Adopted: 9-17-91

Log 2310A

National Transportation Safety Board

Washington, D.C. 20594

Safety Recommendation

Date: October 11, 1991

In reply refer to: A-91-94

Mr. Phil Boyer, President
Aircraft Owners and Pilots Association
421 Aviation Way
Frederick, Maryland 21701

Mr. Jonathan Howe, President
National Business Aircraft Association
1200 18th Street, N.W.
Washington, D.C. 20036

Frank L. Jensen, Jr., President
Helicopter Association International
1619 Duke Street
Alexandria, Virginia 22314-3439

On April 4, 1991, around 12:10 eastern standard time, a Lycoming Air Services Piper PA-60, N3645D, and a Bell helicopter, model 412, N78S, operated by Sun Company Aviation Department, were involved in a midair collision over Lower Merion Township, Pennsylvania. The flightcrews aboard the aircraft, including the passenger aboard the airplane, were fatally injured. There were no passengers aboard the helicopter. The aircraft crashed onto the grounds of an elementary school, fatally injuring two children and seriously injuring one child. Four other persons received minor injuries.[1]

N3645D was operating as an on-demand air taxi flight under 14 Code of Federal Regulations (CFR) Part 135. The airplane had departed the Williamsport-Lycoming County Airport (IPT), Williamsport, Pennsylvania, about 1022 eastern standard time on an instrument flight rules (IFR) flight plan for the Philadelphia International Airport (PHL), Philadelphia, Pennsylvania. The captain, first officer, and one passenger were on board.

---

[1] For more detailed information, read Aviation Accident Report--"Midair Collision Involving Lycoming Air Services Piper Aerostar PA-60, N3645D, and Sun Company Aviation Department, Bell 412, N78S, Merion, Pennsylvania, April 4, 1991" (NTSB-AAR-91/01/SUM)

As the flight approached PHL, it was cleared for an instrument landing system approach to runway 17. While on the approach, at 1201:28, the captain of N3645D reported that the nose landing gear position light had not illuminated, indicating that the nose gear was not in the down and locked position, and that he might need to cycle the landing gear.

Shortly before N3645D began its approach, N78S departed from PHL on a visual flight rules (VFR) flight to Sun Company corporate headquarters in Radnor, Pennsylvania. As N78S departed the PHL terminal control area, the pilots heard the communications regarding the possible unsafe nose gear indication on N3645D. The captain and first officer were the only persons on board. The aircraft was operated under 14 CFR Part 91.

The crew of N3645D was told to maintain 1,500 feet to allow N78S to pass underneath as the helicopter departed the area. As he passed under N3645D, at 1202:29, one of the pilots of N78S reported to the tower "that Aerostar that went past us, looks like the gear is down." The captain of N3645D acknowledged to ATC that he had heard N78S's transmission and stated that "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 can be seen from the cockpit on the propeller spinner. The tower acknowledged the transmission and advised that the helicopter was no longer a factor and that N3645D was cleared to land on runway 17. The controller later stated that he interpreted N3645D's situation as justifying an emergency.

At 1203:35, the controller offered N3645D the option of making a low-altitude pass by the control tower so that the tower personnel could observe the position of the nose gear. The controller further stated that there was "almost no traffic right now - we can do whatever you like." N3645D acknowledged that it would do a flyby of the tower. At 1204:12, the captain of N78S advised the tower that they "could take a real close look at that if you wanted." The tower acknowledged the transmission. At 1204:19, the captain replied that N78S was turning back to the airport, presumably to perform an in-flight inspection of N3645D's nose gear.

As N3645D passed by the control tower, the controller advised that the nose gear appeared to be down. The captain of N3645D responded that he could see the nose gear in the reflection of the propeller spinner and that it appeared to be down, but the indicator light was not green. The controller requested N3645D to make a left turn and enter a downwind leg for runway 17. He further advised that N78S was inbound from the north and that N78S could take a look at the nose gear. At 1205:30, the captain of N3645D stated "okay, I appreciate it."

Commencing at 1205:45, the controller provided directional information to the flightcrew of N78S to assist in visually acquiring N3645D. This information was acknowledged by the first officer. By 1207:54, the pilots of each aircraft acknowledged that they had each other in sight and that a speed of 125 knots would be used during the join up. At that time, the aircraft were joining up on an extended downwind leg for runway 17 at an altitude of about 1,100 feet. The controller advised N3645D of antenna towers 6 miles

ahead and requested the pilot of N3645D to notify the tower when he wanted to turn back toward the airport or make a heading change.

At 1208:21, the captain of N78S contacted N3645D on tower frequency and requested the pilot of N3645D to slow down. At 1208:52, the first officer of N78S contacted N3645D and stated that "we're going to come up behind you on your left side so just hold your heading." The captain of N3645D responded that the antenna towers were straight ahead and that he might need to change heading by 15^0 to the left. At 1209:30, the first officer of N78S stated on tower frequency "Aerostar, we're gonna pass around your right side now, take a look at everything as we go by." The captain of N3645D responded with "Okay." At 1210:00, there was a transmission from N3645D that was unintelligible because of a transmission from another aircraft. The controller asked N3645D to repeat the transmission, and the pilot of N3645D again stated that the indicator for the nose gear did not show down and locked.

At 1210:16, the first officer of N78S stated "everything looks good from here. The captain of N3645D replied "Okay, appreciate that we'll start to turn in." These transmissions were the last ones received from either N78S or N3645D. The last transmission was abruptly terminated by considerable noise. At 1210:51, the controller requested N3645D to make a left turn back to the airport, and he cleared the airplane to land on runway 17. Shortly thereafter, the controller noticed a smoke plume to the north of the airport. Subsequent attempts by the controller to contact either N78S or N3645D by radio were unsuccessful.

Since the encoded altitude (Mode C) coordinates of the radar data have a resolution of 100 feet for a tolerance of plus or minus 50 feet, it was not possible to develop definitive plots of the altitude and airspeed profiles of the two aircraft. However, within the accuracy limits of the data, it would appear the their altitudes and airspeeds were relatively constant during and after the join up maneuver, although there were variations in the altitudes for both aircraft, including a possible gain in altitude by N78S before the collision. Since the helicopter was behind and below N3645D, it would have been virtually impossible for either the captain or first officer of N3645D to maintain a continuous observation of N78S. This situation was further complicated by the need to maintain visual contact with the antenna towers that were nearly directly ahead. The Safety Board believes that during the join up and while the flightcrew of N78S was inspecting the landing gear, it would have been incumbent upon the pilot of N3645D to maintain a constant altitude and airspeed. Such action would have minimized the efforts of the pilots of N78S to maintain position with N3645D. However, the pilot of N78S had a responsibility to maintain a safe distance from the aircraft to allow for any possible deviations in the flightpath of N3645D.

The investigation found that the cockpit overhead windows on N78S had been permanently covered. When the Bell 412 was certificated for IFR operations, the reflection of light from the main rotor was reportedly found to induce flicker vertigo in the pilots. Consequently, the installation of curtains or other means of blocking the reflected light was required for IFR certification. N78S had initially been fitted with removable curtains.

Later, the windows were painted over, and a noise insulation barrier was installed to reduce the ambient cabin noise. Additionally, the pilots of N78S are said to have normally adjusted their seats to a full up or a nearly full up position. As a result, the flightcrew of N78S would have had 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 tip.

Eyewitnesses stated that they first noticed the two aircraft because of the relatively loud noise from the helicopter engines and rotor blades. After they saw how close together the two aircraft were flying, the witnesses continued to watch them, primarily because it was unusual to see two aircraft flying in such close proximity at such a relatively low altitude. Most of the witnesses reported that the aircraft were flying straight and level and that their flightpaths were parallel before the collision. Although many witnesses saw the aircraft collide, reports about movements of the aircraft just prior to the collision varied considerably. There was general agreement that prior to the collision the helicopter was below and to the right of the airplane. Several witnesses reported that the airplane veered to the right and struck the helicopter. Other witnesses said that the helicopter climbed and collided with the airplane. Most of the witnesses stated that the first impact was the rotor of the helicopter striking the underside of the airplane. They also saw fire on both the right side of the airplane and on top of the helicopter's cabin and numerous parts coming off both aircraft following the collision. The investigation determined that the outer right wing panel from N3546D and one of the main rotor blades from N78S had separated from the respective aircraft as a result of the collision. Therefore, both aircraft were rendered uncontrollable because of damage from impact with each other.

The investigation found that the pilots of N78S had not received any formal training in formation flying. However, on at least one occasion, they had flown in close proximity to another helicopter. There is no evidence that they had experience flying in close proximity to an airplane. The Sun Company chief pilot stated that he had once told the two pilots that if they were ever involved in an in-flight observation of another aircraft, they should maintain a separation of at least 300 to 700 feet. There is no evidence that the pilots aboard N3645D had any experience in or instruction on flying in close proximity to an airplane or a helicopter.

The examination of the wreckage of both aircraft revealed no evidence of precollision damage or structural or system failures. Additionally, the maintenance records of each aircraft did not indicate any deferred maintenance items or recent maintenance that might have contributed to the accident. Pilots who had previously flown N3645D did not report problems with the airplane's nose gear position indicator light or any control problems with the airplane. Both aircraft were properly maintained and certificated and were operating within their respective weight and balance limitations at the time of the accident. The captain of N3645D occupied its left cockpit seat and the captain of N78S occupied its right cockpit seat,

the normal captain positions for fixed-wing and helicopter operations, respectively.

Because the collision occurred following the intentional actions by both pilots to engage in close proximity flight, the analysis of this accident is focused on the decision of the captain of N3645D to permit the close inspection of his airplane during flight and the decision and procedures of the captain of N78S to conduct that inspection.

The Safety Board believes that the inexperience of the captain of N3645D as a pilot-in-command in revenue operations was a significant factor in the sequence of events that followed his observation that the nose gear position light did not illuminate when he extended his landing gear. Because he could see the reflection of the nose gear in the propeller spinner, the captain knew that the gear was down but was unsure whether it was properly locked in place because the green position light on the instrument panel did not illuminate to indicate that the locking action had taken place.

The investigation found that the FAA-approved flight manual for the Piper PA-60 does not contain emergency landing gear extension procedures in the emergency procedures section. However, the section containing information on hydraulic pump failure provides information on lowering the gear. If hydraulic pressure is lost, the landing gear will free fall to the down and locked position due to gravity and springs. To prevent the accumulator pressure from holding the gear up, the manual advises that the gear handle be placed in the down position. Additionally, the manual states that the landing gear warning horn will sound if the throttles are set to about the idle position and the nose gear is not locked. Therefore, a method to check whether the nose landing gear is down and locked is to reduce the throttle setting. If the landing gear warning horn does not sound, the pilot can presume that the nose gear is locked. If the horn does sound, the appropriate procedure is to turn off the hydraulic pump, bleed off the hydraulic pressure, and place the landing gear handle into the down position. The gear should then drop into the down and locked position. By retarding the throttles again, it can be determined if the gear is locked into place. The training/check pilot for Lycoming Air Services stated that he did not instruct the captain of N3645D on the operation of the landing gear warning horn but that he had taught him about the push-to-test function of the gear indicator lights.

Without the benefit of a CVR, it could not be determined whether the captain took any action to isolate the problem to the indicator light or to verify that the nose gear was locked in the down position. Although he may have retarded the throttles to check the status of the gear warning horn, he did not mention the results of such a test during his communications with the tower. The Safety Board believes that if he had made this check, he most likely would have informed the tower.

Safety Board investigators examined the nose gear installation of another Piper PA-60 and found that in the down position the landing gear doors close, leaving a very small area around the nose gear strut exposed. Even on the ground, it was difficult to inspect the nose gear steering system

and locking mechanism. The Safety Board believes that it would have been virtually impossible for either the tower controllers or the pilots of N78S to have determined by visual inspection if the gear was indeed locked. The Safety Board believes that the captain of N3645D should have been aware that the nose gear locking mechanism was concealed and that there was no benefit to be gained by having another aircraft, in close proximity, observe the gear. 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. Although it is not a frequent occurrence, a nose gear collapse after landing does not generally result in a major accident or occupant injury. Therefore, the captain should have rejected the offer for the close inspection by N78S.

Having accepted the offer from the captain of N78S to approach his airplane to observe the nose gear, the captain of N3645D should have assured himself that the in-flight inspection would be accomplished without hazard. By direct communication with the pilot of N78S, he should have coordinated the direction of approach and the minimum separation needed between the two aircraft. Also, the maneuver should have been conducted so that the pilots of both aircraft could keep the other in sight at all times without compromising the agreed upon separation. Instead, the captain of N3645D relinquished the responsibility for ensuring the safety of his airplane, giving it entirely to the pilot of N78S. In fact, N78S approached N3645D from behind and below. It is probable that the captain of N3645D did not see the helicopter and, therefore, did not realize the close proximity of the N78S when the collision occurred. The Safety Board considers the passive role of the captain of N3645D to be a further indication of a lack of command leadership experience and a causal factor in the accident.

Unlike the captain of N3645D, the pilots of N78S had considerable flight experience, but their judgement was also faulty. The Safety Board would consider appropriate an offer by a pilot of one aircraft to view the landing gear of another to verify its down position if the gear cannot be seen from the cockpit of the airplane having the unsafe indication. However, the observation to distinguish between an fully extended or retracted gear does not require extremely close proximity flight. To view the gear locking mechanism in most airplanes would require the observing pilot to close to an unsafe distance. In some airplanes, like the Aerostar, the locking mechanism could not be seen even at an unsafe distance. The first officer of N78S reportedly had flight time in or was experienced in Piper Aerostar operations. Therefore, he should have realized that the nose gear locking mechanism was concealed and that there was no reason to maneuver his aircraft closer to visually determine whether the nose gear was fully extended to the down position. Furthermore, there is no benefit in such an inspection since it should be assumed that the pilot of the airplane indicating a gear problem has already used all the procedures available to him to attain a safe gear indication. The same precautions should be used on landing regardless of the observation by another aircraft.

The captain of N78S should have known that he was undertaking a futile and ultimately unsafe task when he offered to take a "real close look" at the nose gear of N3645D. His upward visibility was restricted by the covered

canopy, and he would therefore have had a difficult time positioning his aircraft to view the gear. Moreover, he had no experience flying in close proximity to another aircraft to judge closure rates, rotor tip clearance, or the potential effects on controllability resulting from the aerodynamic interaction between the aircraft.

The Safety Board concludes that after the captain of N78S made the decision to close on N3645D he assumed the burden of responsibility for assuring that safe separation was maintained. He should have communicated his intentions to the captain of N3645D and kept him advised of his relative position throughout the encounter. More importantly, he should have maintained sufficient distance that would have permitted him at any time to maneuver away from N3645D if its flightpath changed. Thus, regardless of the geometry of the collision, the Safety Board views the poor judgement of the captain of N78S to conduct the inspection and his poor procedures in doing so as a cause of the accident.

The Safety Board acknowledges that in the interest of safety there may be situations wherein the close inspection of another aircraft in flight is justified. However, such situations are extremely rare and the Safety Board does not condone the conduct of such inspections under any circumstances by pilots who do not have specific training or experience in formation flying. When in-flight inspections are necessary, the Safety Board believes that a leader should be designated, communications should be established on a clear, preferably separate, frequency, and all procedures and maneuvers should be agreed to by both captains before the inspection. Further, the Safety Board believes that the impromptu inflight inspection of N3645D was accomplished without either flightcrew assessing the potential danger to themselves or to the community over which they were flying. The investigation found that the flightpath of N3645D was an extended pattern for runway 17. Because of the geographic position of Lower Merion Township in relation to PHL and the extended centerline of runway 17, the flightpath of N3645D was over Lower Merion Township and several other densely populated areas. The Safety Board believes that nothing was to be gained by the in-flight inspection of N3645D. Additionally, the inspection of N3645D was not a time-sensitive requirement because N3645D did not have a critical fuel problem. Therefore, the Safety Board believes that after the pilots of the two aircraft decided to conduct the ill-advised inspection, it should have taken place over an area that would have presented the least possible risk to the community.

The Safety Board's investigation of this and other accidents has demonstrated the consequences of poor judgement and poor decision making by pilots. The Safety Board is aware that in the past decade the FAA, Transport Canada, and several aviation industry organizations have supported major research projects that have resulted in the development of training materials. They include a series of manuals on "Aeronautical Decision Making" (ADM), specifically tailored for several categories of pilots, including student and private, instructor, commercial, helicopter, and others. A critical part of this training is improving a pilot's ability to recognize and control hazardous thought processes and situations. Both civil and military airmen trained with these materials have been shown to make

substantially fewer judgement errors and to demonstrate improved decision making.

The Safety Board commends the FAA and the many aviation organizations that supported these research and development efforts and publicized the existence and availability of ADM materials. Moreover, the Safety Board acknowledges the FAA's emphasis on the principles of ADM in its "Back-to-Basics" accident prevention program conducted in 1988 and 1989. However, in view of the obvious significant accident prevention benefits that could accrue from the widespread implementation of ADM training for pilots, the Safety Board believes that the FAA should disseminate more aggressively the available information and materials pertaining to ADM training and actively promote its implementation for all categories of pilots in the civil aviation community.

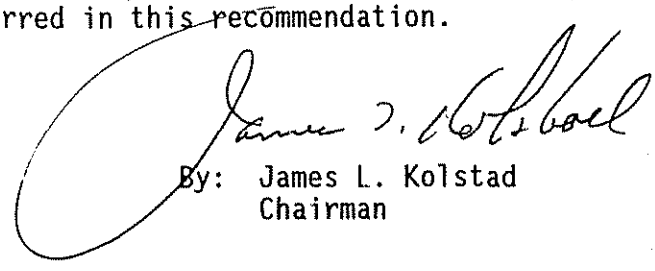
As a result of its investigation of this accident, the National Transportation Safety recommends that the National Business Aircraft Association (NBAA), the Helicopter Association International (HAI), and the Aircraft Owners and Pilots Association (AOPA):

> Advise your members of the circumstances of the midair collision involving Bell Helicopter N78S and Piper Aerostar N3645D and of the potential dangers associated with performing in-flight inspections of other aircraft or other close proximity maneuvers. (Class II, Priority Action) (A-91-94)

Also, the Safety Board issued Safety Recommendation A-91-91 through -93 to the Federal Aviation Administration.

The National Transportation Safety Board is an independent federal agency with the statutory responsibility "...to promote transportation safety by conducting independent accident investigations and by formulating safety improvement recommendations" (Public Law 93-633). The Safety Board is vitally interested in any actions taken as a result of its safety recommendations and would appreciate a response from you regarding action taken or contemplated with respect to the recommendation in this letter. Please refer to Safety Recommendation A-91-94 in your reply.

KOLSTAD, Chairman, COUGHLIN, Vice Chairman, LAUBER, HART and HAMMERSCHMIDT, Members, concurred in this recommendation.



By: James L. Kolstad
Chairman