FLIGHT SAFETY FOUNDATION
Accident Prevention
Vol. 49 No. 3 *For Everyone Concerned with the Safety of Flight* March 1992

Midair Collision — The Links in a Chain

When the pilot of a chartered fixed-wing airplane accepted the offer of a helicopter pilot to fly beneath his aircraft and check his landing gear, the scene was set for disaster.

by
John A. Pope
Aviation Consultant

Fatal midair collisions are always tragic, but when one involves a well-known person, there usually is more focus on it ("News Media Becomes Friend and Foe in Accident Reporting," February 1992 *Flight Safety Digest)*. Such is the case with the midair collision that involved a chartered Piper PA-60 Aerostar and a Bell Helicopter 412SP, April 4, 1991, at Merion, Pennsylvania, U.S. Seven fatalities resulted from the crash — two crew members on each aircraft, one passenger on the Aerostar and two persons on the ground. The passenger aboard the Aerostar was John Heinz, a U.S. senator, and a member of the family associated with the H. J. Heinz food company.

As is its practice when accidents involving non-air carriers arouse public concern and interest, the U.S. National Transportation Safety Board (NTSB) conducted an in-depth accident investigation, and published the results of its findings in a summary report: *NTSB/AAR-991/01/SUM*. In addition to that report, the board allowed public access to its *Operations Group Chairman's Factual Report* that, in some cases, contains more detail than the summary report.

During an analysis of the accident sequence, the familiar "chain of events" pattern emerges very plainly. If any link in that chain had been broken, this midair collision might not have occurred. Considered separately, each link had its own interesting facet that bears further thought and examination for accident prevention purposes.

Offer of Assistance Ends in Midair Collision

On the day of the accident, a Lycoming Air Services Inc. Piper Aerostar was operated as an on-demand air taxi flight under U.S. Federal Aviation Regulations (FARs) Part 135 (Air Taxi Operators and Commercial Operators) and had departed from Williamsport, Pa., at approximately 1022 hours for Philadelphia International Airport (PHL), Philadelphia, Pa. There were a captain, first officer and Sen. Heinz on board.

The en route portion of the flight was uneventful, but at 1201:28 during an instrument landing system (ILS) approach to runway 17 at PHL in visual meteorological conditions (VMC), the captain reported to the control tower that the nose landing gear down light had not illuminated to indicate that the nose gear was in the down and locked position. The captain, who was making the Aerostar radio transmissions, advised that he might need to cycle the landing gear.

Shortly before the Aerostar began its approach, a Bell 412SP helicopter, operated by the Sun Co. Aviation Department under Federal Aviation Regulations Part 91 (General Operating and Flight Rules), departed the company's he-

licopter landing pad at PHL on a visual flight rules (VFR) flight plan for Radnor, Pa. A captain and first officer comprised the crew. As the helicopter departed the PHL terminal control area (TCA), the pilots heard the Aerostar communications regarding the possible unsafe nose gear indication. The helicopter captain offered to approach the Aerostar and visually inspect the nose gear.

The tower controller told the Aerostar pilot to maintain l,500 feet to allow the Bell 412 to pass underneath as the helicopter departed the area. One of the helicopter pilots reported to the tower, "That Aerostar that went past us, looks like the gear is down."

The captain of the Aerostar acknowledged that he heard the transmission and said, "I can tell it's down but I don't know if it's locked. That's the only problem." (A reflection of the nose landing gear on the propeller spinner can be seen from the Aerostar cockpit.). The tower controller acknowledged the transmission and cleared the Aerostar to land on runway 17.

… the Bell 412 advised the tower that they "could take a real close look at that if you wanted," … .

After diverting other arrivals on runway 17 and clearing the frequency, the tower controller decided that the situation justified declaring an emergency. The airport's aircraft rescue and fire fighting units were alerted by the tower supervisor. The tower controller then offered the Aerostar pilot the option of making a low-altitude pass by the tower so that tower personnel could observe the position of the nose gear. Within 37 seconds, the Bell 412 crew advised the tower that they "could take a real close look at that if you wanted," and turned back to the airport.

As the Aerostar passed by the control tower, the controller advised that the nose gear appeared to be down. The captain responded that he could see the nose gear in the reflection of the propeller spinner and that it appeared to be down but the panel indicator light was not green. The Aerostar was requested to make a left turn and enter a downwind leg for runway 17 and advised that the Bell 412 was then inbound from the north and could take a look at the nose gear. The Aerostar captain said, "Okay, I appreciate it."

The offer by the helicopter crew to be of assistance was in keeping with the Sun Co.'s "good neighbor" policy in the event of emergency situations. However, the company's chief pilot stated that he was not aware of any previous in-flight inspections of other aircraft by the pilots aboard the Bell 412 or by other company pilots.

At 1205:45 hours, the tower controller provided directional information to the Bell 412 to assist in visually locating the Aerostar. By 1207:45, the pilots of each aircraft acknowledged that they had each other in sight. They agreed that a speed of 125 knots would be used during a join-up during which the helicopter would fly closely enough to the Aerostar to check the gear position. At that time, both aircraft were on an extended downwind leg for runway 17 at an altitude of approximately 1,100 feet. The controller advised the Aerostar pilot of antenna towers six miles ahead; he requested that the pilot notify the tower when he wanted to turn back toward the airport or to make a heading change.

At 1208:21, the Bell 412 first officer contacted the Aerostar pilot on the tower frequency and requested that the Aerostar slow down. At 1208:52, the helicopter pilot stated that "We're going to come up behind you on your left side so just hold your heading."

The Aerostar captain responded that the antenna towers were straight ahead and that he might need to change heading by 15 degrees to the left.

At 1209:30, the Bell 412 stated, "Aerostar, we're gonna pass around your right side now, take a look at everything as we go by."

The Aerostar responded with, "Okay." Once again, the Aerostar captain stated that the indicator for the nose gear did not show down and locked.

At 1210:16, the Bell 412 pilot reported, "Everything looks good from here."

The Aerostar replied, "Okay, appreciate that. We'll start to turn in." These transmissions were the last ones received from either aircraft. The last transmission was abruptly terminated by considerable noise. Subsequent attempts by the controller to contact either aircraft were unsuccessful.

Eyewitnesses stated that they first noticed the two aircraft because of the relatively loud noise from the helicopter engines and rotor blades. When they saw how close together the two aircraft were flying, the witnesses continued to watch them. Most of the witnesses reported that before the collision, the aircraft were flying straight and level and that their flight paths were parallel. Although many witnesses saw the aircraft collide, reports about the movements of the aircraft just before the collision varied considerably.

There was general agreement that before the collision the helicopter was below and right of the airplane. Several witnesses reported that the airplane veered to the right

and struck the helicopter. Others reported that the helicopter climbed and collided with the airplane. Most of the witnesses said the first impact was the rotor of the helicopter striking the underside of the airplane.

The Aerostar came to rest in the front yard of the Merion Elementary School and the helicopter came to rest just behind the school building. Crew members of both aircraft and the Aerostar passenger were fatally injured. Two persons on the ground at the rear of the school were fatally injured by debris. The NTSB pinpointed the time of the accident at 1210:20. Weather was not considered a factor and was reported to be 25,000 feet scattered, visibility 10 miles and winds 240 degrees at 10 knots with gusts to 15 knots.

NTSB Faults Both Captains

Among the NTSB conclusions were:

1. There were no pre-existing defects to either aircraft that contributed to the accident. The NTSB could not determine the functional status of the nose gear down indicating light on the Aerostar prior to the collision.

2. The NTSB found deficiencies in the training program of Lycoming Air Services Inc. and in the flight crew checking procedures of the FAA Principal Operations Inspector (POI) assigned to the operator.

3. The emergency procedures section of the Aerostar (Piper PA-60) flight manual does not contain sufficient information on the actions to take if the nose landing gear down indicating light fails to illuminate.

4. The captain of the Aerostar could see from the reflection of the nose landing gear in the propeller spinners that the nose landing gear was fully extended and that the gear doors had closed over the wheel well area. Therefore, there was no additional information that could be gained by flying past the tower or from an inflight inspection.

5. None of the flight crew members of the two aircraft had experience flying in close proximity to another aircraft.

6. The Aerostar captain, after accepting the offer of the inflight inspection, did not coordinate the maneuvering procedures to be used with the flight crew of the helicopter to ensure the safety of his aircraft.

7. The Bell 412 was maneuvered into a position where it could not be seen by the Aerostar crew.

8. The flight crew of the Bell 412 should have terminated the inspection after they saw that the nose landing gear locking mechanism was concealed in the wheel well.

9. The final movements of both aircraft that led to the midair collision could not be determined, but the pilots of the Bell 412 had the responsibility for maintaining safe separation from the Aerostar.

The NTSB determined that the probable causes of this accident were "the poor judgment by the Aerostar captain to permit the inflight inspection after he had determined to the best of his ability that the nose landing gear was fully extended, the poor judgment of the captain of the helicopter to conduct the inspection and the failure of the flight crew of the helicopter to maintain safe separation." Contributing to the accident was the incomplete training and checking of the Aerostar flight crew by Lycoming Air Services Inc. and the FAA POI assigned to the operation, according to the NTSB.

Vision of Pilots Restricted and Conditions for Hazardous Aerodynamics Existed

Radar ground tracks of the two aircraft were developed. However, because the encoded altitude (Mode C) coordinates of the radar data have a resolution of 100 feet (a tolerance of plus or minus 50 feet) it was not possible to develop definitive plots of the altitude and airspeed profiles of the aircraft. Within the accuracy limits of the data, though, it appeared to the NTSB that the altitudes and airspeeds of the two aircraft were relatively constant during and after the join-up maneuver. There were some variations in the altitudes for both aircraft, including a possible increase in altitude by the helicopter just prior to the collision.

Because the helicopter was behind and below the Aerostar, it would have been virtually impossible for either crew member of the Aerostar to keep the helicopter in sight. Complicating this was the need to maintain visual contact with the antenna towers that were nearly directly ahead. The NTSB stated its belief that it was incumbent upon the Aerostar pilot to maintain constant airspeed and altitude to minimize the efforts of the helicopter pilot to maintain position. The board also observed that it was the helicopter pilot's responsibility to maintain a safe distance to allow for possible deviations in the Aerostar's flight path.

The NTSB found that the cockpit overhead windows on the Bell 412 had been permanently covered. When the helicopter was certificated for IFR operations, the reflection of light from the rotating main rotor blades reportedly induced flicker vertigo in some pilots. Consequently, installation of curtains or other means of blocking the reflected light was required for IFR certification. The Sun Co.'s Bell 412 had been initially fitted with remov-

able curtains. Later, the windows were painted and a noise insulation barrier was installed. The result was that this helicopter crew would have unobstructed vision forward and to the sides but they would have been unable to see objects directly above their aircraft. In this position, upward visibility was limited approximately to an angle that intercepted the main rotor blade tip.

Even though the NTSB reviewed the aerodynamic interaction between fixed- and rotary-wing aircraft, no quantitative data could be developed. However, qualitative information was obtained that indicated two distinct and potentially hazardous aerodynamic interactions:

- Turbulence-induced blade stall and settling experience by rotary-wing aircraft when flying in the turbulent area behind and below a fixed-wing aircraft; and,

- Opposing pitch changes experienced by both aircraft when one aircraft flies closely behind and below the other.

The NTSB summary report referred to the U.S. textbook, *Aerodynamics for Naval Aviators* that specifically refers to the case of one aircraft inspecting the landing gear of another. It states that when one aircraft is flying closely behind and below another, the lower aircraft experiences a nose-up pitching moment and the higher aircraft experiences a nose-down pitching moment. The author states that the opposing pitch moment changes can be large and must be anticipated or a collision may result. Engineers at Bell Helicopter stated to NTSB that the Bell 412 would experience such a nose-up pitch change. The NTSB noted that while final seconds of raw radar data suggested an upward movement of the helicopter toward the Aerostar, the data did not show a downward movement of the Aerostar toward the helicopter.

… when one aircraft is flying closely behind and below another, the lower aircraft experiences a nose-up pitching moment … .

From the above discussion, this possible scenario can be reconstructed. The helicopter positions itself below and behind the Aerostar. The Aerostar crew cannot see the helicopter and must be conscious of the antenna towers directly ahead. The helicopter crew members cannot see upward and, yet, this is what would really be required if they were to look up into the nose gear wheel well to confirm a down and locked position. (This was not possible because the wheel doors were closed.) It would be a reasonable assumption that neither aircrew had the other aircraft completely in sight. Since the aircraft were in very close proximity to one another, the aerodynamic interaction could have caused the helicopter to encounter a nose-up pitching moment and collide with the Aerostar.

Aerostar Pilot's Log Differed From Company Records

Lycoming Air Services is an on-demand air taxi operating under FAR Part 135, and furnished the Aerostar and crew in response to a request from Sen. Heinz's office which stipulated that two pilots would be required. The assigned captain was making his second revenue flight in an Aerostar. He had 1,547 hours of single-engine airplane time and about 425 hours of multi-engine time. His logbook indicated a total of 15.9 hours in the Aerostar, but the NTSB Operations Group found that he only had 2.9 total hours of Part 135 command experience in the Aerostar at the time of the accident. The NTSB found discrepancies between the pilot's logbook time and company records.

The first officer had a total of 1,351 hours in single-engine airplanes and about 194 hours in multi-engine aircraft. He had received a one-hour check ride in the Aerostar. On the night before the accident flight, he had accumulated approximately three hours of flight time during a period from approximately 2100 hours until 0600 on the day of the accident. He had slept from approximately 0630 to 0900 before reporting for flight on the accident day.

The POI for Lycoming Air Services also was responsible for 16 other certificate holders and stated that the work schedule was so busy that he had been unable to visit Lycoming personally until mid-January 1991. In December 1990, two of Lycoming's pilots required recurrency check rides from the POI. Both pilots failed the first check ride. One passed the second check ride but the other did not. Based on this experience, the POI decided to make the January 1991 inspection. Upon inspecting the company's records, he found that training records, pilot record keeping and other operations records were not in compliance with the FARs. He notified the chief pilot and allowed the company 30 days to make corrections. The POI stated later that the company made satisfactory corrections prior to the accident date.

On February 25, 1991, the POI administered a competency flight check to the company's check airman and described the check as "pretty bad" under simulated instrument conditions and, "… I had to take the airplane away from him or we would have hit the hill after takeoff." The check pilot received a notice of unsatisfactory performance and loss of Part 135 airmen's privileges.

The check airman was retested on February 27 and passed.

This picture shows an on-demand taxi operator that did not consistently meet the basic requirements of the FARs and which tolerated pilots with less than adequate capabilities. The NTSB Operations Group interviewed a former chief pilot and check pilot for Lycoming Air Services who said that he had developed the opinion that Lycoming had "weak management, not experienced enough to operate a Part 135 business and especially with turbine airplanes." He expressed the belief that pilots were not receiving enough training and while "management meant well," they were compromising safety. On April 26, 1988, he elected to resign his chief pilot's position and when the NTSB asked why he resigned, he said, "I was fired for refusing to sign the check-out sheets for two pilots I didn't think were qualified."

… it would have been impossible for either the tower controllers or the pilots of the helicopter to have determined by visual inspection if the gear was indeed locked.

In a very competitive market, it is conceivable that some compromises might be made to survive economically. The question that arises in this instance is, "Did Lycoming Air Services provide Sen. Heinz with the best and most experienced Aerostar air crew it had or did it crew the airplane with whatever pilots were ready and willing to go?"

Captain Demonstrated Lack of Familiarity with Aerostar

The NTSB Operations Group report details a number of inconsistencies in the way the captain had logged his pilot-in-command time, noting that not all of it was credible as pilot-in-command. In several cases, the company's records indicated that another, more senior pilot was responsible for the flight.

On the pilot's first revenue flight as a captain in an Aerostar (April 1, 1991), the passenger was an executive with AVCO Lycoming, the manufacturer of the Aerostar's engines. The passenger had been employed by Piper Aircraft, had been trained at the Piper factory on Aerostar operations and had logged some 500 hours as a pilot in the Aerostar. The passenger occupied the copilot seat.

Asked if the pilot had mentioned that it was his first flight as a captain, the passenger said that the captain did not mention that fact. He said that it had appeared that the pilot had "checked out and started the engines before he arrived and they were warm." On the captain's attempt to start the engines, the passenger said, "he simply flooded them out … one, then the other. It was evident that he just didn't know how to start them. I asked him if I could show him how to start them."

The passenger described the takeoff as "erratic and it had me concerned" because the captain was overcontrolling the electric/hydraulic nosewheel steering. After becoming airborne, the passenger said, "He handled the plane OK. I guess he could fly the airplane OK. He just didn't know the systems." On reaching cruise altitude, the right engine began to surge and the captain did not appear to respond to the problem. The passenger said he had to persuade the captain to return to the airport where a maintenance inspection found that the fuel controller was defective.

A link begins to take shape with a relatively inexperienced captain who, according to a passenger on a previous flight with considerable pilot time in the Aerostar, …"didn't know the systems." On the accident flight, there is a system problem with the nose gear possibly not being down and locked. NTSB's Operations Group found that the Aerostar landing gear is designed to free fall to the "down position" and "lock down with a spring mechanism" in the event of a loss of hydraulic pressure. In interviewing pilots qualified in the Aerostar, the opinions were that the Aerostar system is designed so that if the gear is extended, it is "down and locked" because of the spring mechanism. The aforementioned passenger confirmed, "Once that gear is down, it's locked."

Asked what procedures were required to make sure the gear is down and locked, the response from pilots surveyed was, "Check the mains visually and for a reflection of the nose wheel in the spinner. The gear warning horn is on the nose gear down lock, so all you need to do is retard a throttle to hear if the horn sounds."

On the accident flight, the nose landing gear down light did not illuminate, and the captain probably made the right decision to break off his landing to verify that it was down and locked. The NTSB stated that it would have been impossible for either the tower controllers or the pilots of the helicopter to have determined by visual inspection if the gear was indeed locked.

According to the NTSB, the captain should have been aware that the nose gear locking mechanism was concealed by the gear doors and that there was no benefit to be gained by having another aircraft crew observe it. To the board, a more experienced pilot would probably have accomplished the emergency procedures and proceeded to land the airplane, accepting the possibility that the nose gear could collapse during the landing roll. Many

pilots, said NTSB, confronting such a situation would consider shutting the engines down after touchdown of the main gear to minimize the potential for propeller and engine damage and would attempt to keep weight off the nose gear until the airplane was slowed.

Even with knowledge of the systems and a desire to be reassured that the nose gear was down and locked, the Aerostar captain, said NTSB, had the responsibility to ensure that the in-flight inspection could be done without hazard, and should have coordinated the direction of approach and the minimum separation between the two aircraft. He should have insisted that the maneuver be conducted so that each aircraft could keep the other in sight at all times without compromising the agreed-upon separation. The NTSB said that the Aerostar captain relinquished the responsibility for ensuring the safety of his airplane and gave it entirely to the crew of the helicopter.

On the other hand, what might have happened had the Aerostar captain declined the offer from the Bell 412 to look at the nose gear?

Aircraft Chartering Requires Careful Scrutiny

This accident raises questions about evaluating on-demand air taxi operators prior to engaging their services. Customers cannot always allow sufficient time for careful consideration if business pressures and travel needs develop on the spur of the moment. On-demand suggests that the air taxi operator can respond to the customer's requirement.

However, if using air taxi services is a relatively constant requirement, a professional evaluation by competent aviation personnel is suggested. For example, if the company has its own aviation department, its personnel can visit and evaluate potential charter operators and prepare a list of those who meet the basic requirements.

What should be evaluated? Most important should be the stability of the air taxi operation as determined by its financial condition, ownership, management personnel and their approach to safety. This should include competent and experienced pilots, well-maintained aircraft and experienced maintenance personnel.

The bottom line has to be that the on-demand air taxi operator can be expected to deliver the passengers to their destinations safely. ♦

About the Author

John A. Pope established John A. Pope & Associates, an aviation consulting firm located in Arlington, Va., U.S., after retiring in 1984 as vice president of the U.S. National Business Aircraft Association. He specializes in developing operations manuals for corporate flight departments.

Pope is a frequent contributor to Flight Safety Foundation's publications.

He served as a command pilot in the U.S. Air Force and the U.S. Air National Guard. He retired as a colonel from the U.S. Air Force Reserve after 33 years of service.

What's Your Input?

Flight Safety Foundation welcomes articles and papers for publication. If you have an article proposal, a completed manuscript or a technical paper that may be appropriate for *Accident Prevention* please contact the editor. Submitted materials are evaluated for suitability and a cash stipend is paid upon publication. Request a copy of "Editorial Guidelines for Flight Safety Foundation Writers."

ACCIDENT PREVENTION