Log 1468

National Transportation Safety Board

Washington, D.C. 20594

Safety Recommendation

Date: October 27, 1986
In reply refer to: A-86-124 through -127

Honorable Donald D. Engen
Administrator
Federal Aviation Administration
Washington, D. C. 20591

On September 21, 1985, a Beech Bonanza Model V-35B, N5NG, crashed at Warwick Rhode Island, killing both occupants aboard the airplane. The crash occurred during a forced landing following a loss of engine power. The National Transportation Safety Board's investigation of the accident disclosed that the engine's crankshaft had broken through the crankcheek as a result of subsurface origin metal fatigue. A new Teledyne Continental Motors (TCM) IO-520-BA engine had been installed in N5NG in 1978. Since that time, the engine had operated for 1,022 flight hours. On March 22, 1986, a Beech Bonanza Model S-35, N5629K, crashed at Laconia, New Hampshire, after sustaining a similar crankshaft subsurface fatigue failure. The airplane was destroyed but, fortunately, none of the three occupants aboard was injured seriously. This airplane was also powered by an IO-520-BA engine which had operated for 888 hours since having been remanufactured by TCM in 1979.

The Safety Board has previously addressed the problem of broken crankshafts as a result of subsurface origin crankcheek metal fatigue in TCM IO-520 series engines in Safety Recommendations A-77-43 and -44 issued to the Federal Aviation Administration (FAA) on June 20, 1977. These recommendations were prepared following an accident at the Chillicothe Municipal Airport, Chillicothe, Missouri, on August 3, 1976, involving a Beech Baron 58. This accident, which occurred after takeoff when the left engine (TCM IO-520-C) crankshaft broke due to fatigue, resulted in the deaths of all six occupants. Subsequently, the FAA, on March 7, 1978, issued Advisory Circular No. 20-103 "Aircraft Engine Crankshaft Failure" and on June 15, 1981, TCM issued Service Bulletin M 81-2 Rev. 1, "Crankshaft Ultrasonic Inspection." The bulletin recommends ultrasonic inspection of the intermediate main bearing fillet area to detect subsurface origin fatigue cracks on IO-520 and TSIO-520 crankshafts each time they are removed from the engine for overhaul or for any other reason.

The FAA advised the Safety Board that crankshaft failures such as the one at Chillicothe are caused by high cycle fatigue which originates at the site of a subsurface inclusion in certain crankshafts manufactured between 1965 and 1977 from airmelt steel. The problem, according to FAA, was confined to 33 heat codes from which 17,361 airmelt steel crankshafts were made. The heat code is stamped on the crankshaft crankcheek but, according to FAA, there are no records available to identify which engines contain crankshafts from the suspect heat codes. As a result, the engine must be disassembled to determine whether or not the crankshaft is susceptible to subsurface fatigue. According to TCM, the majority of crankshaft subsurface fatigue failures occur at engine operating times of less than 1,000 hours. The manufacturers recommended

time between overhaul (TBO) for the 520 series engines, i.e., the time at which the engine is removed, disassembled, overhauled, and presumably inspected ultrasonically, varies from 1,400 to 2,000 hours, depending on model. Therefore, the crankshafts in some 520 series engines, such as the one installed in N5NG, are subject to fatigue failure before the first TBO cycle has elapsed and before an ultrasonic inspection to detect potential fatigue problems has been performed.

In 1978, TCM introduced two product improvements in the manufacture of 520 series engines: the use of vacuum arc remelt steel for the crankshaft instead of the previously used air melt alloy and a redesigned crankshaft to reduce the working stress in the crankshaft fillet areas. 1/ The redesigned engines were designated by appending the letter "B" to the original engine model, e.g., the redesigned IO-520C engine is designated as IO-520CB, and were subsequently incorporated in newly manufactured airplanes. Owners/operators of pre-1978 airplanes powered by the 520 series engines may elect to have the improved crankshafts or redesigned engines installed at the time of engine overhaul or remanufacture. For example, several of the Beech Baron airplanes are certified for operation with either the IO-520C or the IO-520CB. However, many owners/operators of airplanes powered by the 520 series engines may not be aware of the availability of the improved/redesigned engines since TCM has not issued a customer Information Bulletin regarding this matter. Neither of the engines installed in N5NG or in N5629K incorporated these improvements.

Although TCM's 1978 crankshaft design changes have apparently been effective, i.e. very few crankshaft failures of any kind have subsequently been evidenced in the improved/redesigned crankshafts, the continued occurrence of crankshaft failure in pre-1978 IO-520 and TSIO-520 series engines installed in various 1965 through 1978 model airplanes is alarming. For example, between 1975 and 1985, there have been 51 loss-of-engine-power accidents caused by broken crankshafts in these pre-1978 engines. Most of the accidents involve Cessna Model A 188, 206, 207, and 210 airplanes and Beech Model 33, 35, and 36 airplanes. A majority of the broken crankshafts have been attributed to material failure or fatigue in the crankshaft crankcheek, propeller flange, or journal bearing areas. The Safety Board believes that some propeller flange failures may be due to inadequate inspection of the flange following a propeller strike and that a lack of good operating and maintenance practices, such as checking for oil contamination at each oil change, may be a factor in certain kinds of failures originating in the journal bearing area.

Additionally, during the period January 1980 to January 1986, the loss of engine power as a result of such crankshaft failures in these engines, primarily in Cessna Model 206, 207, and 210 airplanes, resulted in 15 other incidents. Moreover, 93 service difficulty reports (SDR) were submitted to the FAA during this period describing similar crankshaft failures, not only in all of the aforementioned single-engine airplanes, but in a significant number of twin engine Cessna Model 310, 340, 401, and 402 airplanes as well.

Therefore, the National Transportation Safety Board recommends that the Federal Aviation Administration:

> Issue an Airworthiness Directive requiring: (1) compliance with Teledyne Continental Motors (TCM) Service Bulletin M 81-2 Rev. 1, "Crankshaft Ultrasonic Inspection," each time airmelt steel alloy crankshafts from TCM IO-520 or TSIO-520 series engines are removed

1/ Redesigned crankshafts were installed only in the so-called "Permold" engines, i.e., those cast from a permanent mold.

for overhaul or for any reason; (2) that all TCM IO-520 or TSIO-520 series engine airmelt steel alloy crankshafts which have not been previously inspected ultrasonically and which have less than 1,200 hours total time in service since manufactured be removed and inspected in accordance with TCM Service Bulletin M 81-2 Rev. 1 within the next 50 hours, and (3) that the heat codes and type of steel used on crankshafts installed in TCM IO-520 and TSIO-520 engines be recorded in the engine maintenance log any time the engine is disassembled for overhaul or for any reason. Crankshafts identified as being susceptible to fatigue (having "suspect" heat codes) should be replaced with the improved/redesigned crankshafts introduced in 1978 or the engine should be exchanged for a redesigned "B" engine, i.e., those manufactured from vacuum arc remelt steel which incorporate the redesigned crankshaft. (Class II, Priority Action) (A-86-124)

Publish in the Federal Aviation Administration's Advisory Circular (AC) 43-16, General Aviation Airworthiness Alerts, an article relating to aircraft engine crankshaft failures, with special emphasis on those installed in TCM IO-520 and TSIO-520 engines. The general operating and maintenance practices outlined in FAA Advisory Circular No. 26-103, "Aircraft Engine Crankshaft Failure," and in TCM Service Bulletin M 77-6, "Main bearing and Transfer Collar Distress" should be referenced, e.g., sluggish/erratic propeller control operation, checking of oil screen or filter for signs of contamination at each oil change, etc. (Class II, Priority Action) (A-86- 125)

Require Teledyne Continental Motors to issue a Customer Information Bulletin advising customers of the availability of the improved IO-520 and TSIO-520 engines introduced in 1978. The enhanced structural reliability of crankshafts manufactured from vacuum arc remelt steel should be emphasized. The bulletin should be disseminated by FAA and TCM to all owners/operators of airplanes equipped with 520 series engines. (Class II, Priority Action) (A-86-126)

Issue an Airworthiness Directive requiring that airplanes with TCM IO-520 on TSIO-520 engines that are involved in a propeller strike incident comply with TCM Service Bulletin 84-16, "Airplanes involved in Prop Strike Incidents." In addition to the dye penetrant and 10X magnified inspections outlined therein, the propeller flange should also be checked for perpendicularity (runout) with a dial gage. If any of these checks disclose evidence of defects, or if the propeller was removed for repairs, the engine should be disassembled and inspected internally for damage to the crankshaft, propeller flange, crankshaft bearing saddles, and counterweights. (Class II, Priority Action) (A-86-127)

BURNETT, Chairman, GOLDMAN, Vice Chairman, and LAUBER and NALL, Members, concurred in these recommendations.

By: Jim Burnett
Chairman

National Transportation Safety Board
Washington, D.C. 20594

Brief of Accident

File No. - 2423 9/21/85 WARWICK,RI A/C Reg. No. N5NG Time (Lcl) - 1026 EDT

----Basic Information----
Type Operating Certificate-NONE (GENERAL AVIATION)

Type of Operation -PERSONAL
Flight Conducted Under -14 CFR 91
Accident Occurred During -LANDING

Aircraft Damage
DESTROYED
Fire
NONE

Injuries	Fatal	Serious	Minor	None
Crew	1	0	0	0
Pass	1	0	0	0

----Aircraft Information----
Make/Model - BEECH V35B
Landing Gear - TRICYCLE-RETRACTABLE
Max Gross Wt - 3400
No. of Seats - 4

Eng Make/Model - CONTINENTAL IO-520-BA-10B ELT Installed/Activated - YES/YES
Number Engines - 1 Stall Warning System - YES
Engine Type - RECIP-FUEL INJECTED
Rated Power - 285 HP

----Environment/Operations Information----
Weather Data
Wx Briefing - FSS
Method - TELEPHONE
Completeness - FULL
Basic Weather - VMC
Wind Dir/Speed- 260/009 KTS
Visibility - 3.000 SM
Lowest Sky/Clouds - CLEAR
Lowest Ceiling - NONE
Obstructions to Vision- HAZE
Precipitation - NONE
Condition of Light - DAYLIGHT

Itinerary
Last Departure Point
WORCESTER,MA
Destination
CHATHAM,MA

ATC/Airspace
Type of Flight Plan - IFR
Type of Clearance - IFR
Type Apch/Lnds - FORCED LANDING

Airport Proximity
OFF AIRPORT/STRIP

Airport Data
PROVIDENCE
Runway Ident - 16
Runway Lth/Wid - 6081/ 150
Runway Surface - ASPHALT
Runway Status - DRY

----Personnel Information----
Pilot-In-Command
Certificate(s)/Ratings(s)
PRIVATE
SE LAND

Age - 64
Biennial Flight Review
Current - YES
Months Since - 4
Aircraft Type - V35B

Medical Certificate - VALID MEDICAL-WAIVERS/LIMIT

Flight Time (Hours)			
Total	1604	Last 24 Hrs	1
Make/Model	1304	Last 30 Days	7
Instrument	298	Last 90 Days	15
Multi-Eng	UNK/NR	Rotorcraft	UNK/NR

Instrument Rating(s) - AIRPLANE

----Narrative----
WHILE EN ROUTE AT 5000' MBL, THE PLT TRANSMITTED THAT HE HAD AN ENG PROBLEM & REQUESTED CLEARANCE TO LAND AT THE PROVIDENCE/THEODORE FRANCIS GREEN STATE ARPT, WHICH WAS APRX 12 MI AWAY. THE PLT THEN ASKED THE CONTROLLER IF THAT WAS THE CLOSEST ARPT; HOWEVER, DUE TO THE RADIO CONGESTION, THE CONTROLLER HAD DIFFICULTY UNDERSTANDING THE PLT. VECTORS WERE PROVIDED TO THE PROVIDENCE ARPT. SUBSEQUENTLY, THE ACFT CRASHED ACROSS AN INTERSTATE HIGHWAY APRX 2 MI FROM THE ARPT WHILE ON A HEADING IN THAT DIRECTION. DURING THE CRASH LANDING, THE ACFT COLLIDED WITH A CONCRETE DIVIDER/BARRIER. AN INVESTIGATION REVEALED THAT THE ENG CRANKSHAFT, PN 639243, HAD FAILED FROM FATIGUE AT TWO LOCATIONS. THE FORWARD FAILURE WAS THRU THE CRANKCHEEK BETWEEN THE #2 MAIN BEARING JOURNAL & THE #3 CONNECTING ROD CRANKPIN. THE AFT FAILURE WAS THRU THE CRANKCHEEK BETWEEN THE #4 CONNECTING ROD CRANKPIN & THE #3 MAIN BEARING JOURNAL. BOTH FATIGUE CRACKS HAD SUBSURFACE ORIGINS.

Brief of Accident (Continued)

File No. - 2423 | 9/21/85 | WARWICK,RI | A/C Reg. No. N5NG | Time (Lcl) - 1026 EDT

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

Finding(s)
1. ENGINE ASSEMBLY,CRANKSHAFT - FATIGUE

Occurrence #2 FORCED LANDING
Phase of Operation DESCENT - EMERGENCY

Occurrence #3 IN FLIGHT COLLISION WITH OBJECT
Phase of Operation LANDING - FLARE/TOUCHDOWN

Finding(s)
2. WEATHER CONDITION - HAZE
3. TERRAIN CONDITION - NONE SUITABLE

----Probable Cause----

The National Transportation Safety Board determines that the Probable Cause(s) of this accident is/are finding(s) 1

Factor(s) relating to this accident is/are finding(s) 2,3