National Transportation Safety Board
Aviation Accident Final Report

Location:	Englewood, CO	**Accident Number:**	DEN05FA034
Date & Time:	12/10/2004, 1940 MST	**Registration:**	N538EA
Aircraft:	Mitsubishi MU-2B-60	**Aircraft Damage:**	Destroyed
Defining Event:		**Injuries:**	2 Fatal
Flight Conducted Under:	Part 135: Air Taxi & Commuter - Non-scheduled		

Analysis

Shortly after takeoff, the pilot reported to air traffic control he needed to return to the airport to land. The controller asked the pilot if he required any assistance, and the pilot responded, "negative for right now uh just need to get in as soon as possible." The controller then asked the pilot what the problem was, in which the pilot responded, "stand by one minute." Approximately 30 seconds later and while the airplane was on a left downwind to runway 35R, the pilot stated he was declaring an emergency and "...we've got an air an engine ta shut down uh please roll the equipment." The controller and other witnesses observed the airplane on the base leg and then overshoot the final approach to runway 35R. After observing the airplane overshoot the final approach, the controller then cleared the pilot to the next runway, runway 28, and there was no response from the pilot. The controller observed the airplane's landing lights turn down toward the terrain, and "the MU2 was gone." A witness observed the airplane make an "immediate sharp bank to the left and descend to the ground. The impact appeared to be just less than a 45 degree angle, nose first." A performance study revealed that while the airplane was on downwind, the airplane started to bank to the left. The bank angle indicated a constant left bank angle of about 24 degrees as the airplane turned to base leg. Twenty-three seconds later, the bank angle began to increase further as the airplane turned to final approach, overshooting the runway, while the angle of attack reached stall angle of about 17 degrees. The flight path angle then showed a decrease by 22 to 25 degrees, the calibrated airspeed showed a decrease by 40 to 70 knots, and the vertical speed indicated a 3,000 feet per minute descent rate just before impact. Examination of the airframe revealed the flaps were in the 20 degree position, and the landing gear was retracted. According to the airplane flight manual, during the base leg, the flaps should remain in the 5 degree position and the landing gear extended; and when landing is assured, the flaps then extended to 20 degrees and maintain 125 knots calibrated airspeed (KCAS) during final and 110 KCAS when over the runway. Minimum controllable airspeed (Vmc) for the airplane is 99 KCAS. Examination of the propellers revealed that at the time of impact, the left propeller was in the feathered position and the right propeller was in the normal operating range. Examination of the left engine revealed static witness marks on several internal engine components, and no anomalies were noted that would have precluded normal operation. The reason for the precautionary shutdown of the left engine was not determined. Examination of the right engine revealed rotational scorring and

metal spray deposits on several internal engine components. Four vanes of the oil pump transfer tube were separated and missing. The gearbox oil-scavenge pump was not free to rotate and was disassembled. Disassembly of the oil-scavenge pump revealed one separated oil pump transfer tube vane was located in the pump. Pitting and wear damage was noted on all of the roller bearing elements and the outer bearing race of the propeller shaft roller bearing. No additional anomalies were noted.

Probable Cause and Findings

The National Transportation Safety Board determines the probable cause(s) of this accident to be: the pilot's failure to maintain minimum controllable airspeed during the night visual approach resulting in a loss of control and uncontrolled descent into terrain. A contributing factor was the precautionary shutdown of the left engine for undetermined reasons.

Findings

Occurrence #1: LOSS OF ENGINE POWER
Phase of Operation: TAKEOFF - INITIAL CLIMB

Findings
1. 1 ENGINE - STOWED
2. (F) REASON FOR OCCURRENCE UNDETERMINED

Occurrence #2: LOSS OF CONTROL - IN FLIGHT
Phase of Operation: APPROACH - VFR PATTERN - BASE LEG/BASE TO FINAL

Findings
3. (C) AIRSPEED(VMC) - NOT MAINTAINED - PILOT IN COMMAND

Occurrence #3: IN FLIGHT COLLISION WITH TERRAIN/WATER
Phase of Operation: DESCENT - UNCONTROLLED

Findings
4. TERRAIN CONDITION - GROUND

Factual Information

HISTORY OF FLIGHT

On December 10, 2004, approximately 1940 mountain standard time, a Mitsubishi MU-2B-60 twin-engine turbo-prop airplane, N538EA, operated as American Check 900 (ACT 900), was destroyed when it impacted terrain following a loss of control while maneuvering near Centennial Airport (APA), Englewood, Colorado. The airplane was registered to and operated by Flight Line, Inc., Watkins, Colorado. Night visual meteorological conditions prevailed at the time of the accident. The unscheduled domestic cargo flight was being operated under the provisions of Title 14 CFR Part 135 under an instrument flight rules flight plan. The airline transport pilot and pilot-rated passenger sustained fatal injuries. The flight departed APA at 1936, and was en route to Salt Lake City International Airport (SLC), Salt Lake City, Utah.

According to Federal Aviation Administration (FAA) Centennial Air Traffic Control Tower (ATCT) transcripts and Denver Air Route Traffic Control Center (ARTCC) radar data, at 1929:27, the local controller cleared ACT 900 to taxi to runway 35R, and the pilot acknowledged the instruction. At 1933:09, the pilot informed the local controller they were ready for takeoff at the end of the runway. At 1935:05, the controller instructed ACT 900 to "full length runway three five right position and hold..." At 1936:04, the controller cleared ACT 900 for takeoff on runway 35R, and the pilot acknowledged the takeoff clearance. At 1936:56, the controller instructed ACT 900 to turn left to a heading of 280 degrees, and the pilot acknowledged the instruction.

At 1937:02, the airplane was approximately 500 feet agl, and the local controller instructed the pilot to contact Denver departure control; the pilot acknowledged the request. At 1937:36, the airplane was approximately 900 feet agl, and the pilot stated, "...we need to uh go around back in the pattern and come back in on uh either three five right or left please." At 1937:42, the controller stated, "...make a right turn make well you already your left turn keep keep un left turn and uh make left traffic for runway three five right." At 1937:53, the controller asked, "uh mitsubishi nine hundred uh are you do you require any assistance?" The pilot responded, "negative for right now uh just need to get in as soon as possible." At 1938:03, the controller stated, "o k say nature of the problem." At 1938:11, the pilot stated, "stand by one minute."

At 1938:31, the airplane was approximately 500 feet agl, and the pilot reported, "tower americheck nine hundred declaring emergency we've got an air an engine ta shut down uh please roll the equipment." At 1938:49, the controller cleared ACT 900 to land on runway 35R and stated the rescue/fire equipment was responding. At 1939:19, the controller requested from ACT 900 the souls on-board and fuel remaining. The airplane was approximately 400 feet agl, and the pilot responded, "two souls on board uh nineteen hundred pounds of fuel." At 1939:47, the controller stated, "americheck nine hundred you you can go ta two eight if you can do it." There was no response from ACT 900. At 1940:00, a transmission from an unknown source stated, "wind check". No further communications were received from ACT 900.

According to the controller-in-charge statement, "I saw ACT 900 turn base, overshoot final, and finally turn north. The aircraft lights made an abrupt nose down turn and the MU2 was gone." According to the local controller statement, "I cleared [pilot] to land on [runway] 35R. He overshot the base to final turn and went down east of the [runway]."

A witness, located in an airplane at APA who was monitoring the radio communications,

reported he observed the airplane make the turn to base, "however, they shot through the final approach course, headed approximately due east." He stated the airplane was approximately 500 feet agl. While the airplane was on base leg, the witness observed the airplane continue to the east in a shallow descent with the left wing slightly low until it went out of the witness's sight. The witness stated he could tell the left wing was slightly low based on looking at the red position light and the rotating beacon.

Another witness, located in a vehicle traveling south on a nearby road, stated she observed the airplane at "less that 75 feet [agl], an average height, in my opinion, had the airplane been aligned with runway 35R to land. The airplane appeared to be flying on its side, as if to make a hard left turn. It then leveled out briefly, and I could see the bottom of the fuselage. Considering the darkness, I did not see the landing gear deployed... As the airplane passed my side window, I heard an aggressive throttle and the airplane make an immediate sharp bank to the left and descended to the ground. The airplane was descending as the speed increased. The impact appeared to be just less than a 45 degree angle, nose first." Approximately 5 minutes after the crash, rescue personnel arrived on the accident scene.

Another witness, located in a vehicle traveling north on the nearby road, stated he observed the airplane flying "very low". He stated, "just before impact, [the airplane] banked left and down."

PERSONNEL INFORMATION

The pilot, age 28, who was seated in the left front seat position, held an airline transport pilot certificate, issued June 24, 2002, with an airplane multi-engine land rating, and a private pilot certificate with an airplane single-engine land rating, issued September 10, 1996. The pilot's most recent FAA first-class airman medical certificate was issued on September 1, 2004, and contained a limitation for corrective lenses.

The pilot's logbook was used to document the pilot's flight experience. The pilot's total flight time at the time of the accident was 2,495.8 hours, with 1,864.2 hours in multi-engine airplanes. The pilot had accumulated 363.8 total hours in the accident airplane make and model, of which all were recorded as pilot-in-command. In the 90 days preceding the accident, the pilot had accumulated 206.5 total flight hours, all of which were in the accident airplane make and model; and 70.1 total hours in the 30 days preceding the accident.

According to the "Remarks, Procedures, Maneuvers, Endorsements" section in the pilot's logbook, one engine inoperative operations and other multi-engine maneuvers were recorded as having been conducted on October 15, 1998, on an undocumented date in 1998, and on March 3 and March 7, 1999. Both entries were recorded as having been conducted in a Piper PA-34-200 airplane. On February 5, 2003, the pilot recorded in the remarks section of the logbook, "Engine Failure", which was listed as occurring on a flight in a Piper PA-31-310. No additional one engine inoperative operations were documented.

In the logbook remarks section, on April 21, 2001, "Part 135 Checkride" in a Piper PA-31-350 was documented; on June 19 - 23, 2003, "Simuflite Training Level D Simulator" was documented; on June 28, 2002, "135 Check" in a Beech BE-200 was documented; and on January 29, 2003, "Check Ride" in a Piper PA-31-350 was documented. No check ride entries were documented in the logbook for the accident aircraft make and model.

On June 30, 2004, the pilot recorded the first entry in the logbook for a flight (APA to SLC) in the accident airplane make and model. No documentation was noted in the "Remarks, Procedures, Maneuvers, Endorsements" section of the pilot's logbook for the accident airplane make and model.

The operator provided the pilot's personnel records to the NTSB investigator-in-charge (IIC). A review of the records revealed the operator hired the pilot in January 2003. The pilot completed the operator's "initial new-hire" training in the Piper PA-31 model airplane on January 29, 2003. According to the flight training records, on the second of three training flights, the instructor noted, "Very good, stalls, single engine work, precision [and] non-precision approaches."

The pilot completed the operator's "initial new-hire" training in the accident airplane make and model on July 12, 2004. The initial training consisted of 44 hours ground school, which included: Basic Indoctrination (Operator, Airman - Specific), Emergency Training (General Situation, Drill Training), Hazardous Materials, and Aircraft Ground (General Subjects, Aircraft Systems, Systems Integration). In addition to the ground training, the pilot completed 8.1 hours recorded as flight training. A review of the operator's flight training record revealed five training flights were conducted on July 1, 8, 9, 10, and 11. The training flights on July 1, 8, 9 were not recorded in the pilot's personal logbook. During the second and last training flight, landings "From Precision Approach with Most Critical Engine Inop." were conducted; during the third and forth flight, climbs "One-engine inoperative" were conducted; during the second and fifth flight, en route "With a Powerplant Inoperative" were conducted; during the fifth flight, approaches "ILS/One-engine Inoperative" and missed approaches "With Powerplant Failure" were conducted. During the first and fourth flights, systems procedures (emergency) "Powerplant Failure/Fire" were conducted. The second and third training flights were conducted in the accident airplane.

On July 12, 2004, the pilot completed a FAR 135 Airman Competency/Proficiency Check. The flight was conducted from Helena Regional Airport (HLN), Helena, Montana, to APA with a total flight time of 2.3 hours.

A review of the pilot's previous employment records revealed the pilot completed single-engine inoperative training in Piper PA-31 airplanes in April 2001, and in a Beech BE-300 simulator in June 2002.

The pilot-rated passenger, age 25, who was seated in the right front seat position, held a commercial pilot certificate with airplane single-engine land, airplane multi-engine land, and instrument ratings. He also held a flight instructor certificate with an airplane single-engine land rating and advanced ground instruction privileges. The passenger's most recent FAA first-class airman medical certificate was issued on October 22, 2003, and contained no waivers or limitations. According to the operator, the pilot-rated passenger was on board the accident airplane for aircraft familiarization training (The operator stated new-hire pilots would receive approximately 25 hours of aircraft familiarization prior to the initial training). The passenger had no pilot-related responsibilities during the accident flight. A review of the operator's pilot profile for the passenger revealed he had accumulated 857.0 total flight hours, of which 218.9 hours were in multi-engine airplanes.

Attendance records of Mitsubishi Heavy Industries America, Inc. (MHIA), which in conjunction with SimCom, conducts Pilot's Review of Proficiency (PROP) seminars for pilots,

owners and operator's of MU-2 airplanes, did not reflect the pilot or pilot-rated passenger had attended any of the PROP seminars. According to MHIA, the purpose of the PROP seminar is to improve pilot awareness and decision making skills, meet other MU-2 operators and learn more about how to operate an MU-2 safely and to better understand the various support programs available for the MU-2.

AIRCRAFT INFORMATION

Between 1967 and 1986, 703 Mitsubishi MU-2B airplanes were assembled in the US. Two variants, known colloquially as the long-body and short-body versions, were built during the production run. All models were manufactured using two AirResearch (or Garrett) TPE 331 series turboprop engines. Horsepower of the TPE 331 engines, as installed on MU-2B airplanes, progressively increased to an airframe limit of 715 shaft horsepower (shp) through the various TPE 331 "dash" models installed on the airplanes. The TPE 331 engine exhaust also produces approximately 148 pounds of jet thrust, the total engine output-as installed on MU-2B's is often expressed as equivalent shaft horsepower (eshp), which varied from 605 eshp to a maximum of 778 eshp on the MU-2B fleet.

The long-body version has increased cabin area, the result of a fuselage redesign, which increases the overall length of the aircraft from 33 feet 3 inches to 39 feet 5 inches. Wingspan and area remained unchanged over the production life of the airplane. During the production period, maximum gross takeoff weights increased from the original MU-2B-10's 8,930 pounds to the MU-2B-60's 11,575 pounds. All versions were certificated for single-pilot operation, and did not require a copilot.

FAA certification of the Mitsubishi MU-2B was originally accomplished under the provisions of the Bilateral Airworthiness Agreement between the US and Japan, dated February 1, 1963. In accordance with Part 10 of the Civil Air Regulations (currently 14 CFR 21.29), FAA Type Certificate (TC) A2PC was issued for the MU-2B on November 4, 1965. The airplanes were initially shipped to the US as completed airframe kits; engines and other accessories were then added and the airplanes were test flown and released. Interior furnishings, additional avionics, and instruments were usually added after the airplane was released by Mitsubishi's US representative, which was originally Mooney Aircraft Corporation.

On September 12, 1973, Mitsubishi Aircraft International, Inc. (MAI) submitted an application for type certification of the MU-2B under the provisions of 14 CFR 21.21. The stated intent was to place control of the type design data with MAI at San Angelo, Texas, and to place direct responsibility for specific approval of type design, and changes thereto, with the FAA, rather than through the Japan Civil Aviation Bureau and bilateral agreements. Exemption number 1951 was granted on February 4, 1974, to permit use of the same certificating regulations as were used for airplanes manufactured under TC A2PC. On January 20, 1976, FAA type certificate approval A10SW was granted for the MU-2B-25 and -35 models. Subsequent approval was granted for -26, -26A, -36, -36A, -40, and -60 models, as part of TC A10SW.

The accident airplane, a long-body Mitsubishi MU-2B-60, serial number 1538SA, was a high performance, high wing, semi-monocoque design airplane. The airplane was powered by two 715-horsepower Honeywell TPE331-10-511M turboprop engines (serial numbers P36414C and P-36284C). The airplane was equipped with 4-bladed, Hartzell HC-B4TN-5GL single acting, hydraulically operated, constant speed with feathering and reversing capability, propellers. The airplane was equipped with flight controls for the left and right seats.

The airplane was issued a standard airworthiness certificate on September 1, 1981. The airplane was registered to the operator on June 18, 1999, and was maintained under a FAA approved airworthiness inspection program. According to maintenance records obtained from the operator, on November 14, 2004, at a total airframe time of 12,606.6 hours (Hobbs 5,775.2), the airframe underwent 100-, 200-, and 12,500-hour inspections that were completed in accordance with Mitsubishi Inspection Requirements MR-0179-2.

On February 15, 2004, the left engine, serial number P-36414C, was installed on the airframe. According to the engine logbook, on November 18, 2004, the engine oil was changed, the oil filter and fuel filter were replaced, the igniter plugs were inspected, and a Spectrometric Oil Analysis Program (SOAP) entry was recorded. The SOAP result was the following: "Normal Sample - Continue Sending Samples at the Recommended Interval." At the time of the November 18, 2004 maintenance, the left engine had accumulated 8,468.9 hours and 9,241 cycles since new; 2,799.7 hours and 2,622 cycles since overhaul; and 857.8 hours since hot section inspection.

On February 25, 2004, the right engine, serial number P-36284C, was installed on the airframe. According to the engine logbook, on November 18, 2004, the oil filter and fuel filter were replaced, the igniter plugs were inspected, and a SOAP entry was recorded. The SOAP result was the following: "Important!! Inspect This Engine Immediately!!!!" The sample contained shiny M50 steel platelets, a material used in the manufacture of bearings. At the time of the November 18, 2004, SOAP, the engine had accumulated 8,513.9 hours and 8,257 cycles since new; 4,981.2 hours and 5,437 cycles since overhaul; and 1,271.9 hours since hot section inspection.

On August 24, 2004, the SOAP recommended a resample of oil in the right engine after 10 hours of operation. After 110 hours of operation, the oil from the right engine was resampled on October 11, 2004. M50 platelets were detected in the oil sample. The October 11, 2004, SOAP recommended a resample of oil in the right engine after 10 hours of operation. The right engine oil was resampled after 92 hours of engine operation on November 17, 2004.

On November 16, 2004, the following discrepancy was noted on the aircraft right engine work order # SLC, "Pilot reports fire warning [light] set off two separate times while engine operating. (No Fire)." Maintenance corrective action to that entry was, "Tightened loose leads on [engine]; [operations check] good".

On November 18, 2004, the left and right propellers underwent a 100-hour inspection. At the time of the inspection, the left and right propellers had accumulated 867.7 and 1,678.9 hours respectively, since overhaul.

At the time of the accident, the Hobbs reading was 5,833.6 hours.

At the request of the NTSB IIC, Mitsubishi Heavy Industries America, Inc. (MHIA) calculated the accident airplane's takeoff weight and center of gravity as 10,616.0 pounds and 196.9 inches, respectively. The airplane's maximum takeoff weight was 11,575 pounds and the center of gravity limits were 190.9 to 199.4 inches.

METEOROLOGICAL INFORMATION

At 1953, the APA METAR (routine aviation weather report) reported the wind from 270 degrees at 10 knots, visibility 10 statute miles (or greater), few clouds at 8,000 feet agl, temperature 9 degrees Celsius, dew point minus 4 degrees Celsius, and an altimeter setting of

30.25 inches of Mercury.

AIRPORT INFORMATION

The Centennial Airport, APA, is a public, controlled airport located approximately 15 miles southeast of Denver, Colorado, at 39 degrees, 34.207 minutes north latitude, and 104 degrees, 50.957 minutes west longitude, at a surveyed elevation of 5,883 feet. The airport features three asphalt runways, Runway 17L/35R, which is 10,002 feet by 100 feet, Runway 17R/35L, which is 7,004 feel by 77 feet, and Runway 10/28 is 4,800 feet by 75 feet.

WRECKAGE AND IMPACT INFORMATION

The accident site was located near the edge of a parking lot in a business complex and an adjacent field, approximately 0.7 miles south-southeast of the threshold of runway 35R. A global positioning system (GPS) receiver reported the location as north 039 degrees 32.786 minutes north latitude and 104 degrees 50.591 minutes west longitude. A blue wooden fence structure that separated the parking lot from the adjacent field was destroyed.

The initial impact point was two craters and a ground scar consistent with the dimensions of the right wing-tip fuel tank, right engine, and right wing. Portions of the right wing-tip fuel tank were found within the first impact crater. The right engine assembly, to include the propeller and engine cowling, was found within the second of the two craters, approximately 13 feet from the first impact crater. Another crater, consistent with the nose of the airplane, was located approximately 20 feet from the first impact crater. Two additional craters, consistent with the left engine and left wing-tip fuel tank, were located approximately 25 feet and 40 feet respectively, from the first impact crater (According to the MU-2B-60 Pilot's Operating Manual, the span between the two wing-tip fuel tanks is approximately 39 feet). The five impact craters were orientated along a measured magnetic heading of 30 degrees. The main wreckage came to rest on a measured magnetic heading of 150 degrees. The airplane impacted terrain in a slightly inverted nose-down attitude at an angle of approximately 50 degrees, which was determined from crush angles on the wing-tip fuel tanks relative to ground level.

The main wreckage consisted of the cockpit, fuselage, both wings, the left engine, and empennage. The fuselage came to rest on its left side. The wing center section was separated from fuselage, and the wings were separated from the center section. All of the flight control surfaces were located in the wreckage debris. The cockpit, to include the instrument panel, windscreen, and crew area was crushed and destroyed. The right side of the windscreen was fragmented and had separated from the windscreen frame. The left side of the windscreen was shattered, but remained intact within the windscreen frame. The cargo, which consisted of check bags and machinery parts, was located within the fuselage structure. The landing gear travel nut was found in the retracted position, and the three landing gears were found in the retracted position. The flap selector switch was found in the UP position.

The cockpit area, to include the instrument panel was crushed and torn aft. The instrument panel was destroyed and a majority of the instrument gauges were destroyed. Both the left and right engine fire extinguisher handles were found in the stowed position. The following readings were obtained from the left side of the instrument panel: airspeed indicator, 90 knots; altimeter, 5,940 feet; Kollsman window, 30.21 inches. The following readings were obtained from the right side of the instrument panel: airspeed indicator, 270 knots; Kollsman window, 29.99 inches; vertical speed indicator, 700 foot per minute descent. The engine instrument cluster displayed the following readings: left engine torque, 75 percent; right

engine torque, 115 percent; left engine exhaust gas temperature (EGT), 325 degrees Celsius; right engine EGT, destroyed; left engine fuel flow, zero; right engine fuel flow, 270 pounds per hour; left engine RPM, 0; right engine RPM, destroyed; left and right engine oil temperature, less than minus 50 degrees Celsius; left engine oil pressure, zero; right engine oil pressure, 100 psi; left fuel pressure, 18 psi; right fuel pressure, 75 psi. The cockpit engine controls were found in the following positions: left engine power lever, Flight Idle; right engine power lever, Take Off; left engine condition lever, "Emergency Stop"; right engine condition lever, "Take Off Land".

The left wing was separated from the wing center section and outboard of the left engine nacelle. The leading edge was crushed, and the outboard 4 feet of the wing was bent upward. The flap was separated from the wing. The wing-tip fuel tank was separated. The right wing was separated from the center wing section and outboard of the right engine nacelle. The leading edge was crushed aft. The flap, outboard of the engine nacelle, remained attached to the wing, and the inboard flap was separated. The wing-tip fuel tank was separated. The flap traveling nut position corresponded with the flaps in the 20-degree position.

The left engine had separated from the left wing and came to rest adjacent to the main wreckage. The cowling was crushed and partially separated from around the engine. The engine inlet contained earthen debris, which obscured a visual examination of the first stage compressor impeller. The gear case was fractured in several locations. The starter/generator was separated from the gear case, and the input shaft was intact. The fuel control and fuel pump assemblies were separated from the gear case. The manual fuel shutoff linkage was found in the OFF position. No evidence of metal spray deposits were noted on the suction side of the third-stage turbine rotor, and no evidence of damage to the leading edge of the blades of the third-stage turbine rotor.

The left propeller spinner was crushed aft, and the propeller remained attached to the engine. Three of the four propeller blades remained attached to the left propeller hub and were found in the feathered position, and one blade was separated at the hub. One blade contained chordwise scratches from the leading edge of the blade aft and had a slight twist starting at the blade hub, extending 1/4 of the distance out from the hub. The second blade contained chordwise scratches from the leading edge to the trailing edge of the blade. The blade had a slight "S" bend that extended from the blade hub to the tip of the blade. The third blade contained longitudinal scratches from towards the tip of the blade. The separated blade was found embedded in the terrain in the impact crater consistent with the left engine.

The right engine had separated from the right wing and came to rest adjacent to the second impact crater. The engine displayed sooting consistent with fire damage. The engine inlet contained earthen debris, which obscured a visual examination of the first stage compressor impeller. The gear case was fractured in several locations. The starter/generator was separated from the gear case, and the input shaft was fractured and separated. The manual fuel shutoff linkage displayed damage and was found in the OFF position. Metal spray deposits were noted on the suction side of the third-stage turbine rotor, and no evidence of damage to the leading edge of the blades of the third-stage turbine rotor.

The right propeller spinner was destroyed and a portion of the spinner was crushed and deformed around the hub. The right propeller was embedded in the soft ground and remained attached to the engine. Visual examination of the propeller blades revealed all four blades were bent inward towards the engine. Two blades displayed S-bending, which extended from the

blade hub to the blade tip. All four blades contained chord wise scratching along the face of the blade and minor leading edge gouging.

The empennage, including the rudder, elevator, and horizontal and vertical stabilizer separated from the fuselage at the aft pressure bulkhead. The right side of the empennage assembly displayed forward-to-aft accordion type crush damage. The leading edge of the vertical stabilizer was undamaged. The vertical stabilizer was partially separated aft from the main empennage assembly. The rudder was deflected to the right. The leading edges of the left and right horizontal stabilizers were undamaged, and the trailing edge of the left elevator control was bent upward. The elevator trim tabs remained attached to the elevators.

The wreckage was recovered to Beegles Aircraft Service, Inc., Greeley, Colorado, for further examination.

MEDICAL AND PATHOLOGICAL INFORMATION

Autopsies were performed on both the pilot and pilot-rated-passenger by the Douglas County Coroner's Office, Castle Rock, Colorado, on December 13, 2004. Specimens for toxicological tests were taken from the pilot and passenger by the medical examiner. According to the autopsies, the cause of death for the occupants was due to massive bodily injury secondary to blunt force trauma.

The FAA's Civil Aeromedical Institute's Forensic and Accident Research Center, Oklahoma City, Oklahoma, examined the specimen's taken by the medical examiner. Toxicological tests performed on both the pilot and the passenger were negative for carbon monoxide, cyanide, ethanol, and all screened drugs.

TESTS AND RESEARCH

Airframe

On December 13 and 14, 2004, at the facilities of Beegles Aircraft Services, the wreckage was examined by the NTSB IIC, FAA inspectors, representatives of the airframe, engine, and propeller manufacturers, and the operator. Examination of the wreckage revealed that the left main fuel shutoff valve at the main tank was in the off position. The right main fuel shutoff valve at the main tank had separated during the impact sequence, and it was found in the open position. Both the right and left fuel filters were removed and found to be clear of contaminants. Utilizing compressed air, both the left and right fuel lines were examined for obstructions; no obstructions were noted from the fuel filter to the left and right engine connections.

Examination of the rudder trim control revealed that the traveling nut was in a 20 degrees nose right position. The rudder actuator was found in the full nose right position. The elevator trim actuator was in a positive 2 degrees, or nose up position. Each wing has three jackscrews, which control flap extension and retraction. The flap relay and the six jackscrews confirmed that the flaps were at 20 degrees position. The aileron trim actuator measurement corresponded to a 20 degrees right position. The aileron trim selector switch was found in the BOTH position. Wing spoiler positions could not be determined.

Control continuity was established to the rudder and elevator control surfaces. Control cable continuity could not be established to the spoilers and flaps due to damage.

Propellers

Examination of the left propeller revealed the propeller remained attached to the engine. The piston was at the feather position, one blade was separated and three blades were in the feather position. The spinner dome was deformed over the three of four blade counterweights with the counterweights in the feathered position. The piston had two internal gouges consistent with cylinder contact while in the feather position. The piston displayed impression marks from the feather stop screws. One link arm was bent and gouged from contact with the blade clamp. The gouge occurred with the link arm positioned at or near the feather position.

Examination of the right propeller revealed the propeller remained attached to the engine. One blade was at the feather position and the other three blades were at a low blade angle position. The piston was measured to be 1-23/32 inches from the aft side of the piston to the guide collar. The position equated to approximately 33.4 degrees blade angle, which was a position within the normal operating range. Blade identification marks from one blade butt had transferred to the corresponding hub arm. The parts were visually aligned which positioned the blade at an angle consistent with the normal operating range.

Powerplants

On February 1 through 3, 2005, at the facilities of Honeywell Engines, Systems, and Services, Phoenix, Arizona, both engines were disassembled and examined under the supervision of the NTSB IIC, representatives from the FAA, airframe and engine manufacturer, and the operator. Examination of the left engine (P-36414C) revealed the engine was broken into two sections, gearbox and power sections. The engine propeller shaft and power section were not free to rotate as received. Static witness marks were found on the following engine components: forward face of the propeller shaft roller bearing, torque sensor gear housing, first-stage compressor impeller shroud which corresponded to the blade profiles of the first-stage compressor impeller, second-stage compressor impeller shroud which corresponded to the blade profiles of the second-stage compressor impeller, second-stage turbine stator shroud which corresponded to the blade profiles of the second-stage turbine rotor, and the third-stage turbine stator shroud which corresponded to the blade profiles of the third-stage turbine rotor. Damage consistent with erosion was noted on the leading edge and suction surface on four vanes of the first-stage turbine stator. Damage consistent with erosion was also noted on the leading edge and tips of all first-stage turbine rotor blades. No foreign debris was noted on the magnetic drain plug in the accessory drive housing.

The manual fuel shutoff lever on the fuel shutoff solenoid valve was in the off position and was found rotated over center, opposite the direction of normal operation. No foreign debris was found in the fuel and oil filters. The tach generator was intact and the input shaft was free to rotate. The fuel pump, fuel control assembly and propeller governor were sent to the manufacturer for examination.

Examination of the right engine (P-36248C) revealed the engine propeller shaft and power section were not free to rotate as received. Four vanes/ribs of the oil pump transfer tube, located in the nose cone housing, were cracked and missing. Metallurgical examination of the tube revealed fatigue cracks initiated on both sides of each rib near the inner diameter wall of the tube. Cracks were noted in the corner radii at the base of nearly all of the ribs that had not separated. No material defects were associated with the crack initiation sites. The corner radii were approximately 0.002 inches. The engineering drawing specified a maximum typical

radius of 0.025 inches and no minimum was specified. Rotational scoring was noted on three areas of the propeller shaft. Two planet gears were free to rotate, one rotated with resistance, and one would not rotate. Disassembly of the planet gear assembly revealed the inner bearing race of two planet gears were fractured, and rotational scoring was noted on the aft face of two planet gears, which corresponded to rotational scoring on the ring gear support. Rotational scoring was noted on the sun gear, which corresponded with the scoring noted on the propeller shaft. Metallic particles were noted on the magnetic drain plug in the accessory drive housing. Pitting and wear damage was noted on all of the roller bearing elements and the outer bearing race of the propeller shaft roller bearing. The bearings were manufactured with M50 material. The gearbox oil-scavenge pump was not free to rotate and the pump was disassembled. Disassembly of the pump revealed a piece of metallic debris that originated from the oil pump transfer tube.

Rotational scoring was noted on the first-stage compressor impeller and shroud. The leading edges of all first-stage compressor blades were bent opposite the direction of rotation. Silver colored deposits were noted in the first-stage compressor impeller blade passages. Rotational scoring was noted on the second-stage compressor impeller shroud and the shroud line edge of all second-stage compressor impeller blades. Earthen debris and metallic particles were noted adhering to the inlet of the second-stage compressor diffuser assembly vane passages. Metal spray deposits were noted on the suction side of the first and second-stage turbine stator vanes. Rotational scoring was noted on the first-stage turbine blade tip shroud segments and shroud line edge of all first-stage turbine rotor blade tips. Metal spray deposits were noted on the suction side of the first and second-stage turbine rotor blades.

The manual fuel shutoff lever on the fuel shutoff solenoid valve was in the intermediate position, between on and off, and the lever displayed damage. The fuel pump could not be functionally tested due to a fractured housing, and was disassembled. The low to high-pressure drive shaft and splines were intact. The carbon bushings were fractured. No foreign debris was found in the fuel filter. Metallic particles were noted on the oil filter. The tach generator displayed black soot and fire damage, and the input drive was free to rotate. The fuel control and propeller governor was sent to the manufacturer for examination.

Fuel Controls

On May 9 and 10, 2005, at the facilities of Woodward Governor Company, Rockford, Illinois, the engines' fuel controls, propeller governors, and left engine fuel pump were examined under the supervision of the FAA, and representatives from airframe and engine. The fuel control and fuel pump for the left engine were tested together as a system. As previously mentioned in this report, the fuel pump on the right engine housing was fractured and could not be functionally tested with the fuel control as a system. The fuel control from the right engine was tested with slave pump provided by Woodward Governor Company.

According to the manufacturer, the left engine fuel control and fuel pump were tested in accordance with Woodward approved acceptance test. The fuel control was functionally tested. Some fuel control schedules could not be run because of damage sustained during impact. All test points where data was taken showed satisfactory operation. No indications of a pre-incident malfunction were found.

The right engine fuel control was tested in accordance with Woodward approved acceptance test. The fuel control was functionally tested. Some fuel control schedules could not be run

because of damage sustained during impact. All test points where data was taken showed satisfactory operation. No indications of a pre-incident malfunction were found.

Propeller Governors

The left propeller governor was functionally tested. Maximum and minimum speed points were not within approved test procedure specifications, as well as the travel between them on initial testing. It was determined that the airframe manufacturer routinely trims the governor setting to meet aircraft specific installations, and this likely accounted for the disparity between the governor and what the governor manufacturer specified. An external leak was noted in the synchrophasing coil wires and cover. The leak was consistent with the damage to the housing during impact. Anomalies noted during the examination were consistent with impact damage, and the unit functioned properly.

The right propeller governor was functionally tested. Maximum and minimum speed points were not within approved test procedure specifications, as well as the travel between them on initial testing. The same airframe manufacturer modifications that applied to the left governor applied to the right. No anomalies were noted, and the unit functioned properly.

NTSB Performance Study

Continuous Data Recordings (CDR), National Track Analysis Program (NTAP) data, and a curve fit were used to compile three plots for the performance study. Due to the inherent coarseness of the radar data and the uncertainty, all performance parameters calculated should be used as estimates only and not as quantitative measurements. Although references are made to quantitative values, they are merely for references purposes and the plots should be used to look at increasing or decreasing trends in the data. The three plots are: 1) a plot of the airplane's ground track as north and east distance from the runway threshold, 2) a plot of the aircraft's altitude and speed versus time, 3) a plot of the calculated angles versus time. The CDR data has a higher sampling rate and was the primary source of data. The NTAP provided additional 6.9 seconds of data to 1939:56. The NTAP data point was combined with the CDR data and a curve fit was applied. The performance calculations were completed utilizing the curve fit of the combined data.

A review of the performance study's calculated parameters revealed that at 1939:01, the airplane started to bank to the left. About 12 seconds later, the vertical speed increased, the calibrated airspeed began to decrease from 143 knots, and the angle of attack began to increase. Starting at 1939:21, the bank angle indicated a constant bank angle of about 24 degrees to the left as the airplane turned to base leg. Twenty-three seconds later, the bank angle began to increase further as the airplane turned final, overshooting the runway, while the angle of attack reached stall angle of about 17 degrees. The flight path angle then showed a decrease by 22 to 25 degrees, the calibrated speed showed a decrease by 40 to 70 knots, and the vertical speed indicated 3,000 feet per minute descent rate just before impact with terrain.

Best Rate of Climb Calculations

At the request of the NTSB IIC, MHIA calculated three cases of best rate of climb speed (Vy and Vyse) and feet per minute (fpm) based on the following conditions: weight - 10,616 pounds (ramp weight); altitude - 5,883 feet (airport elevation), and temperature - 8.9 degrees Celsius (airport temperature). The following three scenarios were calculated: 1) Two engines, gear and flaps up; 2) one engine inoperative, gear and flaps up; 3) one engine inoperative, gear down and flaps 20 degrees.

The following calculations were the results for the three aforementioned conditions: Scenario 1 - 2,400 fpm, 154 KCAS (knots calibrated airspeed), 170 KTAS (knots true airspeed); Scenario 2 - 500 fpm, 148 KCAS, 163 KTAS; and Scenario 3 - 60 fpm, 111 KCAS, and 122 KTAS.

ADDITIONAL INFORMATION

MU-2B-60 Airplane Flight Manual

The Airplane Flight Manual (AFM) airspeed limitations are listed as: Minimum control airspeed (Vmc), Flaps 5 and 20 degrees - 99 KCAS.

The AFM "Emergency Procedures", Single Engine Landing procedure (in part) is as follows:

Before Landing Checklist - Use normal procedures except as follows:

1. Inoperative Engine - Secured (Use Engine Shutdown Procedure)
2. Fuel Quantity and Balance - Check Within Limitations
3. Cabin Air Selector Switch - Off or Ram
4. Condition Lever (Operating Engine) - Take Off Land
5. Power Lever (Operating Engine) - Set as Required to Maintain Airspeed and Desired Flight Path
6. Landing Gear - Up
7. Flaps - Up (Vxse = 140 KCAS)
8. Airspeed - 150 KCAS

Beginning final approach descent or base leg: (approximately 1,000 feet agl)

9. Flaps - 5 degrees (Vxse = 130 KCAS)
10. Airspeed - 140 KCAS
11. Landing Gear - Down
12. Power Lever (Operating Engine) - As Required to Maintain Airspeed and Desired Flight Path

When Landing is assured:

13. Flaps - 20 degrees (Vxse = 125 KCAS)
14. Airspeed - 110 KCAS when over runway

Operator's Ground and Flight Training Program

The operator provided their "Air Carrier Training Program" manual to the NTSB. According to the training program manual, dated August 1, 1998, the categories of training included: initial new-hire, initial equipment, transition, upgrade, recurrent, requalification, and differences training. The manual summarized in general terms the categories of training as follows: "All personnel not previously employed by our company must complete initial new hire training," and "All personnel who are being assigned by us to a different duty position and/or aircraft type must complete either initial equipment, transition, upgrade or requalification training, depending on the aircraft type and duty position for which they were previously qualified."

The chief pilot was responsible for insuring that the training program was adhered to as approved by the FAA. The check airman may be assigned the duty of monitoring the training programs. The flight training was to be conducted from the pilot's base whenever practical. According to the Transfer of Training and Testing Requirements section, the FAA had approved a minimum number of training hours for newly hired pilots; however, the FAA recognized circumstances where a pilot had been previously trained or certified for a similar level of air carrier operations would not be required to complete the operator's entire training program. The manual states, "Case-by-case individual approvals to reduce training time should be done. Blanket approvals are discouraged...Flight training is not waived; however, the training program allows for reduced flight training times if the pilot completes all of the required maneuvers and passes a flight check."

Operator's Training Manual - Safety Considerations

According to the Safety Considerations in Flight Training section for simulated engine failures, "No engine shutdowns below 5,000' (feet) agl; No propeller featherings with engine operating below 2,500' agl; Below 5,000' agl use zero thrust as recommended by the POH to simulate a single-engine condition." Other considerations are as follows, "No engine shutdowns or featherings without visual meteorological conditions; Other than V1 cuts (only in aircraft for which that demonstration is required) no simulated engine failures between 60 KIAS and establishment of a positive rate of climb and selection of gear-up during take-off or missed approach; In-flight, no simulated failures below Vsse in any aircraft."

Aircraft Ground Training Module

The training manual included Aircraft Ground and Flight Training modules for all series of MU-2 aircraft. For the Aircraft Ground Training "New-Hire, Initial Equipment, Upgrade and Transition Training", all of the course material will be taught, including testing and reviews. This may be either in an individual training session or in a class setting. The table of approved training times included 16 hours of aircraft ground and 8 hours of flight training. The training notes indicated that no simulators are used or have been approved. The schedule of training included, but was not limited to, the following aircraft systems training modules: powerplants, electrical system, flight controls, warning systems, fire protection. The powerplants module included emergency and abnormal operations. The following modules were noted in the general operational subjects: aircraft-specific procedures, weight and balance, performance characteristics, hazardous weather considerations, and accident history. The performance characteristics module included effects of normal, special purpose, abnormal, and emergency flight modes on aircraft performance and endurance capabilities.

Aircraft Flight Training Module

The flight training module objective was to insure that the pilot is able to operate the aircraft to applicable FAA Practical Test Standards criteria in all normal and emergency situations. All flight maneuvers and procedures must be taught in initial new-hire, initial equipment, upgrade, and transition training. The Instructional Delivery Method stated, "Unless simulators are approved, all flight training will be conducted in the aircraft. If approved by the FAA, we may use approved training centers and their simulators instead of aircraft for all flight training phases. Training center programs are submitted as separate documents for approval." At the time of the accident, the operator did not have an approved training center program, nor was one required. The flight maneuvers segment module included, but was not limited to, the

following required training activity:

1. Takeoff - Vmc Demonstration and Recovery

2. Climb - One-Engine Inoperative

3. En route - Powerplant Shutdown and Restart; With a Powerplant Inoperative

4. Approaches - VFR Procedures - With 50 percent Loss of Power on One Side

IFR Precision Approaches - ILS, MLS, PAR/ One-Engine Inoperative

IFR Non-Precision Approaches - Non-precision approach With One-Engine Inoperative, LOC/Backcourse, RNAV, Circling Approach

Missed Approaches - With a Powerplant Failure

5. Landings - From Precision Instrument Approach With Most Critical Engine Inoperative; With 50 percent Power Loss on One Side.

6. System Procedures Training During Any Airborne Phase (Emergency) - Powerplant Failure/Fire; Electrical, Hydraulic, Pneumatic Systems

According to the Maneuvers Profile section, One-Engine Inoperative Landing diagram, on the downwind leg, the flaps are set to 5 degrees and airspeed at 140 knots minimum; on the base leg, the flaps are at 5 degrees, airspeed 140 knots minimum, the landing gear is down, (approximately 40 percent torque), and sink rate should be checked; on final when landing is assured, flaps should be extended to 20 degrees, airspeed 125 knots minimum, complete landing checklist, check sink rate - 500 to 600 feet per minute; at the threshold, flaps 20 degrees, airspeed 110 knots.

Administrative Information

Parties to the investigation included the Federal Aviation Administration, Mitsubishi Heavy Industries America, Inc., Honeywell Engines, Systems and Services, Hartzell Propeller Inc., and Flight Line, Inc.

The wreckage was released to a representative of the operator's insurance company on February 1, 2006.

Pilot Information

Certificate:	Airline Transport; Private	**Age:**	28, 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 1 Valid Medical--w/ waivers/lim.	**Last FAA Medical Exam:**	09/01/2004
Occupational Pilot:		**Last Flight Review or Equivalent:**	07/12/2004
Flight Time:	2496 hours (Total, all aircraft), 364 hours (Total, this make and model), 2281 hours (Pilot In Command, all aircraft), 207 hours (Last 90 days, all aircraft), 70 hours (Last 30 days, all aircraft), 1 hours (Last 24 hours, all aircraft)		

Co-Pilot Information

Certificate:	Flight Instructor; Commercial	**Age:**	25, Male
Airplane Rating(s):	Multi-engine Land; Single-engine Land	**Seat Occupied:**	Right
Other Aircraft Rating(s):	None	**Restraint Used:**	Seatbelt, Shoulder harness
Instrument Rating(s):	Airplane	**Second Pilot Present:**	Yes
Instructor Rating(s):	Airplane Single-engine	**Toxicology Performed:**	Yes
Medical Certification:	Class 1 Valid Medical--no waivers/lim.	**Last FAA Medical Exam:**	10/22/2003
Occupational Pilot:		**Last Flight Review or Equivalent:**	
Flight Time:	857 hours (Total, all aircraft), 0 hours (Total, this make and model)		

Aircraft and Owner/Operator Information

Aircraft Make:	Mitsubishi	**Registration:**	N538EA
Model/Series:	MU-2B-60	**Aircraft Category:**	Airplane
Year of Manufacture:		**Amateur Built:**	No
Airworthiness Certificate:	Normal	**Serial Number:**	15385A
Landing Gear Type:	Retractable - Tricycle	**Seats:**	2
Date/Type of Last Inspection:	11/01/2004, AAIP	**Certified Max Gross Wt.:**	11575 lbs
Time Since Last Inspection:	60 Hours	**Engines:**	2 Turbo Prop
Airframe Total Time:	12665 Hours at time of accident	**Engine Manufacturer:**	Honeywell
ELT:	Installed, activated, did not aid in locating accident	**Engine Model/Series:**	TPE331-10501M
Registered Owner:	Flight Line Inc.	**Rated Power:**	715 hp
Operator:	Flight Line Inc.	**Operating Certificate(s) Held:**	Air Cargo; On-demand Air Taxi (135)
Operator Does Business As:		**Operator Designator Code:**	VOXA

Meteorological Information and Flight Plan

Conditions at Accident Site:	Visual Conditions	**Condition of Light:**	Night
Observation Facility, Elevation:	APA, 5883 ft msl	**Distance from Accident Site:**	1 Nautical Miles
Observation Time:	1953 MST	**Direction from Accident Site:**	350°
Lowest Cloud Condition:	Few / 8000 ft agl	**Visibility**	10 Miles
Lowest Ceiling:	None	**Visibility (RVR):**	
Wind Speed/Gusts:	10 knots /	**Turbulence Type Forecast/Actual:**	/
Wind Direction:	270°	**Turbulence Severity Forecast/Actual:**	/
Altimeter Setting:	30.25 inches Hg	**Temperature/Dew Point:**	9°C / -4°C
Precipitation and Obscuration:	No Obscuration; No Precipitation		
Departure Point:	Englewood, CO (APA)	**Type of Flight Plan Filed:**	IFR
Destination:	Salt Lake City, UT (SLC)	**Type of Clearance:**	IFR
Departure Time:	1936 MDT	**Type of Airspace:**	Class D

Airport Information

Airport:	Centennial Airport (APA)	**Runway Surface Type:**	Asphalt; Dirt
Airport Elevation:	5883 ft	**Runway Surface Condition:**	Dry
Runway Used:	NA	**IFR Approach:**	Visual
Runway Length/Width:		**VFR Approach/Landing:**	Forced Landing; Traffic Pattern

Wreckage and Impact Information

Crew Injuries:	1 Fatal	**Aircraft Damage:**	Destroyed
Passenger Injuries:	1 Fatal	**Aircraft Fire:**	None
Ground Injuries:	N/A	**Aircraft Explosion:**	None
Total Injuries:	2 Fatal	**Latitude, Longitude:**	39.546389, -104.843056

Administrative Information

Investigator In Charge (IIC):	Aaron M Sauer	**Report Date:**	05/30/2006
Additional Participating Persons:	Robert Dixon; FAA Flight Standards District Office; Denver, CO Ralph Sorrells; Mitsubishi Heavy Industries America, Inc.; Addison, TX Anthony Mulci; Flight Line, Inc.; Watkins, CO Marlin J Kruse; Honeywell Engines, Systems and Services; Phoenix, AZ Tom McCreary; Hartzell Propeller Inc.; Piqua, OH		
Publish Date:			
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/.		