# National Transportation Safety Board
# Aviation Accident Factual Report

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| **Location:** | SEDONA, AZ | **Accident Number:** | LAX93GA195 |
| **Date & Time:** | 05/01/1993, 1115 MST | **Registration:** | N201GK |
| **Aircraft:** | MOONEY M20J | **Aircraft Damage:** | Destroyed |
| **Defining Event:** | | **Injuries:** | 2 Fatal |
| **Flight Conducted Under:** | Part 91: General Aviation - Public Aircraft | | |

History of the Flight

On May 1, 1993, at about 1115 hours Mountain standard time, a Mooney M20J, N201GK, lost control on final approach and collided with terrain short of the approach end of Runway 3 at the Sedona Airport, Sedona, Arizona. The airplane was destroyed by impact forces. The certificated commercial pilot/owner and his passenger, a certificated commercial pilot, were fatally injured. Visual meteorological conditions prevailed at the time. The pilot filed and activated an instrument flight rules flight plan to Sedona, Arizona. The flight departed March AFB at 0857 hours. The pilot later canceled the flight plan and continued to Sedona under visual flight rules.

About 1115 hours, a pilot of another airplane witnessed the accident. The pilot/witness was flying from Phoenix, Arizona, intending to enter the airport traffic pattern and land at the Sedona Airport. At an altitude of 6,000 feet msl and approximately 1.5 miles south of the Sedona Airport, the pilot/witness heard the accident airplane transmit its position over the common traffic advisory frequency (CTAF). The pilot/witness was looking for the aircraft in the traffic pattern when he twice saw an airplane with its wing rolled 90 degrees from horizontal about 3/4 to 1/2 mile west of the approach end of Runway 3.

The pilot/witness estimated the accident airplane's altitude at that moment to have been approximately 5,000 feet msl. The pilot/witness described his recollection of the accident airplane's movement after he first visually acquired it, "like slow motion." The pilot/witness stated, "The nose dropped and the aircraft dropped vertically toward the earth, still in a slow motion state."

The pilot/witness further stated, " Just above the ground, the aircraft pulled out and started moving like lightning; at this moment it was angling toward the base of [the] airport mesa. The wings banked rapidly to the right and appeared to be climbing, now paralleling the base of the mesa and still moving rapidly. The wings then banked swiftly to the left, rolled inverted, and then split-S straight into the ground." The pilot/witness indicated that he saw no dust cloud nor smoke.

The pilot/witness estimated the accident airplane's maneuver took 6 to 10 seconds. The pilot/witness described that the motion of the accident airplane was so rapid in the last few seconds that it looked like a radio controlled model airplane. The pilot/witness then made a transmission on the CTAF and flew over the accident site.

Pilot Information

First Pilot

The first pilot held a commercial pilot certificate which was issued on December 1, 1986, and was based on military competency. The first pilot was an active duty member of the United States Air Force stationed at March AFB. The first pilot performed duties as a standardization/evaluation pilot in C-12F (a Beech 200) aircraft. The most recent second class medical certificate was issued to the pilot on October 17, 1991, and contained no limitations. The first pilot's last military flight physical was on October 28, 1992.

Review of the first pilot's most recent military flight record closeout revealed his total military aeronautical experience consisted of 3228.8 hours, of which 86.5 hours were in the last 90 days. According to the U.S. Air Force, the first pilot's most recent pilot proficiency check was accomplished in a C-12 simulator on May 15, 1992, at Flight Safety International, Wichita, Kansas. Also according to the U.S. Air Force, the flight proficiency check includes a review of high density altitude training.

According to the first pilot's civilian pilot logbook, his total civil aeronautical experience consists of about 297.2 hours, of which 131.7 hours were accrued in the Mooney M20J. In the preceding 90 and 30 days before the accident, the logbook lists a total of 25 and 13.9 hours, respectively, flown in the accident airplane.

In the preceding six months, the pilot had logged 6.1 hours of instrument flight experience in the Mooney M20J. The first pilot's civilian logbook lists eight flights since March 29, 1992, of which he flew four flights under instrument flight rules (IFR) logging all of the 6.1 flight hours. This does not include the accident flight where the first pilot filed IFR from March AFB. The first pilot's spouse indicated during an interview that it was common practice for her husband to file IFR and practice using the aircraft systems. When specifically asked about the autopilot, the spouse indicated, "He would use it, too."

The first pilot's log book also indicated that he had flown to the Sedona Airport on three previous occasions, twice in the accident airplane. The most recent flight before the accident was on August 11, 1992, during a personal flight that originated from Flagstaff, Arizona.

Second Pilot

The second pilot held a commercial pilot certificate which was issued on August 17, 1990, also based on military competency. The second pilot was also an active duty member of the United

States Air Force stationed at March AFB. The second pilot performed duties as a military pilot in C-12F aircraft.

Review of the second pilot's most recent military flight record closeout revealed his total military aeronautical experience consisted of 1,161.8 hours, of which 80.5 hours were in the last 90 days. According to the U.S. Air Force, the first pilot's most recent pilot proficiency check was accomplished in a C-12 simulator on October 30, 1992, at Flight Safety International, Wichita, Kansas.

Aircraft Information

The airplane, a Mooney M20J, was manufactured in June 1977 and accrued about 2,394.6 hours. The weight and balance data for the airplane lists an Edo-Acre Mitchell Century IIB autopilot system, serial number 2B-1331, which was installed under a Supplemental Type Certificate (STC) at the time of airframe manufacture.

The STC requires an FAA approved airplane flight manual supplement, Part Number 68S424-1, dated April 15, 1977, for Mooney M20J owners. The manual supplement outlines the procedures to operate the autopilot system.

The manual supplement indicates an autopilot runaway could result in an uncontrolled bank and loss in altitude. The manual states, "An autopilot runaway, with a 1 second delay in the initiation of recovery, during an approach operation, coupled or uncoupled, could result in a 20 degree bank and 40 foot attitude loss." This equates to an average roll rate of approximately 20 degrees per second and an average rate of descent of approximately 2,400 feet per minute.

In this circumstance, the pilot must electrically disconnect the system by either pulling the circuit breaker or pushing the roll ON-OFF rocker switch located on the lower instrument panel to the OFF position.

The manual supplement indicated the autopilot can be overpowered at either control wheel. According to the autopilot manufacturer, a friction clutch in the roll servo is set to slip at thirty two pounds of pull, plus or minus four pounds, allowing the pilot to overpower the electrically engaged roll servo. (The pilot would have to continue to manually overpower the system under the electrical power was interrupted.) The autopilot installation specifications do not require a control wheel mounted electrical interrupt switch.

The clutch friction is set by the autopilot manufacturer at the time of manufacture or when returned to the factory for maintenance. According to the manufacturer, setting the friction of the clutch is only authorized to be performed at the factory. Accordingly, the autopilot manufacturer does not publish the friction specifications in the autopilot maintenance manual used by repair stations.

Examination of the maintenance records revealed that the most recent annual inspection was

accomplished on the airplane on April 2, 1993. The accident flight was the fifth trip flown since the annual inspection, with the airplane accruing about 14 flight hours. Review of the annual inspection checklist revealed the autopilot system was inspected, and a post inspection operational flight check was accomplished. Additional maintenance was performed on the airplane's pitch trim switch and the stall warning horn was replaced. There was no evidence found in the airplane's maintenance records to indicate that the roll servo had been repaired or replaced since the airplane's manufacture.

Meteorological Information

The closest official weather observation station is at the Sedona Airport. At 1125 hours, a special surface observation reported in part: Sky condition and ceiling, clear; visibility, 50 statute miles; temperature, 76 degrees fahrenheit; dewpoint, 13 degrees fahrenheit; winds, 330 degrees at 10 knots; altimeter, 30.04" inHg.

Aerodrome and Ground Facilities

The Sedona Airport is owned and operated by the County of Yavapai. The published elevation of the airport is 4,827 feet MSL. The Airport Facility Directory lists the airport traffic pattern altitude at 1000 feet above the airport elevation with standard left turns.

The airport has a single surfaced runway on a 030 degree and 210 degree magnetic orientation. Runway 3 is 5,131 feet long by 75 feet wide, and is equipped with a visual approach slope indicator system (VASI). The VASI consists of a two light box system installed on the left side of the runway. The lights are pilot activated over the CTAF. The VASI approach angle is set at 3 degrees with a threshold crossing height of 53 feet. The elevation of Runway 3 at the approach end of the runway is 4,733 feet MSL.

Wreckage and Impact Information

The accident site was located on the southwest slope of Table Top Mountain about 500 feet short of Runway 3, and about 300 feet to the right of the runway centerline. The elevation of the accident site is about 150 feet below the elevation of the threshold of Runway 3. The airplane impacted the ground in a nose down attitude on an approximate 200 degree magnetic heading. A six-foot wide by eight-foot long by one-foot deep crater marked the initial impact point of the fuselage. Shattered plexiglass was found down slope from the crater. A linear ground scar on an 110 degree bearing from the upslope edge of the crater disrupted the soil for about fifteen feet. Fragments of red position light glass were found at the end of the ground scar. The linear ground scar was bordered within inches by trees or bushes along its longitudinal axis. There was no evidence of damage to the upper branches of the vegetation. The lower branches directly above the linear ground scar were cut in a vertical plane.

The wreckage came to rest about fifty feet on a 220 degree magnetic bearing from the fuselage crater. The engine was nose down pinning the propeller against the ground. The fiberglass

upper nose cowling separated from the fuselage at the firewall. The fiberglass exhibited compression type impact damage to the forward left side of the airplane.

The propeller exhibited leading edge gouges in both blades that continued chordwise across the propeller chambered surface. The propeller blades were twisted and displayed forward bending at the tips.

The fuselage was bent up about ninety degrees at the instrument panel. The empennage was bent to the left about 15 degrees just aft of the cabin rear bulkhead. The nose gear was partially extended.

All fixed and moveable empennage control surfaces remained attached at their normal positions. There was impact damage to the leading edge of the left horizontal stabilizer. Elevator and rudder control system continuity was traced from the control surfaces to the cockpit.

The pilot's instrument panel was destroyed. The attitude indicator was detached from the panel leaving broken instrument glass and the attitude reference indicator face plates; the altitude indicator housing was not fund. The autopilot control panel was destroyed. The turn coordinator was intact on the panel and indicated an inverted roll attitude. The wings of the turn coordinators reference airplane were rolled left about 155 degrees.

Both wings exhibited impact damage to their respective wing tip leading edges. The right wing remained attached to the fuselage and the left wing was separated. Fuel was found in both wing tanks.

The right wing came to rest in a vertical position with the leading edge pointing up. Fuel leaked from the fuel cap when it was loosened. The aileron panel and flap panel were attached to the wing. The main landing gear was partially extended.

The left wing came to rest, inverted, with the leading edge facing upslope. The flap panel and aileron separated from the wing. The landing gear was found retracted in the gear well. Fuel was observed in the wing when a fuel tank inspection panel was removed. There was evidence on the ground that the left fuel tank had leaked some fuel, but about one quarter of the tank remained.

The flap actuator jack screw was extended, exposing about 3.5 inches of the jack screw. Two limit switches were found intact about 3 inches apart. The jack screw actuator had tripped the full down flap limit switch. The flap actuator was connected to a torque bar which rotated moving lever arm connected to two control rods attached to the flap panels inboard by the fuselage. The left flap control rod was broken consistent with the separation of the left wing. The right flap control system was continuous. The right flap control rod exhibited compression bending.

Examination of the aileron control tubes from the fuselage to the aileron bellcranks at wing station 147.75 indicated both tubes were pulled along the wing's longitudinal axis.

The right wing aileron bellcrank was fractured separating the control rods from the bellcrank hinge point. The portion of the right aileron bellcrank with the control tubes was pulled inboard through a sheet metal wing former.

The left wing exhibited leading edge damage along its entire span. There were two splits along rivet lines perpendicular to the wings longitudinal axis. The first split was the first seam inboard from the tip. The leading edge was open with the opening converging at the wings trailing edge. The wing spar was exposed but continuous through the opening. Diagonal buckling in the wing skin was noted to transcend the opening from the wing tip to approximately wing station 170. The second split was at wing station 148. The opening was wider at the trailing edge than the leading edge. The wing spar was separated. The wing remained attached by stringers.

The left wing aileron bellcrank remained intact. The two rod end bearings to the aileron control tubes were broken. The two bellcrank stop screws were intact. The autopilot roll servo pushrod remained attached to the aileron bellcrank by a 3/16 diameter steel bolt and was visible through the split in the wing.

The roll servo remained attached to the left wing by two metal brackets. The brackets were bent as well as the base plate that provides the roll servos primary structure for attachment of the electrical components and drive mechanism. The roll servo capstan was found rotated from the neutral position to an outboard position that corresponded to a full left turn limits of the capstan movement.

The pushrod was disconnected from the servo where it attaches to the roll servo capstan. A 3/16 diameter steel bolt that attaches the pushrod to the capstan was found broken. The bolt remained attached to the capstan by safety wire. There was no evidence of impact damage to the head of the broken bolt. Marks on the face of the capstan indicated the bolt was bent inboard.

There was no evidence to indicate the roll servo pushrod was over center when the bolt was bent. The nut, cotter pin and the end of the threaded shaft that attached the capstan to the roll servo gear train were not damaged. It should be noted that the nut serves as the adjustment of the clutch friction. A red paint stripe across the bolt and the threaded shaft in the center of the capstan was intact. There was no evidence that the nut had loosened since the paint strip was applied.

There were rub marks on the face of the capstan and corresponding rub marks on the pushrod that indicated the pushrod was pulled inboard. The geometry of the marks corresponded to the direction the bolt was bent and to a full left aileron position when the pushrod was pulled inboard. There was no evidence that indicated the friction clutch had slipped when the inboard pulling forces were applied.

A machine screw that holds an inspection access plate to the bottom of the wing was found touching the roll servo capstan's outer circumference edge. Scratches were generally parallel to the capstans center shaft indicating the capstan had not rotated after the machine screw touched the capstan.

The roll servo was removed from the wing. The capstan could not be rotated by hand.

Examination of the roll servo revealed that the gear train that transmits motion from the roll servo electrical motor to the capstan was engaged. There was no damage found to any of the teeth of the gear train. The engagement mechanism was traced to an electrical solenoid, which electrically engages the gear train. The engagement mechanism incorporated a metal lever which was spring loaded to mechanically disengage the gear train. The metal lever was found pinned in the engaged position by the bent metal base plate. The disengagement spring on the metal lever was not damaged and was capable of operation. The base plate was marked by the metal lever indicating the levers position when the base plate was bent.

The metal lever was released from its pinned position and the spring mechanism pulled the lever to the disengage position. The roll servo capstan then rotated freely.

Medical and Pathological Information

Post mortem examinations for both pilots were conducted by the Yavapai County Medical Examiner's Office on May 3, 1993, with specimens retained for toxicological examination. According to the Medical Examiner's report, the cause of death for both pilots was attributed to massive blunt trauma. The post mortem examination indicated that there were no fractures to the hands of either pilot.

The results of the toxicological analysis for both revealed negative findings for routine drug and alcohol tests.

Tests and Research

Components of the airplane's aileron control system and roll servo were sent to the Safety Board's materials laboratory for analysis. The metallurgist's report documented capstan damage and the fracture to the roll servo push rod bolt that attaches the push rod to the capstan. According to the metallurgist's report, the bolt "revealed fracture features and deformation typical of a bending stress separation." The report also listed the direction of the bolt bending inboard relative to the capstan's installation in the wing and position found in the airplanes wreckage. A copy of the Safety Board's metallurgist's report is included as part of this report.

Century II Maintenance Manual

The maintenance manual describes the basic operation for the autopilot system and lists the

maintenance and troubleshooting procedures. The manual indicated that the system controls both heading and roll. According to the manual, "The roll (aileron) engagement incorporates a fail-safe electrical engage and disengage mechanism in the roll servo which is operated by an ON-OFF switch in the console. When this switch is only engaged, the autopilot is responsive to only roll axis outputs of the attitude gyro and the commands of the console roll/turn control."

The airplane's artificial horizon provides the roll reference signal for the system. A console-amplifier supplies reference signals to the artificial horizon which in turn supplies the autopilot system information concerning the airplane's roll attitude. The manual indicated that this signal is the most important in the autopilot system.

The maintenance manual indicates loss of the roll reference signal from the artificial horizon will immediately be noted by the pilot. The manual states, "In the roll mode full rotation of the Roll Command Knob causes the aircraft to roll in the direction of the command and establish and maintain a 30 degree bank angle. However, without a roll reference signal the command would cause the aircraft to continue rolling until it was upside-down if the pilot did not stop it."

The manual further states, "Basically, the aircraft could still be flown with only the Roll Command Knob but it would require continuous manipulation since returning the Roll Command Knob to the center position would not return the aircraft ailerons to neutral. Remember, the Century II autopilot is an open loop system. The only reference the autopilot has as to the position of the aircraft's controls is the attitude in which the aircraft is flying.

Loss of the Artificial Horizon roll reference signal can be narrowed down to four causes: defective Artificial Horizon; defective wiring (CD-18 to amplifier); defective Console Amplifier; or a defective Roll Signal Filter."

Additional Information

Wreckage Release

The wreckage was released to the representatives of the owner on September 21, 1993.

## Pilot Information

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| **Certificate:** | Commercial; Military | **Age:** | 33, Male |
| **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):** | None | **Toxicology Performed:** | Yes |
| **Medical Certification:** | Class 2 Valid Medical--no waivers/lim. | **Last FAA Medical Exam:** | 10/17/1991 |
| **Occupational Pilot:** | | **Last Flight Review or Equivalent:** | |
| **Flight Time:** | 3526 hours (Total, all aircraft), 132 hours (Total, this make and model), 2154 hours (Pilot In Command, all aircraft), 111 hours (Last 90 days, all aircraft), 49 hours (Last 30 days, all aircraft), 2 hours (Last 24 hours, all aircraft) | | |

## Aircraft and Owner/Operator Information

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| **Aircraft Make:** | MOONEY | **Registration:** | N201GK |
| **Model/Series:** | M20J M20J | **Aircraft Category:** | Airplane |
| **Year of Manufacture:** | | **Amateur Built:** | No |
| **Airworthiness Certificate:** | Normal | **Serial Number:** | 24-0218 |
| **Landing Gear Type:** | Retractable - Tricycle | **Seats:** | 4 |
| **Date/Type of Last Inspection:** | 04/02/1993, Annual | **Certified Max Gross Wt.:** | 2740 lbs |
| **Time Since Last Inspection:** | 14 Hours | **Engines:** | 1 Reciprocating |
| **Airframe Total Time:** | 2395 Hours | **Engine Manufacturer:** | LYCOMING |
| **ELT:** | Installed, activated, did not aid in locating accident | **Engine Model/Series:** | IO-360-A3B6D |
| **Registered Owner:** | OLSON, RICHARD E. | **Rated Power:** | 200 hp |
| **Operator:** | OLSON, RICHARD E. | **Operating Certificate(s) Held:** | None |

## Meteorological Information and Flight Plan

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| **Conditions at Accident Site:** | Visual Conditions | **Condition of Light:** | Day |
| **Observation Facility, Elevation:** | SEZ, 4827 ft msl | **Distance from Accident Site:** | 1 Nautical Miles |
| **Observation Time:** | 1125 MST | **Direction from Accident Site:** | 35° |
| **Lowest Cloud Condition:** | Clear / 0 ft agl | **Visibility** | 50 Miles |
| **Lowest Ceiling:** | None / 0 ft agl | **Visibility (RVR):** | 0 ft |
| **Wind Speed/Gusts:** | 6 knots / 10 knots | **Turbulence Type Forecast/Actual:** | / |
| **Wind Direction:** | 330° | **Turbulence Severity Forecast/Actual:** | / |
| **Altimeter Setting:** | 30 inches Hg | **Temperature/Dew Point:** | 24°C / -11°C |
| **Precipitation and Obscuration:** | | | |
| **Departure Point:** | RIVERSIDE, CA (RIV) | **Type of Flight Plan Filed:** | IFR |
| **Destination:** | | **Type of Clearance:** | None |
| **Departure Time:** | 0857 PDT | **Type of Airspace:** | Class G |

## Airport Information

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| **Airport:** | SEDONA (SEZ) | **Runway Surface Type:** | Asphalt |
| **Airport Elevation:** | 4827 ft | **Runway Surface Condition:** | Dry |
| **Runway Used:** | 3 | **IFR Approach:** | None |
| **Runway Length/Width:** | 5131 ft / 75 ft | **VFR Approach/Landing:** | Full Stop |

## Wreckage and Impact Information

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| **Crew Injuries:** | 2 Fatal | **Aircraft Damage:** | Destroyed |
| **Passenger Injuries:** | N/A | **Aircraft Fire:** | None |
| **Ground Injuries:** | N/A | **Aircraft Explosion:** | None |
| **Total Injuries:** | 2 Fatal | **Latitude, Longitude:** | |

## Administrative Information

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| **Investigator In Charge (IIC):** | THOMAS H WILCOX |
| **Additional Participating Persons:** | GREGORY ERICKSON; WILLIAMSPORT, PA<br>ROBERT L CPT CUSHING; GLENDALE, AZ |
| **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/. |