# Aviation Investigation Final Report

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| **Location:** | Hana, Maui, Hawaii | **Accident Number:** | WPR10FA085 |
| **Date & Time:** | December 16, 2009, 13:29 Local | **Registration:** | N87EW |
| **Aircraft:** | Eurocopter AS350BA (FX2) | **Aircraft Damage:** | Substantial |
| **Defining Event:** | Loss of engine power (total) | **Injuries:** | 2 Serious |
| **Flight Conducted Under:** | Part 91: General aviation - Instructional | | |

## Analysis

As part of the required normal 6-month competency check for the commercial pilot, a Federal Aviation Administration (FAA) inspector was performing an examination of the pilot's competency in responding to a total loss of engine power event while in cruise flight. To perform this examination, the FAA inspector announced the beginning of the simulated power loss procedure and moved the fuel flow control lever out of the flight detent (the full forward, full open position) and back just enough to keep the lever from springing back into the detent; this was done to ensure that the engine was not supplying power to the rotor system during the autorotation. However, when the fuel flow control lever was moved, the helicopter yawed right and the generator out warning light illuminated, indicating that the engine had flamed out. The pilot briefly attempted a restart, but the engine exceeded the temperature limit and he discontinued the start attempt. Because of their close proximity to the ground, there was inadequate time to attempt another restart of the engine. The pilot-in-command (PIC) identified and proceeded toward a forced landing site. Due to obstructing trees in the touchdown zone below the area where the simulated engine out was conducted, the PIC overflew the trees with up collective input, leading to a decay of the main rotor rpm. Thereafter, insufficient rotor rpm remained to cushion the touchdown. Also, because of down-sloping terrain, the distance between the helicopter and ground level increased seconds before landing, thereby increasing the helicopter's absolute altitude and contributing to a hard impact with the ground.

The fuel control unit and the power turbine governor were removed from the engine and taken to a test facility where they were installed on calibrated test benches and tested in accordance with the manufacturer’s test procedures. The results of the fuel control unit test showed that the internal parts all worked properly; however, the fuel flow at every test point was below the specified minimum limit. The results of the power turbine governor test revealed that the unit was out of specified limits at each test point. The discrepancies noted would affect the fuel flow at the high end of the schedule and is indicative of an improper rigging procedure. Examination of the unit showed that the maximum stop setting had been adjusted in the field and that the travel was set at 80 degrees instead of the required 86 degrees.

While some of the discrepancies found during the tests of the fuel control unit and the power turbine governor are not serious, those at the low end of the fuel schedule are of particular concern. The minimum fuel flow, idle, and the cut-off settings were found to be below the manufacturer's specified minimum limits; when combined with hysteresis, or the lagging of a physical effect on a body behind its cause, the chances of insufficient fuel flow being delivered to the engine during any engine deceleration maneuver (i.e., moving the throttle out of the flight detent) increases dramatically. When the FAA inspector moved the fuel flow control lever as the pilot was manipulating the collective during the beginning of the autorotation, it is likely that the unloading of the engine sent a signal to the fuel control unit to rapidly decrease the fuel flow at the same time the fuel control lever was being brought out of the flight detent and moved aft, which helped induce the flameout.

Review of the operator's flight and maintenance records found a pilot write-up that noted that about 9 months prior to the accident the engine had flamed out when the throttle was manipulated during the start sequence. The operator's maintenance department was unable to find a reason for the event and released the helicopter back to service. The company pilots were aware that this particular helicopter had a "touchy throttle." The pilot noted that, when operating the throttle lever in this particular helicopter, "you have to be gentle and slow with it as you retard the lever…if you pull it back to far or fast, it will shut off the fuel." At least four prior instances of flameouts as a result of minor throttle movements were uncovered in deposition testimony of company pilots. All occurred on the ground and three of the flameouts happened as pilots were bringing the fuel flow control lever back toward ground idle during the post-flight engine cool down period. These instances were not documented in the maintenance records, and no records of attempted remediation were found.

## Probable Cause and Findings

The National Transportation Safety Board determines the probable cause(s) of this accident to be: An uncommanded engine shutdown due to an improperly calibrated fuel control unit (FCU) and power turbine governor (PTG). Also causal was the operator's inadequate maintenance practices and procedures that failed to properly assess and correct the FCU and PTG irregularities/deficiencies. Contributing to the accident was the Federal Aviation

Administration inspector’s selection of an area for the simulated engine failure that offered limited choices for a full-touchdown autorotation.

## Findings

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| **Environmental issues** | Rough terrain - Contributed to outcome |
| **Environmental issues** | Sloped/uneven terrain - Contributed to outcome |
| **Aircraft** | Fuel controlling system - Damaged/degraded |
| **Aircraft** | Turbine governor - Damaged/degraded |
| **Aircraft** | (general) - Incorrect service/maintenance |
| **Personnel issues** | (general) - Maintenance personnel |
| **Personnel issues** | Decision making/judgment - FAA or designated personnel |

# Factual Information

## History of Flight

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| **Enroute-cruise** | Simulated/training event |
| **Autorotation** | Loss of engine power (total) (Defining event) |
| **Autorotation** | Engine shutdown |
| **Landing-flare/touchdown** | Off-field or emergency landing |
| **Landing-flare/touchdown** | Hard landing |

HISTORY OF FLIGHT

On December 16, 2009, about 1329, Hawaiian standard time, an Aerospatiale AS350BA(FX2), N87EW, operated by Sunshine Helicopters, Inc., Kahului, Maui, Hawaii, experienced a total loss of engine power during a simulated forced landing on the island of Maui about 1.3 miles southeast of the Hana (uncontrolled) airport. The helicopter impacted hard on uneven, downsloping, terrain and was substantially damaged. The commercial certificated pilot-in-command and the FAA inspector check pilot, who held an airline transport pilot certificate, were seriously injured. Visual meteorological conditions prevailed, and a company flight plan was filed. The instructional flight was performed under the provisions of 14 Code of Federal Regulations Part 91, and it originated from the Kahului Airport about 1257.

The check pilot was the operator's assigned Federal Aviation Administration (FAA) principal operations inspector (POI). The purpose of the flight was for the POI to administer a 14 CFR Part 135.293 competency check ride to the pilot. Satisfactory completion of the check ride, and other requirements, would enable the pilot to continue operating Part 135 commercial air tours for his employer, Sunshine Helicopters, holder of an air carrier operating certificate.

According to Sunshine's director of operations (DO), at the time of the flight the accident pilot was current in the operation of the helicopter. Several hours prior to the accident flight, the pilot had flown an air taxi flight in N87EW, and no maintenance squawks were noted. The helicopter operated normally, and it was dispatched for the pilot's use later in the day for his FAA check ride.

The FAA coordinator reported to the National Transportation Safety Board investigator that performance of a simulated loss of engine power during this type of check ride was an authorized routine procedure used in evaluating the competency of airmen.

The pilot and the FAA inspector were interviewed and provided written statements.

The FAA inspector said that after he and the pilot completed the oral portion of the examination they then discussed what would be done on the flight.  The check ride was to be a combined 14 CFR 135.299 and 135.293 check rides and a site air tour route review. The selection to fly to Hana reflected the need to integrate the tour check with the 135.299 and 135.293 check rides. During the briefing it was observed that there were Kona winds, fairly light but different from the usual northeast trade winds. A briefing was then conducted talking about the specific maneuvers to be performed during the check ride: 1) confined area pinnacle approaches, 2) site specific operations, 3) simulated engine power loss with a autorotation forced landing to 100 feet above ground level (agl) with a power recovery before touchdown, and 4) settling with power. The maneuvers would be done either going to or coming from Hana.

The inspector said the helicopter flew fine throughout the entire flight.

The inspector noted that they were about 3,000 feet mean sea level (msl) about 1 mile south of the Hana airport when he said "simulated forced landing" to the pilot. He said there is no defined flight idle position to put in the Fuel Flow Control Lever (which is basically the throttle; hereinafter referred to as the FCL) in to ascertain the power setting. He brought the throttle out of the full open flight run position detent and just aft enough back toward flight idle to keep it from springing back into the gate. The purpose of moving it out of the gate was to be certain the engine is not supplying power during the maneuver. He said that he and the pilot had briefed this prior to the flight and that they were to recover with power before getting too low.

The pilot responded to the simulated loss of power by putting the collective down and he turned toward the Hana airport. The inspector questioned the pilot if he thought they were going to make it to the Hana airport. At that point he believed that the engine was no longer operating and he moved the FCL all the way forward back into the flight detent, but it appeared they were not going to get the engine back. The pilot did try to restart, but it was quickly evident that a restart was not an option due to the rapidly approaching ground. He said they were both looking for a suitable field, but there were not a lot to choose from. The only suitable area was the field the accident occurred in. He said the pilot did a good job trying to get to the field. The inspector said he remembers making a call to check the airspeed during the descent.

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The pilot said it was a clear, VFR day with clouds at 2,500 to 3,000 feet. There were some scattered clouds in the area. The wind was light and variable in direction. The visibility was 5 to 10 miles. There is no weather reporting station at Hana.

He said the flight began and they cruised about 1,500 feet along the shore line and went into the Hana Manu to Kano Falls, where he did site specific training and standoffs, then a confined area landing. He initiated the takeoff and they headed toward the coast line. Then, not long after that, the FAA Inspector initiated the simulated engine failure.

The pilot said he became aware that the simulated forced landing had turned into a real forced landing when the helicopter yawed and then he saw the generator warning light illuminate. He said he and the FAA inspector talked briefly about making it to the Hana airport once they realized the engine had stopped running, but then he realized they did not have enough altitude. He entered a normal autorotation and chose a landing spot to his right. He looked at the throttle and initiated a relight by pushing the (FCL lever) throttle forward and the T4 temperature gauge went to 855 degrees. Since that was over limits, he backed the FCL off to 700 degrees and then due to their altitude, was more focused on getting to the landing spot. He aborted the restart because the helicopter was getting low, about 1000 feet agl. There were not a lot of spots to choose from. There was a lot of grass and trees in the area. Since trees can penetrate the helicopter structure, he picked the grass area that they ultimately impacted. During the final part of the descent, about 150 feet agl, there was a low rotor rpm horn just before touchdown.

The pilot said he did not see the FAA inspector reach over to the throttle quadrant, nor did he see him retard the FCL to begin the simulation. The FAA inspector said something like, "simulated engine failure is beginning". He said he was not surprised when the simulation began, and that he was expecting a simulated engine failure maneuver to be performed during the check ride. During this check ride, this was the first simulated engine failure that the FAA inspector had given him. He said that prior to the maneuver the FAA inspector was trying not to distract him and was very straight forward and was very open for questions.

The pilot described movement of the FCL lever (throttle) in this particular helicopter as “you have to be gentle and slow with it as you retard the lever. If you pull it back to far or fast, it will shut off the fuel.”

## PERSONNEL INFORMATION

### Pilot-in-Command, Sunshine Helicopter

The pilot, age 42, holds a commercial pilot certificate with a rotorcraft-helicopter and helicopter instrument ratings, the most recent issuance of which is dated June 8, 2004. In addition he held a flight instructor certificate with a rotorcraft helicopter rating that was issued on September 10, 2004. His most recent medical certificate, a second class, was issued on March 21, 2009, without limitations or waivers.

According to the operators records, the pilot had accrued a total flight time of 4,458 hours, all in rotorcraft, with 662 in the AS350BA(FX). His most recent 14 CFR 135.293 and 135.299 checks were accomplished on January 15, 2009, in an AS350B2. In the 15 days prior to the accident, the pilot had 9 days scheduled time off from work and had flown 20 hours in 6 duty days in air tour operations.

### Passenger, FAA Principal Operations Inspector

The left seat occupant, age 51, is a Federal Aviation Administration operations inspector in the

Honolulu Flight Standards District Office, who is the assigned Principal Operations Inspector for the operator.  He holds an Airline Transport Pilot certificate with an airplane multi engine land rating and type rating in the Shorts SD-3.  His certificate is also endorsed for commercial pilot privileges in single engine land airplanes, rotorcraft helicopters, gliders, and instrument-helicopters.  The most recent issuance of this certificate was dated April 15, 2009, with the addition of the Shorts SD-3 type rating.  At that time, the inspector reported a total flight time of about 10,800 hours, with 6,345 accrued in rotorcraft helicopters.  His most recent medical certificate, a second class, was issued on December 4, 2009.

In an interview, the inspector was asked about his total experience in the AS350 BA, FX conversion with the Honeywell engine.  He stated that he has given one other flight check, and further noted that he is not really aware of the difference between it and a BA model.  He said he became aware it was an FX conversion during the oral.  He said he did readily know the differences between the FX and BA models and could not recall if he ever received training in this specific FX model.

When asked if he had ever performed a check flight in AS 350 FX conversion he replied that he had given other check rides in the FX model at one other operator.  The inspector was asked to explain how a simulated forced landing was performed on those checks.  He replied that he would first announce the simulated forced landing so the pilot can lower the collective and set up the helicopter for the autorotation, then he would bring the throttle out of the flight gate to ensure that the engine was not providing power to the rotor.  The maneuver was terminated between 300 and 500 feet agl.  During the procedure he looks at the rotor rpm, airspeed, EGT gages, plus monitoring the outside situation to ensure the pilot is going toward the selected landing area.

The inspector said he has seen the company training manual and had received refresher training in a Robinson R44 and a Bell 206.  With regard to the training manual, he said that during a check ride if a pilot would question the maneuver during the before the flight briefing, the manner of the item’s performance would be changed.

AIRCRAFT INFORMATION

The helicopter, serial number 2116, was manufactured by Aerospatiale in 1988 as an AS350B model with a Turbomeca Aerial 1B engine.  The helicopter was sold to a customer in Japan and was registered there as JA9761.  In March of 2000 it was imported into the United States from Japan and registered under its current FAA civil registration number.  In November of 2002, the original Turbomeca Aerial 1B engine was removed and a Rolls-Royce Allison 250-C30M was installed in accordance with a Soloy Corporation Supplemental Type Certificate.

On December 16, 2008, the Allison engine was replaced with a Honeywell LTS101-600A3-A engine, serial number LE46110C, under the provisions of Supplemental Type Certificate SR02295NY.  The modifications changed the helicopter’s designation from a AS350B to a AS350BA (FX2).

Review of the maintenance records disclosed that a 100-hour inspection was endorsed in the airframe logbook on December 2, 2009, at an airframe total time of 18,789 hours.

The maintenance records disclose that the engine was a Honeywell LTS101-600-3A, which was manufactured in September of 1984. The most recent 100-hour inspection for the engine was endorsed on December 1, 2009, at a total time since new of 7,725 hours, with 988 hours since the last major overhaul. The major overhaul was noted as completed on December 26, 2007, by the Honeywell facility in Greer, South Carolina, at a total since new of 6,737 hours. At that time, an overhauled Fuel Control Unit and Power Turbine Governor were installed on the engine. After the overhaul, the engine was sold as part of the BA(FX2) conversion kit to Sunshine Helicopters.

The maintenance records have no entries reflecting removal, replacement, adjustment, or maintenance actions for either the Fuel Control Unit or the Power Turbine Governor after installation on the engine at engine overhaul.

Review of the component record card for the Fuel Control Unit identified it as serial number 84490022. The unit was overhauled at Precision Fuel Components on November 20, 2007 and installed on the engine at the time of the engine overhaul by Honeywell, Greer, South Carolina. The final acceptance test sheet prepared by Precision Fuel Components show the unit passed the test on November 16, 2007 and met all test specification points.

Review of the component record card for the Power Turbine Governor identified it as serial number 31248. The unit was overhauled at Precision Fuel Components on November 16, 2007 and installed on the engine at the time of the engine overhaul by Honeywell, Greer, South Carolina. The final acceptance test sheet prepared by Precision Fuel Components show the unit passed the test on November 16, 2007 and met all test specification points.

The company flight record sheets for the helicopter were reviewed. From the 100-hour inspection on December 2 until the date of the accident, no maintenance discrepancies or maintenance actions were recorded on the daily flight sheets. A more comprehensive review of the historical flight sheets found an entry on March 14, 2009, noting a pilot discrepancy write-up of an uncommanded flame-out of the engine. The pilot entry stated, “after lighting off at 42 percent Ng (gas generator speed), I advanced the fuel toward idle, at 60 percent Ng engine flamed out.” The listed maintenance corrective action states:

“Inspect compressor inlet for obstruction, inspect pneumatic and fuel lines for loose fittings and chaffing okay, check throttle for proper position and movement okay. Engine started normal power checked normal. Possible flame out due to water accumulated at bottom of inlet housing after heavy rain. Aircraft okay for service.”

The helicopter had been converted from its original manufactured AS350B type design. In part, the conversion involved installation of a Honeywell LTS101-600A-3A engine, modification of its electrical system and engine performance gauges, installation of a tail boom strake, and installation of modified tail rotor blades. The principal changes, commonly referred to as an "FX" conversion, altered the helicopter's operating parameters as indicated by supplements included in the helicopter's flight manual.

A control quadrant is mounted on the floor between the two front seats. Three lever controls are located on the quadrant. The most left hand lever (looking forward from behind the quadrant) is the Rotor Brake Control. The middle lever is the Fuel Flow Control; on top of the handle the starter button control is located. The most right hand lever is the Emergency Fuel Shut-Off control.

The Fuel Flow Control lever operates in a longitudinal track. Two gate detents are located at the extreme ends of the track, with the forward detent the “full open” or flight run position, and the most aft detent the “closed” or idle cut-off position. Movement of the lever between the detents meters fuel to the fuel control unit mounted on the engine and controls the speed of the engine between the 100 percent at the open position down to engine stopped at the closed position. This model helicopter does not have a minimum flight or ground idle detent for the fuel flow control lever on the power quadrant.

The investigation found that the engine had inadvertently (uncommanded) shut down four prior times, including the March 14, 2009 event noted above. The three other events were disclosed in sworn testimony by company pilots. All four of the events occurred when the helicopter was on the ground, and three of them occurred when pilots were bringing the FCL back to slow the engine speed to ground idle during the post flight engine cool down period. With the exception of the March 14th event, none of the shutdowns were documented in the company system.

## METEOROLOGICAL INFORMATION

The closest official weather observation station was Hana, Maui, airport, which is located 1 nautical mile north of the accident site. At 1356 hours, the Hana surface observation was reporting in part: winds from 300 degrees at 3 knots, 7 miles visibility in light rain showers, clear skies with a temperature of 26 degrees C, and a dew point of 20 degrees C.

Both pilots recalled that the weather conditions were clear beneath scattered clouds at 2,500 to 3,000 feet msl, with 5 to 10 miles visibilities.

## WRECKAGE AND IMPACT INFORMATION

The aircraft was initially observed at the accident site on 18 December 2009. The helicopter had impacted a vegetation covered lava rock formation approximately 1 mile south of the Hana airport. The initial impact was on an east south east heading in a semi-residential area.

The helicopter appeared to have bounced and traveled approximately forty feet, rotating approximately ninety degrees to the right before coming to rest. The wreckage had signatures consistent with impact at a high vertical speed with relatively low forward speed.

The main rotor blades remained attached to the hub. The Yellow Blade was folded over the cabin, with a spar fracture approximately 3 feet from the root. Very little additional damage to the blade was noted. The sleeves were ruptured and the Starflex arm was separated. The Blue Blade and star arm were intact and positioned over the cabin. The pitch change (PC) link was fractured at the upper attachment to the PC arm. The Red Blade was resting on the ground on the left side of the helicopter and exhibited a buckle in the spar and an opening of the after body approximately 6 feet from the blade root. Examination of this blade revealed embedded fibrous material and scratching consistent with a tree strike. A tree to the right of the flight path adjacent to the initial impact point (IIP) exhibited damage consistent with a main rotor blade strike.

Observations regarding the main transmission were:

- The aft right support mount was intact.
- The forward right support mount was fractured in compression.
- The aft left support mount was fractured in tension.
- The forward left support mount was fractured in compression.
- The transmission was displaced forward and slightly left.
- The transmission deck was torn on the left side.
- The lower chip detector was broken.
- The transmission was free to rotate by hand.
- The swashplate was intact and operated.
- The left lateral servo (Dunlop) input rod was broken in compression above the transmission deck.
- The right lateral servo (Dunlop) input rod was binding against the transmission deck.
- The fore and aft servo (Dunlop) input rod was jammed against the transmission deck.
- The gimbal remained attached to the transmission and was displaced to the left with over travel signatures visible on the trumpet.
- The main drive shaft remained in place and intact within the trumpet.
- The hydraulic pump and drive were in place and intact. The Poly-V belt was intact.
- The hydraulic reservoir was in place and intact.

The tail boom was separated just forward of the horizontal stabilizer at the bulkhead. The cabin roof collapsed and the left door post separated. The landing gear remained in its normal relative location, but the cross tubes were spread. Both skids remained attached to the cross tubes and the ankles were intact. Both spring steel extensions were deformed upward. The right step separated at the forward end but remained attached at the rear. The aircraft was float equipped and the floats activated upon impact.

Both crew seats exhibited crushing but remained in place. All restraints were intact. The inertia reels operated as designed. This was confirmed by manual activation of the lock feature. The pilot's seat did not have data tags. The co-pilot's seat was padded and upholstered and had data tags.

The left cross beam was extensively buckled and torn. The right was not observed. Extensive buckling was observed on the external transition section of the fuselage and the engine deck. The forward firewall was buckled on itself, with the deformation more apparent on the left side.

The portion of the tail boom which remained attached to the fuselage exhibited a light main rotor blade strike to the top of the drive shaft cover over the third and fourth hangar bearings (six hangar bearings total), and on the right side of the boom structure. Neither strike had enough energy to cut the tailboom skin. The separated section of the tail boom exhibited a main rotor blade strike to the top of the left horizontal stabilizer that separated the camera and position light but did not cut the stabilizer. The right stabilizer was damaged when it came into contact with the forward section of the boom during the impact sequence. The lower vertical stabilizer was crushed into the tail cone. The forward lower separation of the tail boom exhibited crushing and scoring. Tail rotor drive continuity was established by manual rotation on both sides of the boom separation. The continuity of both drive and pitch control aft of the boom separation was established. Tail rotor pitch control forward of the boom separation could not be established due to impact related damage below the cabin floor.

The fuel tank was breached during the impact and was observed leaking during the aircraft recovery. The lower fuselage was extensively crushed and was not inspected in detail.

The center pedestal was crushed down and slightly forward. As found at the accident site, the throttle was in an 'intermediate' position, but located closer to the cut-off (closed) detent than the flight run detent. Fuel shutoff was aft (off). Rotor brake forward (off).

The tail rotor drive shaft couplings were intact. The long tail rotor drive shaft was disconnected at the forward spline. No rotational damage was noted on the splines. The tail rotor head was disassembled and the key inspected. The key was intact. Aside from some rust, there was no evidence of either under or over drive. The tail rotor blades exhibited damage consistent with low RPM at impact. The paddles were ruptured at the cuffs and were open on the trailing edges. One strike tab was intact.

Oil was observed in the tail rotor gearbox. No debris was noted on the T/R G/B chip detector. Fuel was found in the airframe fuel filter. It was free of debris and clear and bright.

Collective control continuity was established. Cyclic control was established laterally, but was jammed in fore and aft direction due to accident damage. Anti-torque control continuity could not be established due to impact related damage forward of the boom separation. Other than a visual inspection which revealed no damage, the primary and tail rotor servos were not examined.

TESTS AND RESEARCH

The engine was removed from the aircraft and shipped to the Honeywell Product Integrity Investigation Laboratory, in Phoenix, Arizona.

The LTS101 engine is a modular turboshaft engines. Each model consists of an accessory/reduction gearbox module, gas generator module, inlet scroll and a power turbine module. This engine has an output shaft clutch which allows auto rotation without engine power.

During operation, inlet air passes through the inlet scroll and inlet housing and is compressed by an axial and a centrifugal compressor. Air is then directed through the air diffuser to the combustor where fuel is introduced to form a combustible mixture. Combustion occurs in the annular combustor liner and expanding gases are directed through the gas generator nozzle onto blades of the gas generator turbine. The gas generator turbine extracts energy from the gas stream to drive the compressor and certain accessories. The gas stream passes through the power turbine (PT) nozzle onto the blades of the power turbine. The power turbine extracts energy to drive certain accessories and the power output shaft. Gases exit through an exhaust tailpipe.

The engine appeared to be generally intact with no obvious impact damage noted. The data plate identified the engine as a model LTS101-600A-3A turboshaft engine, serial number LE-46110CE.

The examination of the engine, serial number LE-46110CE, disclosed the indication of metal spray deposits adhering to the vanes of the power turbine nozzle assembly; indicative of engine operation at the time of impact with terrain.
No pre-existing condition was found that would have interfered with the operation of the engine as evidenced by the engine operability verification test cell run.

Rotational scoring from approximately the 4 to 7 o’clock positions (As Looking Forward) was noted on the tip shroud area of the power turbine nozzle assembly. Metal spray deposits were noted to be adhering to the vanes of the power turbine nozzle assembly. The compressor section was inspected with a borescope. Minor leading edge damage was noted to some of the axial compressor blades. No apparent damage was noted to the inspected area (around the 6 o’clock position) of the centrifugal impeller and shroud.

The engine fuel filter was removed, examined and reinstalled. No debris was noted. The engine oil filter was removed and replaced. The filter was captured and retained with the engine. No debris was noted on the gearbox chip detector. The gas producer, N1 rotating group, was free to rotate. The power turbine, N2 rotating group, was free to rotate.

Following initial evaluation of the engine, the NTSB investigator in charge agreed to proceed with attempting an engine operability test cell run. The engine was staged and installed in Honeywell's Propulsion Shaft Test Cell 903. The throttle lever on the fuel control was removed and repositioned approximately 180 degrees on the power lever shaft to facilitate the interface with the test cell throttle control unit. The repositioning does not affect the physical stops of the power lever. Prior to removal, it was noted that the original position was previously indexed with a red mark.

The engine was dry motored (fuel flow at cut-off) until a positive oil pressure indication was obtained. No anomalies were noted as the engine decelerated after being motored. The gearbox chip detector was removed and inspected (no findings).

An engine start was initiated and the engine was accelerated to a speed level of approximately 57% gas generator speed (Ng) and allowed to stabilize. The power level (PL) was retarded to the ground idle (GI) setting of 48% – 52% Ng No operational anomalies were noted. After approximately 4 minutes, the data recording system was stopped. The engine was operated for a total period of approximately 11 minutes prior to performing a shutdown.

The noted idle position in the test cell correlates (approximately) to the post accident throttle quadrant/FCU PL position documentation performed during the wreckage review for the idle setting.

During the second test cell run, the engine was started and operated for a period of approximately 36 minutes, consisting of the following activities:

1. Performed normal engine start

2. Stabilized at ground idle for approximately 5 min

3. Stabilized at flight idle (FI) of ~70% NGG for approximately 7 min

4. Slow acceleration and loading (via water brake) to high power setting (approximately 3 min)

5. Operated at power setting indicative of a takeoff configuration for approximately 3 min

6. Engine unloaded to mid-range torque setting of approximately 317 SHP for approximately 7 min

7. Engine load increased to partial power setting of approximately 440 SHP for approximately 3 min

8. Decelerated to flight idle and stabilized for approximately 2 min

9. Decelerated to ground idle and stabilized for approximately 3 min

10. Steady retardation of power lever over a 3 minute period until engine flame out occurred at a 29.40% NGG

Engine Instrument Gauge Examination, Calibration and Accident Flight Data

The Ng RPM indicator, the T4 temperature indicator, and the torque percent indicator were removed from the cockpit and taken to the manufacturer under the supervision of the NTSB investigator in charge where they were subject to examination and a manufacturer's compliance acceptance test. The units passed all tests.

Three engine performance-related gauges were examined by their manufacturer while under National Transportation Safety Board supervision. The gauges were examined for the purpose of ascertaining their calibration and functionality, and to recover non-volatile memory data related to the accident flight. The gauges were the temperature gauge (T4 [deg] C), the torque gauge (Torque %), and the gas generator gauge (Ng %RPM). The gauges had been installed in the accident helicopter as a component of the FX1 modification, and the face plate on each gauge was marked with the "350FX1" identification pursuant to the FX1 supplemental type certificate.

In summary, the gauges were all found calibrated to their respective design specifications, and they were functional. No pertinent anomalies were noted. The non-volatile memory in each gauge was recovered and examined. Recovered memory data from the most recent flight appeared consistent with the reported specifics of the accident flight.

According to the gauges manufacturer, the temperature gauge (T4 [deg] C) was designed to begin sampling and recording data at 4 minute intervals, commencing 4 minutes after being energized (engine start). The green lights (LEDs) in the gauge's face plate cover the range from 740 to 760 degrees Celsius. The first recording from the gauges most recent flight memory indicated a temperature of 453 degrees Celsius (C). Twelve minutes after electric current was provided to the gauge (engine start) the gauge recorded a temperature of 554 degrees C. The last recording occurred 44 minutes after engine start. At this time the temperature was 690 degrees C. The gauge manufacturer reported that the temperature gauge should have recorded additional data 4 minutes later, had the gauge been energized at that time.

The torque gauge (Torque %) was designed to begin sampling and recording data at 4 minute intervals, commencing 4 minutes after being energized (engine start). The LEDs in the gauge's face plate cover the range from 93% to 94% torque. The first recording from the gauges most recent flight memory indicated a torque of 8%. Twelve minutes after engine start the gauge recorded that the torque was 21%. Thereafter, the torque continued increasing and it remained between 45% and 80%. Forty-four minutes after engine start the torque was 62%. The last recording was made 4 minutes later, at which time the torque was 0%. The gauge manufacturer reported that the torque gauge should have recorded additional data 4 minutes later, had the gauge been energized at that time.

The gas generator gauge (Ng %RPM) was designed to begin sampling and recording data at 3 minute intervals, commencing 3 minutes after being energized (engine start). The LEDs in the gauge's face plate cover the range from 95% to 103% RPM. The first recording from the gauges most recent flight memory indicated an RPM of 66.3%. Nine minutes after engine start the gauge recorded that the RPM was 71.0%. Twelve minutes after engine start the recorded RPM was 88.0%. Thereafter, the RPM continued increasing, and [[from 12 to 45 minutes thereafter, it remained between 91.4% and 99.1%.]]  Three minutes later, it was recorded at 34%, and this was the last recorded data. The gauge manufacturer reported that the NG %RPM gauge should have recorded additional data 3 minutes later, had the gauge been energized at that time.

Additional Tests of the Fuel Control Unit and Power Turbine Governor

As part of a Department of Justice investigation, on July 11, 2011, the Fuel Control Unit and the Power Turbine Governor were removed from the engine, which was in storage at Inter-Mountain Turbines, West Lindon, Utah.  All original seals and lock wire were intact. The units were taken to Aviation Controls, Inc., in Independence, Kansas, and were tested on calibrated test benches in accordance with Honeywell acceptance test procedures.  The test results and reports are included in the docket for this accident.

The Fuel Control was tested in accordance with Honeywell Test Specification 12991 in an “as received” condition.  Each test point was established by following the individual input parameters in the specified sequence and the fuel flows were recorded.  The full test showed that the internal Fuel Control parts all worked properly; however, the fuel flow at every test point was below the specified minimum limit.

The Power Turbine governor was tested in accordance with Honeywell Test Specification 12990 in an “as received” condition.  The Max stop setting had been adjusted in the field (allowable procedure in the field) and the travel was set at 80 degrees instead of the required 86 degrees.  The test revealed that the unit was out of specified limits at each test point.  The discrepancies noted would affect the fuel flow at the high end of the schedule.

ADDITIONAL INFORMATION

FAA Regulations, Pilot-in-Command

According to 14 CFR 91.3, entitled "Responsibility and authority of the pilot in command," the pilot in command of an aircraft is directly responsible for, and is the final authority as to, the operation of that aircraft.

The pilot and the FAA inspector reported that prior to takeoff they discussed their respective roles for the upcoming flight. The Sunshine pilot was aware that he was the designated PIC for the flight. Additionally, at no time during the accident flight did his status as PIC change, or did the FAA inspector take control of the helicopter, or did the FAA inspector manipulate the flight controls .

Forced Landing Simulation, FAA Policy

The FAA publishes practical test standards (PTS) for commercial pilots (publication number FAA-S-80-16A). In the foreword of this publication, the FAA states, in part, that FAA inspectors shall conduct practical tests in compliance with these standards, and flight instructors and applicants should find these standards helpful during training and when preparing for the practical test.

As indicated in the PTS, the FAA requires that all practical tests be conducted in accordance with the standards and policies. As written in the PTS, "The examiner is expected to use good judgment in the performance of simulated emergency procedures. The use of the safest means for simulation is expected. Consideration must be given to local conditions (both meteorological and topographical), at the time of the test, as well as the applicant's, workload, and the condition of the aircraft used. If the procedure being evaluated would jeopardize safety, it is expected that the applicant will simulate that portion of the maneuver."

Regarding emergency power failure at altitude operations, the FAA notes that "Simulated power failure at altitude must be given [by the examiner] over areas where actual touchdowns can safely be completed in the event of an actual powerplant failure."

FAA Inspector Handbook Information, Order 8900

In pertinent part, FAA Order 8900 directs the activities of aviation safety inspectors (ASI) responsible for the certification and surveillance of air carriers and certificated airmen. Pursuant to volume 6, chapter 2, section 13, of this Order, the ASI is authorized to perform as a check airman surveillance job function in the administration of proficiency and competency checks. This Order contains direction and guidance to be used by the principal operation inspector's and inspectors when observing or conducting a proficiency or competency check inspection.

A stated objective of the competency check is to evaluate individual airmen performing their duties and responsibilities. In paragraph 6-471, the Order states that before conducting a proficiency and competency check inspection, "inspectors must become thoroughly familiar with the operator’s manuals." Inspectors may also be required to qualify in the operation of the aircraft.

Regarding performance of line checks under 14 CFR 135.299, the Order states in volume 6, chapter 2, section 19, that the inspector should prepare for conducting the check by familiarizing  himself with the operator's procedures. The operator's manuals and operations specification are sources for obtaining this information.

FAA Flight Examination Requirements

The operator reported that the purpose of the accident flight was to examine their company pilot's competency under 14 CFR 135.293 and 135.299. This semiannual flight check was performed by an FAA employee because the company's authorized check airman was temporarily unavailable due to medical reasons. The accident pilot had not previously been examined by an FAA inspector.

Flight Manual Review

The helicopter's flight manual was recovered from the accident site and examined. Its content was compared with an exemplar manual containing all appropriate revisions.

Sunshine Helicopters Training Program, Autorotation

According to Sunshine's Director of Operations (DO), the accident pilot was trained pursuant to the company's FAA approved training program. The program specifies that all autorotations will terminate with a stabilized in ground effect hover (power on recovery).

Regarding autorotations, the program states in revision 7, dated August 1, 2003, that the objective of this training is, in part, "to test the pilot's ability and skills in reacting to a loss of engine power. Training may include performance of both straight-in and 180-degree autorotations. In both cases, the procedure will be initiated by the pilot lowering the collective. Thereafter, the instructor pilot will reduce the FCL to 80% Ng.

## Pilot Information

| | | | |
|---|---|---|---|
| **Certificate:** | Commercial; Flight instructor | **Age:** | 42,Male |
| **Airplane Rating(s):** | None | **Seat Occupied:** | Right |
| **Other Aircraft Rating(s):** | None | **Restraint Used:** | |
| **Instrument Rating(s):** | Helicopter | **Second Pilot Present:** | Yes |
| **Instructor Rating(s):** | Helicopter | **Toxicology Performed:** | No |
| **Medical Certification:** | Class 2 Without waivers/limitations | **Last FAA Medical Exam:** | March 21, 2009 |
| **Occupational Pilot:** | Yes | **Last Flight Review or Equivalent:** | January 15, 2009 |
| **Flight Time:** | 4458 hours (Total, all aircraft), 662 hours (Total, this make and model), 4100 hours (Pilot In Command, all aircraft), 172 hours (Last 90 days, all aircraft), 79 hours (Last 30 days, all aircraft), 3 hours (Last 24 hours, all aircraft) | | |

## Check pilot Information

| | | | |
|---|---|---|---|
| **Certificate:** | Airline transport; Flight instructor | **Age:** | 51,Male |
| **Airplane Rating(s):** | Single-engine land; Multi-engine land | **Seat Occupied:** | Left |
| **Other Aircraft Rating(s):** | Glider; Helicopter | **Restraint Used:** | |
| **Instrument Rating(s):** | Airplane; Helicopter | **Second Pilot Present:** | Yes |
| **Instructor Rating(s):** | Airplane multi-engine; Airplane single-engine; Glider; Helicopter; Instrument airplane; Instrument helicopter | **Toxicology Performed:** | No |
| **Medical Certification:** | Class 2 With waivers/limitations | **Last FAA Medical Exam:** | December 4, 2009 |
| **Occupational Pilot:** | No | **Last Flight Review or Equivalent:** | |
| **Flight Time:** | 10800 hours (Total, all aircraft) | | |

## Aircraft and Owner/Operator Information

| | | | |
|---|---|---|---|
| **Aircraft Make:** | Eurocopter | **Registration:** | N87EW |
| **Model/Series:** | AS350BA (FX2) | **Aircraft Category:** | Helicopter |
| **Year of Manufacture:** | | **Amateur Built:** | |
| **Airworthiness Certificate:** | Normal | **Serial Number:** | 2116 |
| **Landing Gear Type:** | Emergency float; Skid | **Seats:** | 5 |
| **Date/Type of Last Inspection:** | December 2, 2009 100 hour | **Certified Max Gross Wt.:** | 4961 lbs |
| **Time Since Last Inspection:** | 65 Hrs | **Engines:** | 1 Turbo shaft |
| **Airframe Total Time:** | 18789 Hrs at time of accident | **Engine Manufacturer:** | Honeywell |
| **ELT:** | C126 installed, activated, aided in locating accident | **Engine Model/Series:** | LTS101-600A |
| **Registered Owner:** | SUNSHINE HELICOPTERS INC | **Rated Power:** | 720 Horsepower |
| **Operator:** | SUNSHINE HELICOPTERS INC | **Operating Certificate(s) Held:** | On-demand air taxi (135) |
| **Operator Does Business As:** | | **Operator Designator Code:** | SSHA |

## Meteorological Information and Flight Plan

| | | | |
|---|---|---|---|
| **Conditions at Accident Site:** | Visual (VMC) | **Condition of Light:** | Day |
| **Observation Facility, Elevation:** | HNM,78 ft msl | **Distance from Accident Site:** | 1 Nautical Miles |
| **Observation Time:** | 13:56 Local | **Direction from Accident Site:** | 313° |
| **Lowest Cloud Condition:** | Clear | **Visibility** | 7 miles |
| **Lowest Ceiling:** | None | **Visibility (RVR):** | |
| **Wind Speed/Gusts:** | 3 knots / | **Turbulence Type Forecast/Actual:** | / |
| **Wind Direction:** | 300° | **Turbulence Severity Forecast/Actual:** | / |
| **Altimeter Setting:** | 29.93 inches Hg | **Temperature/Dew Point:** | 26°C / 20°C |
| **Precipitation and Obscuration:** | Light - Showers - Rain | | |
| **Departure Point:** | Kahului, HI (OGG ) | **Type of Flight Plan Filed:** | Company VFR |
| **Destination:** | Kahului, HI (OGG ) | **Type of Clearance:** | None |
| **Departure Time:** | 12:57 Local | **Type of Airspace:** | |

## Airport Information

| | | | |
|---|---|---|---|
| **Airport:** | Hana HHN | **Runway Surface Type:** | Asphalt |
| **Airport Elevation:** | 78 ft msl | **Runway Surface Condition:** | Unknown |
| **Runway Used:** | 08 | **IFR Approach:** | None |
| **Runway Length/Width:** | 3606 ft / 100 ft | **VFR Approach/Landing:** | Forced landing |

## Wreckage and Impact Information

| | | | |
|---|---|---|---|
| **Crew Injuries:** | 2 Serious | **Aircraft Damage:** | Substantial |
| **Passenger Injuries:** | | **Aircraft Fire:** | None |
| **Ground Injuries:** | N/A | **Aircraft Explosion:** | None |
| **Total Injuries:** | 2 Serious | **Latitude, Longitude:** | 20.780277,-156.002227 |

## Administrative Information

| | |
|---|---|
| **Investigator In Charge (IIC):** | Pollack, Wayne |
| **Additional Participating Persons:** | Christine Soucy; Federal Aviation Administration; Washington, DC<br>Joe Syslo; American Eurocopter, LLC; Grand Prairie, TX<br>David Studtmann; Honeywell Aerospace; Phoenix, AZ<br>Joel Collins; Sunshine Helicopters, Inc.; Kahului, Maui, HI<br>Matthew Trahearn; Heli-Lynx Helicopter Services, Inc.; Ontario, Canada |
| **Original Publish Date:** | January 15, 2013 |
| **Last Revision Date:** | |
| **Investigation Class:** | Class |
| **Note:** | The NTSB traveled to the scene of this accident. |
| **Investigation Docket:** | https://data.ntsb.gov/Docket?ProjectID=75180 |