National Transportation Safety Board
Aviation Accident Final Report

Location:	Apache Junction, Arizona	**Accident Number:**	LAX05FA053
Date & Time:	December 14, 2004, 22:37 Local	**Registration:**	N971AE
Aircraft:	Eurocopter AS-350-B3	**Aircraft Damage:**	Substantial
Defining Event:		**Injuries:**	1 Fatal, 2 Serious
Flight Conducted Under:	Part 91: General aviation - Positioning		

Analysis

The emergency medical services helicopter crashed while attempting to land in a mall parking lot to pickup an accident victim. Witnesses reported that the helicopter overflew the landing zone in right turns, then approached from the northeast. During the final approach at 100 feet agl, the helicopter was observed to become unstable. It rolled right about 30 degrees, then left about the same, then right about 45 degrees, pitched nose up to the left, and then descended while spinning to the left. The helicopter impacted the parking lot in a nose down attitude on the left side. In an interview several days after the accident, the pilot said she was at about 100 feet agl, and had slowed to 20 - 25 knots when she felt the helicopter nose come up and to the right gently, but not as a yaw or a roll. She said she corrected left with the cyclic, and the helicopter responded with a significant and violent roll to the left. She remembered the helicopter starting to spin (at least once), and saw the buildings of the strip mall. She then put the cyclic to the full left to avoid the building. She said she saw the hydraulic caution light on, but did not hear the aural warning. She then grabbed the cyclic with both hands and pulled back and right, but it didn't move. The anti-torque pedals appeared to work and stopped the spin. The helicopter then impacted the ground. The engine continued to run after the ground impact, and a surviving passenger and multiple rescue personnel moved numerous switches in the cockpit in an attempt to shutdown the engine, hence all postimpact switch positions are unreliable. A guarded hydraulic system on/off toggle switch is mounted on the end of the collective control that allows the pilot to manually turn off the hydraulic system. The collective control and the switch guard were damaged in the impact sequence; the hydraulic switch was found in the OFF position. The systems control panel on the center pedestal has 36 back-lighted, mechanically latched push-on/push-off switches. The hydraulic test switch, which deactivates the hydraulic system for a preflight check of the accumulator pressures, is located diagonally next to the landing light switch. The pedestal switch positions were documented the morning after the accident, and the hydraulic test switch was in the OFF position (OFF is normal, ON turns the system off). In the 3 months prior to the accident, four discrepancies were written against the helicopter for various control system problems, including stiff flight controls, excessive control inputs required for normal flight, and nuisance hydraulic warning light and horn activations. The most recent write-up was 1 month prior to the accident. The

company maintenance department's corrective actions included cleaning the control system bearings, replacing the left hand and collective hydraulic system actuators, and repairing damaged electrical wiring and cannon plugs. No evidence of preimpact failure or malfunction was found in examinations of the control system and functional testing of the hydraulic system components. The hydraulic system accumulators were found to still have an unquantified amount of pressure after the accident. After this accident, the operator installed guards over the hydraulic test switch to prevent inadvertent activation.

Probable Cause and Findings

The National Transportation Safety Board determines the probable cause(s) of this accident to be: A loss of control during the final approach to land for undetermined reasons.

Findings

Occurrence #1: LOSS OF CONTROL - IN FLIGHT
Phase of Operation: APPROACH - VFR PATTERN - FINAL APPROACH

Findings
1. LIGHT CONDITION - DARK NIGHT
2. TERRAIN CONDITION - HIGH OBSTRUCTION(S)
3. (C) REASON FOR OCCURRENCE UNDETERMINED

Occurrence #2: IN FLIGHT COLLISION WITH TERRAIN/WATER
Phase of Operation: DESCENT - UNCONTROLLED

Findings
4. TERRAIN CONDITION - GROUND

Factual Information

1.1 HISTORY OF FLIGHT

On December 14, 2004, at 2237 mountain standard time, a Eurocopter AS-350-B3, N971AE, operating under the call sign Air-Evac II, collided with terrain while attempting a landing in a shopping center parking lot at Apache Junction, Arizona. The helicopter was operated by Petroleum Helicopters, Inc., (PHI) as a positioning flight under the provisions of 14 CFR Part 91. The commercial pilot and a medical crewmember both received serious injuries; a second medical crewmember received fatal injuries. The helicopter was destroyed. The air medical flight originated at a local base of operation and was positioning for a patient recovery at the landing site and transport to a hospital. Visual meteorological conditions prevailed and a company flight plan had been filed. The wreckage was at 33 degrees 24.50 minutes north latitude and 111 degrees 27.15 minutes west longitude.

The emergency landing zone was located in a store parking lot. The area for landing was secured by Apache Junction police and fire department personnel. The pilot was in communication with the ground personnel for a briefing on possible landing obstructions. The pilot confirmed the final landing zone and light pole obstructions that were pointed out to her.

Witnesses reported that the helicopter overflew the landing zone in right turns, then approached from the northeast. The witnesses' observations of the final approach altitude were estimated at 100 to 300 feet above ground level. None of the ground witnesses reported seeing a landing light showing on the front of the helicopter.

During the final approach the helicopter was observed by ground witnesses to become unstable. It rolled right on the longitudinal axis about 30 degrees, then left about the same, then right about 45 degrees, pitched nose up to the left, and descended while spinning to the left. The helicopter impacted the parking lot nose down on the left side. The left skid was destroyed and the right skid was intact. The engine continued to run after impact and was subsequently stopped by the fire department personnel spraying fire suppressant foam into the engine air inlet. Two witnesses heard the helicopter make a hissing sound while descending and spinning; the witnesses likened the sound to an "18 wheeler's (truck) air brakes bleeding off."

The pilot was interviewed in the hospital on December 18 by a Federal Aviation Administration (FAA) inspector and management representatives of PHI. The pilot reported that it was her 5th day of flying nights. She stated that she was not fatigued, nor under any stress, and had eaten regular meals during the day. She said she was not on any prescription or OTC medications other than birth control.

At 2200, her crew was paged for a scene response to Apache Junction for a trauma patient. The landing zone was a secured area in a strip mall parking lot secured by police and fire units from Apache Junction. As the medical crew arrived, she had the helicopter started and running, with all preflight checks completed. Prior to liftoff, she turned the exterior lights on to include the steerable search light, strobes, and rotating beacon; she did not turn these off

while en route to the landing site. The night sun and taxi lights were off. She was wearing her own non-noise canceling headset and the volume control was normal (not all the way down).

The pilot said the scene location was a parking lot, with the designated landing area surrounded by four tall light poles. There was a fire engine on each edge of the LZ. The winds were calm. She performed one full circle around the landing zone and setup to land to the southwest. On final approach, and on top of the power lines along the road, she remembers saying "clear of power lines." She was at about 100 feet above ground level (agl) and had slowed to 20 - 25 knots. At that time she felt the aircraft nose come up to the right gently, but not as a yaw or a roll. She said she corrected left with the cyclic and the helicopter responded with a significant roll to the left. She remembered the aircraft starting to spin (at least once) and saw the buildings of the strip mall. She then put the cyclic to the full left to avoid the building. The helicopter came close to the ground with a 90-degree nose down attitude. She said she saw a red light she thought was the hydraulic caution light on just before impact, but did not hear the warning gong. She then grabbed the cyclic with both hands and pulled back and right but it didn't move. The anti-torque pedals appeared to work and she thinks that is what stopped the spin. The helicopter then impacted the ground.

The director of PHI Flight Safety provided a narrative history of flight on the Safety Board form 6120.1/2, Pilot/Operator Aircraft Accident Report. According to the statement: "Aircraft lifted off IWA at 2229 hours en route to a scene response in Apache Junction which was 9nm away. The LZ was in a strip mall parking lot and was identified by police and fire units on the ground. Upon arrival at the scene location the pilot made a high recon of the area to assess hazards and obstructions. She initiated her approach from the NNE and landing SSW. At approx. 100' and 20-25 knots and just after crossing wires on the approach the pilot states she felt the aircraft pull gently to the right and up. She moved the cyclic left and aircraft rolled violently left and started spinning. (At least once or twice). She saw a building. She pushed pedals to try and avoid buildings and aircraft was close to the ground and nose was approximately 90 degrees down. She grabbed the cyclic with both hands and couldn't move it. She remembers seeing a red caution light she thinks was the hydraulic caution light but does not remember hearing a gong."

1.2 PERSONNEL INFORMATION

A review of the PHI company training records and FAA airman and medical record files revealed that the pilot held a commercial pilot certificate, with rotorcraft ratings for helicopters and instrument-helicopter, and a private pilot certificate for airplanes single engine land at the time of the accident. The pilot obtained her first pilot's certificate in her native land of Spain, a private certificate rated for single engine land airplanes. The FAA issued her a U.S. private certificate on October 11, 1994, at Oakland, California, on the basis of the certificate issued by Spain.

The pilot was hired by PHI, on October 8, 2001. At that time the pilot reported a total helicopter flight time of 3,583 hours and 277 hours of fixed wing time. Of the helicopter hours, 3,084 were accrued in the Robinson R-22. At the time of the accident, the pilot had accrued a total helicopter time of 4,604 with 80 hours in the Eurocopter AS-350-B3. The pilot's flight instructor time was noted as 2,631 hours of R-22 time. With PHI, the pilot had accumulated

about 300 hours PIC in the BO-105 helicopter and 300 hours in the Bell 206L. The pilot's most recent documented second-class flight physical occurred on May 10, 2004, with restrictions.

A review of the pilot training records revealed the most recent Airman Competency/Proficiency Check occurred on September 16, 2004. The type of check was the 14 CFR 135.293 and 135.299, a 12-month check.

The pilot's complete training file appears in the docket for this accident. In summary, the pilot completed three initial and multiple recurrent company 14 CFR Part 135 training programs on three different helicopters (Bell 206L, MBB BO-105, and the AS350) that have critical hydraulic systems. Emergency procedures for the hydraulic system are part of all the training programs, and include the criticality of the hydraulic cutoff and test switches for the AS350. Except for the BO-105 where complete loss of the hydraulic systems is catastrophic, actual flight training was conducted with simulated hydraulic system failures (by the check pilots turning off the systems).

According to PHI, once the pilots report for duty at their assigned base, no extra duties are given to the pilots beyond flying. Rest facilities, including beds, are provided. The pilots are at the facilities for 12-hour shifts. Examination of the flight and duty time logs for the Williams Gateway base disclosed that the pilot was off duty from December 5 to December 9. On December 10 through the accident date the pilot reported for duty each night at 1950 and signed off duty at 0800 the following morning. A one 28-minute flight was conducted on December 10. No flight time was recorded for December 11, 12, or 13. The accident flight was the first one on December 14.

1.3 AIRCRAFT INFORMATION

1.3.1 General Maintenance History

The Eurocopter AS-350-B3 helicopter, serial number 3230, was manufactured in 1999. A review of the aircraft records disclosed that it had accumulated a total time in service of 2,496 hours. A Turbomeca Arriel 2B engine, serial number 22069, was installed in the airframe and had accumulated a total time in service of 1,826 hours.

The helicopter was maintained under an FAA approved continuous airworthiness inspection program. The most recent inspection, a 100-hour, occurred on November 14, 2004, 23 hours prior to the accident, at a total airframe time of 2,472.

1.3.2 Discrepancy History

Review of the PHI engineering report flight log sheets for this helicopter revealed that in the 3 months prior to the accident, two write-ups reported stiff flight controls, the last one recorded on November 15, and one write-up reported an increased amount of cyclic required to maintain straight and level forward flight. One additional write-up on September 3, 2004, noted that the hydraulic warning horn and light momentarily activated in flight.

The records list the corrective action for the September 3 horn and light discrepancy as "repaired damaged wire at the right-hand servo solenoid valve and cleaned cannon plug."

For the "stiff flight control" write-ups, a October 20, 2004, entry noted "flight controls stiff." The corrective action recorded by the maintenance department stated: "Disconnected servos from stationary swashplate. Isolated stiffness to lower controls. Cleaned bearing surfaces on lower controls. Reattached servos."

In a October 29, 2004, write-up, a pilot reported that an increased amount of cyclic input was required to maintain straight and level forward flight. The corrective action recorded by maintenance was: "Performed flight control rigging check. No Adjustments required."

On 15 November 2004 a pilot reported stiffness in the cyclic control. The corrective action listed by maintenance was: "Replaced L/H and Collective servos due to rough and ratchety piston. Performed M/R rigging."

1.3.2 Hydraulic Control System

1.3.2.1 Transparency Phenomena

Discussions and correspondence were conducted between Safety Board investigators and Eurocopter engineers and flight test pilots, concerning the hydraulic control system transparency phenomena. While typical hydraulic systems in other helicopters and fixed wing aircraft operate at pressure ranges from 1,000 to 3,000 psi, the hydraulic system in the AS350 series helicopters operates at 600 psi. This system pressure was chosen during design as a balance between the loads generated by the rotor system that must be overcome and acceptable load limits on the rotor system dynamic components (control rods, links and fittings, etc.).

The "servo transparency" effect occurs in maneuvers that result in increased positive g-loading on the helicopter and rotor system. The threshold g-load values for onset of the phenomenon vary according to helicopter speed, gross weight, and the atmospheric density altitude. As explained by Eurocopter, when the helicopter reaches a threshold g-loading for the phenomenon onset, the hydraulic system does not have enough pressure available to move the main left lateral, right lateral, and fore/aft servos against the dynamic forces being fed back from the rotor system into the controls. At the onset of "servo transparency," the flight controls essentially go from boosted to manual reversion, where they remain until the g-loads decrease below the onset threshold values. According to the Eurocopter France Chief Test Pilot for the AS350 program, as the system enters the "transparency mode" the pilot would feel the collective lever moving down and the cyclic pitch channel moving to the right.

At the request of Safety Board investigators, Eurocopter France provided a copy of certification flight test report H/EV 17.530. The report documents a series of test flights conducted in 1985 to explore the points where the servo transparency effect (also called control reversibility) occurs. From the data collected, a series of graphic plots were developed and included in the flight test report, which predict the g-loading for phenomenon onset for a given weight, density altitude, and helicopter speed.

Eurocopter personnel stated that the "transparency" phenomenon is non-violent and transitory, lasting only 2 to 3 seconds at most due to the "self-correcting actions of the pilots" to reduce the g-loads and/or the natural static and dynamic stability "response of the helicopter." They also stated that the controls are fully operable throughout the entire "transparency" event; however, the force required to effect movement of the flight controls against the rotor system dynamic feed back loads would increase significantly. Eurocopter stated that the force feed back for each control channel would be dependent in part on the amount of g-loading experienced; however, they estimated that about 22 pounds of force would be required to move the collective in the UP or increased pitch direction, with the same amount to move the cyclic to the left.

Safety Board investigators reviewed Section 3.2 of the FAA/DGAC Approved Rotorcraft Flight Manual, which covers hydraulic system failures. This section lists the approximate force increase to move the flight controls following a hydraulic system failure. As examples, at a speed of 140 knots the force required for movement of the collective would go from minimal (boosted condition) to 44 pounds, while the force for lateral cyclic movement would go from minimal to 26 pounds, and the force for fore/aft cyclic movement would go from minimal to 9 pounds, depending on the direction of control input. According to Section 7.8 of the FAA/DGAC Approved Rotorcraft Flight Manual, the hydraulic system has accumulators for each control channel, which would "provide continued hydraulic assistance for a limited time in the event of a hydraulic pressure loss in the system. The limited time is sufficient to allow the pilot to achieve a flight regime (airspeed of 40 to 60 knots) under which the control feedback forces are acceptable without hydraulic assistance."

1.3.2.2 Hydraulic System Shut-off Switch

A toggle switch is mounted on the end of the collective control lever, which allows the pilot to manually turn off the hydraulic system by depressurizing the pump output, system, and accumulators. Prior to 1990, the switch was guarded by perpendicular walls the height of, and on each side of, the toggle. In response to in-service reports (including one accident) where inadvertent deactivation of the hydraulic system occurred by objects (principally sleeve cuffs and straps) catching on the switch, Eurocopter changed the design of the switch guard, which incorporated a horizontal fixed plate cover over the toggle switch to preclude inadvertent movement of the toggle. With the new guard, two separate motions are required to first reach the toggle, then move it. Service Bulletin 67-17R2 was issued on October 25, 1990, and called for replacement of the old style guards with the new ones. A check of Eurocopter manufacturing documents and airworthiness conformity documents in the maintenance records disclosed that the accident helicopter was equipped with the new style guard, with SB 67-17 (through revision 2) incorporated on the production line.

1.3.2.2 Hydraulic System Test Switch

The systems control panel (pedestal) has provisions for 36 backlighted push-on push-off switches. The switches have mechanical position locks. There were 22 switches being utilized on the accident helicopter. The hydraulic system test switch is located diagonally (No.11) next to the landing light switch (No. 18). Depressing the switch shuts off the hydraulic pump for preflight system checks in part to ensure that the pressure accumulators for the servo channels

are pressurized and working.

At the request of Safety Board investigators, on December 14, 2005, the Manager of Accident Investigation, American Eurocopter, performed a flight in an AS-350-B3 to determine the capabilities of the hydraulic accumulators in a hydraulics-off configuration. The following are the results of several different approach profiles performed:

In order to simulate the final minutes of the accident flight in accordance with the information obtained from the pilot's interview, a right turn was initiated at approximately 20-25 knots. One minute and thirty seconds passed between the time that the "HYD TEST" button was pushed and the time in which a lateral servo accumulator stopped assisting in control inputs.

An 80-knot right-hand (approx 20 degree bank) approach was made. Approximately 1 minute 2 seconds passed between the time that the "HYD TEST" button was pushed and the time in which a lateral servo accumulator stopped assisting in control inputs.

A "normal" straight-in approach was made with minimal control inputs at an airspeed of 80 knots. Three minutes and thirty seconds passed between the time that the "HYD TEST" button was pushed and the time in which a lateral servo accumulator stopped assisting in control inputs.

A "normal" straight-in approach was made with "normal" control inputs at an airspeed of 100 knots. One minute and forty-seven seconds passed between the time that the "HYD TEST" button was pushed and the time in which a lateral servo accumulator stopped assisting in control inputs.

A "normal" straight-in approach was made with excessive control inputs at an airspeed of 80 knots. Forty-five seconds passed between the time that the "HYD TEST" button was pushed and the time in which a lateral servo accumulator stopped assisting in control inputs.

Some operators have modified their Eurocopters, by way of a Supplemental Type Certificate offered by Geneva Aviation in Washington State. The modification is to the center electrical panel presentation. Changes and relocation of switches and pull type circuit breakers are features of the modification as is consideration for inadvertent activation of switches. That STC was not incorporated in the accident helicopter.

After this accident the operator PHI, designed, fabricated, and installed switch guards on their fleet of Eurocopters, over the hydraulic test switch. On November 18, 2005, Eurocopter issued Service Bulletin No. 67.00.32, Installation of "Hydraulic Test" push-button protection flap on Honeywell control units. Additionally, the protection flap has been incorporated on new production aircraft since January 1, 2006.

1.4 METEOROLOGICAL INFORMATION

The closest aviation weather reporting facility is the Phoenix International Airport that is located 23 nautical miles west of the accident site. At 2133, the facility was reporting clear sky conditions with a visibility of 10 miles and light and variable winds. In her statement, the pilot

reported that the wind conditions were calm. None of the witnesses to the accident reported observing any unusual weather phenomena at the time of the accident.

1.5 WRECKAGE AND IMPACT INFORMATION

The helicopter impacted the ground in a paved asphalt parking lot. The helicopter was lying on its left side. The left skid was destroyed. The right skid remained intact. The left forward quarter of nose structure was crushed, conforming to the asphalt surface. The tail boom was broken downward at the attach point to the main fuselage and resting on a collapsed horizontal stabilizer and tail rotor gearbox. The tail rotor was attached to the drive shaft and appeared largely undamaged with only one tip gouged. The main rotor blades revealed abrasion patterns and color transfer consistent with asphalt contact and were highly fragmented. Fragments of the blades and other parts of the airframe's composite structure were widely scattered about the accident site.

The fuel tank was damaged at the filler neck during the impact, spilling a large amount of fuel. The accident area was well saturated, with pooling of the fuel in some areas. The fire department provided a foam cover over the area. In the interest of physical site safety, Safety Board investigators further secured the area by removing the aircraft battery, oxygen bottles, and releasing the pressure from all accumulators without measuring the internal accumulator pressures. All three main rotor servos had positive unquantified pressure; the tail rotor compensator also had positive pressure, to a higher degree. The emergency locator transmitter was also removed.

The rotor head was damaged from the rotor blades striking the asphalt while turning. All three sleeves were broken loose from the Starflex with the Starflex arms broken. The hydraulic belt and pump appeared to be intact and operational. The hydraulic filter impending bypass button was found to be extended in the impending bypass position.

The tail boom was broken at the attach point. The lower vertical fin was bent to the right. The horizontal stabilizer was bent upwards on the left side. The tail rotor short shaft was ejected from the aircraft and found adjacent to the wreckage. The hydraulic cutoff switch on the collective grip appeared to be the later style guarded switch and was in the OFF position. The left forward cabin area was crushed inward. The right skid was intact but bent. The left skid and forward cross tube was broken and bent. The pilot seat was broken at the base in a left direction.

The cockpit pedestal switch positions were documented the morning after the accident. As noted in the History of Flight section, the engine continued to run for several minutes after the ground impact. The one surviving medical crew on board attempted to shut the engine down, thinking that if she were to exit she may be hit by the rotors. She activated various switches around the cockpit in an attempt to shut the engine down, to no avail. Rescuers attempted to shut the engine down as well, including a passerby helicopter pilot. Therefore, some switch positions may have changed. The switches that appeared to be depressed were: Generator, Position lights, Instrument lights 1, Instrument lights 2, Inverter, and Attitude.

1.6 TESTS AND RESEARCH INFORMATION

1.6.1 Hydraulic Control System Components

On January 5, 2005, the hydraulic control system actuators were taken to the Hawker Pacific Aerospace in Sun Valley, California, for functional testing. All of the servos functioned. One Goodrich Servo control actuator, s/n 2009, was tested successfully against the requirements of the Goodrich Actuation Systems component maintenance manual (CMM) SC5083. Servo s/n 765 was out of limits for extension and retraction, with the pressure noted at 360 psi and 530 psi for the respective movements (pressure limit is 333.586 psi). Servo control actuator, s/n 865, was within limits for CMM SC5084; a bent rod affected response to command signal around "zero" psi, and the maximum rate check for unpressurized servocontrol, and the stability check. Servo control, s/n 547, was tested against CMM SC5072; the extension speed was 7.68 inches/second, which exceeded the 6.3 inch/second limit, and, the extension/retraction maximum pressure exceeded the 333.586 limit by 490 and 540 psi respectively.

Some components were examined and tested in France, with the Bureau D'Enquetes et D'Analysis (the BEA, the French government equivalent of the National Transportation Safety Board) providing oversight. The hydraulic pump was examined and successfully tested. The principal control accumulators were pressure tested for 15 hours and 36 hours after pressurizing. The accumulators pressure remained constant. The filter/valve block BFS s/n 572 was successfully tested. The solenoid electrovalves were tested for continuity and electric beam successfully.

1.6.2 Engine Examination

The engine examination convened at Turbomeca Engine Corporation facilities in Grand Prairie, Texas, to examine the engine and related control components. The engine, a Turbomeca Arriel 2B, serial number 22069, was first viewed when the sealed shipping crate was opened. The VEMD (Vehicle Engine Monitor Display), part number B19030MC02, serial number 461, and the DECU (Digital Engine Control Unit), part number 70BMB01020, serial number 380, were packed in the shipping crate with the engine.

After removal from the crate, the engine was placed on a stand for detailed external examination. The only apparent damage was an impact mark on the end of the freewheel shaft outboard of the splined coupling and the manual throttle cable attach point on the fuel control unit. The N1 and N2 shafts turned freely with no apparent scraping or binding. The engine was then borescoped to view the internal condition of the turbine sections. The only anomaly noted was a blade to shroud rub measuring less than 0.5 inches at the 3:30 o'clock position of the T2 wheel.

The freewheel shaft was turned by hand; the freewheel unit locked in the driven direction and slipped in the freewheel direction. Roughness was felt in the shaft during this process. The freewheel unit and shaft were removed from the engine and the freewheel unit was disassembled. The spragues remained in their races and were in a near "rolled over" condition. Multiple indentations consistent with the dimensions of the spragues and their spacing in the races were observed on the underlying input shaft.

The DECU was connected to a computer for data retrieval of stored fault codes. Four faults were recorded at time codes of 281 and 280 for cycle 00005AD1, and two faults for time code 000000FF for cycle 0567B. The complete data listing detailing the recovered fault codes is attached to the powerplant examination report in the docket for this accident. The technicians at Turbomeca, Grand Prairie, could not decode the fault codes and the data was sent to Turbomeca, France, for interpretation. The DECU was secured in a sealed shipping container and forwarded to the Bureau D'Enquetes Accidents (BEA) in France for full functional testing of the unit at the Turbomeca factory under supervision of the BEA.

The VEMD unit also records faults and other system parameters and might contain information that can help interpret the fault codes recorded in the DECU. The VEMD was packaged in a sealed shipping container for forwarding to the BEA for download of the information at the manufacturer, Thales Avionics, Bordeaux, France, under the supervision of the BEA. No useful information was returned from the download.

The engine was then installed in an instrumented test cell for a test run. The engine was coupled to a dynamometer that can simulate varying torque loads. No engine components were replaced or repaired. The complete test cell report attached to the powerplant examination report in the docket for this accident. In pertinent part, the findings of the test cell run are as follows:

The engine was run for a total of 83 minutes in five start/shutdown cycles. The last run cycle was 35 minutes at 98 percent N1 and 100 percent N2.

The engine started immediately without hesitation on each cycle.

All engine parameters remained in the normal ranges during each run.

Accelerations and decelerations were accomplished with varying torque loads and the engine responded immediately, smoothly, and appropriately to the commanded speed.

Both sets of sensors installed on N1 and N2 functioned normally and supplied signal outputs of the correct voltage and wave form.

A failure of the N1 and N2 sensors was simulated by interrupting the signals for the purpose of verifying that the DECU controlled stepper motor was actually locked out and could not move the fuel metering valve. With the engine running at a stabilized mid-power range, a torque load was applied to the power shaft and an uncorrected droop of N2 was observed. With the engine again stabilized at the mid-power range, the torque load was decreased, with a corresponding uncorrected increase in N2 observed.

1.6.3 Airframe Examination

The airframe and the control system were examined twice, once at the site in situ and the second following recovery.

The entire control system run from the cockpit to the rotor head pitch change links was examined visually (all floor panels pulled up and access holes cut into the fuselage structure where required). No evidence of torque tube disconnects, foreign object interference, or abnormal operating signatures were observed to any component. All rods, rod ends, rod end bearings were accounted for and examined. The linkage adjustments were found in the mid range of normal per the rigging section of the maintenance manual. The swash plate position matched the positions of the actuator arm extensions.

The hydraulic system was intact. The pump, including the drive shaft splines, and all the drive belts were intact. The hydraulic filter impending by-pass indicator was extended out (according to Eurocopter, a hard landing can cause this indication). The filter was opened for examination and the element was clean except for one 2 by 2 mm piece of debris. The fluid was drained from the hydraulic system and was observed to be clean and bright red. A sample was collected in a container from the filter housing and forwarded to an oil analysis laboratory. The results of the test were positive for water at 47 parts per million, a particle count that was out of range, and various metals in the fluid (see the laboratory report in the public docket for details). The laboratory report noted in the comments section that there was possible contamination from the oil filter.

The hydraulic test switch on the center console was found in the OFF position at the accident site. The switch panel was removed from the console and the rear portion of the switch was examined for external damage and none was found. The switch was not examined for internal electrical continuity, nor was electrical continuity established between the switch and the solenoid valves.

1.7 ADDITIONAL INFORMATION

The wreckage was released to the insurance company representative.

This narrative was modified on September 20, 2007.

Pilot Information

Certificate:	Commercial; Flight instructor	**Age:**	39,Male
Airplane Rating(s):	Single-engine land	**Seat Occupied:**	Right
Other Aircraft Rating(s):	Helicopter	**Restraint Used:**	
Instrument Rating(s):	Helicopter	**Second Pilot Present:**	No
Instructor Rating(s):	Helicopter	**Toxicology Performed:**	No
Medical Certification:	Class 2 With waivers/limitations	**Last FAA Medical Exam:**	May 1, 2004
Occupational Pilot:	Yes	**Last Flight Review or Equivalent:**	September 1, 2004
Flight Time:	4604 hours (Total, all aircraft), 80 hours (Total, this make and model), 4262 hours (Pilot In Command, all aircraft), 21 hours (Last 90 days, all aircraft), 4 hours (Last 30 days, all aircraft)		

Aircraft and Owner/Operator Information

Aircraft Make:	Eurocopter	**Registration:**	N971AE
Model/Series:	AS-350-B3	**Aircraft Category:**	Helicopter
Year of Manufacture:		**Amateur Built:**	
Airworthiness Certificate:	Normal	**Serial Number:**	3230
Landing Gear Type:	Skid	**Seats:**	4
Date/Type of Last Inspection:	November 1, 2004 AAIP	**Certified Max Gross Wt.:**	4961 lbs
Time Since Last Inspection:	77 Hrs	**Engines:**	1 Turbo shaft
Airframe Total Time:	1826 Hrs at time of accident	**Engine Manufacturer:**	Turbomeca
ELT:	Installed, activated, did not aid in locating accident	**Engine Model/Series:**	Arriel 2 B
Registered Owner:		**Rated Power:**	557 Horsepower
Operator:		**Operating Certificate(s) Held:**	On-demand air taxi (135)
Operator Does Business As:		**Operator Designator Code:**	HEEA

Meteorological Information and Flight Plan

Conditions at Accident Site:	Visual (VMC)	**Condition of Light:**	Night/dark
Observation Facility, Elevation:	KPHX,2133 ft msl	**Distance from Accident Site:**	23 Nautical Miles
Observation Time:	22:56 Local	**Direction from Accident Site:**	265°
Lowest Cloud Condition:	Clear	**Visibility**	10 miles
Lowest Ceiling:	None	**Visibility (RVR):**	
Wind Speed/Gusts:	/	**Turbulence Type Forecast/Actual:**	/
Wind Direction:		**Turbulence Severity Forecast/Actual:**	/
Altimeter Setting:	30.2 inches Hg	**Temperature/Dew Point:**	14°C / 8°C
Precipitation and Obscuration:	No Obscuration; No Precipitation		
Departure Point:	Phoenix, AZ (IWA)	**Type of Flight Plan Filed:**	Company VFR
Destination:	Apache Junction, AZ (NONE)	**Type of Clearance:**	None
Departure Time:	22:29 Local	**Type of Airspace:**	Class B

Wreckage and Impact Information

Crew Injuries:	1 Serious	**Aircraft Damage:**	Substantial
Passenger Injuries:	1 Fatal, 1 Serious	**Aircraft Fire:**	None
Ground Injuries:	N/A	**Aircraft Explosion:**	None
Total Injuries:	1 Fatal, 2 Serious	**Latitude, Longitude:**	33.408332,-111.452499

Administrative Information

Investigator In Charge (IIC):	Petterson, George
Additional Participating Persons:	Bill Pratt; Federal Aviation Administration; Scottsdale, AZ Jim Carver; American Eurocopter LLC; Grand Prarie, TX Archie Whitten; Turbomeca USA; Grand Prarie, TX Terry Kaufman; Petroleum Helicopters, Inc.; Lafayette, LA
Original Publish Date:	April 25, 2007
Note:	The NTSB traveled to the scene of this accident.
Investigation Docket:	https://data.ntsb.gov/Docket?ProjectID=60722