National Transportation Safety Board
Aviation Accident Final Report

Location:	Smith, NV	**Accident Number:**	LAX06FA277A
Date & Time:	08/28/2006, 1506 PDT	**Registration:**	N879QS
Aircraft:	Raytheon Hawker 800XP	**Aircraft Damage:**	Substantial
Defining Event:		**Injuries:**	2 Minor, 3 None
Flight Conducted Under:	Part 91 Subpart K: Fractional		

Analysis

The Hawker and the glider collided in flight at an altitude of about 16,000 feet above mean sea level about 42 nautical miles south-southeast of the Reno/Tahoe International Airport (RNO), Reno, Nevada, which was the Hawker's destination. The collision occurred in visual meteorological conditions 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.

Before the collision, the Hawker had been descending toward RNO on a stable northwest heading for several miles, and the glider was in a 30-degree, 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 was able to land 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 each aircraft may have been within 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 instrument flight rules, 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 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.

Although the Hawker was equipped with a traffic alert and collision avoidance system (TCAS)-II capable of generating vertical resolution (collision avoidance) advisories (RA), the glider's Mode C transponder was turned off (and, therefore, not detectable by the Hawker's equipment) because the glider pilot wanted to reserve battery power for radio use. Although transponder installation is not required on gliders, FARs require that any person operating a transponder-equipped aircraft must use the transponder. 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 would have generated an RA to alert the crewmembers and prompt them to deviate their course in time to prevent the accident. 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. In a 30-day interval before the accident, the facility recorded four such TCAS RA events reported by pilots. Each event involved a conflict with transport-category airplane operated under 14 CFR Part 121 and a glider.

In addition to the TCAS benefits, the accident glider's Mode C transponder, if turned on, would have provided position and altitude information to air traffic control (ATC) personnel who could have used that information to provide separation services and traffic advisories to the Hawker crew. 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. Review of the Aviation Safety Reporting System (ASRS) database revealed that, since 1988, there have been more reports of near midair collisions (NMACs) involving air carrier/corporate jet traffic and gliders in the vicinity of RNO than any other airport area. Because ASRS reports are voluntary, it is possible that other NMAC events occurred but were unreported.

The Federal Aviation Administration (FAA) has long been aware of the potential for a collision involving a glider and air carrier traffic in the vicinity of RNO. More than 10 years before this accident, Reno Flight Standards District Office (FSDO) personnel concluded that, on the basis of many NMAC reports, FAA inspectors' observations of traffic conflicts, and other information, the increasing glider operations in the departure and arrival areas around RNO represented an "extremely dangerous situation," especially because many gliders were not equipped with transponders, were difficult for air carrier flight crews to see, and were flown by pilots who were not communicating with ATC. On April 11, 1997, the Reno FSDO manager submitted a memorandum to the FAA's Office of Accident Investigation, Recommendation and Analysis Division that detailed these concerns and suggested a number of solutions, including mandatory transponder installation in gliders. In response to the concerns, the FAA published a notice to airmen cautioning pilots about glider soaring operations 30 to 50 miles south of RNO and took action that resulted in revisions to the San Francisco Sectional Aeronautical Chart and five of the RNO-published instrument procedures to include caution boxes to warn pilots of extensive glider activity. However, the FAA elected not to implement the transponder recommendation.

Probable Cause and Findings

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

Findings

Occurrence #1: MIDAIR COLLISION
Phase of Operation: DESCENT - NORMAL

Findings
1. (C) TRANSPONDER - NOT USED - PILOT OF OTHER AIRCRAFT

Factual Information

"THIS CASE WAS MODIFIED ON MARCH 5, 2008."

1.1 HISTORY OF FLIGHT

On August 28, 2006, at 1506 Pacific daylight time, a Raytheon Aircraft Company Hawker 800XP transport airplane, N879QS, and a Schleicher ASW27-18 glider, N7729, collided in midair about 10 miles west-northwest of Smith, Nevada. Both airplanes sustained substantial damage. The Hawker flight crew (both airline transport pilots) sustained minor injuries, while their three passengers were not injured. The glider pilot (a private pilot) received minor injuries. The Hawker 800XP was fractionally owned by different corporations and managed by NetJets Aviation, Inc., of Columbus, Ohio. Its flight was being conducted under the provisions of 14 CFR Part 91 Subpart K as an executive/corporate flight. The glider was registered to a private individual and was operated by the pilot under the provisions of 14 CFR Part 91 as a personal flight. An instrument flight rules flight plan was filed for the Hawker, which began its flight from Carlsbad, California, at 1400, and was destined for Reno, Nevada. No flight plan had been filed for the glider, which was on a local flight that had departed Minden, Nevada, at 1300. Visual meteorological conditions prevailed at the time of the collision.

1.1.1 Hawker 800XP Flight Crew Statements

According to interviews conducted by the NTSB investigator-in-charge (IIC), the flight crew indicated that they were cleared by air traffic control from 16,000 feet to 11,000 feet. The captain was the flying pilot and the first officer was working the radios. Oakland Air Route Traffic Control Center (ARTCC) transferred the flight to Reno approach control just prior to the collision. The first officer tuned in the Reno approach control radio frequency and looked out the right cockpit window. He then heard the captain shout and the audio tone for the autopilot, and noted that the captain had pushed the control yoke down and to the right. As he was turning his head to see what was going on, he observed the captain's side of the instrument panel "explode."

The captain reported that they were cleared to descend and as she looked outside she noted something out of the corner of her eye to the left. As she looked to the left, she noted a glider filling the windshield. She moved the control yoke down and to the right in an attempt to avoid hitting the glider.

The first officer and captain reported that the cockpit was noisy with wind after the collision, and the captain's headset had been knocked off. The first officer attempted to communicate with Reno controllers but had difficulty. The captain recovered the airplane as the first officer communicated to Reno that they had some sort of structural problem (he later learned that they had collided with a glider) and declared an emergency. The crew asked for vectors to the Reno airport as their instrument panel was severely damaged by the impact. As the flight progressed north, they spotted an airport and asked air traffic controllers if the RNO airport was at their 11 o'clock. The controllers responded by indicating that the airport was at their 11 o'clock at 20 miles. The crew continued to the airport they observed (Carson City, Nevada, CXP) and elected to land.

As the flight neared CXP, the flight crew noted that the right engine shut down as a result of the impact. The flight crew entered a left downwind for runway 9 and the landing gear would not extend normally. The flight crew overshot final for runway 9 due to the terrain limiting the

available length of the downwind leg and attempts to maintain an adequate airspeed to control the airplane. Then, they entered the downwind leg for runway 27. As the captain slowed the airplane for final approach she asked the first officer to assist in controlling the airplane's bank and pitch attitudes. The airplane touched down on the runway centerline, with the landing gear retracted, and came to rest uneventfully.

The airplane was equipped with a cockpit voice recorder (CVR), which recorded the captain and first officer's communications with air traffic control, and with one another, as they descended toward RNO. The last clearance received from Oakland ARTCC was for them to descend to flight level (FL) 220, then, at pilot discretion, maintain 16,000 feet. The captain and first officer then discussed the descent and/or approach, and at 1506:19, the CVR recorded a sound similar to a gasp on the captain's microphone followed by unusual electronic sounds. The recording ended at that point, at 1506:24.

1.1.2 Glider Pilot Statement

On the morning of the accident, the glider pilot received a flight review in a DG-505 glider and then flew his first flight in the accident glider. He started his second flight in the accident glider at 1300. He intended on thermal flying for about 5 hours and wanted to stay in the local area to familiarize himself with the accident glider. He flew around the local area and entered a thermal on the southwest side of Mt. Seagul. He entered a 30-degree left bank spiraling climb at 50 knots. During the climb, as the glider turned toward the south, the pilot saw a jet aircraft heading toward him. He estimated that one second passed between the time he noted the jet aircraft and the time they collided. He said he may have entered a slight nose down control input, but it wasn't enough to avoid the collision.

The Hawker jet impacted the right wing of the glider near the right outboard wing joint (the glider had a 4-piece wing with two inboard sections and two outboard sections). The glider entered a flat spin after the impact, so the pilot elected to remove the cockpit canopy and bail out. After removing the canopy, the pilot checked his ripcord location, unbuckled his restraint system, and bailed out of the glider. The pilot pulled the ripcord and the parachute successfully opened. During his descent, he observed the glider spiral to the ground below him and noted that the left wing and inboard section of the right wing remained attached to the fuselage. He landed uneventfully, but sustained minor injuries when the parachute dragged him along the ground. The pilot waited near his landing area for 1.5 hours before he began walking toward Carson Valley. After 2 hours and 10 minutes of walking along a dirt road, he was picked up by local authorities.

1.2 PERSONNEL INFORMATION

1.2.1 Hawker Flight Crew Information

The captain held an airline transport pilot certificate with a multi-engine airplane rating and type ratings in Cessna 500 and Hawker Siddeley HS-125 airplanes. She also held a commercial pilot certificate for single-engine airplanes. She was issued a first-class medical certificate on April 17, 2006, with no limitations. According to the Pilot/Operator Aircraft Accident Report (NTSB Form 6120.1/2) submitted by NetJets Aviation, Inc., the captain accumulated a total of 6,134 total flight hours, of which 1,564 hours were accrued in Hawker 800XP airplanes.

The captain was wearing sunglasses at the time of the event.

The first officer held an airline transport pilot certificate for multi-engine airplanes and type ratings in Beech 400, Hawker Siddeley HS-125, and Mitsubishi MU-300 airplanes. He also held a commercial pilot certificate for single-engine airplanes. He was issued a first-class medical certificate on May 16, 2006, with a limitation indicating he must wear corrective lenses. According to the 6120.1/2 Form, he accumulated 3,848 total flight hours, of which 548 hours were accrued in the Hawker 800XP.

The first officer was wearing corrective glasses, with sunshades clipped over the glasses, at the time of the event.

1.2.2 Glider Pilot Information

The glider pilot was a Japanese national, and had last flown in the Minden area in 2000. He held a private pilot certificate with a glider rating. He obtained the equivalent of a second-class medical certificate on June 20, 2006, from Japan's Civil Aeronautics Board; however, he did not hold a current FAA-issued medical certificate, nor was one required to act as pilot-in-command of a glider.

1.3 AIRCRAFT INFORMATION

1.3.1 Hawker 800XP Information

The Hawker 800XP was equipped with a Traffic Collision and Avoidance System (TCAS). TCAS is an airborne collision avoidance system based on radar beacon signals, which operates independent of ground-based equipment. TCAS-I generates traffic advisories only. TCAS-II generates traffic advisories, and resolution (collision avoidance) advisories (RA) in the vertical plane. For an aircraft equipped with TCAS to provide an RA, it must receive beacon information from the transponder installed on another local aircraft. The Hawker was equipped with the TCAS-II version, which would have provided a RA had it received a signal from another transponder.

1.3.2 Glider Information

The glider was equipped with a panel mounted communication radio, global positioning system (GPS) unit, a Cambridge 302, and a Mode C transponder; however, the pilot did not turn on the GPS and transponder. According to the glider pilot, he did not turn on the transponder because he was only intending on remaining in the local glider area, and because he wanted to reserve his batteries for radio use. The glider was equipped with two batteries (one main and one spare), however, due to the previous glider flights, the pilot was unsure of the remaining charge in the battery.

1.4 METEOROLOGICAL INFORMATION

At 1456, the weather observation facility located at RNO reported the following information: wind from 280 degrees at 11 knots with gusts to 17 knots, visibility 10 statute miles, a few clouds at 11,000 feet, temperature 34 degrees Celsius, dew point minus 04 degrees Celsius, and an altimeter setting of 30.01 inches of mercury.

1.5 COMMUNICATIONS

The Hawker 800XP was in radio communication with Oakland ARTCC and had just been handed off to the RNO Terminal Radar Approach Control (TRACON) facility when the collision occurred. The flight crew had not yet contacted the RNO TRACON prior to the collision. According to air traffic control personnel located within the RNO TRACON, they did not see

any primary radar returns in the vicinity of the Hawker on their radar screen prior to establishing contact with the Hawker and/or the collision.

1.6 AERODROME INFORMATION

According to the Reno TRACON personnel, when traffic is arriving and departing to the south, it is common for them to bring flights into RNO from the south, east of the 157 radial from Mustang VOR (very high omnidirectional range navigation facility). This provides room for departing aircraft over the Carson Valley (west of the 157 radial). The inbound flights to Reno are usually descended from 16,000 feet to 11,000 feet in the area of the collision.

According to the local glider operators, the area of the collision is very popular with gliders for the thermal lift provided by the Pine Nut Ridge (Mt. Seagul is located on the south side of the Pine Nut Ridge). The gliders can reach altitudes of 18,000 feet (FL 180) in that area. If they care to go higher than FL 180 in that area, they either need to have a transponder with mode C capabilities or activate a glider operation box that provides clearance from arriving traffic. According to the local glider pilots, this box is usually activated during wave flying conditions, and that during thermal flying the pilots stay below FL 180.

1.7 FLIGHT RECORDERS

The Hawker jet was equipped with a Universal CVR30B 30-minute solid-state CVR (serial number 257). The exterior of the CVR showed no signs of heat or impact damage. Information recovered from the CVR consisted of four tracks of unusable to good quality audio recordings. The first track contained no audio information. The second track contained audio information from the first officer's audio panel, and the third track contained audio information from the captain's audio panel. The fourth track contained audio information from the cockpit area microphone, but the background noise level for this track was too low for intelligibility. The CVR did not contain any recorded communications after the midair collision.

1.8 WRECKAGE AND IMPACT INFORMATION

Review of radar data provided by Reno TRACON personnel indicated that the collision likely occurred at 16,000 feet mean sea level (msl) at a latitude and longitude position of 38 degrees 50 minutes 41 seconds north and 119 degrees 29 minutes 50 seconds west. The collision took place about 42 nautical miles south-southeast of the RNO airport.

1.8.1 Hawker 800XP Damage

The Hawker sustained significant impact damage to its nose section. A section of the glider's wing spar remained imbedded in the nose structure, with the captain's side sustaining the most damage. The pressure bulkhead had been compromised by the impact. The captain's instrument panel was destroyed with the primary instrumentation being indiscernible. Examination of control continuity after the accident, with the glider spar in place, revealed that the elevator controls could not be pushed forward of a neutral position.

The right wing sustained leading edge damage that compromised the fuel tank. The left horizontal stabilizer's leading edge exhibited a large hole that extended aft to the mounting flange. The belly of the fuselage and inboard wings sustained scrape marks from landing with the gear retracted.

The left engine fan blades displayed nicks and cracks, and the lower cowling drain mass was broken. The right engine inlet area also sustained significant impact damage leaving a large

void into the cowling. The fan blades were cracked and broken. The tail pipe had fiberglass embedded in the duct and fuel was dripping from the lower cowling and fuel control unit.

The CVR was removed and sent to the NTSB's Vehicle Recorder Laboratory in Washington, D.C. The Honeywell Instrument Package (navigation, flight guidance and enhanced ground proximity warning systems - EGPWS) was removed and shipped to Honeywell's facility in Phoenix, Arizona, for further examination.

1.8.2 Glider Damage

As noted from the glider pilot's statement, the right wing separated just inboard of the outer wing joint. The glider also sustained damage during its impact with terrain.

1.9 SURVIVAL ASPECTS

During the post-accident examination of the Hawker jet, it was noted that the inboard attach points for the #5 and #7 seats were loose and the seatbelts were buckled. Interviews with the passengers revealed that one passenger was in seat #7, with his lap belt buckled, when the midair collision occurred. While the aircraft was in the traffic pattern at Carson City, the first officer informed the passengers that they were going to make a gear-up landing and everyone was to secure their seatbelts. The passenger in seat #7 tightened his lap belt and the inboard attachment end came out from between the seat cushions. He jumped up from seat #7 and sat down in seat #5 and buckled the lap belt. When he went to tighten that belt, the inboard attachment end came out from between the seat cushions. He then grabbed onto the attached portion of the seatbelt, leaned over in the prone position, and held on.

Examination of the belt's attach points revealed that the metal keepers for the hook were distorted, bent, and to some extent, expanded.

1.9 TESTS AND RESEARCH

On September 28, 2006, engineers at Honeywell's facility in Phoenix, Arizona, examined the EGPWS and found that no data had been recorded at the time of the impact with the glider. None of the other submitted instruments contained data on the accident flight.

1.10 ADDITIONAL INFORMATION

1.10.1 Transponder and Altitude Reporting Equipment Use

Transponder use is regulated by 14 CFR Part 91.215. According to that regulation, gliders are not required to have a Mode C transponder installed. However, the rule does stipulate that "...each person operating an aircraft equipped with an operable ATC transponder maintained in accordance with Sec. 91.413 of this part shall operate the transponder, including Mode C equipment, if installed..."

1.10.2 Local Soaring Procedures

There are three soaring groups near the RNO airport; Soar Minden operating out of the Minden-Tahoe Airport (MEV, 35 nautical miles south of RNO), Air Sailing operating out of the Reno/Stead Airport (4SD, 14 nautical miles north-northwest of RNO), and Soar Truckee operating out of the Truckee-Tahoe Airport (TRK, 23 nautical miles southwest of RNO). Each soaring group had published operating procedures that were issued to glider pilots belonging to their flying group or to renters of their gliders. Review of the published operating procedures revealed all included some information regarding transponders, transponder use,

and/or Near Mid Air Collision (NMAC) avoidance.

The Soar Minden operating procedures briefing material indicated under a section titled, Collision Avoidance, that "Recent and past near mid air collisions over the Carson Valley between gliders and Reno bound air carriers have prompted discussions between Reno FSDO, Reno Tower, and glider operators in Minden, Tahoe, and Pyramid Lake. Increased glider and power pilot awareness is the key to eliminating collisions in jointly used airspace." The briefing indicated that there are victor airways to/from RNO just east and west of the MEV airport. There is "large, fast commercial traffic" passing along the routes between "9,000 and 14,000 feet msl." The briefing suggested that pilots monitor the RNO approach control frequencies and to report glider position when they are above 11,000 feet and to look for fast moving traffic. The Soar Minden procedures briefing included a copy of a sectional chart with slash marks indicating "areas of increased potential midair" collisions from the surface to 18,000 feet msl.

The Air Sailing flying and field operations publications indicated that, "pilots should recognize that Air Sailing is located in proximity to Reno Airport approach paths" and that pilots should "become familiar with normal airline traffic patterns in the vicinity." The briefing material reviewed some of the more familiar air carrier routes, and "highly recommends" that gliders be equipped with transponders, and that the pilots use them.

The Soar Truckee standard operating procedures cited this accident and while they acknowledged that the Federal Aviation Regulations do not require gliders to be equipped with transponders, they indicated that, "most seasoned glider pilots are electing to install and fly with a transponder."

All of the RNO glider operation procedures indicated that glider pilots could utilize a transponder code of 0440 below 15,000 feet within 50 nautical miles of RNO. This transponder code came from an agreement between the local air traffic controllers and the local glider groups, and was intended to let controllers know that the aircraft squawking 0440 was a glider (relatively slow, not powered, and maneuvering).

When the accident glider pilot was interviewed following the accident, he indicated he was not aware of the jet routes into and out of RNO. He was not renting a glider from one of the three main glider groups in the area, and was instead borrowing the glider from a friend.

1.10.3 Previous Near Mid Air Collisions in the Reno Area

1.10.3.1 ATC Reports

The RNO TRACON personnel indicated that it is not uncommon for arriving and departing air traffic to obtain a TCAS warning from transponder-equipped gliders operating in the area. The facility keeps track of any Resolution Advisories (RA - as noted previously in this report, the TCAS-II systems provide collision avoidance advisories on the vertical plane; climb/descend instructions) that pilots receive from their TCAS equipment, as many of the pilots must deviate from an air traffic control clearance to comply with the RA. The TCAS RAs are only retained for 30-day-intervals, and the last 30 days worth of reports were provided to the NTSB (4 total). They all included airplanes conducting operations under 14 CFR Part 121. TRACON personnel also reported that they receive numerous VFR transponder codes and/or reports from transport category airplanes indicating that gliders are operating over the final approach course for RNO. In addition, the controllers can sometimes see primary radar returns from a suspected glider, but are not able to ascertain its altitude and if it is a glider.

A number of the RNO TRACON personnel indicated that they were not surprised that a midair collision had occurred between a transport category airplane and a glider, and that it was just a matter of time before it happened.

1.10.3.2 Previous FAA Recommendation

On April 11, 1997, the Federal Aviation Administration's (FAA) Reno Flight Standards District Office (FSDO) wrote a memorandum to the FAA's Office of Accident Investigation, Recommendation, and Quality Assurance Division (AAI-200). The subject of the memorandum was Safety Recommendation for the Reno, Nevada Airspace and Radar Coverage. According to the memo, the recommendation was pursuant to "many reports or Near Mid Air Collision reports, reports of TCAS RA's and FAA inspectors' observations of traffic conflicts." The memo added that, "There is an extreme aviation safety concern in the Reno, Nevada area."

The memo indicated that glider activity was increasing in the Reno area and they were operating on the departure and arrival path to RNO. The memo added that, "This is an extremely dangerous situation and may lead to an aviation disaster. These 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 continued by stating, "The office has an ongoing program to try and educate the glider community and the air carriers; 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 FSDO memo then offered a number of solutions to the problem, which included the following:

1.) Install a second radar site to look down into the Carson City and Minden valley, and a remote communications outlet (RCO) so the aircraft on the ground in Carson City and Minden can communicate with RNO approach control.

2.) Design airspace to prohibit glider activity in the arrival and departure areas.

3.) Require gliders to carry transponders with appropriate mode for air traffic and TCAS.

4.) Require gliders to communicate with RNO approach control and report their position every 5 minutes.

On January 29, 1998, the FAA's Planning, Information, and Analysis Division (ATX-400) wrote a memorandum to AAI-200 indicating that they would continue their efforts to secure funding to support the installation of a second radar site and a RCO, but they did not plan any further action. At the time of this report's writing, neither the secondary radar site nor the

RCO have been installed.

With regards to designing airspace to prohibit glider activity in the arrival and departure areas, the response indicated that RNO did not meet the enplanements requirement to qualify for Class B airspace establishment. In order to "immediately address the glider activity in Carson City/Minden, a Notice to Airmen (NOTAM) was published, cautioning pilots about glider soaring operations 30 to 50 miles south of RNO. In addition, a charting request was made to publish the San Francisco Sectional Aeronautical Chart and 5 of the RNO published instrument procedures with 'caution boxes' to warn pilots of extensive glider activity." Those changes were in effect at the time of the accident.

In a memo dated December 29, 1997, the FAA's Director of Flight Standards Service (AFS-1) indicated that with regards to glider operators utilizing transponders, and requiring communications with RNO Approach Control, the FAA was "not aware of any reports of similar incidents occurring at other locations around the country." They continued by indicating that they believed "this singular incident does not justify implementation of these recommendations."

1.10.3.3 Air Sailing News Article

The September 2006 edition of Air Sailing News (Reno, Nevada) included an article titled "Way Too Close", which was written by a glider pilot. The editor's note for that article indicated that it was written/submitted prior to this midair accident. In that article, the writer explained a NMAC he experienced while operating his glider in the RNO area. At the time of that NMAC, the pilot's glider was not equipped with a transponder, and he was not speaking with air traffic control, though he was listening to the radio communications. The author of the article now utilizes a transponder and indicated that he has a "typical Power-Sonic battery pack, and it powers the radio, transponder, encoder, and electric variometer just fine. There is plenty of [battery power] left, even after four hours and more of flying."

1.10.4 Other NMAC Reports Between Jet Traffic and Gliders

The National Aeronautics and Space Agency (NASA) maintains the Aviation Safety Reporting System (ASRS) to collect, analyze, and respond to voluntarily submitted aviation safety incident reports in order to lessen the likelihood of aviation accidents. ASRS data are used to identify deficiencies and discrepancies in the National Aviation System (NAS), support policy formulation and planning for, and improvements to, the NAS, and strengthen the foundation of aviation human factors safety research.

Review of the ASRS database revealed that, since 1988, there were 56 reports of NMACs between air carrier/corporate jet traffic and gliders. Of the 56 reports, 8 focused on the airspace around RNO.

The 56 reports cited above did not include hang-gliders. Most of the reports indicated that the glider traffic was not visible on the jet traffics' TCAS equipment and was not visible on air traffic control's radar screen. Some of the reports indicated that once the glider traffic was reported to air traffic controllers, the controllers would report seeing primary radar returns in the vicinity of the jet traffic, and in some instances, the controllers had called out primary radar returns to the jet traffic, but informed the pilots that they did not know what the traffic was or at which altitude it was flying. Some crews also reported that the slim design of the gliders and the relative speed between the two aircraft made them very difficult to see.

Following the Reno area, the next airport area with the most NMAC reports was near the Chicago Midway International Airport in Chicago, Illinois, with 4 reports, followed by Colorado Springs, Colorado, with 3 reports. The Washington, DC area also had 4 NMAC reports filed.

In August 2006, a pilot of a Cessna 560 airplane reported a NMAC. According to the ASRS report, the airplane was climbing on a 240-degree heading at 280 knots on standard instrument departure from the Boulder Jefferson County Airport when one of the pilots saw a glider at their same altitude (16,000 feet msl) flying approximately the same heading. The ASRS report indicated that the airplane passed the glider in about 2 seconds time and was about 100 yards off the Cessna 560's right wing. The flight crew of the Cessna 560 reported the near miss to the departure control facility, but they reported that they did not have any radar or radio contact with the glider. The ASRS report indicated that they were outside of Class A, B, and C airspace at the time of the near miss.

1.10.5 Previous Accident Prevention Efforts

1.10.5.1 RNO TRACON Efforts

The RNO TRACON facility employed a controller who was also a glider pilot. According to the TRACON facility manager, they would often send the controller to the various glider groups located around RNO and brief them on the arrival and departure traffic at RNO and how this conflicted with some of the glider activity. A pilot advisory was developed that denoted arrival and departure traffic routes into and out of RNO via color-coded arrows. The advisory also noted minimum crossing altitudes for various intersections, and provided two warning areas where the "most frequent near mid air reports occur." These warning areas had recommendations associated with them indicating that, if gliders were above a certain altitude, they should be utilizing transponders. In addition, the advisory suggested that pilots monitor the RNO approach control frequencies.

1.10.5.2 Soaring Society of America News Flyer

The Soaring Society of America (SSA), through its Pacific Soaring Council (PASCO), published a seasonal newsletter that was disseminated to glider pilots throughout the area. All of the newsletters have included a message regarding transponders since January 1998. The message reads as follows:

"The potential conflict between gliders and commercial air traffic near Reno has increased with the growth of commercial jet traffic into Reno-Tahoe Airport (RNO) during the past few years. PASCO emphasizes that glider pilots operating in the Reno area must be alert for all air traffic arriving and departing RNO.

Transponder signals are received by Traffic Collision Avoidance Systems (TCAS) on board commercial aircraft as well as by Air Traffic Control (ATC) Radar. By ATC Letter of Agreement, gliders in the Reno area can transmit the 0440 transponder code in the blind, without establishing radio contact with Reno Approach Control.

PASCO recommends that gliders operating cross country, within 50 NM of Reno-Tahoe Airport, install and use a Mode C altitude encoding transponder."

In addition, the Soaring Society of America published a two-part article in the February and March 2002 issues of Soaring Magazine regarding transponders and their use in gliders. The

article was updated in December 2004, and was published on the Soaring Society of America's Soaring Safety Foundation website. That transponder article discussed the problems associated with a flight crew's ability to see and avoid a glider in flight, such as the sleek design of gliders, the relative speed difference between the aircraft, and the lack of transponders on gliders. The article informed glider pilots that transponders made their aircraft visible to both ATC radar screens and TCAS systems.

The article also discussed a number of other issues associated with transponders, such as transponder size and weight, installation concerns, maintenance, and battery power.

1.10.6 SSA Transponder Code and Transponder Use Exemption Request

In 2001, the SSA requested that the FAA dedicate a national transponder code for glider operations. By utilizing a national code, the SSA believed that the air traffic controllers would be trained to recognize the code belonged to a glider, and therefore would understand that the aircraft would have non-powered aircraft limitations and as a result would be restricted as to what they could and could not do. As of this report's writing that request has not been codified.

In 2004, the SSA also submitted a petition to the FAA requesting that glider pilots be allowed to operate transponder-equipped gliders with the transponders turned off, when the glider is being operated more than 40 nautical miles from the primary airport in Class B airspace and more than 20 nautical miles from the primary airport in Class C airspace. The reasoning provided was the lack of battery power for exceptionally long flights. As of this report's writing that request has not been answered. It should be noted that this midair collision took place beyond the 20 nautical miles from the primary Class C airport (RNO).

1.10.7 Post-Accident Efforts

1.10.7.1 Traffic Briefing for Glider Pilots and Cockpit Card

Following the accident, the NTSB IIC, RNO TRACON personnel, and glider pilots met to discuss potential solutions to the NMAC problems found around the RNO airport. As a result of that meeting, 4 working groups were established between the RNO TRACON personnel and the local glider pilots to establish interim policies and procedures for their area of operation. Through the cooperative efforts of the air traffic controllers and the local glider groups, a glider briefing document has been finalized and released to the local glider groups. The new briefing document outlines policies and procedures that the controllers and pilot groups (both powered and non-powered) have established to ensure safety for all aircraft operating around RNO and to improve communications between glider pilots and air traffic control. In addition to the briefing document, the glider community developed a cockpit card for glider pilots, which delineates the arriving and departing jet traffic, ATC-identified intersections and their minimum altitudes, and radio communication procedures.

1.10.7.2 Seat Belt Mandatory Service Bulletin

On September 8, 2006, NetJets Aviation, Inc., issued a Maintenance Information Bulletin (MIB) calling for the inspection of their Hawker 800XP fleet for unattached lapbelts.

In October 2006, Raytheon Aircraft Company issued a Safety Communique to all owners and operators, Raytheon Aviation Centers, Chief Pilots, Directors of Operations, Directors of Maintenance, all Raytheon Aircraft Authorized Service Centers, and international distributors and dealers, regarding the inspection and maintenance of lap belts for all Hawker Series 800, 800XP, 850XP, and 1000 airplanes.

In February 2007, Raytheon Aircraft Company issued a Mandatory Service Bulletin calling for the inspection of the lap belt attachments and modification of the lap belt attach shackles.

Raytheon Aircraft Company also updated their 300-hour inspection to specifically include the passenger seat safety belts, and to "check seat belt attachment hook and safety clip for distortion and security."

1.10.8 Limitations to See-and-Avoid Principle

The Federal Aviation Regulations require that "when weather conditions permit, pilots operating under instrument flight rules (IFR) or visual flight rules (VFR) are required to observe and maneuver to avoid other aircraft." This concept is commonly referred to as the see-and-avoid principle.

In April 1991, the Australian Transport Safety Bureau (ATSB) issued a research report on the Limitations to the See-and-Avoid Principle. The ATSB reprinted the report in November 2004. In that report the ATSB referenced studies conducted throughout the aviation industry (both civilian and military) and cited reports issued by the Federal Aviation Administration (FAA). The research report indicated that there were numerous limitations to the see-and-avoid principle, including those of the human visual system, the demands of cockpit tasks, and various physical and environmental conditions. These limitations combine to make see-and-avoid an uncertain method of traffic separation. Though it was acknowledged that the see-and-avoid principle undoubtedly prevented many collisions, the concept was a flawed and unreliable method of collision avoidance.

The report also indicated that there was considerable data available that was against the reliance on see-and-avoid. Although see-and-avoid was often effective at low closing speeds, it usually failed to avert collisions at higher speeds. It was estimated that see-and-avoid prevents 97 percent of possible collisions at closing speeds of between 101 and 199 knots but only 47 percent when the closing speed is greater than 400 knots. In addition, the human visual system is better at detecting moving targets than stationary targets, yet in most cases, an aircraft on a collision course appears as a stationary target in the pilot's visual field. An approaching aircraft, in many cases, presents a very small visual angle until a short time before impact. In addition, complex backgrounds such as ground features or clouds hamper the identification of aircraft via a visual effect known as 'contour interaction'. This occurs when background contours interact with the form of the aircraft, producing a less distinct image. The report continued by indicating that even when an approaching aircraft has been sighted, there is no guarantee that evasive action will be successful, as it takes a significant amount of time to recognize and respond to a collision threat.

A FAA study concluded that although see-and-avoid was usually effective, the residual collision risk was unacceptable. The FAA, having recognized the limitations of the concept, has turned to other methods such as TCAS to ensure traffic separation. The ATSB concluded in its report that because of its many limitations, the see-and-avoid concept should not be expected to fulfill a significant role in future air traffic systems.

This report was modified on November 16, 2007.

Pilot Information

Certificate:	Airline Transport; Commercial	**Age:**	38, Female
Airplane Rating(s):	Multi-engine Land; Single-engine Land	**Seat Occupied:**	Left
Other Aircraft Rating(s):	None	**Restraint Used:**	Seatbelt, Shoulder harness
Instrument Rating(s):	Airplane	**Second Pilot Present:**	Yes
Instructor Rating(s):	Airplane Multi-engine; Airplane Single-engine; Instrument Airplane	**Toxicology Performed:**	Yes
Medical Certification:	Class 1 Without Waivers/Limitations	**Last Medical Exam:**	04/01/2006
Occupational Pilot:	Yes	**Last Flight Review or Equivalent:**	04/01/2006
Flight Time:	6134 hours (Total, all aircraft), 1564 hours (Total, this make and model)		

Co-Pilot Information

Certificate:	Airline Transport; Commercial	**Age:**	35, Male
Airplane Rating(s):	Multi-engine Land; Single-engine Land	**Seat Occupied:**	Right
Other Aircraft Rating(s):	None	**Restraint Used:**	Seatbelt, Shoulder harness
Instrument Rating(s):	Airplane	**Second Pilot Present:**	Yes
Instructor Rating(s):	Airplane Multi-engine; Airplane Single-engine; Instrument Airplane	**Toxicology Performed:**	Yes
Medical Certification:	Class 1 With Waivers/Limitations	**Last Medical Exam:**	05/01/2006
Occupational Pilot:	Yes	**Last Flight Review or Equivalent:**	02/01/2006
Flight Time:	3848 hours (Total, all aircraft), 548 hours (Total, this make and model)		

Aircraft and Owner/Operator Information

Aircraft Manufacturer:	Raytheon	**Registration:**	N879QS
Model/Series:	Hawker 800XP	**Aircraft Category:**	Airplane
Year of Manufacture:		**Amateur Built:**	No
Airworthiness Certificate:	Transport	**Serial Number:**	258379
Landing Gear Type:	Retractable - Tricycle	**Seats:**	10
Date/Type of Last Inspection:	08/01/2006, AAIP	**Certified Max Gross Wt.:**	28120 lbs
Time Since Last Inspection:		**Engines:**	2 Turbo Fan
Airframe Total Time:	6727 Hours	**Engine Manufacturer:**	Garrett
ELT:	Installed, not activated	**Engine Model/Series:**	TFE 731
Registered Owner:	c/o NetJets Sales Inc.	**Rated Power:**	4750 lbs
Operator:	NetJets Aviation, Inc. (as Program Manager)	**Air Carrier Operating Certificate:**	On-demand Air Taxi (135)
Operator Does Business As:		**Operator Designator Code:**	DXTR

Meteorological Information and Flight Plan

Conditions at Accident Site:	Visual Conditions	**Condition of Light:**	Day
Observation Facility, Elevation:	RNO, 4415 ft msl	**Observation Time:**	1456 PDT
Distance from Accident Site:	46 Nautical Miles	**Direction from Accident Site:**	330°
Lowest Cloud Condition:	Few / 11000 ft agl	**Temperature/Dew Point:**	34°C / -4°C
Lowest Ceiling:	None	**Visibility**	20 Miles
Wind Speed/Gusts, Direction:	11 knots/ 17 knots, 280°	**Visibility (RVR):**	
Altimeter Setting:	30.01 inches Hg	**Visibility (RVV):**	
Precipitation and Obscuration:	No Obscuration; No Precipitation		
Departure Point:	Carlsbad, CA (CRQ)	**Type of Flight Plan Filed:**	IFR
Destination:	Reno, NV (RNO)	**Type of Clearance:**	IFR
Departure Time:	1400 PDT	**Type of Airspace:**	Class E

Wreckage and Impact Information

Crew Injuries:	2 Minor	**Aircraft Damage:**	Substantial
Passenger Injuries:	3 None	**Aircraft Fire:**	None
Ground Injuries:	N/A	**Aircraft Explosion:**	None
Total Injuries:	2 Minor, 3 None	**Latitude, Longitude:**	38.844722, -119.497222

Administrative Information

Investigator In Charge (IIC):	Nicole L Charnon	**Adopted Date:**	03/20/2008
Additional Participating Persons:	Larry Cheek; WP-FSDO-Reno, NV; Reno, NV Eric West; Federal Aviation Administration; Washington, DC Michael J Gibbons; Raytheon Aircraft Company; Wichita, KS David Hewitt; NetJets, Inc.; Columbus, OH Sandra O'Seen; IBT 1108/Hawker ERT; Columbus, OH Scott Dunham; NTSB; Washington, DC Joeseph Gregor; NTSB; Washington, DC		
Publish Date:	05/21/2013		
Investigation Docket:	NTSB accident and incident dockets serve as permanent archival information for the NTSB's investigations. Dockets released prior to June 1, 2009 are publicly available from the NTSB's Record Management Division at pubinq@ntsb.gov, or at 800-877-6799. Dockets released after this date are available at http://dms.ntsb.gov/pubdms/.		