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Inflight Loss of Propeller Blade on MU-2B Results in Uncontrolled Collision with Terrain

Flight crew did not communicate the full seriousness of the problem to controllers until minutes before the crash.

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The crash of a Mitsubishi MU-2B-60B has resulted in recommendations to the U.S. Federal Aviation Administration (FAA) regarding propeller hub design, certification and continuing airworthiness and air traffic control training, said the official U.S. National Transportation Safety Board (NTSB) accident investigation report. Both flight crew members and all six passengers (one of whom was the governor of South Dakota) were killed in the April 19, 1993, crash.

The airplane, operated by the South Dakota Department of Transportation (DOT), was on an instrument flight rules (IFR) flight plan from Cincinnati, Ohio, to Sioux Falls, South Dakota. While cruising at Flight Level 240 (24,000 feet [7,320 meters]), the crew reported a decompression and declared a "Mayday" to the FAA Chicago Air Route Traffic Control Center (ARTCC).

Air traffic controllers eventually vectored the MU-2B for an instrument landing system (ILS) approach at Dubuque, Iowa (DBQ). Radar contact was lost with the MU-2B about 10 miles (16 kilometers) southeast of DBQ at 1,900 feet (579.5 meters). The airplane crashed 8.5 miles (13.7 kilometers) southeast of DBQ, when it collided with a silo on a farm. Instrument meteorological conditions (IMC) existed at the time.

"The probable cause of this accident was the fatigue cracking and fracture of the propeller hub arm," the NTSB said. "The resultant separation of the hub arm and the propeller blade damaged the engine, nacelle, wing, and fuselage, thereby causing significant degradation to aircraft performance and control that made a successful landing problematic.

"The cause of the propeller hub arm fracture was a reduction in the fatigue strength of the material because of manufacturing and time-related factors (decarburization, residual stress, corrosion, mixed microstructure, and machining/scoring marks) that reduced the fatigue resistance of the material, probably combined with exposure to higher-than-normal cyclic loads during operation of the propeller at a critical vibration frequency (reactionless mode), which was not appropriately considered during the airplane/propeller certification process."

The MU-2B (registered in the U.S. as N86SD) departed Cincinnati-Lunken Airport (LUK) at 1406 central daylight time (CDT). "At 1428, the crew requested and was granted clearance to deviate from course to avoid weather build-ups at Flight Level 230 [23,000 feet (7,015 meters)] over Indiana. At 1509 and 1537, the crew again requested and obtained clearance to deviate around poor weather conditions at Flight Level 240 over Illinois," the report said. At this point in the flight, the crew was in contact with Chicago ARTCC.

"At 1540, the crew reported, 'Chicago, Sierra-Delta, we had a decompression,'" the report said. Seconds later, the crew called again: "Mayday, mayday, mayday, Six-Sierra-Delta, we're going down here." The Chicago Center controller acknowledged: "Roger, tell me what you need," the report said. "The closest airport we can get to here," replied the crew.

"The controller informed N86SD that DBQ was 25 miles [40.2 kilometers] away at their two o'clock position and asked what altitude the airplane needed. The airplane was actually 37 miles [59.5 kilometers] from DBQ. At this time, the controller was unaware of the weather at DBQ," the report said. The flight crew responded, "We need to get down to our oxygen level." The center controller then cleared the airplane to 8,000 feet (2,440 meters), the report said.

The controller considered several other airports for N86SD; however, these airports were smaller, uncontrolled and unmanned. "She [the controller] considered Quad City Airport (MLI), Moline, Illinois, but believed it was farther away from the airplane than DBQ. At 1542:12, the flight requested DBQ weather conditions. The controller replied by clearing the flight to DBQ and stating that DBQ was at about a 330-degree heading, and that the airplane should fly 'direct when able.' She also reported the DBQ weather as 300 feet [91.5 meters], 1.5 miles [2.4 kilometers] visibility in rain and fog, and winds of 060 degrees at 20 knots," the report said.

N86SD was now about 31 miles [50 kilometers] from DBQ. "Also at that time, the current weather observation for MLI (about 33 miles [53 kilometers] away from N86SD) indicated visual meteorological conditions (VMC) on the surface. Also at that time, instrument landing system (ILS)-equipped Clinton Airport (CWI), Clinton, Iowa, was nine miles [14.5 kilometers] south, with a ceiling of 400 feet [122 meters], and a visibility of five miles [eight kilometers]. The air traffic controllers involved in the emergency situation did not query their computer for the MLI surface observation, which would have been available. The CWI surface observation is not available via a computer query," the report said.

The NTSB report continued: "About 1542, one of the controllers contacted Quad City approach control to point out to the approach controller that N86SD was descending, with the following land-line transmission: 'Yeah, just northeast of Davenport, 15 miles [24 kilometers], that emergency squawk you're seeing, he's going down to eight right now.'

"At 1543:11, the controller asked the flight if it could change frequency. The flight answered in the affirmative, and contacted the low altitude radar controller. The DBQ radar controller assigned a heading to join the ILS final approach course for Runway 31 at DBQ and asked if the flight crew wanted emergency equipment standing by. The flight crew replied, 'We might need the equipment.'

"At 1544, the controller asked, 'Can you hold altitude?' The flight crew responded, 'Well, standby.' The controller then cleared the flight to 6,000 feet [1,830 meters]. At 1545, the flight crew reported difficulty holding altitude, and the controller then cleared the flight to 4,000 feet [1,220 meters] and restated the heading to join the approach course.

"The flight crew replied, 'We might need the equipment.'"

"Chicago ARTCC notified DBQ tower at 1545 that N86SD was diverting to DBQ with an emergency. At 1546, the flight crew requested the distance to DBQ, and the controller replied that the airplane was 23 miles [37 kilometers] southeast of the airport. N86SD then requested vectors to the ILS. At 1547, the controller informed N86SD that his radar showed the airplane joining the approach course. N86SD acknowledged and asked, 'Could you have the ambulance standing by?' At 1548:06, N86SD transmitted that they 'had an engine out' as well as a decompression.

"At 1549, the controller stated the airplane's altitude readout of 2,700 feet [823.5 meters] and asked: 'Can you hold … there?' N86SD answered, 'I don't think so.' Radar contact was lost at 1551, about 10 miles [16 kilometers] southeast of DBQ when the airplane was at 1,900 feet [579.5 meters]. The controller reported the loss of radar contact to the flight crew and directed them to contact DBQ tower.

"The flight crew reported on DBQ tower frequency at 1551, was informed that emergency equipment was in position, and was cleared to land on Runway 31. N86SD acknowledged and asked, 'How far out are we?' The tower controller, unable to answer the question because no equipment to determine the airplane's range was installed in the tower, stated that radar contact had been lost and asked if the airplane had distance measuring equipment. The flight crew's affirmative response at 1552 was the last transmission received."

A witness four miles [6.4 kilometers] east-southeast of the crash site told investigators that he heard an airplane overhead about the time of the accident but did not see the plane because of clouds. Another witness, two miles [3.2 kilometers] from the site, said that he saw the aircraft come out of the clouds to his east, pass about 100 feet [30.5 meters] overhead and continue west-northwest. "He described the airplane as inclined right wing down, with the left propeller stopped. He stated that he saw a single left propeller blade, stationary above the left wing and bent forward," the NTSB report said. Three witnesses driving on a highway told investigators that they saw the airplane cross from east to west at low altitude and later saw fire at the crash site.

The aircraft came to rest in a barnyard on a heading of 303 degrees magnetic. "The wreckage path began at a demolished 75-foot [22.9-meter] concrete and steel silo and continued for about 498 feet [151.9 meters] on a magnetic heading of between 290 and 320 degrees. The farthermost pieces of airplane debris that were found were the left and right tip tanks, which showed minor frontal damage and no fire damage," the report said. An intense fuel-fed, post-crash fire erupted following impact.

"The nose of the airplane was crushed inward into the cockpit area, a distance of about four feet [1.2 meters]. Mortar, concrete block and galvanized hardware were interspersed throughout the nose and cockpit areas. The fuselage area contained molten aluminum and unrecognizable fragments of metal. The empennage was separated from the fuselage at the factory joint (the attachment area between fuselage and tail structure) and was about 59 feet [18 meters] from the fuselage," the report said.

The report said that the wreckage was almost completely consumed by fire, "eliminating the possibility of evidence of a propeller strike." It said that no propeller material was found in the fuselage area.

The report said: "Both the left and right engines were approximately 175 feet [53.4 meters] from the silo and adjacent to the severely burned cockpit/cabin section of the fuselage, the central point of the crash site." One of the side panel beams that attaches the left engine to the wing had separated from the front wing spar. "The rear engine mount was separated with evidence of multiple rubbing marks. The left and right engine mounts from the left engine were placed in their respective positions relative to the left wing. Damage to the wing leading edge indicated that the left mount had rotated about 30 degrees inboard," the report added.

The propellers on N86SD were the Hartzell HC-B4, a four-blade, single-action, hydraulically operated, constant speed propeller with full-feathering and reversing capabilities. "Both the left and right propellers were attached to their respective engine output shafts. The right propeller, except for the cylinder and piston assembly, was complete. However, all four blades were severely damaged," the report said.

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Examination of the left propeller disclosed that the propeller blade operating cylinder and piston assembly and the entire No. 3 blade had separated. The remaining three blades were attached but severely damaged, the report said.

The left engine powerplant cowling and the missing propeller blade, blade clamp and separated hub arm were found 25 days later, about 27 miles (43.4 kilometers) east-southeast of the crash site. A laboratory examination of the left propeller hub and blades was conducted.

The report said that examination of the left propeller revealed that the fracture in the separated hub arm "was the result of a fatigue crack that initiated from the inside diameter of the pilot tube hole in the hub arm. This portion of the hub arm would experience maximum tensile stresses during normal operation of the propeller (forward thrust). The fatigue cracking propagated through about 45 percent of the hub arm cross section before final fracture occurred. The origin area contained a large number of ratchet marks, indicative of fatigue crack initiation from a large number of individual initiation sites."

The report added: "The surface of the pilot tube hole on the vicinity of the fatigue crack origin area contained general corrosion damage (primarily in the form of corrosion pits). However, the number of individual initiation sites was far greater than the number of corrosion pits. A narrow gap with corrosion deposits extended between the inboard end of the pilot tube and the inside diameter surface of the pilot tube hole on the hub arm. The surface of the pilot tube hole also contained burnished machining marks. The origin area was along one of these machining marks for a substantial portion of its width."

The NTSB said that disassembly of the propeller hub revealed "no evidence of bearing damage. Measurements of the propeller hub revealed no dimensional anomalies that might have contributed to the initiation of the fatigue crack. Inspection of the hub revealed no indications of additional cracks.

"The propeller blade that separated from the left propeller in flight was intact and contained slight damage to the electrical deicing boot," the report said. "Other than slight damage associated with the boot, no mechanical damage was noted on the blade. In particular, the leading and trailing edges of the blade showed no signs of contact with any solid object."

A review of Hartzell, Mitsubishi and Garrett records and FAA service difficulty reports revealed that Hartzell HC-B3T (three-blade) and HC-B4T (four-blade) propeller blades (as opposed to propeller hubs) "had failed on 10 occasions prior to the N86SD accident. One failure occurred on a Dornier 228, three failures occurred on Swearingen Metro IIs, three failures occurred on Mitsubishi MU-2B-60s, and three failures occurred on other models of the MU-2B. Hartzell attributed the blade failures to corrosion."

The NTSB report noted that another MU-2B-60 experienced a fracture of one of the propeller hub arms on the right propeller (a Hartzell model HC-B4) in a 1991 incident at Utica, New York.

"In this accident, a right propeller hub failed and released one blade," the report said. "This blade, or a piece of another damaged blade, pierced the fuselage. The engine mounts did not fail completely, and the engine remained aligned with the relative wind. The propeller autofeathered. According to the pilot, he could not arrest his descent after the hub failure and autonomous engine shutdown, and he was 'just barely' able to reach the runway at Utica.

"Metallurgical examination of the broken hub at the Safety Board's Materials Laboratory revealed that the fracture was the result of fatigue cracking that initiated from multiple initiation sites on the surface of the hole for a pilot tube. The longitudinal location of the origin area was in the same position as the [N86SD] accident hub (near the inboard end of the pilot tube), but the circumferential location of the origin area was at the two o'clock position, approximately diametrically opposite from the origin area of the [N86SD] accident hub. …

"Corrosion pitting was also found on the surface of the pilot tube hole in the hub arm. However, the fatigue initiation sites could not be traced to specific corrosion pits. At the time of this failure the propeller hub had accrued a total operating time of 4,460 hours."

As a result of the 1991 accident, NTSB issued three safety recommendations to the FAA:

- "Develop, with the assistance of Hartzell Propeller, Incorporated, a nondestructive inspection technique capable of detecting hub arm cracks stemming from the inside diameter surface of the hub arm at the approximate location of the inserted end of the pilot tubes on Hartzell model HC-B4 propeller hubs, and issue an airworthiness directive [AD] requiring that HC-B4 hubs with 3,000 hours or more be inspected using this technique the next time the propeller assembly is overhauled for any reason, or at the next annual inspection (or equivalent), whichever is first;
- "Determine, based on the results of the [above-requested inspections], if the hub arms on Hartzell model HC-B4 propeller hubs with 3,000 hours or more should be inspected at periodic intervals. If such inspections are warranted, issue an airworthiness directive, as appropriate, requiring periodic inspections; and,
- "Determine if Hartzell model HC-B3 and -B5 propeller hubs, based on similarity of design and fabrication processes with the HC-B4 propeller hub, should be inspected for cracking in the hub arms. If such inspections are warranted, issue an airworthiness directive, as appropriate, requiring periodic inspections."

The left propeller hub on N86SD had been installed new by the airplane manufacturer at the time of original delivery and had remained with the airplane throughout its service. At the time of the accident, this propeller hub had accrued a total operating time of 4,585 hours.

"The last recorded inspection of the propellers was performed three months before the accident. The inspection included an examination of the propellers for smooth rotation of the blades on the hub pilot tubes. The inspection of the propeller hub for cracks, required to be conducted during the 100-hour periodic inspection, was performed visually and was limited to the exterior of the hub and the hub arm. The interior pilot tube and hub bore were not inspected at that time due to their inaccessibility.

"Following the N86SD accident, Hartzell attempted to develop an inspection method that would be capable of detecting cracks that initiate from the interior of the hub arm. No method was capable of detecting such cracks unless the pilot tubes were removed," the report said.

Fourteen days after the accident, the FAA issued an AD (93-09-04) regarding Hartzell model HC-B4 propellers on MU-2B-60 airplanes. "The purpose of the AD was 'to prevent fatigue cracks in propeller hub arm assemblies progressing to failure, resulting in departure of the hub arm and blade, and that may result in engine separation and subsequent loss of aircraft control. …' It required that the propeller hubs on all MU-2B-60 airplanes be magnetic particle inspected with the pilot tubes removed. The AD required that the inspection be repeated at 600-hour intervals," the report said.

Forty-three days later, the FAA issued a second AD (93-12-01) that required these inspections on Hartzell HC-B4 propellers installed on other MU-2B airplanes (the -26A, -36A, and -40A versions), the report said.

Hartzell has reported that as of Oct. 13, 1993, a total of 373 hubs from MU-2B airplanes had been inspected per the two ADs. "This number represents 79 percent of the U.S. fleet of hubs used on MU-2B series airplanes and includes nearly all of the hubs in service on MU-2B-60 airplanes," the report said.

The report added: "As a result of compliance with AD 93-09-04, propeller hubs on MU-2B-60 airplanes were subjected to magnetic particle inspection with the pilot tubes removed. During these inspections, another hub was found with a cracked arm. The propeller was delivered to the airplane manufacturer in 1979 and was overhauled in 1985. The operating time at this overhaul could not be determined. There were 4,121 hours accumulated since the 1985 overhaul. This propeller was received at Hartzell for a hub inspection with the latest style blades installed. It was reported that the blades from this hub were reinstalled on a new hub when the propeller was reassembled.

"Following the N86SD accident, Hartzell gathered information concerning the condition of the pilot tube hole surface on many other Hartzell three-, four-, and five-blade steel propeller hubs. Most of these hubs had corrosion damage, including some with severe corrosion pitting. Many of the hubs had scratches or machining marks of some type."

The report said that Hartzell indicated that the normal flight loads on the MU-2B-60 induce stresses on the propeller hub that are some of the highest of any of the Hartzell steel hubs. "Therefore, hub arm failures on the MU-2B-60 could be consistent with hub cracking as a result of degraded fatigue properties and normal operating stresses," the NTSB said.

The report said that "one of the known vibration modes that must be considered is that which can be experienced when a crosswind or tailwind component acts on the blades as they revolve during ground operations. The changes in the wind force on the propeller blades, because of the proximity to the airplane's wing, excite the blade vibration.

"In the case of four-blade propellers, pairs of opposite blades vibrate in phase with one pair vibrating forward while the other pair vibrates aft. Such vibration results in reverse bending stresses in the blade and hub arms with little or no relative motion or vibration of the mounting flange because the resulting motion of the blades is balanced on the propeller shaft. This is termed the 'reactionless' mode of vibration and is particularly insidious because the pilot may be unaware of the propeller vibration. When in the reactionless mode condition, each blade and hub arm experiences two cycles of vibration for each revolution of the propeller.

"The post-accident testing conducted by Hartzell demonstrated that the cyclic component of the stresses in the origin area of the Utica hub are about the same as those for the origin area for the N86SD hub for both the reactionless mode of vibration and during normal flight. Because the cyclic component has a much greater effect on fatigue crack initiation than does the steady state portion of the stress, the location of the origin areas on the two broken hubs could be consistent with stresses from either the reactionless mode or the normal flight," the report said.

The report said that Hartzell indicated that the normal flight loads on the MU-2B-60 induce stresses on the propeller hub that are some of the highest of any of the Hartzell steel hubs.

Thus, the NTSB said it could not rule out that the normal operating stresses on the MU-2B-60 "are sufficient, given the degraded fatigue properties, to cause fatigue cracking."

The NTSB added: "Because of this possibility, the Safety Board believes that the FAA should identify Hartzell steel propeller hubs on other airplanes that have high stresses during flight and should conduct a designated safety inspection for cracks in the pilot tube hole of the hub arm on those hubs that have high amounts of operating time and that were manufactured with pilot tube holes machined prior to heat treatment. The Safety Board also believes that the reduced fatigue properties are present on the three- and five-blade Hartzell hubs, and that similar actions should also be considered for hubs with similar stress levels.

"Despite the precautions that are taken to avoid operating the propeller in an rpm range that matches the resonant frequency of the reactionless mode of vibration, the post-accident testing that Hartzell performed indicated that the resonant frequency of the reactionless mode can increase to within the normal ground operating rpm range for the MU-2B when the propeller contains worn or repaired blades. This was demonstrated using a propeller with blades similar to those from the hub involved in the Utica accident, and with propeller blades installed on the N86SD hub prior to the AD-mandated propeller blade change.

"The Safety Board found that two factors must interact in order for the reactionless mode of vibration to occur at or above the ground idle speed of the engine. First, there must be a relatively small difference between the resonant frequency of the propeller with new blades and the minimum ground idle speed of the engine. Second, material must be lost from only the tip portion of the blade.

"Hartzell has therefore demonstrated that both of the propeller conditions needed to allow operation in an rpm range corresponding to the resonant frequency of the reactionless mode of vibration are more likely to occur on the MU-2B than on any other application. The FAA has indicated that a study of the propensity of other propeller/airframe combinations to experience the reactionless mode of vibration is being conducted and that appropriate action will be taken to ensure that aircraft operations are kept out of this mode of vibration as much as possible.

"The Safety Board found substantial circumstantial evidence that the reactionless mode of vibration contributed to the initiation of the fatigue cracking on the N86SD hub. As the reactionless mode occurs, the steady state and cyclic portions of the stress are nearly the same at the locations of the origin areas for the N86SD and Utica hubs. Therefore, cracking that initiates from the reactionless mode of vibration could initiate on either side of the hub.

"Based on the stress levels associated with the reactionless mode and the propensity of the MU-2B airplanes to experience the reactionless mode at or above the ground idle rpm, the Safety Board concludes that the fatigue fracture of the hub is more likely to have initiated as a result of increased cyclic stresses produced during the reactionless mode of vibration, in combination with the substantially reduced fatigue properties of the hub material."

The NTSB also concluded that the precautions taken during the initial certification that were intended to minimize the exposure of propellers on MU-2B airplanes to the reactionless mode of vibration were inadequate. "Specifically, the Safety Board found no evidence that Hartzell conducted or the FAA required or Mitsubishi requested any additional vibration survey tests using propeller assemblies having blades dimensionally conforming to the repair manual limits during the certification demonstration of compliance to propeller vibration requirements in 1976. Thus, the identification of engine speed at which the reactionless mode could occur was only applicable to propeller assemblies having new blades, and the full engine speed range at which a reactionless mode condition could be experienced during the service of the airplane was evaluated by tests," the report said.

"The Safety Board found substantial circumstantial evidence that the reactionless mode of vibration contributed to the initiation of the fatigue cracking on the N86SD hub."

The NTSB report said that the "potential increase in the reactionless mode frequency for propeller blades of reduced mass should have been apparent to engineering personnel and that they should have required additional tests in order to ensure that the propeller operating limits and engine speed restrictions cited in the 1976 propeller vibration and stress survey report were adequate to prevent operation at the highest possible reactionless mode frequency."

The NTSB said it was concerned that hubs on other airplanes may have also been subjected to increased stress because of the reactionless mode of vibration in the normal operating range.

It recommended that the FAA identify "those airplanes that can, through a combination of the resonant rpm, the ground idle rpm range, and repair limits at the blade tip, produce the reactionless mode in the normal operating range." The report said that for those airplanes containing Hartzell hubs at risk for reduced fatigue properties (manufactured prior to April 1984), the FAA "should require inspection for cracks in the pilot tube hole."

The NTSB also urged the FAA to "immediately determine the whereabouts of all four-blade Hartzell propeller hubs that have been installed at any time on MU-2 airplanes, and require immediate inspections for potential fatigue damage in the hubs.

"Because the N86SD accident demonstrated that the Utica failure could no longer be considered unique, the FAA issued AD 93-09-04 and AD 93-12-01 (both in 1993), requiring that all Hartzell HC-B4TN propeller hubs in service on MU-2B airplanes be inspected for cracks after removal of the pilot tubes. The ADs also require repeated inspections at an interval not to exceed 600 hours. Because of the potential risks from damage created by the removal and insertion of the pilot tubes during the inspection program, the FAA has authorized only Hartzell to perform the inspections," the report said.

The NTSB also reviewed the qualifications and training of the two pilots operating N86SD.

The report said the captain, 52, held an airline transport pilot certificate with endorsements for airplane single- and multi-engine land. His total flight time was 10,607 hours, with 1,922 hours in the MU-2. In the last 30 days, he had flown 26 hours, 12 of which were in the MU-2. His instrument time totaled 921 hours in actual instrument conditions and 112 hours in simulated instrument conditions. He completed a recurrency check as MU-2 pilot-in-command on Dec. 6, 1992.

The first officer, 45, held a commercial pilot certificate with ratings for helicopter and airplane, single- and multi-engine land, and instrument airplane and helicopter. His total flight time was 8,085 hours, with 982 hours in the MU-2.

Both pilots had flight instruction in the accident airplane that included emergency descents, single-engine failures in various flight regimes and single-engine instrument approaches, the report said.

The NTSB also reviewed the maintenance program for N86SD, which was inspected under Federal Aviation Regulations (FAR) Parts 91 and 43. "The Safety Board determined that the airplane was being maintained and flown by the State of South Dakota personnel in accordance with procedures that were applicable at the time of the accident," the report said.

The NTSB also devoted considerable attention to pilot and controller decision making. The report said "that the pilots initiated an emergency descent and descended down to and through 9,000 feet [2,745 meters] in a very rapid manner very likely because of the cabin depressurization. Had they attempted to arrest the descent at 12,000 feet [3,660 meters], for example, and turned toward DBQ at the first instruction for a northerly turn from ATC, they might have had sufficient range to reach DBQ. In addition, had the crew stated the true seriousness of their situation to [Chicago ARTCC] controllers, the controllers might have been more prone to search for a more suitable diversion airport."

At the time, the airplane was flying in IMC and was probably experiencing significant buffeting, the report said. “Unfortunately, the pilot had received no training for the combination of circumstances that he faced. This combination included an engine failure, a displaced engine, cowl damage, unusually large control inputs, an unchecked descent, and only flight instruments for reference.”

The report added: “An emergency descent would have required lower power settings for the operating engine, less wheel and rudder deflections to maintain control, and would have been conducted at higher airspeeds. Until the moment that the pilot attempted to arrest the rate of descent, he would have been unaware of potential control problems.

“Once the pilot determined that he could not appreciably arrest the rate of descent by slowing down, but could gain a significant margin in available flight controls by flying faster, he probably chose to maintain a higher airspeed and more control of the airplane, thus accepting a higher descent rate.”

The report noted that during the 1991 Utica incident, the pilot stated that he “could not maintain level flight, even though his airplane sustained less aerodynamic damage than did N86SD.” It concluded that the pilot acted “in a reasonable manner in continuing the high rate of descent to lower altitudes and that once he was at lower altitudes, he continued to fly at higher airspeeds and rates of descent to gain more aerodynamic control,” the report said.

At the time, the airplane was flying in IMC and was probably experiencing significant buffeting, the report said.

The NTSB said that it did “not believe that the flight crew deliberately attempted to fly below the 200- to 300-foot [61- to 91.5-meter] ceiling in the Dubuque local area to attempt to locate DBQ. Their level of training, their overall experience in the MU-2 almost certainly precluded this possibility. In addition, and most importantly, they were aware of the low ceiling at Dubuque, and were undoubtedly aware of the inadvisability of low level flight over unfamiliar terrain.

“The Safety Board believes that at the time of the crash into the silo, the engine was displaced downward about 30 degrees. In addition, the Safety Board believes that the engine mounts were totally separated prior to contact with the silo, and, at one point, the engine had been displaced inboard about 30 degrees,” the report said. It noted that “damage to the nacelle would have resulted in a loss of lift, which, in turn, would induced a rolling moment that would require additional wheel deflections to maintain control of the airplane.”

Reviewing the actions of the air traffic controllers in response to N86SD’s predicament, the report said: “Following the loss of the propeller blade and the decompression, the flight crew requested from the Chicago ARTCC controller vectors to the ‘closest airport we can get to,’ at 1540:46. Four seconds later, the controller transmitted that DBQ was at the airplane’s two o’clock position and 25 miles [40.2 kilometers] away. DBQ was actually about 37 miles [59.5 kilometers] from the airplane. At that same time, the airplane was within two miles [3.22 kilometers] of being equidistant from MLI and DBQ and only about nine miles [14.5 kilometers] from CWI. The DBQ and CWI local areas were experiencing IFR weather conditions, and the MLI local area was experiencing visual flight rules [VFR] weather conditions.

“Immediately after the decompression, as N86SD progressed westward and descended, its relationship to DBQ and MLI remained about the same, while the distance from CWI increased. At 1542:16, the airplane was directed to turn to a heading of 330 degrees, but it did not do so. The nearly equidistant relationship from DBQ and MLI continued until the low altitude sector radar controller assigned the airplane the heading of 360 degrees, at 1543:45. After that, the distance from the airplane to DBQ decreased, while the distances from CWI and MLI increased, as the airplane descended to the north.

“The Safety Board believes that N86SD would have broken out of the overcast at a higher altitude if it was on a course toward MLI, rather than DBQ, although N86SD was not offered this option by the controllers. This would have given the pilot more time to select a flat, open area on the ground to crash land the airplane, and the probability of flight crew and occupant survival would have been greatly increased.

“Following the propeller hub failure, the airplane probably had sufficient altitude to attempt an ILS approach and landing at CWI, although the flight was not offered this option by air traffic control. The difficulty of the approach would have been compounded by the low 400-foot ceiling. Also, the flight crew would have had to fly some distance southwest of the airport to align the airplane for an approach to Runway 3, which was the runway with the ILS approach.”

The report said that the center radar controller “did not have readily available weather information for CWI to issue to the flight. Weather information for CWI was generated by AWOS [automated weather observing system], which is not available via the … screen used by the controllers. The controller would have had to contact either the Center Weather Service Unit or Quad City Approach Control to obtain the latest CWI observation. This process would have taken at least one minute or longer.”

The report added: "The reason the controllers said that they selected DBQ as the landing airport for N86SD, rather than MLI or CWI, was that they perceived that it was the closest suitable airport to the airplane when the emergency situation was announced. Of the two airports that they considered sending the flight to, DBQ was closer by about two miles [3.22 kilometers]. Acting upon the information they possessed at the time, they probably believed that they were complying specifically to the pilot's request. The fact that they were only aware of a decompression aboard the airplane (with no other complicating factors) at that juncture, and the fact that they knew the flight crew was qualified to fly into IFR conditions might have also entered into their decision-making process. In addition, they believed that DBQ possessed adequate emergency response equipment."

But the NTSB report concluded that the controllers involved in the emergency "should have, at some point, determined that the weather at MLI was much better than that at DBQ. Moreover, they should have been aware that CWI was much closer than either MLI or DBQ and then relayed that information to the pilots of N86SD."

The report said that there were also "systemic shortfalls that hindered the effectiveness of the assistance that the controllers could provide N86SD. These include a lack of readily available current weather sequence reports for the controllers, and a lack of written guidance for controllers during emergency situations."

The NTSB report said that had the "appropriate weather sequences been constantly displayed, the controllers would have been immediately aware that the weather in the MLI area was considerably better. This knowledge would have provided N86SD a better opportunity to land without catastrophic consequences." ♦

Editorial Note: This article was adapted from *Aircraft Accident Report, In-Flight Loss of Propeller Blade and Uncontrolled Collision with Terrain, Mitsubishi MU-2B-60, N86SD, Zwingle, Iowa, April 19, 1993*, Report No. NTSB/AAR-93/08, prepared by the U.S. National Transportation Safety Board. The 124-page report includes illustrations and appendices.

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