



National Transportation Safety Board Aviation Accident Final Report

Location:	Sierra Vista, AZ	Accident Number:	LAX05LA025
Date & Time:	11/02/2004, 0731 MST	Registration:	N106LN
Aircraft:	Eurocopter AS350B3	Aircraft Damage:	Substantial
Defining Event:		Injuries:	3 None
Flight Conducted Under:	Part 91: General Aviation - Positioning - Air Medical (Medical Emergency)		

Analysis

The helicopter experienced a partial loss of power during the transition from an out of ground effect hover to forward flight, and collided with the ground in a parking lot. About 10 seconds after the transition to forward flight, at 35 knots and between 150 to 200 feet above ground level, the pilot sensed the engine turbine start to spool down towards idle. He saw a red 'GOV' light illuminated on the instrument panel. The pilot did not disengage the flight notch on the collective twist grip to manually control the fuel flow to the engine and proceeded to fly the helicopter about 1/8 mile towards the parking lot, working the collective to try to keep the helicopter above the trees and the roofs of the houses. He used all the available rotor rpm in an attempt to arrest the landing. The helicopter landed hard, collapsing the landing skids, and the ship slid about 100 feet. After the helicopter came to rest, the main rotor was still rotating at a slower rpm, and the engine was operating at what seemed like a low idle speed. The partial loss of engine power was initiated by an inconsistency of greater than 3 percent between the two N2 (free turbine speed) sensors on the engine. This inconsistency resulted in the fuel control entering a fixed mode that freezes the fuel flow at the level it was at when the inconsistency was detected, and the illumination of a red 'GOV' light in the cockpit. The power required for forward flight is less than the power required to hover. The fixed fuel flow to the engine provided insufficient power to fly and land the helicopter at speeds below 35 knots, which resulted in low rotor rpm and a high rate of descent prior to the hard landing. In the event of a red 'GOV' light the pilot is to disengage the flight notch and control the fuel manually with the collective twist grip, which would allow the pilot to regain the full power range of the engine. At an altitude of 150 to 200 feet and airspeed of 35 knots, the pilot was operating in the avoidance zone of the documented height-velocity diagram, and therefore, may not have had enough time to fully respond to the partial loss of power by selecting an emergency landing site, disengaging the twist grip flight notch, and exercising manual control of the engine.

Probable Cause and Findings

The National Transportation Safety Board determines the probable cause(s) of this accident to be: An inconsistency between the engines' two N2 sensor signals caused the fuel control to enter a fixed mode, which limited the power available. Contributing to the accident was the lack of

altitude and airspeed available to give the pilot time to select a landing zone, disengage the flight notch, and exercise manual control of the engine after the illumination of the red 'GOV' light.

Findings

Occurrence #1: LOSS OF ENGINE POWER(PARTIAL) - MECH FAILURE/MALF
Phase of Operation: TAKEOFF - INITIAL CLIMB

Findings

1. (C) FUEL SYSTEM,FUEL CONTROL - FAILURE,PARTIAL
2. (C) PROCEDURES/DIRECTIVES - NOT PERFORMED - PILOT IN COMMAND

Occurrence #2: FORCED LANDING
Phase of Operation: EMERGENCY LANDING AFTER TAKEOFF

Occurrence #3: IN FLIGHT COLLISION WITH TERRAIN/WATER
Phase of Operation: EMERGENCY LANDING AFTER TAKEOFF

Findings

3. TERRAIN CONDITION - CONGESTED/CONFINED AREA
4. (F) HEIGHT/VELOCITY CURVE - EXCEEDED - PILOT IN COMMAND
5. (F) AUTOROTATION - NOT POSSIBLE - PILOT IN COMMAND

Factual Information

HISTORY OF FLIGHT

On November 2, 2004, at 0731 mountain standard time, a Eurocopter AS350B3, N106LN, experienced a partial power loss after takeoff followed by a hard landing into a parking lot, in Sierra Vista, Arizona. LifeNet, Inc., was operating the helicopter under the provisions of 14 CFR Part 91 as a positioning flight. The commercial pilot and two medical flight crew were not injured, and the helicopter was substantially damaged. Visual meteorological conditions prevailed, and a company flight plan had been filed for the flight that was destined for Portal, Arizona.

The pilot stated in the Pilot/Operator Accident Report and in a telephone interview with the National Transportation Safety Board investigator (IIC), that he and two medical attendants were on a flight to pickup a patient. Prior to takeoff he checked his instrument panel and then lifted the helicopter to a 50-foot hover over the elevated pad at Sierra Vista Hospital, which positioned the helicopter about 100 feet above ground level (agl). After receiving clearance from the Sierra Vista Municipal Airport tower he transitioned to forward flight. About 10 seconds later, at 35 knots and between 150 to 200 feet agl, he sensed the engine turbine start to spool down towards idle. He lowered the collective and saw a red 'GOV' light illuminated on the instrument panel. He identified a bank parking lot as a possible emergency landing area. He flew the helicopter about 1/8 mile towards the parking lot, working the collective to try to keep the helicopter above the trees and the roofs of houses. He lined up for the parking lot and used all the available rotor rpm to arrest the landing. The helicopter landed hard collapsing the landing skids, and the ship slid about 100 feet, rotating 90 degrees to the left as it did so. After the helicopter's motion had stopped, the main rotor was still rotating at a slower rpm, and the engine was operating at what seemed like a low idle speed. He rolled the twist grip to 'min,' pulled the fuel shutoff valve, and used the rotor brake to stop the rotor. Throughout the emergency landing he did not recall hearing a "low rotor rpm" aural warning.

PERSONNEL INFORMATION

A review of the Federal Aviation Administration (FAA) airman records revealed that the pilot held a commercial pilot certificate with ratings for rotorcraft-helicopter and instrument helicopter, issued on February 28, 2002, and a flight instructor certificate rated in helicopters issued November 16, 1998. Additionally, the pilot held a private pilot certificate with a single engine land rating. The pilot held a second-class medical issued on September 9, 2004, with the limitation that he must wear corrective lenses.

The pilot reported that he had 9,992 flight hours of total time, 350 hours in the AS350B3, and had flown 25 hours in the last 30 days.

AIRCRAFT INFORMATION

The helicopter was a Eurocopter, AS350B3, serial number 3251, that was equipped to operate as an emergency medical evacuation helicopter. The engine was a Turbomeca Arriel 2B, serial number 22036, capable of producing 825 horsepower. Examination of the maintenance records revealed that the helicopter had 3,163.8 operating hours at the time of the accident, and had undergone a 30-hour inspection on October 28, 2004. On November 1, 2004, the engine had undergone a 600-hour inspection and had a total time of 3,382.7 hours.

The operator, LifeNet, Inc., reported that the helicopter weight at the time of the accident was 4620.4 pounds; aircraft weight of 3,200.4 pounds plus; medical equipment 198 pounds; crew 565 pounds; and fuel 657 pounds.

The engine is controlled by a Digital Engine Control Unit (DECU) that receives sensor signals from the gas generator turbine (NG), the free power turbine (NF), the outside air temperature (OAT), rotor speed (NR), and controls the fuel flow into the engine via the hydromechanical control unit. In the event that the hydromechanical fuel control or the DECU becomes inoperative the pilot is notified of the condition by the illumination of a red 'GOV' light on the annunciator panel and an aural 'gong.' By releasing the flight notch slide lock on the collective twist grip the pilot can manually meter fuel to the engine by manipulating the twist grip. Rotation of the twist grip mechanically controls the amount of fuel delivered to the engine.

The AS350B3 flight manual states that aural warnings to the pilot are operative only if the 'horn' push button is in. The manual also states that the red 'GOV' light will illuminate when one of two conditions are present; 1- MANU mode (manual mode switch) is engaged. This switch allows the pilot to switch from 'auto' or automatic fuel governing of the engine to 'MANU,' or manual fuel governing of the engine for the purposes of pilot training; or 2- "Governing failure: the fuel flow is frozen at the value prior to the failure." The red 'GOV' light is accompanied by a 'gong' sound if the 'horn' button is in. The pilot should take the following steps when the red 'GOV' light is illuminated.

1- "Check flight parameters."

2- "Maintain NR in green arc."

3- "Unlock the 'FLIGHT' notch, the fuel flow can be increased or decreased by turning the twist grip."

4- "Only apply small amplitude adjustments synchronized with the collective in order to maintain NR in the green range."

5- "Fly the approach at 40 knots and adjust the fuel flow rate to maintain NR within the upper section of the green range. Slowly reduce the speed if necessary adjust the fuel flow rate slightly on the twist grip to maintain NR within the green range. On final approach, when the collective pitch is increased on reaching the hover, let the NR drop for touchdown, reduce the fuel flow rate before lowering the collective pitch."

TESTS & RESEARCH

Vehicle and Engine Multifunctional Display (VEMD)

The VEMD is an instrument that displays the engine and vehicle parameters in the cockpit. It replaces the conventional indicators and presents engine information, fuel quantity, electrical power, and torque readings. Additionally the VEMD, when in maintenance mode, can display recorded in-flight anomalies and discrete helicopter performance monitoring data.

Investigators at the scene of the accident photographed the maintenance pages on the VEMD that displayed error messages from flight number 4600, which was the accident flight. At 2 minutes 08 seconds into flight 4600, an "INVAL NF-A," "FL AMB GOV NF B," and "FL AMB GOV NF A," errors were recorded. At 2 minutes 36 seconds into the flight a "OUT OF RNG OAT" and "FLI LOSS" error are recorded. The over limit page for flight 4600 displayed no

limit exceedences for TRQ, T4, NG, NF, or NR parameters. The Turbomeca Arriel 2 Maintenance Manual defines these error messages and parameters as:

INVAL NF-A (Invalid NF-A parameter)
FL AMB GOV NF B (Flashing Amber GOV light, N2 failure (B on the harness))
FL AMB GOV NF A (Flashing Amber GOV light, N2 failure (C on the harness))
OUT OF RNG OAT (Out of Range OAT parameter)
FLI LOSS (Amber GOV light, To failure)
To (Outside Air Temperature (OAT))
T4 (Engine temperature measured by VEMD)
TRQ (Torque, percent)
NG (Engine power rating, percent)
NF (Free turbine expressed in NR speed, rpm)
NR (Rotor, rpm)

Engine Exam

On December 7, 2004, the Turbomeca Arriel 2B, serial number 22036, was examined and test run, under the supervision of the Safety Board IIC, at Turbomeca USA, Grand Prairie, Texas, and was observed by investigators from Turbomeca, LifeNet, Inc., and American Eurocopter.

The engine was placed on a test stand in the test cell. The DECU was removed and the engine was connected to the test cell DECU. The engine was started and was run up to ground idle and then flight idle. The engine was then run through a series of 1-second jam accelerations from flight idle to max power. No performance discrepancies were noted. The T1/OAT sensor was disconnected and investigators observed that the engine performed normally using the default of 15C for a T1/OAT signal. Full details of the test run are in the official docket of this investigation.

The Digital Engine Control Unit (DECU) was downloaded and the data sent to the Bureau d'Enquetes et d'Analyses (BEA) in France along with the N2 sensor harness for analysis by the BEA, Turbomeca France, and Eurocopter France. The examination was performed on February 16, 2005, under the supervision of the BEA. The DECU data confirmed the occurrence of a double N2 sensor failure, which triggered the red 'GOV' light shortly after takeoff. The DECU and VEMD data indicate that the red 'GOV' alarm was due to the detection of an inconsistency between the two N2 sensors (N2B and N2C). The inconsistency is triggered by the DECU as soon as the two values differ more than 3 percent. Additionally, the VEMD pages show that the twist grip manual command remained neutral during the event, which is consistent with the pilots' report of not disengaging the twist grip flight notch. A functional test of the DECU at temperatures ranging from -50C to 70C resulted in no anomalies. The three N2 sensors were tested for continuity, insulation, resistance, and output voltage comparison, which resulted in no anomalies. The N2 sensors harness was tested. No anomaly was found during electrical continuity and insulation tests.

A detailed test report is contained in the official docket of this investigation.

Airframe Examination

On January 4, 2005, the airframe was examined at the LifeNet facility in Phoenix, Arizona, by investigators from LifeNet, American Eurocopter, and Turbomeca USA, under the supervision of the Safety Board IIC.

The helicopters landing skids were completely collapsed and spread so that the underskin of the helicopter contacted the pavement. The tailboom was creased and bent downwards at the base of the boom. The outside air temperature (OAT) probe, which is located on the underside of the helicopter, was sheared off.

The AUTO/MAN switch in the cockpit was observed to be in the AUTO position and the start select switch was in the 'ON' position. The emergency fuel shutoff was closed. Electrical circuit continuity was established from the OAT probe to the VEMD. The AUTO/MAN circuit, and the OFF/IDLE/ON circuit exhibited electrical continuity to the Digital Engine Control Unit (DECU) harness cannon plug. The 'HORN' button was documented as being 'out' by a photo taken on-scene.

Helicopter Performance Calculations

Eurocopter provided helicopter performance calculations based on the helicopter weight of 4620 pounds, estimated density altitude of 5,000 feet, and outside air temperature of 1C. To maintain an out of ground effect (OGE) hover using these conditions the torque would be 69 percent, NG would be 92.6 percent, T4 would be 746 C, and fuel flow would be 139 kg/h. For a condition of level flight at 60 knots the torque would be 37 percent, NG would be 84 percent, T4 would be 638 C, and fuel flow would be 92 kg/h. Power required for forward flight at 60 knots is less than the power required to maintain an OGE hover.

The height-velocity (H-V) diagram in the AS350B3 flight manual depicts the avoidance zone as the flight regime between 8 feet to 550 feet, and 0 knots to 54 knots. The FAA Rotorcraft Flying Handbook (FHH-8083-21) states that operating in the H-V diagram avoidance zone "...may not allow enough time for the critical transition from powered flight to autorotation." The handbook continues to state: "An engine failure in a climb after takeoff occurring in section A (the avoidance zone) of the diagram is most critical. During a climb, a helicopter is operating at higher power settings and blade angle of attack. An engine failure at this point causes a rapid rotor rpm decay because the upward movement of the helicopter must be stopped, then a descent established in order to drive the rotor. Time is also needed to stabilize, then increase the rpm to the normal operating range. The rate of descent must reach a value that is normal for the airspeed at the moment. Since altitude is insufficient for this sequence, you end up with decaying rpm, an increasing sink rate, no deceleration lift, little translational lift, and little response to the application of collective pitch to cushion the landing."

Pilot Information

Certificate:	Flight Instructor; Commercial	Age:	48, Male
Airplane Rating(s):		Seat Occupied:	Right
Other Aircraft Rating(s):	Helicopter	Restraint Used:	Seatbelt, Shoulder harness
Instrument Rating(s):	Helicopter	Second Pilot Present:	No
Instructor Rating(s):	Helicopter; Instrument Helicopter	Toxicology Performed:	No
Medical Certification:	Class 2	Last FAA Medical Exam:	09/01/2004
Occupational Pilot:		Last Flight Review or Equivalent:	10/01/2004
Flight Time:	9992 hours (Total, all aircraft), 350 hours (Total, this make and model), 9867 hours (Pilot In Command, all aircraft), 70 hours (Last 90 days, all aircraft), 25 hours (Last 30 days, all aircraft), 0 hours (Last 24 hours, all aircraft)		

Aircraft and Owner/Operator Information

Aircraft Make:	Eurocopter	Registration:	N106LN
Model/Series:	AS350B3	Aircraft Category:	Helicopter
Year of Manufacture:		Amateur Built:	No
Airworthiness Certificate:	Normal	Serial Number:	3261
Landing Gear Type:	Skid	Seats:	4
Date/Type of Last Inspection:	11/01/2004, 100 Hour	Certified Max Gross Wt.:	4961 lbs
Time Since Last Inspection:	0 Hours	Engines:	1 Turbo Shaft
Airframe Total Time:	3163.8 Hours at time of accident	Engine Manufacturer:	Turbomeca
ELT:	Installed, activated, did not aid in locating accident	Engine Model/Series:	Arriel 2B
Registered Owner:	AIR METHODS CORP	Rated Power:	825 hp
Operator:	AIR METHODS CORP	Operating Certificate(s) Held:	None
Operator Does Business As:	LifeNet	Operator Designator Code:	QMLA

Meteorological Information and Flight Plan

Conditions at Accident Site:	Visual Conditions	Condition of Light:	Day
Observation Facility, Elevation:	KFHU, 4719 ft msl	Distance from Accident Site:	
Observation Time:	0655 MST	Direction from Accident Site:	
Lowest Cloud Condition:	Clear	Visibility	10 Miles
Lowest Ceiling:		Visibility (RVR):	
Wind Speed/Gusts:	4 knots /	Turbulence Type Forecast/Actual:	/
Wind Direction:	Variable	Turbulence Severity Forecast/Actual:	/
Altimeter Setting:	30.31 inches Hg	Temperature/Dew Point:	1°C / 8°C
Precipitation and Obscuration:	No Obscuration; No Precipitation		
Departure Point:	Sierra Vista, AZ (AZ89)	Type of Flight Plan Filed:	Company VFR
Destination:	Portal, AZ	Type of Clearance:	None
Departure Time:	0730 MST	Type of Airspace:	

Airport Information

Airport:	Sierra Vista Hosp (AZ89)	Runway Surface Type:	
Airport Elevation:	4660 ft	Runway Surface Condition:	
Runway Used:	NA	IFR Approach:	None
Runway Length/Width:		VFR Approach/Landing:	Forced Landing

Wreckage and Impact Information

Crew Injuries:	3 None	Aircraft Damage:	Substantial
Passenger Injuries:	N/A	Aircraft Fire:	None
Ground Injuries:	N/A	Aircraft Explosion:	None
Total Injuries:	3 None	Latitude, Longitude:	33.450000, -111.716667

Administrative Information

Investigator In Charge (IIC): Van S McKenny **Report Date:** 03/28/2006

Additional Participating Persons: John Eller; Federal Aviation Administration; Scottsdale, AZ
Archie Whitten; Turbomeca USA; Grand Prairie, TX
Joseph Syslo; American Eurocopter; Grand Prairie, TX
Chris Meinhardt; Life Net; Chesterfield, MO
John Beck; Thales; Arlington, TX

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 pubinquiry@ntsb.gov, or at 800-877-6799. Dockets released after this date are available at <http://dms.ntsbt.gov/pubdms/>.

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