Log 1859

National Transportation Safety Board

Washington, D. C. 20594

Safety Recommendation

Date: October 5, 1988

In reply refer to : A-88-130

Honorable T. Allan McArtor
Administrator
Federal Aviation Administration
Washington, D.C. 20591

Since 1982, the National Transportation Safety Board has investigated 22 Bell 206L-1 model helicopter accidents caused by engine power losses. In 11 of the 22 accidents, the probable cause of the power loss was undetermined. In a majority of the accidents, postaccident functional testing of the Allison 250-C28B engine, fuel control, and governor revealed no discrepancies. For this reason, the Safety Board is concerned about the adequacy of the Bell 206L model fuel system design and its past service history. The two Bell 206L-1 accidents discussed in the following paragraphs reflect the type of problems that have been identified with this helicopter's fuel system.

On April 16, 1985, a 206L-1 crashed in Prestonburg, Kentucky, following an engine power loss.[1] Two months later, a 206L-1 crashed in Ghent, West Virginia, under similar circumstances.[2] In both accidents, the helicopters had less than 200 pounds (about 30 gallons) of fuel on board, and the engine power losses occurred shortly after reaching cruising altitude. Neither pilot, the sole occupants, were injured during the autorotational landings. In the Kentucky accident, the helicopter was substantially damaged when it collided with trees during the landing. The fuel tanks ruptured, thus negating any subsequent fuel system functional tests. The helicopter in the West Virginia accident was not badly damaged. Subsequent examination and functional testing of both engines did not reveal any discrepancies.

The fuel system of the helicopter involved in the West Virginia accident was intact. Postaccident examination disclosed that the tank venting system was intact and free of obstructions. When the battery was turned on, the fuel quantity gauge indicated 100 pounds. About 19.4 gallons (130 pounds) of fuel was drained from the three interconnected tanks with the following distribution: left forward--1.3 gallons; right forward--.53 gallon; and aft tank (main)--17.6 gallons.

During fuel system calibration tests, fuel was added in 5-gallon increments for a total of 25 gallons. The fuel quantity gauge was accurate, and the fuel low-level warning light extinguished at the proper time (10.9 gallons). The two fuel boost pumps were turned on, and the fuel pressure gauge fluctuated between 5 and 7 pounds psi. Since the functional test of the system revealed normal operation,

[1] For more detailed information, read Field Accident Brief No 1015 (attached)
[2] For more detailed information, read Field Accident Brief No 1550 (attached).

the "Ranger Extender" filler neck was removed so that the fuel transfer from the forward cells to the aft cell could be observed. When both fuel boost pumps were activated, strong fuel transfer was observed from the forward cells to the aft cell. When the left boost pump circuit breaker was pulled, fuel transfer decreased slightly. With the left pump operating and the right pump circuit breaker pulled, the transfer rate decreased to motive flow. Both circuit breakers were then reset and the strong transfer of fuel resumed. Near the end of the transfer cycle (exhaustion of fuel in the forward cells), the transfer stream turned milky white and continued in this manner for about 2 to 3 minutes until only motive flow was evident. The fuel level in the aft cell during the transfer cycle was always below the transfer discharge tube outlet increasing the possibility of aerated fuel reaching the engine fuel control.

The helicopter was defueled and 30 gallons of fuel was added to the aft cell. The helicopter sat for about 24 hours, and then the fuel depth was measured through the fuel probe openings in the aft and left forward cells. The depth in the left forward cell was 4.75 inches and in the aft cell, 3.06 inches. The left fuel boost pump was then turned on; the flow through the transfer tube was about 0.4 gallon per minute (motive flow rate). The left pump was turned off and the right pump activated. The fuel transfer rate increased to about 2 gallons per minute. Both pumps were activated, and about 4 minutes later, the transfer stream turned milky white and continued for about 3 minutes before subsiding into motive flow.

A small amount of residual fuel was noted in the left forward cell. Both pumps were turned off, and the cells were monitored for fuel migration, aft to forward. About 5 minutes later, 1 inch of fuel had migrated to the left forward cell. Since the fuel migration was abnormal, the dual element ejector transfer pump, located between the two forward cells, was removed and examined. A piece of masking tape was found in the left intake port which effectively blocked the fuel transfer from the left side. Also, it was determined that the standpipe for the fuel interconnect tube and its O-ring were not seated properly, which allowed the fuel to migrate from the aft cell to the forward cells through the union at the base of the standpipe. The flow switches and check valves operated normally.

In summary, it appears that aerated fuel can be supplied to the engine during the next flight when certain conditions are present, namely, normal engine shutdown procedures are followed, less than 40 gallons of fuel are in the system, and intercell migration of fuel occurs under static conditions. Since the Allison 250 model engine incorporates a single fuel nozzle design, it could be susceptible to fuel flow instability or momentary interruption of fuel flow. For this reason, the Safety Board believes that a continuous engine ignition system, available as a customer option, should be considered.

The Safety Board recently commented favorably on a notice of proposed rulemaking (NPRM) which, if adopted, will require the installation of a more reliable fuel system flow switch and relocation of in-line fuel filters. These modifications will make the Bell 206L model fuel system less susceptible to clogging by fuel system contaminants. These proposed modifications, along with the actions recommended below should minimize the possibility of engine power losses for unexplained reasons.

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

Conduct a directed safety investigation of the Bell 206L helicopter fuel system to: (1) determine problems that allow intertank transfer of fuel under static conditions when a low fuel state exists; (2) evaluate the minimum fuel requirements for takeoff, taking into consideration the possibility of aerated fuel being supplied to the engine; and (3) determine whether a continuous ignition system with an automatic relight capability should be required. Following completion of the directed safety investigation, take appropriate corrective action to preclude engine flameout. (Class II, Priority Action) (A-88-130)

KOLSTAD, Acting Chairman, and BURNETT, LAUBER, NALL, and DICKINSON, Members, concurred in this recommendation.

By: James L. Kolstad
Acting Chairman

National Transpor' 'n Safety Board
Washingto C. 20594

Brief of Accident

File No. - 1015 4/16/85 PRESTONBURG,KY A/C Reg. No. N773WW Time (Lcl) - 1440 EST

----Basic Information----
Type Operating Certificate-ON-DEMAND AIR TAXI
Type of Operation -POSITIONING
Flight Conducted Under -14 CFR 91
Accident Occurred During -APPROACH

Aircraft Damage
SUBSTANTIAL
Fire
NONE

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

----Aircraft Information----
Make/Model - BELL 206L-1
Landing Gear - SKID
Max Gross Wt - 4050
No. of Seats - 6

Eng Make/Model - ALLISON 250-C28B
Number Engines - 1
Engine Type - TURBOSHAFT
Rated Power - 500 HP

ELT Installed/Activated - NO -N/A
Stall Warning System - NO

----Environment/Operations Information----
Weather Data
Wx Briefing - NO RECORD OF BRIEFING
Method - N/A
Completeness - N/A
Basic Weather - VMC
Wind Dir/Speed- 225/006 KTS
Visibility - 7.0 SM
Lowest Sky/Clouds - UNK/NR
Lowest Ceiling - 4000 FT BROKEN
Obstructions to Vision- NONE
Precipitation - NONE
Condition of Light - DAYLIGHT

Itinerary
Last Departure Point
SAME AS ACC/INC
Destination
LOCAL

ATC/Airspace
Type of Flight Plan - NONE
Type of Clearance - NONE
Type Apch/Lnds - NONE

Airport Proximity
OFF AIRPORT/STRIP

Airport Data
Runway Ident - N/A
Runway Lth/Wid - N/A
Runway Surface - N/A
Runway Status - N/A

----Personnel Information----
Pilot-In-Command
Certificate(s)/Rating(s)
COMMERCIAL
SE LAND,ME LAND
HELICOPTER

Age - 34
Biennial Flight Review
Current - YES
Months Since - 2
Aircraft Type - 206B-3

Medical Certificate - VALID MEDICAL-NO WAIVERS/LIMIT

Flight Time (Hours)			
Total -	5433	Last 24 Hrs -	7
Make/Model-	121	Last 30 Days-	UNK/NR
Instrument-	202	Last 90 Days-	93
Multi-Eng -	216	Rotorcraft -	4333

Instrument Rating(s) - AIRPLANE,HELICOPTER

----Narrative----
THE PAX DEPLANED & THE PLT TOOK OFF ON A SHORT FLT TO A NEARBY ARPT TO REFUEL. AFTER CLIMBING FOR ABOUT 30 TO 40 SEC & ACCELERATING TO APRX 100 KTS, THE PLT STARTED TO ADJUST THE PWR FOR LVL FLT. AT ABOUT THAT TIME, THE ENG LOST PWR. THE PLT ATTEMPTED TO RESTORE ENG PWR, BUT WAS UNABLE. HE TURNED TO LAND IN A LARGE FIELD THAT HE HAD JUST OVERFLOWN. DRG AN AUTOROTATION, THE ENG STABILIZED AT IDLE RPM, BUT WOULD NOT RESPOND TO THROTTLE MOVEMENTS. THE PLT SAW POWER LINES IN HIS AUTOROTATION PATH & ELECTED TO CROSS OVER A CREEK & A ROW OF TREES & LAND IN ANOTHER FIELD. HOWEVER, THE HELICOPTER HAD INSUFFICIENT ALT TO CLEAR THE TREES. SUBSEQUENTLY, IT HIT THE TREES & CRASH LANDED ON A CREEK BANK. AFTER LANDING, THE ENG WAS STILL RUNNING & WAS SHUT DOWN BY USING THE FUEL SHUT-OFF SW. THE AFT FUEL CELL WAS PUNCTURED DRG IMPACT; THEREFORE, THE AMOUNT OF FUEL ON BOARD COULD NOT BE DETERMINED. THE ENG OPERATED DRG A POST-CRASH CHECK, BUT IMPACT DAMAGE PREVENTED OPERATING IT AT HIGH RPM. NO PREIMPACT PART FAILURE OR MALFUNCTION WAS VERIFIED.

File No. - 1015 4/16/85 PRESTONBURG,KY A/C Reg. No. N773WW Time (Lcl) - 1440 EST

Occurrence #1 LOSS OF POWER
Phase of Operation CRUISE

Finding(s)
1. FUEL SYSTEM - UNDETERMINED
2. FLUID,FUEL - STARVATION

Occurrence #2 FORCED LANDING
Phase of Operation DESCENT - EMERGENCY

Finding(s)
3. AUTOROTATION - PERFORMED - PILOT IN COMMAND

Occurrence #3 IN FLIGHT COLLISION WITH OBJECT
Phase of Operation APPROACH - VFR PATTERN - FINAL APPROACH

Finding(s)
4. TERRAIN CONDITION - HIGH OBSTRUCTION(S)
5. MANEUVER - PERFORMED - PILOT IN COMMAND
6. OBJECT - TREE(S)

----Probable Cause----

The National Transportation Safety Board determines that the Probable Cause(s) of this accident is/are finding(s) 1,2

Factor(s) relating to this accident is/are finding(s) 4,6

National Transr tion Safety Board
Washin D.C. 20594

Brief of Accident

File No. - 1550 6/21/85 GHENT,WV A/C Reg. No. N27716 Time (Lcl) - 1810 EDT

----Basic Information----
Type Operating Certificate-NONE (GENERAL AVIATION)
Type of Operation -EXECUTIVE/CORPORATE
Flight Conducted Under -14 CFR 91
Accident Occurred During -LANDING

Aircraft Damage
SUBSTANTIAL
Fire
NONE

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

----Aircraft Information----
Make/Model - BELL 206L-1
Landing Gear - SKID
Max Gross Wt - 4050
No. of Seats - 6
Eng Make/Model - ALLISON 250-C28B
Number Engines - 1
Engine Type - TURBOSHAFT
Rated Power - 500 HP
ELT Installed/Activated - YES/NO
Stall Warning System - NO

----Environment/Operations Information----
Weather Data
Wx Briefing - NO RECORD OF BRIEFING
Method - N/A
Completeness - N/A
Basic Weather - VMC
Wind Dir/Speed- 210/006 KTS
Visibility - 10.0 SM
Lowest Sky/Clouds - 4000 FT SCATTERED
Lowest Ceiling - 6500 FT OVERCAST
Obstructions to Vision- NONE
Precipitation - NONE
Condition of Light - DAYLIGHT

Itinerary
Last Departure Point
ODD,WV
Destination
BECKLEY,WV

ATC/Airspace
Type of Flight Plan - NONE
Type of Clearance - NONE
Type Apch/Lndg - FORCED LANDING

Airport Proximity
OFF AIRPORT/STRIP

Airport Data
Runway Ident - N/A
Runway Lth/Wid - N/A
Runway Surface - N/A
Runway Status - N/A

----Personnel Information----
Pilot-In-Command
Certificate(s)/Rating(s)
PRIVATE,COMMERCIAL
SE LAND
HELICOPTER

Age - 35
Biennial Flight Review
Current - YES
Months Since - 4
Aircraft Type - UNK/NR

Medical Certificate - VALID MEDICAL-NO WAIVERS/LIMIT

Flight Time (Hours)

Total -	1857	Last 24 Hrs -	5
Make/Model-	13	Last 30 Days-	UNK/NR
Instrument-	327	Last 90 Days-	135
		Rotorcraft -	1704

Instrument Rating(s) - HELICOPTER

----Narrative----
THE PLT TOOK OFF AT 1805 WITH 150 LBS OF FUEL REMAINING, INTENDING TO FLY TO BECKLEY, WV TO REFUEL. HE STATED THAT AFTER HE WAS IN LVL FLT AT ABOUT 3000 FT MSL FOR 3 TO 4 MIN, HE NOTED AN UNUSUAL JERK OR VIBRATION IN THE REAR, SUSPECTING A PSBL TAIL ROTOR PROBLEM, HE LOWERED THE COLLECTIVE & TURNED TOWARD AN OPEN AREA. HE THEN NOTED THAT THE ENG HAD LOST POWER. DRG AN AUTOROTATIVE LANDING, THE HELICOPTER TOUCHED DOWN HARD WITHOUT ENOUGH RPM TO CUSHION THE LNDG. AN EXAM OF THE FUEL SYS REVEALED THERE WAS ABOUT 20 GAL OF FUEL REMAINING. THE ENG & FUEL PUMPS OPERATED NORMALLY WHEN TESTED. HOWEVER, FURTHER CHECKS REVEALED THAT WHEN FUEL IN THE AFT TANK WAS BELOW THE STAND PIPE, FUEL WOULD LEAK TO THE FRONT TANK; ALSO, THERE WAS VIRTUALLY NO INDUCED FLOW IN THE LEFT TRANSFER SYS. DISASSEMBLY REVEALED THE STANDPIPE IN THE AFT TANK WAS NOT PROPERLY ALIGNED, THUS THE O-RING WAS NOT PROPERLY SEATED, WHICH ALLOWED A LEAK. A PIECE OF MASKING TAPE WAS FND IN THE INLET TO THE LEFT TRANSFER PUMP. AS THE FRONT TANK APCHD EMPTY (DRG OPN) AIR WAS ENTRAINED IN THE FUEL.

File No. - 1550 6/21/85 GHENT,WV A/C Reg. No. N27716

Occurrence #1 LOSS OF POWER(TOTAL) - NON-MECHANICAL
Phase of Operation CRUISE - NORMAL

Finding(s)
1. MAINTENANCE,INSTALLATION - IMPROPER - OTHER MAINTENANCE PSNL
2. FUEL SYSTEM - FOREIGN OBJECT
3. FUEL SYSTEM - BLOCKED(PARTIAL)
4. FLUID,FUEL - MOVEMENT RESTRICTED
5. FUEL SYSTEM,LINE FITTING - LEAK
6. FLUID,FUEL - OTHER
7. FLUID,FUEL - STARVATION

Occurrence #2 FORCED LANDING
Phase of Operation DESCENT - EMERGENCY

Finding(s)
8. AUTOROTATION - PERFORMED - PILOT IN COMMAND

Occurrence #3 HARD LANDING
Phase of Operation LANDING - FLARE/TOUCHDOWN

Finding(s)
9. FLARE - MISJUDGED - PILOT IN COMMAND
10. IMPROPER USE OF PROCEDURE,LACK OF TOTAL EXPERIENCE IN TYPE OF AIRCRAFT - PILOT IN COMMAND

----Probable Cause----

The National Transportation Safety Board determines that the probable cause(s) of this accident is/are finding(s) 1,5,6,7,9

Factor(s) relating to this accident is/are finding(s) 2,3,4,10