which occurred in daylight VMC, the Board issued a July 27, 1987, safety recommendation letter to the Federal Aviation Administration (FAA). This letter emphasized the Board's longstanding belief that midair collision avoidance is significantly improved when pilots are alerted to the presence and location of potentially conflicting traffic by ATC personnel or a TCAS.[9]

In the letter, the Safety Board expressed specific concerns about airspace in the vicinity of airports that is used not only by arriving and departing air carrier traffic but also by transiting aircraft operating under visual flight rules (VFR). The Safety Board concluded that, because both airborne TCAS and controller-initiated conflict alerts rely upon operating transponders, such transponders should be required for all aircraft that share airspace with TCAS-equipped air

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[7] The facility retains TCAS RA reports for only 30-day intervals. Safety Board investigators reviewed reports for the most recent available 30-day interval before the accident.

[8] Also, as a result of this accident, the Safety Board issued Safety Recommendations A-08-14 and -15 to the Soaring Society of America, Inc., regarding expanding similar safety efforts in other areas and informing the glider community about this accident and the importance of transponders.

[9] The letter also reiterated two safety recommendations to the FAA that were originally issued in 1985. Safety Recommendation A-85-64 asked that the FAA "expedite the development, operational evaluation, and final certification of . . . [TCAS] for installation and use in certificated air carrier aircraft," and Safety Recommendation A-85-65 asked that the FAA "amend 14 CFR Parts 121 and 135 to require the installation and use of . . . [TCAS] equipment in certificated air carrier aircraft when it becomes available for operational use." Both of these recommendations were classified "Closed—Acceptable Action" on May 23, 1989, because the FAA implemented the TCAS requirements and issued guidance materials for TCAS airworthiness and operational approval.

carriers. The Board issued a safety recommendation to the FAA on this issue.[10] Although the FAA responded and issued a final rule on June 17, 1988, requiring transponders for aircraft operating near primary airports and in airspace at or above 10,000 feet msl, gliders and other aircraft without an engine-driven electrical system remain exempt from many requirements.[11]

As evidenced by this accident, aircraft that are not using or not equipped with transponders and are operating in areas transited by air carrier traffic represent a collision hazard. This hazard has persisted more than 20 years since the Safety Board initially expressed concern. According to glider operators in the RNO area, the area of the collision is very popular with gliders for the thermal lift provided by the Pine Nut Ridge, and gliders can reach altitudes up to 18,000 feet msl or higher.[12]

Review of the Aviation Safety Reporting System (ASRS) database revealed that, from 1988 to August 2007, 60 near midair collisions (NMACs) involving air carrier/corporate jet traffic and gliders were reported.[13] Of these events, nine occurred in the vicinity of RNO, which represents more reports than any other airport area during that timeframe.[14] Although the most recent reported RNO-area NMAC event, which occurred in August 2007, involved a glider that

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[10] Safety Recommendation A-87-97 asked that the FAA "require transponder equipment with Mode C altitude-reporting for operations around all Terminal Control Areas and within Airport Radar Service Areas after a specified date compatible with implementation of . . . [TCAS] requirements for air carrier aircraft." This recommendation was classified "Closed—Acceptable Action" on May 3, 1989, because the FAA implemented transponder requirements for aircraft operating near certain primary airports and in other airspace at and above 10,000 feet msl.

[11] According to 14 CFR 91.215(b), all aircraft, unless otherwise authorized or directed by ATC, must be equipped with an operable transponder and altitude-reporting equipment for operations in Class A, Class B, and Class C airspace and within 30 nm of listed Class B airports, from the surface upward to 10,000 feet msl. However, 14 CFR 91.215(b)(3) states that, "any aircraft which was not originally certificated with an engine-driven electrical system or which has not subsequently been certified with such a system installed, balloon or glider may conduct operations in the airspace within [30 nm of listed Class B airports, provided such operations are conducted] . . . (i) Outside any Class A, Class B, or Class C airspace area; and (ii) Below the altitude of the ceiling of a Class B or Class C airspace area designated for an airport or 10,000 feet msl, whichever is lower." In addition, 14 CFR 91.215(b)(5) states that "all aircraft except any aircraft which was not originally certificated with an engine-driven electrical system or which has not subsequently been certified with such a system installed, balloon or glider" are required, unless otherwise authorized or directed by ATC, to be equipped with an operable transponder and altitude-reporting equipment for operations in the following airspace: "(i) In all airspace of the 48 contiguous states and the District of Columbia at and above 10,000 feet msl, excluding the airspace at and below 2,500 feet above the surface; and (ii) In the airspace from the surface to 10,000 feet msl within a . . . [10-nm radius of a Class B airport] excluding the airspace below 1,200 feet outside of the lateral boundaries of the surface area of the airspace designed for that airport."

[12] The floor of Class A airspace begins at 18,000 feet msl, and 14 CFR 91.135 requires that all aircraft operating in Class A airspace must do so under IFR and must operate an appropriate transponder with altitude-reporting capabilities, in accordance with 14 CFR 91.215. Therefore, glider pilots who wish to fly at 18,000 feet msl or higher must operate a transponder and activate the local glider operations box, which provides clearance from arriving traffic. According to the local glider pilots, the box is usually activated during mountain wave flying conditions. During thermal flying conditions, the gliders usually remain below 18,000 feet msl.

[13] Because ASRS reports are voluntary, it is possible that other NMAC events occurred but were unreported.

[14] Some of the reports did not specify where the event occurred, and those reports were excluded from determining area totals. After the RNO area, the next airport with the most NMAC reports was the Chicago Midway International Airport area in Chicago, Illinois, with four reports; followed by the City of Colorado Springs Municipal Airport area in Colorado Springs, Colorado, with three reports. The Washington, D.C., area (which includes more than one airport and the surrounding areas) had four NMAC reports filed.

was equipped with a transponder that both ATC and the other aircraft's TCAS detected,[15] most of the ASRS reports involved gliders that were neither detected by the jet flight crews' TCAS equipment nor visible on the ATC facilities' radar screens, indicating that the gliders were not equipped with, or not using, a transponder. Some of the reports indicated that, after the flight crews reported to ATC that they saw the glider, the controllers noticed primary radar returns in the vicinity of the jet traffic. In some instances, the controllers had notified the jet crews of the primary radar returns but informed the pilots that they did not know what the traffic was or at which altitude it was flying. During postaccident interviews, Reno TRACON personnel reported that, although they can sometimes see primary radar returns for what they suspect are nontransponder-equipped gliders, they did not see any primary returns from the accident glider before this collision. Further, even when ATC personnel detect primary returns, they cannot ascertain the type or altitude of the aircraft.

More than 10 years before this accident, Reno Flight Standards District Office (FSDO) personnel concluded that, on the basis of many NMAC reports, inspectors' observations of traffic conflicts, and other information, the increasing glider operations in the departure and arrival areas around RNO represented a collision hazard. On April 11, 1997, the Reno FSDO manager submitted a memorandum to the FAA's Office of Accident Investigation, Recommendation and Analysis Division (AAI-200)[16] detailing these concerns. The memo indicated that:

> Gliders are invisible to radar because they do not have a transponder, and they will not show up as a primary target on radar due to their design. Air carrier pilots are very busy with the approach or departure procedure and tend to rely on their TCAS for identifying traffic. Gliders do not show up on TCAS unless they use an appropriate transponder. In addition, due to the design of the gliders, they are very difficult to see unless the air carrier is very close to them, which may be too late to avoid the glider.

The memo detailed some of the FSDO's efforts to correct the problem, stating that it developed an ongoing program to try to educate the glider community and air carriers. The memo stated that:

> However, the gliders continue to operate in the arrival and departure areas around RNO. This office has suggested that gliders carry transponders and/or communicate with the RNO tower. The glider community does not want to adopt the FAA's suggestion. The glider community wants ATC to reroute the air carriers around their area of operation. RNO is located in a valley and if ATC were to try and reroute the air carriers then they would not be able to make a safe descent for landing.

The memo suggested a number of solutions, including a proposal to require gliders to carry transponders with appropriate modes for ATC and TCAS. In response to the FSDO's

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[15] The reported circumstances of this event are discussed in more detail later in this letter.

[16] The original memo was addressed to the "Office of Accident Investigation, Recommendation and Quality Assurance Division, AAI-200," which slightly misidentified the division's title. However, the memo reached its intended recipient, and the manager of AAI-200 responded to it.

concerns, the FAA published a notice to airmen (NOTAM) cautioning pilots about glider soaring operations 30 to 50 miles south of RNO and ensured that the San Francisco Sectional Aeronautical Chart and five of the RNO-published instrument procedures were updated with caution boxes to warn pilots of extensive glider activity.[17] However, the FAA elected not to implement the transponder recommendation.

The Safety Board acknowledges that the FAA's actions to publish the NOTAM and the chart updates are steps in the right direction. However, because the collision threats observed by Reno FSDO personnel 10 years ago persist today, the Safety Board concludes that the safety measures implemented by the FAA to notify air carriers and other RNO-area traffic of glider activity are insufficient to prevent collisions. The Board notes that, because of the limitations of the see-and-avoid concept, transponder-initiated collision alerts (either from ATC or TCAS) provide both VFR and IFR aircraft with a higher degree of safety in an environment where high-speed closure rates are possible. Therefore, the Safety Board further concludes that transponders are critical to alerting pilots and controllers to the presence of nearby traffic, so that collisions can be avoided, and that gliders should not be exempt from the transponder requirements. This is especially important at higher altitudes, where flight crews may rely more on their TCAS, expecting that other aircraft, including light aircraft, are in contact with ATC and/or are transponder-equipped. Therefore, the Safety Board believes that the FAA should remove the glider exemptions from the FARs that pertain to transponder requirements and use.

**Considerations for Transponder Installation Retrofits in Gliders**

Since 1998, the Soaring Society of America, Inc. (SSA) has encouraged glider operators to voluntarily install and use transponders because of their safety benefits. However, as mentioned previously, the Reno FSDO's suggestion of voluntary transponder installation and use was met with resistance from members of the local glider community. When transponders were mandated in general aviation aircraft, gliders were excluded from the requirement because they lack an engine-driven electrical system to power the equipment.

Although some newer transponders require less battery power than older models or models originally designed for powered aircraft, power limitations remain a concern for glider operators. According to a transponder article available from the SSA's Soaring Safety Foundation (SSF), in order to power a transponder, a glider owner would likely need to install an additional battery, which would allow anywhere from 5 to 12 hours of transponder operation, depending on the type of transponder, the temperature conditions during the flight, and the age of the battery.[18]

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[17] Before this accident, the government's National Oceanic Service (NOS) standard instrument departure (SID) and standard terminal arrival route (STAR) charts for RNO contained a relatively large box cautioning pilots of "intensive glider activity." The instrument approach procedures for RNO published by Jeppesen Sanderson, which were used by the Hawker flight crew, contained a glider caution in the approach briefing section, but the SIDs and STARs did not have a glider caution. Following the accident, the Hawker's operator contacted Jeppesen and requested that a similar caution advisory, as found on the NOS SIDs and STARs, be placed on the Jeppesen charts. Jeppesen has since added the caution advisory to its RNO SIDs and STARs.

[18] The article, "Choosing, Installing, and Using a Transponder," was originally published in two issues of *Soaring* magazine in February and March 2002 and was updated December 2004 and made available on the SSF Web site at <http://www.soaringsafety.org/prevention/transponders.pdf>.

However, gliders typically have limited space to accommodate transponder equipment and the additional batteries needed to power it.

The Safety Board recognizes that glider design issues present unique challenges for transponder retrofit installations and that some glider operators have voiced concerns about a lack of transponder installation guidance. The SSF article noted that some gliders do not have room to carry additional batteries and that glider fuselage designs and trailering, rigging, towing, and landing considerations have limited the locations where owners can feasibly mount transponder antennas. The Board notes that, in the past, the FAA has published guidance to help aircraft owners understand their options for approved installations of retrofit equipment to ensure that such retrofits meet airworthiness regulations. The Safety Board concludes that a policy statement for transponder installation in gliders would help facilitate timely and effective transponder retrofits. Therefore, the Safety Board believes that the FAA should develop guidance material for glider owners/operators that describes feasible installation options to aid in the prompt installation and approval of transponders in gliders.

**National Transponder Code to Identify Gliders and Minimize Battery Draw**

As mentioned previously, glider transponders require battery power. Many glider operators have reported having sufficient battery power to operate their transponders and other instruments/avionics[19] during a 5- to 6-hour flight. However, during cross-country flights, which can last twice that time, transponders and other equipment can drain the installed batteries before the end of the flight. In fact, the glider pilot involved in the collision had turned off his transponder because he wanted to conserve battery power for radio use.

Battery power issues are of such concern for gliders that, on November 5, 2003, the SSA submitted a petition[20] to the FAA requesting that pilots of transponder-equipped gliders be allowed to turn the transponders off when flying more than 40 nm from the primary airport in Class B airspace and more than 20 nm from the primary airport in Class C airspace.[21] On January 22, 2008, the FAA responded and denied the SSA's request but stated that an ongoing rulemaking project proposes revisions to 14 CFR 91.215(c) that will cover the relief that the SSA's petition sought. Although the Safety Board recognizes that gliders have electrical power limitations, the Board is opposed to any rulemaking action that would enable such exemptions because aircraft would remain at risk for a midair collision. The Board notes that this midair collision took place more than 40 nm from RNO, a Class C airport, and rulemaking exemptions could allow the circumstances of this accident to be repeated.

Currently, all transponder-equipped aircraft, including gliders, operating under VFR use the transponder code 1200 unless otherwise instructed by ATC. According to transponder manufacturers, the battery draw from a transponder varies, depending on the number of

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[19] Many gliders are equipped with a radio, variometer, and global positioning system, which all require battery power.

[20] The letter was open for public comments in FAA docket No. FAA-2003-16475.

[21] Class B and Class C airspace consists of specified airspace containing at least one primary airport around which the airspace is designated. All aircraft operations within Class B and C airspace are subject to certain operating rules and equipment requirements, including ATC transponder equipment requirements.

interrogations it receives (either from a ground-based unit or from a TCAS) and on the code tuned on the unit. The lower the transponder code, the lower the battery draw per interrogation. Some glider communities, including those in the vicinity of RNO, have worked to secure a letter of authorization with their local ATC facilities that establishes a local glider transponder code to notify controllers of glider activity in their area. For example, glider operations in the vicinity of RNO can use the transponder code 0440.

In 2001, the SSA requested that the FAA provide a single, national transponder code for gliders so that ATC personnel could readily differentiate gliders from other aircraft appearing on their displays. This would enable ATC personnel to consider the limited flight options of these nonpowered aircraft when providing separation and advisory information to other pilots. For example, in an August 2007 ASRS report, a captain of a Boeing 737-300 reported that, while the captain's flight was at 14,000 feet msl 25 nm southwest of RNO, a controller advised that traffic with a transponder was showing at or near the flight's altitude.[22] The captain did not see the traffic but noted that the TCAS unit provided an RA to descend, and the captain did so; however, the TCAS then "quickly commanded ['climb, climb now']," and the captain initiated a maximum-power climb with a course deviation to the west. The captain reported then seeing a glider pass off the right side of the airplane, about 200 feet away and coming head-on. The captain reported that, because the glider was climbing and descending, the TCAS reversed its initial RA and that the captain had to respond with "aggressive" maneuvers.

Although this ASRS report did not provide any information about whether the controller knew or advised that the traffic was a glider or provided any advisories on its altitude or flightpath variations, the report further illustrates that both flight crews and ATC personnel could benefit from the ability to readily identify glider transponder returns and understand the limitations and variable flightpaths that may be associated with them. Therefore, the Safety Board supports the SSA's request for the establishment of a unique national transponder code for gliders. Further, because of the battery power limitations of gliders, the Safety Board concludes that a glider-specific transponder code that is low in the transponder code range could reduce battery draw, which would increase the feasibility of using transponders in gliders. Therefore, the Safety Board believes that the FAA should establish a national transponder code for glider operations, as low in the transponder code range as feasible, that would notify air traffic controllers of glider operation/position. Also, to ensure the maximum possible safety benefit of this unique code, the Safety Board concludes that ATC personnel must be adequately informed of the code, what it represents, and under what limitations the users are typically operating. Therefore, the Safety Board believes that, upon establishment of a national transponder code for glider operations, the FAA should ensure that ATC personnel are informed of the code, what it represents, and under what limitations the users are typically operating.

[22] The report did not provide any information as to whether the traffic was using a unique transponder code, was in radio communication with ATC, or was known to ATC personnel to be a glider.

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

> Remove the glider exemptions from the Federal Aviation Regulations that pertain to transponder requirements and use. (A-08-10)
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> Develop guidance material for glider owners/operators that describes feasible installation options to aid in the prompt installation and approval of transponders in gliders. (A-08-11)
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> Establish a national transponder code for glider operations, as low in the transponder code range as feasible, that would notify air traffic controllers of glider operation/position. (A-08-12)
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> Upon establishment of a national transponder code for glider operations, as per Safety Recommendation A-08-12, ensure that air traffic control personnel are informed of the code, what it represents, and under what limitations the users are typically operating. (A-08-13)

The Safety Board also issued safety recommendations to the SSA. In your response to this letter, please refer to Safety Recommendations A-08-10 through -13. If you need additional information, you may call (202) 314-6177.

Chairman ROSENKER, Vice Chairman SUMWALT, and Members HERSMAN, HIGGINS, and CHEALANDER concurred with these recommendations.

*[Original Signed]*

By: Mark Rosenker
Chairman