National Transportation Safety Board
Aviation Accident Final Report

Location:	Strafford, MO	**Accident Number:**	CHI04LA144
Date & Time:	06/03/2004, 1215 CDT	**Registration:**	N693V
Aircraft:	Beech M35	**Aircraft Damage:**	Substantial
Defining Event:		**Injuries:**	2 None
Flight Conducted Under:	Part 91: General Aviation - Personal		

Analysis

The airplane collided with a fence and a guy wire during a forced landing following a loss of engine power. The pilot reported he was flying at 8,500 feet mean sea level when the number 2 cylinder departed the engine resulting in a total loss of engine power. He reported that with no airports within gliding distance, he elected to land in a farmer's field where the airplane contacted a fence and a guy wire. The number 2 cylinder and the left magneto were not located after the accident. Half of the crankcase, two fractured cylinder through-bolts, two cylinder through-bolt nuts with pieces of bolts inside, four cylinder hold down nuts with pieces of studs inside, a connecting rod cap with the connecting rod cap bolt, and a connecting rod nut were submitted for a metallurgical examination. The studs and through-bolts were arbitrarily numbered clockwise starting at the upper forward stud. All of the studs and through-bolts that were examined exhibited fatigue cracking with stud 3 exhibiting the largest fatigue region. A lip was observed on the surface of the crankcase which corresponded to the forward edge of the cylinder barrel flange, adjacent to the through-bolts. Linear marks aligned with the axis of the cylinder were observed at the aft side of the cylinder hole corresponding to sliding contact with the cylinder barrel skirt. Sectioning of studs 3 and 4 revealed cracks and/or rolling laps at the thread roots. On stud 4, many of the cracks extended radially then turned. Two studs were removed from cylinder #4 and one of them also displayed sharp thread radii and cracking. This cylinder did not fail. The engine was overhauled on July 6, 2000, at a tach time of 2440.33 hours. The engine had accumulated 194.03 hours since the overhaul.

Probable Cause and Findings

The National Transportation Safety Board determines the probable cause(s) of this accident to be: The improper installation of the cylinder during the engine overhaul which resulted in the fatigue failure of the cylinder studs and through-bolts and the subsequent separation of the cylinder. Factors associated with the accident were the fence and the guy wire which the

airplane contacted during the forced landing.

Findings

Occurrence #1: LOSS OF ENGINE POWER(TOTAL) - MECH FAILURE/MALF
Phase of Operation: CRUISE - NORMAL

Findings
1. (C) MAINTENANCE,OVERHAUL - IMPROPER - OTHER MAINTENANCE PERSONNEL
2. (C) MISCELLANEOUS,BOLT/NUT/FASTENER/CLAMP/SPRING - FATIGUE
3. (C) ENGINE ASSEMBLY,CYLINDER - SEPARATION

Occurrence #2: FORCED LANDING
Phase of Operation: EMERGENCY DESCENT/LANDING

Occurrence #3: ON GROUND/WATER COLLISION WITH OBJECT
Phase of Operation: LANDING

Findings
4. (F) OBJECT - FENCE
5. (F) OBJECT - GUY WIRE

Factual Information

On June 3, 2004, at 1215 central daylight time, a Beech M35, N693V, collided with a fence and a guy wire during a forced landing after the number 2 cylinder departed the engine in Strafford, Missouri. The pilot and passenger were not injured. The airplane was substantially damaged. The 14 CFR Part 91 flight was operating in visual meteorological conditions and a visual flight rules flight plan was filed. The flight originated in Tell City, Indiana, at 1005, with a planned destination of Tulsa, Oklahoma.

The pilot reported he was flying at 8,500 feet mean sea level when the number 2 cylinder departed the engine resulting a total loss of engine power. He reported that with no airports within gliding distance, he elected to land in a farmer's field. The airplane was damaged when it contacted a fence and a guy wire during the landing.

The number 2 cylinder and the left magneto were not located after the accident.

The Continental IO-470-C, s/n 242060-R, engine was torn down under the supervision of an inspector from the Federal Aviation Administration Kansas City, Missouri, Flight Standards District Office. Half of the crankcase, two fractured cylinder through-bolts, two cylinder through-bolt nuts with pieces of bolts inside, four cylinder hold down nuts with pieces of studs inside, a connecting rod cap with the connecting rod cap bolt, and a connecting rod nut were submitted to the NTSB for a metallurgical examination.

The following are excerpts from the metallurgical examination report.

"For reference in this report, the studs and through-bolts were numbered clockwise starting with the upper forward stud... . Stud number 1 was contained in the fractured piece of the crankcase.... . The crankcase fracture intersected the hole for stud 2, and the inboard piece of stud 2 was missing. The outboard piece of stud 3 and the nut for stud 3 also were missing. Three of the four stud pieces and nuts ... mated to studs 1, 4, and 6. One stud and nut did not mate to any of the stud fractures and was therefore identified as the mating side of stud 2. The two through-bolt pieces with nuts mated to the other two submitted through-bolt pieces at positions 7 and 8."

"Each stud and through-bolt fracture surface had a relatively smooth flat region oriented approximately perpendicular to the longitudinal axis, features consistent with fatigue. ... Crack arrest lines were observed emanating from multiple origins at one side of the fracture surfaces for studs 2 to 5. The fracture surfaces for studs 1 and 6 were slightly rougher and did not have distinct crack arrest lines, but ratchet marks were visible indicating fatigue from multiple origins. Although the fracture surface for stud 1 ... was nearly obliterated by post-fracture damage, the mating fracture surface showed the described fatigue features. In each case where orientation could be determined, the fatigue emanated from origins at the cylinder side of the stud or through-bolt."

"Of all the stud and through-bolt fractures, stud 3 had the smallest overstress region. The fatigue region covered more than 90 percent of the fracture surface."

"A lip was observed on the crankcase surface at a location corresponding to the forward edge of the cylinder 2 barrel flange, adjacent to the through-bolt positions. At the aft side of the cylinder 2 area of the crankcase, linear marks aligned with the axis of the cylinder were observed at the aft side of the hole for cylinder 2 corresponding to sliding contact with the

cylinder barrel skirt. Also, fretting was observed in the barrel flange contact area around through-bolt number 7."

Studs 3 and 4 were sectioned longitudinally. "Cracks and/or rolling laps were observed at the thread roots of both sections. On stud 3, the cracks generally followed the material flow lines and were limited to within 0.001 inch of the surface."

"On stud 4, cracks, many of them branching cracks, ... extended radially for some distance then turned, following the flow lines in the material. Many of the thread roots had sharp radii... ."

The hardness of studs 3 and 4 was measured. The hardness of stud 3 was 33 HRC, and the hardness of stud 4 was 31 HRC. The manufacturer specified harness range for the studs was 32 - 38 HRC.

Two studs from cylinder 4 were also removed and sectioned. One of these studs had thread roots with sharp radii and many cracks at the thread roots similar to those on one of the studs from cylinder 2. The other stud from cylinder 4 had a small rolling lap in one thread. No sharp thread root radii were noted on this stud.

"The connecting rod cap bolt from cylinder 2 ... was slightly bent. ... The thread peaks on the connecting rod bolt ... were deformed and worn, visually appearing flattened and shiny. The threads closest to the end of the bolt, the thread peaks were mostly deformed toward the end of the bolt. At the other end of the threaded region closest to the head, the thread peaks were deformed both toward the end and toward the head."

The engine was overhauled on July 6, 2000, at a tachometer time of 2440.33 hours. The engine accumulated 194.03 hours since the overhaul.

Parties to the investigaiton were the Federal Aviation Administration and Teledyne Continental Motors.

Pilot Information

Certificate:	Commercial	**Age:**	78, Male
Airplane Rating(s):	Multi-engine Land; Single-engine Land	**Seat Occupied:**	Left
Other Aircraft Rating(s):	None	**Restraint Used:**	Seatbelt
Instrument Rating(s):	Airplane	**Second Pilot Present:**	No
Instructor Rating(s):	None	**Toxicology Performed:**	No
Medical Certification:	Class 3 Valid Medical--no waivers/lim.	**Last FAA Medical Exam:**	04/07/2003
Occupational Pilot:		**Last Flight Review or Equivalent:**	07/20/2002
Flight Time:	26000 hours (Total, all aircraft), 5000 hours (Total, this make and model)		

Aircraft and Owner/Operator Information

Aircraft Make:	Beech	**Registration:**	N693V
Model/Series:	M35	**Aircraft Category:**	Airplane
Year of Manufacture:		**Amateur Built:**	No
Airworthiness Certificate:	Normal	**Serial Number:**	D-6444
Landing Gear Type:	Retractable - Tricycle	**Seats:**	4
Date/Type of Last Inspection:	07/09/2003, Annual	**Certified Max Gross Wt.:**	2950 lbs
Time Since Last Inspection:	88 Hours	**Engines:**	1 Reciprocating
Airframe Total Time:	5778 Hours	**Engine Manufacturer:**	Continental
ELT:	Installed, not activated	**Engine Model/Series:**	IO-470-C
Registered Owner:	Bernard A. Armstrong	**Rated Power:**	250 hp
Operator:	Bernard A. Armstrong	**Operating Certificate(s) Held:**	None

Meteorological Information and Flight Plan

Conditions at Accident Site:	Visual Conditions	**Condition of Light:**	
Observation Facility, Elevation:	SGF	**Distance from Accident Site:**	
Observation Time:	1152	**Direction from Accident Site:**	
Lowest Cloud Condition:	Scattered / 39800 ft agl	**Visibility**	10 Miles
Lowest Ceiling:	None	**Visibility (RVR):**	
Wind Speed/Gusts:	6 knots /	**Turbulence Type Forecast/Actual:**	/
Wind Direction:	360°	**Turbulence Severity Forecast/Actual:**	/
Altimeter Setting:	30.22 inches Hg	**Temperature/Dew Point:**	22°C / 13°C
Precipitation and Obscuration:			
Departure Point:	Tell City, IN (TEL)	**Type of Flight Plan Filed:**	None
Destination:	Tulsa, OK (TUL)	**Type of Clearance:**	None
Departure Time:	1005 CDT	**Type of Airspace:**	Class G

Wreckage and Impact Information

Crew Injuries:	1 None	**Aircraft Damage:**	Substantial
Passenger Injuries:	1 None	**Aircraft Fire:**	
Ground Injuries:	N/A	**Aircraft Explosion:**	
Total Injuries:	2 None	**Latitude, Longitude:**	37.244444, -93.386944

Administrative Information

Investigator In Charge (IIC):	Pamela S Sullivan	**Report Date:**	06/08/2005
Additional Participating Persons:	Alan Martens; FAA; Kansas City, MO Matthew Fox; NTSB; Washington, DC Scott Boyle; Teledyne Continental; Mobile, AK		
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/.		