Aviation Investigation Final Report

Location:	CHILLICOTHE, Ohio	**Accident Number:**	NYC96LA188
Date & Time:	September 28, 1996, 08:35 Local	**Registration:**	N618BB
Aircraft:	Mitsubishi MU-2B-30	**Aircraft Damage:**	Substantial
Defining Event:		**Injuries:**	4 None
Flight Conducted Under:	Part 135: Air taxi & commuter - Non-scheduled		

Analysis

The Pilot (plt) said that after climbing about 500' after takeoff, at 120 kts with the gear retracted, the left engine lost power. He feathered the propeller, lowered the nose to the horizon, & began a shallow left turn back to the airport. He left the flaps at 20 deg & noted a descent of 200' to 300' per min in the turn. After clearing trees, the plt extended the landing gear, banked the aircraft (acft) to the right to align it with the runway (rwy), & lowered flaps to 40 deg. After touchdown, he applied single engine reversing. Acft went off right side of rwy & into a ditch, collapsing the right main & nose gear. Exam of the engine revealed the torque sensor housing had failed, resulting in loss of drive to the fuel pump. Metallurgical exam of the housing arm of the torque sensor revealed it had failed from fatigue. On 9/14/79, a service bulletin (SB) was issued for replacement of the torque sensor housing with an improved housing. The manufacturer overhauled the engine on 12/1179, but SB was not complied with. SB indicated a history of resonant vibration causing cracks in the housing arm of original torque sensor & gear assemblies, & that the housing should be replaced, no later than during next part exposure. Investigation revealed pilot did not comply with engine failure procedures & airspeeds. Flight manual cautioned not to use 40 deg of flaps during single engine landings.

Probable Cause and Findings

The National Transportation Safety Board determines the probable cause(s) of this accident to be: failure of the pilot to follow the published emergency procedures after loss of power in the left engine. Factors relating to the accident were: fatigue failure of the left torque sensor and gear assembly, which resulted in the loss of engine power, failure of the manufacturer to comply with the respective service bulletin, and the pilot's improper use of the flaps and reverse (single-engine) thrust.

Findings

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

Findings
1. 1 ENGINE
2. (F) TORQUEMETER SYSTEM - FATIGUE
3. (F) MAINTENANCE,SERVICE BULLETIN/LETTER - NOT COMPLIED WITH - MANUFACTURER

Occurrence #2: LOSS OF CONTROL - ON GROUND/WATER
Phase of Operation: EMERGENCY LANDING

Findings
4. PRECAUTIONARY LANDING - PERFORMED
5. (C) EMERGENCY PROCEDURE - NOT FOLLOWED - PILOT IN COMMAND
6. (F) FLAPS - IMPROPER USE OF - PILOT IN COMMAND

Occurrence #3: ON GROUND/WATER ENCOUNTER WITH TERRAIN/WATER
Phase of Operation: EMERGENCY LANDING

Findings
7. TERRAIN CONDITION - DITCH

Occurrence #4: GEAR COLLAPSED
Phase of Operation: EMERGENCY LANDING

Findings
8. LANDING GEAR,MAIN GEAR - OVERLOAD
9. LANDING GEAR,NOSE GEAR - OVERLOAD

Factual Information

On September 28, 1996, at 0835 eastern daylight time, a Mitsubishi MU-2B-30, N618BB, was substantially damaged during a precautionary landing at the Ross County Airport (RZT), Chillicothe, Ohio. The certificated airline transport pilot and three passengers were not injured. Instrument meteorological conditions prevailed for the passenger flight that originated at RZT, at 0830. An instrument flight rules flight plan had been filed for the flight conducted under 14 CFR Part 135.

According to a pilot statement, he departed runway 05, destined for Columbus, Ohio. He further stated:

"...had climbed to around 500 feet. I think it was about 30 seconds after I had brought the landing gear up. We experienced a sudden loss of all power on the left engine. I then secured the left engine, then I began to make a left turn back to the airport and determined that the aircraft would not hold airspeed, or altitude. I decided to continue the left turn to runway no. 23. During this time I was having a great deal of control problems. I was attempting to land on the runway, but may have touched down on the grass. I know that I flared over the runway; however, there was a pulling of the plane to the right caused by the right engine beta. This caused the plane to run into the grass, off of the right side of the runway..."

During a telephone interview, the pilot stated that the takeoff was performed with the flaps set at 20 degrees. When the airplane obtained a positive rate of climb, he raised the gear handle. During the climb, with the gear in transit, the airplane's airspeed was about 110 to 115 knots. The airplane was about 500 feet above the ground, and about 1 mile straight out from the departure end of the runway, when he observed the gear handle red light extinguish. He stated that this indicated that the gear was retracted and the gear doors were closed. At that point, with the airspeed at 120 knots, the left engine lost power.

When the engine lost power, he feathered the propeller, lowered the airplane nose to the horizon, and began a left turn. He estimated the airplane's speed was about 115 knots. He left the flaps set at 20 degrees, and noted the vertical speed was showing a descent of about 200 to 300 feet per minute in the turn. He was too low to see the runway, but continued in the direction of the airport, just above the trees. When the airplane cleared the trees he saw the runway. He then lowered the landing gear, and banked the airplane to the right, to align the airplane with the runway. The airplane was about 50 to 100 feet above the runway when he lowered the flaps to 40 degrees.

In a telephone interview, the pilot rated passenger that occupied the copilot's seat stated that shortly after the gear handle was raised, the left engine lost power. He was not sure if the gear had completely retracted when the loss of power occurred. The pilot immediately

feathered the left propeller and started a left turn into the dead engine. The passenger stated that the airplane touched down on the runway at an angle, and when the right engine was reversed on the ground, the airplane veered off the right side of the runway.

According to the Ohio State Police report, the airplane came to rest in a drainage ditch about 900 feet beyond the point where it departed the right side of the runway. A post crash fire erupted on the right engine, and was extinguished by the local fire department.

The left engine was removed and shipped to Allied Signal, Phoenix, Arizona. On November 6, 1996, the engine was examined under the supervision of a Federal Aviation Administration Inspector from the Flight Standards District Office, Scottsdale, Arizona. The Inspector's report stated:

"...the most likely cause of the engine failure was the failure of the torque sensor housing. This allowed the disengagement of the direct-drive fuel control gear train, which interrupted the mechanical drive to the fuel pumps and fuel control assemblies resulting in an engine shutdown failure."

The failed parts were sent to the NTSB Materials Laboratory Division for examination. The metallurgist's factual report stated:

"...The fractures on this arm [torque sensor and gear assembly] contained mechanical damage that resulted from the mating fractures rubbing against each other which obliterated the original fractured features...No surface anomalies such as a gouge mark or porosity was found in the origin area. Fatigue propagation was through the entire wall in the general direction indicated by unmarked arrows...No anomalies such as porosity was found in the microstructure..."

A Garrett Turbine Engine Company (Allied Signal) Service Bulletin was issued September 14, 1979, with subsequent revisions issued through 1986. The Service Bulletin (SB) stated that resonant vibrations set up in the torque sensor housing arm resulted in cracking of the housing arm. It also stated that several instances of torque sensor housing arm fractures occurred, and the corrective action was to replace the torque sensor housing and support with a newer design. The SB further stated that the rework of the torque sensor and gear assembly was to be accomplished at an overhaul facility, and recommended that the SB be accomplished at the operator's convenience, but not later than the next access to the affected parts.

The overhaul of the left engine to zero time and zero cycles by the AIResearch Mfg. Company (Garrett Turbine Engine Company), was completed on December 11, 1979. The SB was not complied with at the time of overhaul. On December 15, 1989, at 1,846 hours, a hot section inspection of the engine was completed, which did not require the examination of the torque sensor. At the time of the failure, the engine had accrued about 3,350 hours, 250 hours short of a mandatory overhaul.

According to Allied Signal Minimum Modification Standards, all recommended SBs which were in effect at the time of overhaul would be incorporated into the engine; however, it further stated that only SBs released 30 days prior to the induction of the engine into the overhaul cycle would be applied. An Allied Signal document revealed that the failed engine was received into the overhaul cycle on August 8, 1979, about 35 days before the torque sensor SB was issued. The overhaul was completed 88 days after the SB was issued.

Service Difficulty Reports (SDR) maintained by the Federal Aviation Administration were reviewed. The SDRs revealed that between 1978 and 1985, over 40 malfunctions of torque sensors were reported, of which over 24 resulted in the loss of engine power. All of these were related to the old style torque sensor. Between 1986 and 1996, only 5 cases of torque sensor problems were reported. These also were related to the old style torque sensor.

Engine monitoring had been conducted through an oil analysis program. An oil analysis report of the left engine oil filter, dated September 24, 1996, recommended, "Resample after 25 hours due to minor magnesium."

Weather reported at other airports at the time of the accident were as follows:

Rickenbacker International Airport (LCK), 24 miles north-northeast of RTZ;

At 0819: wind 320 degrees at 6 knots, visibility 3 miles, clouds 1,000 scattered, 3,500 broken, 6,500 overcast.

Port Columbus International (CMH), 34 miles north-northeast of RTZ;

At 0822: winds 290 degrees at 6 knots, visibility 3 miles and rain, clouds 700 few, 1,200 broken, 3,000 overcast.

At 0832: winds 310 degrees at 9 knots, visibility 4 miles and rain, clouds 1,200 scattered, 3,700 overcast.

Ross County Airport Observation taken by the airport manager;

At 0805: winds 290 degrees at 6 knots, visibility 4 miles, ceiling 700 foot overcast.

In a letter submitted by the pilot, dated November 25, 1996, he stated that factors contributing to the accident were, "...Improper training: Flight Safety International & Enterprises both teach 20 [degree] flaps takeoffs as normal procedure for the MU-2B-30, even when the POH/AFM specifically warns that a climb is not assured should an engine fail in this configuration..." He also stated that the Mitsubishi publications were contradictory and vague regarding takeoff procedures and engine failures.

A review of the MU-2B-30 operator's manual revealed that the first half of the manual was

the Pilot's Operating Manual (POM), while the second half of the manual was the Airplane Flight Manual (AFM).

The POM contained a section on general twin-engine performance and controllability, which began on page 3-79. The first paragraph indicated that what followed was generic to twin-engine operation, and was not specific to the MU-2. However, after the lead paragraph was a NOTE that referenced the MU-2B-30. It stated that the left engine was the critical engine on the MU-2B. It further stated, "All other information is technically correct." The NOTE was repeated on page 3-88. The POM general twin-engine performance text contained information regarding P-factor and yawing. It also contained the most efficient operating condition with the "slip/skid" ball out of trim, and banking the airplane into the live engine.

A review of the emergency procedures in the AFM revealed that a NOTE on page 3-2 stated, "Single engine climb rates are best attained with wings level by use of rudder to correct for yawing tendency and using the minimum amount of spoiler necessary to maintain lateral control." The AFM procedure was contrary to the POM procedure.

The AFM published an emergency procedure for "Engine Failure After Liftoff - Gear down or in Transit to UP." The procedure stated, "If the engine failure occurs after liftoff, but before the landing gear cycle is fully completed (gear up, doors closed) and continued flight is not possible:

1. Landing Gear.....DOWN 2. Operating Engine.....POWER AS REQUIRED 3. Flaps.....LEVER IN SELECTED TAKEOFF POSITION 4. Land straight ahead using airspeed appropriate for the airplane weight, but not less than 105 KCAS."

The POM and AFM published normal procedures which allowed for a takeoff to be accomplished with the flaps set to either 5 or 20 degrees. Neither of the sections suggested a preferred setting. According to the AFM, the 2 engine takeoff rotation speed (Vr), at maximum gross weight, with the flaps set to 20 degrees, was 105 KCAS, with a published best angle climb speed (Vx) of 113 KCAS. An AFM chart depicted single engine climb speeds for a 20 degree flaps takeoff condition. The chart included a single engine best angle of climb speed (Vxse) of 125 KCAS, and a single engine best rate of climb speed (Vyse) of 135 KCAS.

A review of the AFM emergency procedure section revealed a WARNING which stated:

"If flaps 20 [degrees] takeoff is selected and engine failure occurs after liftoff, continued climb performance is not assured unless the landing gear has completely retracted, the gear doors are closed, and the flaps have reached 5 degrees or less."

Directly below the warning was the procedure for "Engine Failure in Takeoff Climb -Gear Fully Retracted." The first 2 steps listed in the procedure were:

1. Airspeed...140 KCAS Minimum 2. Flaps.....5 degrees

A review of the POM and AFM revealed that a procedure was not published for a pilot to transition from a standard Vr of 105 KCAS, with the flaps set to 20 degrees for takeoff; to a Vxse of 125 KCAS or Vyse of 135 KCAS, in the event of an engine failure. It also did not publish a procedure to transition to the 140 KCAS, 5 degree flaps setting listed in the emergency procedure section.

The pilot had attended Flight Safety International (FSI), and received training in the MU-2B. The FSI training manual for the MU-2B provided by the pilot did not recommend a specific flap setting for takeoff; however, it did contain the following procedure for an engine failure after takeoff, with the flaps set to 20 degrees:

"Maintain 20 degrees flaps and 8 degrees pitch until reaching safe altitude. Adjust climb rate to increase speed to 125 knots minimum, then retract flaps to 5 degrees. A slight increase in pitch attitude will correct for the sink induced by flap retraction. Continue to increase speed, to 140 knots and retract flaps to zero."

The FSI manual also contained a note under "Engine Failure After Liftoff - Able to Climb:"

"Maintain aircraft control and maximum power on operating engine. Establish to 8 [degree] pitch for 20 [degree] flap, or 10 [degree] for 5 [degree] flap, until sufficient altitude to attain Vxse then maintain Vxse for climb."

The AFM Single Engine Landing section of the manual contained a CAUTION that stated, "The use of 40 [degrees] flaps with an engine inoperative is not recommended. Always maintain airspeed above Vxse for flap setting being used until landing is assured."

Another CAUTION in the Single Engine Landing section stated, "On other than dry, hard surface runways, it is possible to apply more reverse thrust that can be countered by rudder, brake, and nosewheel steering."

The AFM contained a chart that provided the single engine rate of climb, based on landing gear retracted, flaps up, and the bleed air off. The estimated rate of climb for a 10,000 pound airplane, at 750 feet pressure altitude, and 15 degrees C, was 550 feet per minute.

Pilot Information

Certificate:	Airline transport; Commercial	**Age:**	32,Male
Airplane Rating(s):	Single-engine land; Multi-engine land	**Seat Occupied:**	Left
Other Aircraft Rating(s):	None	**Restraint Used:**	
Instrument Rating(s):	Airplane	**Second Pilot Present:**	No
Instructor Rating(s):	Airplane multi-engine; Airplane single-engine; Instrument airplane	**Toxicology Performed:**	No
Medical Certification:	Class 1 Valid Medical--no waivers/lim.	**Last FAA Medical Exam:**	July 2, 1996
Occupational Pilot:	Yes	**Last Flight Review or Equivalent:**	
Flight Time:	5400 hours (Total, all aircraft), 2150 hours (Total, this make and model), 5100 hours (Pilot In Command, all aircraft), 180 hours (Last 90 days, all aircraft), 55 hours (Last 30 days, all aircraft)		

Aircraft and Owner/Operator Information

Aircraft Make:	Mitsubishi	**Registration:**	N618BB
Model/Series:	MU-2B-30 MU-2B-30	**Aircraft Category:**	Airplane
Year of Manufacture:		**Amateur Built:**	
Airworthiness Certificate:	Normal	**Serial Number:**	533
Landing Gear Type:	Retractable - Tricycle	**Seats:**	10
Date/Type of Last Inspection:	September 24, 1996 AAIP	**Certified Max Gross Wt.:**	10800 lbs
Time Since Last Inspection:	11 Hrs	**Engines:**	2 Turbo prop
Airframe Total Time:	6644 Hrs	**Engine Manufacturer:**	Garrett
ELT:	Installed, not activated	**Engine Model/Series:**	TPE-331-1-151
Registered Owner:	AIR-HI-O CORP	**Rated Power:**	665 Horsepower
Operator:		**Operating Certificate(s) Held:**	On-demand air taxi (135)
Operator Does Business As:		**Operator Designator Code:**	H20A

Meteorological Information and Flight Plan

Conditions at Accident Site:	Instrument (IMC)	**Condition of Light:**	Day
Observation Facility, Elevation:	RTZ ,725 ft msl	**Distance from Accident Site:**	
Observation Time:	08:15 Local	**Direction from Accident Site:**	
Lowest Cloud Condition:	Unknown	**Visibility**	4 miles
Lowest Ceiling:	Broken / 700 ft AGL	**Visibility (RVR):**	
Wind Speed/Gusts:	6 knots /	**Turbulence Type Forecast/Actual:**	/
Wind Direction:	290°	**Turbulence Severity Forecast/Actual:**	/
Altimeter Setting:	29 inches Hg	**Temperature/Dew Point:**	15°C
Precipitation and Obscuration:	N/A - None - Fog		
Departure Point:	(RZT)	**Type of Flight Plan Filed:**	IFR
Destination:	COLUMBUS , OH (OSU)	**Type of Clearance:**	IFR
Departure Time:	08:30 Local	**Type of Airspace:**	Class E

Airport Information

Airport:	ROSS COUNTY RZT	**Runway Surface Type:**	Asphalt
Airport Elevation:	726 ft msl	**Runway Surface Condition:**	Wet
Runway Used:	23	**IFR Approach:**	None
Runway Length/Width:	5400 ft / 100 ft	**VFR Approach/Landing:**	Precautionary landing

Wreckage and Impact Information

Crew Injuries:	1 None	**Aircraft Damage:**	Substantial
Passenger Injuries:	3 None	**Aircraft Fire:**	On-ground
Ground Injuries:	N/A	**Aircraft Explosion:**	None
Total Injuries:	4 None	**Latitude, Longitude:**	39.329402,-82.980911(est)

Administrative Information

Investigator In Charge (IIC):	Pearce, Robert
Additional Participating Persons:	RICHARD J HERMANNS; CINCINNATI , OH BRUCE BESSEIT; PHOENIX , AZ
Original Publish Date:	October 31, 1997
Last Revision Date:	
Investigation Class:	Class
Note:	
Investigation Docket:	https://data.ntsb.gov/Docket?ProjectID=39245