Aviation Investigation Final Report

Location:	Oklahoma City, Oklahoma	**Accident Number:**	CEN13FA174
Date & Time:	February 22, 2013, 05:42 Local	**Registration:**	N917EM
Aircraft:	Eurocopter AS 350 B2	**Aircraft Damage:**	Substantial
Defining Event:	Loss of engine power (total)	**Injuries:**	2 Fatal, 1 Serious
Flight Conducted Under:	Part 91: General aviation - Positioning		

Analysis

The emergency medical services helicopter departed a hospital helipad in dark night visual flight rules conditions and proceeded on its mission. Satellite data showed that, after takeoff, the helicopter began a gradual climb toward its planned destination. The data stopped about 3 minutes and 30 seconds into the flight. No distress calls were heard from the pilot. Fixed video surveillance cameras located near the accident site showed the last few seconds of the helicopter descending toward the ground. The helicopter impacted a parking lot, and a postimpact fire occurred.

Examination of the wreckage revealed that three of the engine's first-stage axial compressor blades exhibited deformation consistent with soft body foreign object damage. The remainder of the engine and airframe exhibited no evidence of malfunction that would have contributed to an in-flight loss of engine power.

The helicopter's air intake design, which had been modified to accommodate a different engine than that originally supplied by the helicopter's manufacturer, incorporated a blanking plate attached to the top side of the engine cowling that covered a portion of the air inlet screen. A gap in the area where the blanking plate and the screen overlapped made it possible, in certain meteorological conditions, for water or snow to pass through the screen, accumulate on the blanking plate, and freeze into ice. Ice accumulation in this area, if left undetected, could result in the ice detaching from the blanking plate and entering the engine during operation, causing soft body foreign object damage and a loss of engine power. Precipitation and outside temperatures ranging from 35 to 19 degrees F occurred during the 12-hour period preceding the accident. The combination of these meteorological conditions was conducive to the formation and accumulation of ice in the area between the air inlet screen and the blanking plate.

Although the helicopter's flight manual supplement for cold weather operations recommended installation of an air inlet cover after the last flight of the day, during the day and night before the flight, the helicopter was parked outside on the helipad without an air inlet cover installed. According to the helicopter's mechanic, he inspected the helicopter on the afternoon before the flight and noted that some snow had accumulated on it. It is likely that the lack of an engine air inlet cover allowed precipitation to accumulate in the vicinity of the engine air intake.

The helicopter's flight manual cold weather operations supplement also contained instructions for the pilot to perform a visual and manual (tactile) inspection of the air intake duct up to the first-stage compressor for evidence of snow and ice. Furthermore, the manufacturer and the Federal Aviation Administration had previously released information notices regarding inflight loss of engine power due to snow or ice ingestion caused by inadequate inspection or removal of snow or ice from the engine air inlet. These notices recommended a thorough inspection in and around the engine inlet area in order to detect and remove any snow or ice accumulation before flight.

The initial on-scene examination found no remnants of ice or snow on these components because exposure to the postcrash fire would have melted such evidence. Surveillance video of the helipad showed that most of the helipad lights were off at the time of the pilot's preflight inspection immediately before the flight, making it difficult for him to detect any ice or snow accumulation in the area of the engine air intake. Thus, the ice accumulation between the air inlet screen and the blanking plate remained undetected, and shortly after takeoff, the ice detached from the blanking plate, slid into the air inlet, and was subsequently ingested by the engine, resulting in an in-flight loss of engine power.

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Probable Cause and Findings

The National Transportation Safety Board determines the probable cause(s) of this accident to be:

The loss of engine power due to engine ice ingestion during initial climb after takeoff in dark night light conditions. Contributing to the accident were the lack of an installed engine air inlet cover while the helicopter was parked outside, exposed to precipitation and freezing temperatures before the accident, and the pilot's inadequate preflight inspection that failed to detect ice accumulation in the area of the air inlet.

Findings

Aircraft	Powerplant parameters - Attain/maintain not possible
Environmental issues	Conducive to structural icing - Effect on equipment
Environmental issues	Dark - Effect on personnel
Aircraft	Intake anti-ice, deice - Not used/operated
Environmental issues	Low temperature - Effect on equipment
Environmental issues	Snow - Effect on equipment
Personnel issues	Preflight inspection - Pilot

Factual Information

History of Flight

Prior to flight	Aircraft inspection event
Initial climb	Loss of engine power (total) (Defining event)
Emergency descent	Collision with terr/obj (non-CFIT)

On February 22, 2013, approximately 0542 central standard time, an Eurocopter AS350B2 emergency medical service (EMS) configured helicopter, N917EM, registered to Wells Fargo Equipment Finance Inc., care of EagleMed LLC, of Wichita Kansas, impacted in the parking lot of St. Ann's Retirement Home located in Oklahoma City, Oklahoma. The flight was being conducted under the provisions of 14 CFR Part 91 as a repositioning flight. The intent of the flight was a prescribed inter-hospital transfer of a cardiac patient from the Watonga Municipal Hospital to the University of Oklahoma Medical Center. Of the three crewmembers onboard, the commercial pilot and flight nurse sustained fatal injuries and the paramedic sustained serious injuries. Dark night visual meteorological conditions prevailed in the vicinity along the route of flight and accident site and a company flight plan was filed with EagleMed flight dispatch control. The flight originated from the Integris Baptist Hospital (OK19) helipad at 0538 and its intended destination was Watonga, Oklahoma.

SkyConnect satellite data showed that the helicopter departed OK19 and began a gradual climb on a northwest bearing toward Watonga. The data stopped approximately 3 minutes and 30 seconds into the flight.

Fixed video surveillance cameras located on a building adjacent to the parking lot showed the last few seconds of the helicopter descending toward the ground. The video showed that the helicopter burst into flames upon impact. From the initial impact point, the debris path was approximately 75 feet in length, on a heading of 065 degrees magnetic. All of the impact signatures were consistent with a right side low (approximate 40 degree) attitude, with a high rate of descent. Using the geometry of impact signatures and adjacent structures clearance, the helicopter's angle of descent was approximately 25 degrees.

Witness Statement Summaries

Witness 1 was a person who was driving in the vicinity of the accident site reported that he distinctly observed a "flash" in the sky in front of him. After the flash, he saw the helicopter in an increasingly rapid descent before it disappeared behind buildings. He then drove toward an area where smoke was emanating and saw that the helicopter was on fire in the parking lot of St. Ann's. He immediately assisted others (St. Ann's employees) in pulling the surviving paramedic away from the burning aircraft.

Witness 2 was a resident of St. Ann's and her apartment was on the third floor. The window from which she observed the helicopter impact area faced in an approximate south-easterly direction. She was awake in her bedroom when she heard the helicopter come over, followed by the sound of the crash-impact. She said it sounded like the helicopter came over her building from the north and that it sounded like a very loud motor-type sound. It was a constant sound, not cutting in and out up to the time of the impact.

When she heard the impact, she ran to her window and saw the helicopter on fire and people running out to assist. She said after the initial impact, there were two more explosions. One of the two explosions blew out her next door neighbor's window. It was dark outside at the time.

Witness 3 arrived at St. Ann's for work about 0540. She was parking her car and saw the helicopter flying nose down but appeared to be normal. The helicopter seemed to hover as if looking for a place to land. I thought it was a normal landing, then, the helicopter started to angle down as if trying to land. Then the helicopter touched down and the impact wasn't violent but a fire started. She went inside, pulled the alarm and announced "fire" and grabbed an extinguisher and ran back out. She made eye contact with one of the persons in the wreckage and tried to pull him out, then, another St. Ann's employee came and pulled him out. Another man came up and helped and there was another explosion as the St. Ann's employees were trying to pull persons from the wreckage. The Fire Department showed up and took over.

Witness 4 was sitting in her car when she saw the helicopter "fall." The helicopter was heading toward her car when it hit the ground and skidded into an embankment. All of this happened in a few seconds. There was a fire immediately upon impact. She heard a "screech" sound that lasted a few seconds prior to impact.

Witness 5 was in his home preparing to go on duty with the Oklahoma County Sheriff's Office. He heard what sounded like the EagleMed helicopter approaching from the southeast. He stated that this indicated a recent lift off from Integris Baptist or possibly one of the other Oklahoma City hospitals located in that general direction. He said that the particular type of aircraft used by EagleMed makes a very distinct sound and it is not hard to distinguish from other helicopters. As the helicopter flew over his house, the engine of the helicopter very suddenly powered down so quickly that the engine noise became silent. He was not certain as to what altitude the aircraft was at, but before the engine went silent, it sounded as though it was maybe 500 to 600 feet above the house. This estimation was made from having lived in the Wiley Post Airport (PWA) flight path for several years and observing different aircraft.

He stated that he was inside his home at the time and did not physically see the helicopter. When he heard the engine go silent, he glanced at the clock and noted that it showed 0542. In the ensuing few moments after glancing at the clock, he wondered what was going on. It was then that an explosion shook the walls and windows of every home in the area.

NOTE: Additional and Complete Witness Statements are Included in the Docket

Summary of Interview with EagleMed Integris Hospital Base Pilot (Prior Shift)

The prior shift pilot stated that she had spoken with the EagleMed base mechanic at the Integris Hospital crew quarters on the afternoon of February 21st. They talked about the weather and the mechanic told her that he was concerned about precipitation melting in the tail area and re-freezing.

She stated that the accident pilot arrived for his night shift on the evening of the 21st between 1840 and 1845, which was about 20 minutes later than he normally arrived, due to traffic.

She stated that when inclement weather was coming in, they would normally fly the helicopter to a nearby company hangar. About 2200, several hours after she went off shift, she sent a message to the accident pilot to warn him that it was icing over outside due to the cold weather and asked him not to fly.

Summary of Interview with EagleMed Base Mechanic

The base mechanic last saw the accident helicopter parked on the Integris Hospital helipad on February 21st, about 1430. The helicopter had been out of service due to inclement weather. He knew that there was a hard freeze coming and went to check on the helipad to clear off any snow/ice that had accumulated on and around the helicopter. He took a shovel with him and cleared slush and snow off the sidewalk, the area around the helicopter, and the drain nearby. At that time he also generally inspected the condition of the helicopter. During this general inspection, he looked up on the top of main rotor, the engine inlet, canopy, exhaust duct, and horizontal stabilizer for snow/ice accumulation. He noted that engine inlet plugs, pitot plugs, or covers were not installed. Early in the interview, he stated that there was a little bit of residual accumulation in the engine inlet, and there was some accumulation in the exhaust duct which he cleaned out. Later in the interview, he stated there was no accumulation in the engine inlet. He said there was some snow/slush on the horizontal stabilizer which he removed with a brush. He also checked fluid levels, pitch links, and the tail rotor, which seemed fine. He looked around the pad for leaking fluids and noted none. At that time, it was drizzling and wet outside. The temperature was above freezing, and the accumulation was melting. He stated that he was generally concerned about removing any moisture because of the freeze warning.

When the mechanic went inside to visit with the crew, he talked with the pilot (prior shift pilot) about the weather. They walked outside under a covered area and discussed that it wasn't clear enough to fly at that time. He said the pilot said she had been checking the weather every hour and that it wasn't looking good.

The mechanic further commented that when he was out on the helipad with the helicopter he did not open the cabin doors, but he noticed that the aircraft cabin heater was plugged in. He also added that the windows were polished recently to help prevent moisture accumulation. When asked whether any plugs or covers were normally installed over the engine inlet or pitot tube when it was parked, he said no.

When the mechanic was asked whether he or the crew perceived any pressure from the hospital when the aircraft was out of service due to weather, he said no. When asked whether he perceived that the aircraft would remain out of service for the foreseeable future due to weather, he said yes. When asked when he expected that the daily inspection would be accomplished, he said he expected that the pilot on duty (the accident pilot) would perform the daily inspection later that evening.

NOTE: Complete Statements of the Prior Shift Pilot and Base Mechanic are Included in the Docket

Pilot Information

Certificate:	Commercial	**Age:**	47,Male
Airplane Rating(s):	None	**Seat Occupied:**	Right
Other Aircraft Rating(s):	Helicopter	**Restraint Used:**	
Instrument Rating(s):	Helicopter	**Second Pilot Present:**	No
Instructor Rating(s):	None	**Toxicology Performed:**	Yes
Medical Certification:	Class 2 Without waivers/limitations	**Last FAA Medical Exam:**	January 22, 2013
Occupational Pilot:	Yes	**Last Flight Review or Equivalent:**	March 14, 2012
Flight Time:	(Estimated) 4960 hours (Total, all aircraft), 202 hours (Total, this make and model), 3702 hours (Pilot In Command, all aircraft), 17 hours (Last 90 days, all aircraft), 6 hours (Last 30 days, all aircraft)		

The pilot was employed with EagleMed since February, 2011. He held a valid Commercial Helicopter Pilot Certificate with an Instrument Helicopter rating. His most recent FAA medical certificate, Second Class, was dated January 1, 2013, with no limitations or waivers.

The pilot's total flight time was 4,960 hours (3,702 hours Pilot-in-Command), all of which were in helicopters. His total time in the AS350B2 helicopter was 202 hours. His most recent annual training was completed on January 15, 2013, which included practice autorotations and simulated engine failure scenarios.

The EagleMed chief pilot reported that the pilot was in good health, had a great sense of professional conduct, and did not have any extraordinary events in the previous 72 hours prior to the accident. He worked his normal shifts and seemed to be well rested.

Aircraft and Owner/Operator Information

Aircraft Make:	Eurocopter	**Registration:**	N917EM
Model/Series:	AS 350 B2	**Aircraft Category:**	Helicopter
Year of Manufacture:		**Amateur Built:**	
Airworthiness Certificate:	Normal	**Serial Number:**	3865
Landing Gear Type:	High skid	**Seats:**	3
Date/Type of Last Inspection:	AAIP	**Certified Max Gross Wt.:**	4961 lbs
Time Since Last Inspection:		**Engines:**	1 Turbo shaft
Airframe Total Time:	6474 Hrs at time of accident	**Engine Manufacturer:**	Honeywell
ELT:	Installed, not activated	**Engine Model/Series:**	LTS-101-700D
Registered Owner:	WELLS FARGO EQUIPMENT FINANCE INC	**Rated Power:**	650 Horsepower
Operator:	EagleMed LLC	**Operating Certificate(s) Held:**	On-demand air taxi (135)
Operator Does Business As:	EagleMed LLC	**Operator Designator Code:**	

The Eurocopter AS350 B2 helicopter, also known as the "AStar", was originally equipped with a single Turbomeca Arriel 1D1 turboshaft engine, mounted behind the main transmission, which provides power to the main and tail rotor systems. On the accident helicopter, the operator had replaced the Turbomeca engine with a Honeywell (formerly Lycoming) LTS101-700D-2 turboshaft engine under Soloy Aviation Solutions supplemental type certificate (STC) No. SR01647SE on July 30, 2008.

The airframe-supplied engine air intake system was modified to accommodate the Honeywell LTS101 engine under the same STC. An optional inlet air filter kit, manufactured by Aerospace Filtration Systems (AFS), was offered as part of STC No. SR01647SE if installed at the time of the LTS101 engine conversion, or under STC No. SR02393CH if installed after the LTS101 engine conversion was performed; the inlet air filter kits under both STCs are identical in design. Neither of the inlet air filter kits was installed on the accident helicopter. According to soloy, the design of the air intake system for STC SR01647SE is virtually identical to the design of the Airbus Helicopters AS350D equipped with a LTS 101-600A2 engine.

The LTS101-700D-2 engine installed on the helicopter at the time of the accident was serial number (S/N) LE-46036C, which was installed on the accident helicopter on June 8, 2012. According to the engine data plate, the date of manufacture for engine S/N LE-46036C was September 1983. Prior to the accident flight, the engine had accumulated a total time of 8,568.1 hours since new (TSN) and the helicopter accumulated a total (Hobbs) time of 6,473.6 hours. Refer to the Maintenance Group Chairman's Factual Report for more information on the maintenance history of engine S/N LE-46036C.

The Honeywell LTS101-700D-2 engine is a dual-spool turboshaft that features a single-stage axial compressor and a single-stage centrifugal compressor, a reverse flow annular combustor, a single stage turbine rotor that drives the compressor, an accessory gearbox, and a power turbine rotor that drives the helicopter's main and tail rotors. The LTS101-700D-2 engine's maximum takeoff power rating is 732 shaft horsepower (shp) and a maximum continuous power rating of 650 shp, both of which are flat-rated to 72 Degrees F.

NOTE: The Maintenance Group Chairman's Report is available in this Report's Public Docket.

Meteorological Information and Flight Plan

Conditions at Accident Site:	Visual (VMC)	**Condition of Light:**	Night
Observation Facility, Elevation:	PWA,1301 ft msl	**Distance from Accident Site:**	3 Nautical Miles
Observation Time:	04:53 Local	**Direction from Accident Site:**	195°
Lowest Cloud Condition:	Clear	**Visibility**	10 miles
Lowest Ceiling:	None	**Visibility (RVR):**	
Wind Speed/Gusts:	10 knots /	**Turbulence Type Forecast/Actual:**	/
Wind Direction:	340°	**Turbulence Severity Forecast/Actual:**	/
Altimeter Setting:	30.02 inches Hg	**Temperature/Dew Point:**	19°C / 12°C
Precipitation and Obscuration:			
Departure Point:	Oklahoma City, OK (OK19)	**Type of Flight Plan Filed:**	Company VFR
Destination:	Watonga, OK	**Type of Clearance:**	None
Departure Time:	05:38 Local	**Type of Airspace:**	

On the morning of the accident, at 0453, an automated weather reporting facility at the Wiley Post Airport (PWA), Oklahoma City, Oklahoma, reported wind from 340 degrees at 10 knots, visibility 10 statute miles, temperature 19 degrees Fahrenheit (F), dew point 12 degrees F, and a barometric pressure of 30.02 inches of mercury.

The day prior to the accident, on February 21, 2013, METAR data from PWA reported 0.07 inches of precipitation in the last 6 hours at 1153 while METAR data from Will Rogers World Airport (OKC) reported 0.14 inches of precipitation in the last 6 hours at 1152 CST. METAR data from WPA and OKC reported trace precipitation from 1553 CST to 1752 CST with temperatures around 35°F. The Integris Hospital Helipad (OK19) is about 3 miles east of PWA and about 8 miles north of OKC. METAR data from PWA reported that temperatures fell consistently from a high of 35°F (recorded at 1753 on February 21, 2013) to a low of 19°F (recorded at 0753 on February 22, 2013).

WRECKAGE AND IMPACT INFORMATION (On Site)

Airframe

The majority of the helicopter structure was thermally damaged consistent with a post-impact fire, and fragmented from impact forces localized in the area of its final resting location. The majority of the burned structure debris indicated the aircraft came to rest in the upright position. The energy debris path was approximately 75 feet in length and on a heading of 065 degrees. All the impact signatures were consistent with a right side low (approximately 40 degrees) attitude, with a forward movement from a high rate of descent.

The fuselage was broken open (both doors were separated from the fuselage and found near the main wreckage and damaged from the impact and post-impact fire), the medical litter, the pilot's seat and rear seats remained inside the aircraft. The pilot's seat was a conventional bucket type seat; the seat was burned away from the floor and leaning forward. A 4-point seat restraint buckle was found clasped together in the ash of the wreckage. The 4 steel frames of the aft medical service seats remained mounted to the aft bulkhead.

The 'Starflex' remained in the center of the rotor hub; however, all of the star arms and sleeves were thermally damaged. All three of the main rotor blades remained attached to the rotor head and mast. The leading edges of each blade exhibited light impact damage; the tips of each blade were bent up. One of the MRB tips was missing its tracking finger and static and dynamic balance weights. Ground scars consistent to low rotor RPM from the main rotor blades were found near the final wreckage resting place.

The tail section (which includes the tail-boom, tail-rotor gear box, rotor blades, drive shaft and pitch change system) was separated from the main fuselage at the forward tail cone attach point from thermal distress. The right horizontal stabilizer was damaged from impact forces, bending up approximately 50 degrees. Almost no damage was observed to the left horizontal stabilizer. The tail ventral fin and stinger were bent up and aft, consistent with a forward flight path at impact. The tail rotor blades were damaged at the hub consistent with lateral impact forces. Both blade tips had dirt debris consistent with rotation at ground contact, and ground scars were present matching the tail rotor blade tips. The ventral fin and tail skid had correlated ground impact signatures in the same area as the tail rotor, consistent with a 40-degree angle, right side low.

Tail rotor drive continuity was confirmed when the tail rotor drive was manually turned by hand. Tail rotor pitch change continuity was confirmed to each blade by the manual actuation of the pitch change tube. The forward tail rotor drive shaft was found still connected to the engine, and the tail rotor drive shaft flex coupling to the aft drive shaft exhibited minor distortion.

The main transmission was found attached to the helicopter structure, relatively intact and attached to the engine and the rotor mast assembly. The transmission drive shaft was still connected to the engine and the forward flex coupling to the main transmission input. The main rotor to transmission continuity could not be confirmed due to the impact and thermal damage to the main rotor drive system. A slight bend was observed in the rotor mast.

The fuel tank was not recognizable in the wreckage. Only small pieces of the composite fuel tank structure were found lying around the accident site. The odor and visual evidence of a fuel splash, post-crash fire was observed at the accident site. A Michigan Dynamic supplemental airframe fuel filter system was found loose among the wreckage. No fuel was observed in the fuel filter bowl, and a trace amount of debris was in the bottom of the filter bowl. All fuel lines were consumed by the post-impact fire.

The instrument panel was fragmented, thermally damaged and separated from the airframe. Most of the instruments were not readable due to the thermal damage and burned loose lengths of wiring were found in the area of the forward cabin. The caution warning panel and the avionics panel where thermally damaged and unable to provide switch or light conditions. According to EagleMed, the instrument panel was configured for the Night Vision Goggle (NVG) operations, and a set of NVGs were found in the wreckage.

The collective control was found in the full down position and was heavily damaged from fire and separated from the structure of the aircraft along with the throttle quadrant area (i.e. the rotor brake, fuel flow control, and fuel shut-off control levers). The fuel-shut off control was full forward/down. The rotor brake handle was stowed. The fuel flow control lever was in the flight position. All the hydraulic servo actuators were accounted for and relatively intact and partially attached to the rotor control system; however, thermally damaged.

Both the cyclic, collective, and anti-torque pedals push-pull control tubes were thermally damaged and separated under the cabin floor areas running aft in the helicopter. The cyclic control yoke was free and easy to move, the friction lock was loose. Flight control continuity could not be confirmed due to the thermally decayed condition of the wreckage.

The landing gear was separated at the forward and aft cross tubes on the right side, about mid-span. The ground signatures on the concrete in the parking lot, correlated to the right side of the right landing gear skid, also consistent with the helicopter contacting the ground about 40-degrees attitude, right side low.

Engine

The engine was found directly aft of the main transmission. The engine was laying on its right side attached to the lower engine deck by the right engine mount, which was standing on edge, and covered on its left side by a partially burned engine access panel. The engine was covered in soot, particularly on its right side.

The upper and lower air inlet scrolls were in place and remained together. The air inlet scrolls were thermally distressed and easily separated when touched. The air inlet screen from the top of the helicopter was separated from the engine cover and found nearby in the wreckage. The air inlet screen was bent and distorted with the appearance of exposure to the post-impact fire; the screen did not have any holes in the mesh. The engine's exhaust pipe was in place on the combustor plenum. The end of the pipe was bent radially inward and forward between the 5 o'clock and 9 o'clock positions. The interior surfaces of the exhaust duct and struts did not exhibit impact damage.

The axial compressor rotor remained in place and could be turned slightly by hand. The fuel manifolds remained in place and the manifold heat shields were partially burned. There was no indication of leakage from any of the manifolds. The power turbine (PT) blades were all in place and did not exhibit damage. The PT blades could not be rotated by hand.

The engine throttle lever was disconnected from the throttle cable; there was about 4.5 inches of extension of the cable out of the shield. The PT speed set cable was extended out of the shield by about 6 inches and was not connected to the PT governor lever. The emergency fuel shutoff valve was broken off at the fitting. The engine-mounted fuel filter housing was partially melted and broken open, exposing the filter element. The airframe-mounted fuel filter housing was found intact and covered with soot, but the attaching fuel hoses were consumed by the post-crash fire. Trace amounts of debris were observed in the bottom of the airframe-mounted fuel filter bowl. The electronic overspeed governor was located to the left of the engine and was thermally distressed.

Wreckage and Impact Information

Crew Injuries:	2 Fatal, 1 Serious	**Aircraft Damage:**	Substantial
Passenger Injuries:		**Aircraft Fire:**	On-ground
Ground Injuries:	N/A	**Aircraft Explosion:**	On-ground
Total Injuries:	2 Fatal, 1 Serious	**Latitude, Longitude:**	35.565555,-97.646942(est)

Medical and Pathological Information

On February 25, 2013, an autopsy on the pilot was completed by the Office of the Chief Medical Examiner. Oklahoma City, Oklahoma. No evidence of any medical conditions were found that could have contributed to the accident.

Toxicological analysis revealed no evidence of drugs, ethyl alcohol (ethanol), or carbon monoxide.

Tests and Research

Documentation of the Integris Hospital Helipad (OK19)

A search of the helipad at OK19 did not reveal any evidence of debris. A fixed surveillance video of the helipad immediately prior to the helicopter's departure for the accident flight revealed most of the helipad lights were off. In comparison, the surveillance video from the two evenings prior showed all helipad lights were on, completely illuminating the helipad. According to the helicopter mechanic, the day prior to the accident, the helicopter was forced to park outside and overnight on the helipad due to adverse weather conditions. Typically, the helicopter would be parked inside a hanger at a different location. According to the helicopter mechanic, the helicopter did not have the engine air inlet cover and exhaust blank installed while the helicopter was parked on the helipad and exposed to precipitation. The helicopter remained exposed to low temperatures overnight. The helicopter mechanic stated he had last examined the helicopter at about 1430 the day before the accident and that during his last examination, he discovered residual snow and slush had accumulated on the top surfaces of the helicopter and the horizontal stabilizer. A broom was used to brush off the accumulated snow and slush. The on-scene examination found no remnants of ice or snow on these components because exposure to the post-crash fire would have melted such evidence. The operator stated the pilot performed a preflight inspection immediately prior to the accident flight.

Engine Examination and Teardown

The engine was removed from the wreckage and transported to Honeywell facilities in Phoenix, Arizona. On March 7, 2013, members of the Powerplants Group convened at Honeywell to perform an engine examination and teardown.

General

The external condition of the engine was visually examined. The insulation had melted from the majority of the electrical wiring. There was soot on the engine, particularly on the right side of the accessory gearbox and on both sides of the combustor plenum at about the 3 o'clock and 9 o'clock positions. The airframe-supplied front and rear drive shafts remained installed. The forward driveshaft was not deformed. The cover over the forward driveshaft was partially burned and melted down onto the driveshaft. The rear driveshaft was fractured about 13 inches aft of the forward coupling. The forward coupling of the rear driveshaft did not exhibit evidence of deformation.

The PT rotor could be rotated by hand with light finger pressure. When the forward driveshaft stub shaft was rotated in the clockwise direction, the rear driveshaft and PT rotor turned concurrently confirming continuity and engagement of the freewheeling clutch7. When the forward driveshaft stub shaft was rotated in the counterclockwise direction, the rear driveshaft rotated concurrently, but the PT rotor did not turn, consistent with disengagement of the freewheeling clutch.

Air Inlet Section

The upper air inlet scroll duct was in place on the lower air inlet scroll duct. However, the upper and lower air inlet scroll ducts were separated on the left side and the strap was separated from the clamp. The upper air inlet scroll duct was partially broken away on the left side, about halfway down the duct. The upper rear frame of the upper air inlet scroll duct was displaced forward. The right side of the upper air inlet scroll duct had several splits and areas burned through. The right side of the interior of the upper air inlet scroll duct was sooted. The optional anti-ice system, Honeywell kit No. 4-201-080-01, was not installed.

The lower air inlet scroll duct was in place. The lower air inlet scroll duct exhibited delamination in several locations. Debris, including several pieces of re-solidified molten metal, was found lying in the bottom of the lower air inlet scroll duct. The left side drain on the lower air inlet scroll duct was open, but the right side drain was blocked with debris from the wreckage. The compressor inlet housing was intact. The exterior of the compressor inlet housing was sooted. The 12 bolts attaching the compressor inlet housing to the air diffuser housing flange were tight. The air diffuser housing was intact and did not exhibit evidence of damage. No evidence of bird remains was found in the air inlet scroll ducts.

Compressor Section

The No. 1 bearing was intact, wet with oil, and free to rotate. The bearing balls were in good condition.

The disk portion of the axial compressor rotor was intact. The disk bore and rim were coated with soot. All of the axial compressor blades remained in place. Two axial compressor blades exhibited leading edge tip curling deformation in the direction opposite of rotation consistent with soft body object impact damage. One of the deformations was observed to be about 0.344 inches chordwise and the other deformation was observed to be about 0.406 inches chordwise. A dent about 0.031 inches chordwise was observed on the leading edge of a third axial compressor blade. After the axial compressor blades were cleaned, no evidence of hard body impact damage was observed in the damaged areas of the three aforementioned blades. Nine additional axial compressor blades exhibited leading edge tip curling deformation in the direction opposite of rotation; the curling deformation was about .031 inches wide for all nine blades. Several of the blades exhibiting tip curls exhibited a slightly torn leading edge at the location of the deformation. Eight blades exhibited a bend at the tip end directly aft of the leading edge. One of the blades exhibited a circumferential rub mark on the tip end.

The axial compressor stator vane halves remained intact. All of the axial compressor stator vanes were in place and did not exhibit damage. The upper axial compressor stator vane half aft shroud rail had a 0.188 inch long section that was pushed rearward at about 1:30 o'clock. The lower axial stator vane half forward shroud rail had a 0.25 inch long section that was pushed rearward to the center rail at about 6:30 o'clock. The axial compressor stator vane halves did not have any apparent circumferential rub marks on the blade shroud.

The centrifugal compressor was intact. All of the centrifugal compressor blades had a 0.094 inch wide rub mark on the edges of the blades about 0.156 inches from the exducer end of the impeller. The centrifugal compressor impeller had a light coating of soot. The centrifugal impeller shroud was intact. The inner surface of the impeller shroud was sooted. The centrifugal impeller shroud did not have any visible circumferential rub marks.

Combustion Section

The combustion chamber liner was intact. The combustion chamber liner aft louver exhibited a white residue at about the 9 o'clock position. The combustion chamber liner did not exhibit evidence of sooting.

The fuel manifold hoses between the fuel nozzles were all in place and their red insulation were partially burned away. There were no indications of leakage or thermal distress around the fuel manifold hoses as well as around the flow divider. The fuel nozzles were all in place. There was no sooting on the fuel nozzles or on the combustor dome around each of the nozzles.

The first stage nozzle assembly and curl were intact and did not exhibit evidence of thermal distress. All of the first stage nozzle airfoils were in place and did not exhibit evidence of damage.

The outer transition liner was intact and did not exhibit evidence of thermal distress.

Turbine Section

The rear bearing (Nos. 2 and 3) support housing outer case was intact but exhibited evidence of sooting. The rear bearing support housing outer case did not reveal signatures consistent with thermal distress or ruptures. The inner diameter forward edge of the de-swirl vanes contained two notches of broken away material, 0.375 and 0.438 inches long, at the 5 o'clock and 12 o'clock positions, respectively.

The gas producer (GP) turbine shroud was intact and did not exhibit evidence of damage. The GP turbine shroud had an intermittent circumferential rub mark that corresponded to the rub marks on some of the GP turbine blade tips.

The GP turbine disk remained intact. All of the GP turbine blades were in place in the disk and did not exhibit evidence of impact damage. Several of the GP turbine blades exhibited rub marks on the tips that corresponded to circumferential rub marks on the GP turbine shroud. Almost all of the GP turbine blades had a few, very small, silver-colored flakes on the suction side of the airfoil just aft of the leading edge. Three of the GP turbine blades were examined in a scanning electron microscope. Energy dispersive spectroscopy of about 15 of the silver-colored flakes determined that one was a stainless steel material, one was an impact mark with smeared metal from the drift that was used to push the blades out of the slots, and the remaining flakes were determined to be dirt.

The No. 2 bearing was intact, wet with oil, and could be rotated, although there was a slight roughness and resistance felt when the bearing was rotated.

The PT nozzle assembly remained intact. All of the PT nozzle airfoils were in place and did not exhibit evidence of damage. The PT blade shroud did not exhibit evidence of circumferential rub marks. The PT shaft did not exhibit evidence of distortion, twisting, or rub marks. The PT disk and blades remained intact. The PT blades were sooted. The No. 3 bearing remained intact, wet with oil, and free to rotate. The bearing balls were in good condition.

Accessory Gearbox Module

The four nuts securing the engine accessory gearbox to the engine power section were tight. The accessory gearbox case was intact and the case cover was in place. Almost all of the case cover bolts were not tight. The accessory gearbox magnetic chip detector did not have any debris on the tip. The oil drained from the accessory gearbox was black, but did not exhibit an acrid smell. The breakaway torque of the PT thrust retention nut was measured in the loosening direction; the breakaway torque was in excess of 300 inch-pounds; the required installation torque for the PT thrust retention nut is 300 – 320 inch-pounds.

The starter-generator stub shaft was intact and the splines did not exhibit evidence of deformation. The forward drive shaft stub shaft spline was intact and the splines did not exhibit evidence of deformation. The rear drive shaft splines were intact and did not exhibit evidence of deformation.

Engine Controls and Accessories

The fuel control governor servo pressure (Py) was intact. The fuel pump mount flange bolts were not tight. The fuel pump housing was heavily sooted. The fuel pump drive shaft was intact and the splines were not deformed. The fuel pump drive shaft could be rotated by hand using a pair of pliers on the splines, but there was intermittent resistance as the driveshaft was turned.

The fuel control was in place attached to the fuel pump. The fuel control-to-fuel pump flange could be flexed by hand. The fuel control housing had several fittings that were burned away at the threads. The fuel control housing was burned away at the acceleration bellows, exposing the bellows. The fuel control throttle lever was in the idle power position. The fuel control driveshaft was intact and the splines were not deformed. The fuel control driveshaft could be rotated by hand with some resistance. The fuel control driveshaft did not exhibit evidence of end play or looseness. The coupling between the fuel pump and fuel control was melted. The fuel control data plate was stamped 'SD'.

The head of the fuel filter bowl housing was partially burned away at the threads to the filter bowl and the threads to an adjacent fitting. The fuel filter bowl was intact along a 270° arc, but was enlarged with spider web-like cracks and distorted along a 90° arc. There was a pinhole in the filter bowl in the damaged part of the filter bowl. The fuel filter element remained intact and contained a few randomly located pieces of debris on the element. Both the fuel filter element and the inside of the filter bowl were sooted.

The PT governor housing was partially burned and cracked open. All three of the PT governor mount flange bolts were not tight. The PT governor driveshaft could be rotated but exhibited some resistance. The screen in the PT governor housing had a flat, trapezoidal-shaped translucent object on the inside surface of the screen, but was otherwise free of debris. The flyweight spool bearing remained intact and was free to rotate.

The PT overspeed controller box was burned and the wires were pulled out of both ends. The oil pump housing mount flange bolts were not tight. The oil pressure transducer housing was burned and sooted and its electrical cable was burned away at the fitting. The pneumatic inlet temperature (T1) compensator line between the T1 compensator and the fuel control was not tight at the T-fitting on the fuel control. The fuel line between the fuel filter housing and the fuel control was loose at the crimp on the fitting to the fuel control. The torque transducer housing was burned and the end was partially melted.

Fueling History

The operator reported that the accident helicopter was last refueled at ValAir Aviation at PWA. ValAir Aviation is a fixed-base operator located on the east side of the airport. ValAir sells Phillips 66 fuel products and has a jet fuel storage facility consisting of two tanks, Nos. 3 and 4, which hold 10,000 and 6,000 gallons of fuel, respectively. According to ValAir, pipes from each tank are routed to one pump that services the refueling trucks. ValAir's records show that the fuel farm storage tanks and filters underwent daily checks and the inspection checklists for February 2013 show that there were no discrepancies recorded.

ValAir refueling records showed that on February 18, 2013, at 1415, N917EM was serviced with 36 gallons of Jet A fuel from Jet A truck No. 3. Truck No. 3 is a 3,000 gallon tank that has one single-point fueling nozzle and two overwing fueling nozzles. It was noted that the overwing fueling nozzles were black and the nozzle ends were rectangular in shape. The records showed that the accident helicopter was refueled from the forward overwing fueling nozzle. ValAir's records showed that truck No. 3 underwent daily, monthly, and quarterly inspections and checks, and no discrepancies were noted. Attachment 3 contains the inspection records for Jet A truck No. 3.

According to ValAir's records, the last delivery of Jet A fuel prior to refueling the accident helicopter was on February 16, 2013, when they received 8,012 gallons each to tank Nos. 3 and 4. The Certificate of Analysis provided with the fuel delivery indicated the delivered fuel conformed to the American Society for Testing and Material (ASTM) Standard D1655 for jet fuel. According to ValAir, the jet fuel they sell is premixed with a fuel system icing inhibitor (FSII) at the fuel terminal before it is delivered to them. According to the fuel delivery ticket, 10 gallons of FSII was added to the 8,012 gallons of delivered fuel; this resulted in a dosage of about 0.12 percent. According to the specifications for FSII, the recommended dosage rate is 0.1% to 0.15 percent by volume. ValAir did not know the brand of FSII that was added to its fuel delivery.

On February 22, 2013, upon hearing about the accident, another ValAir customer, who had at least two other airplanes refueled from truck No. 3, contacted ValAir regarding concerns about the fuel. In response to that customer's concerns, ValAir tested the fuel for water and American Petroleum Institute (API) gravity. ValAir reported no evidence of water in the fuel and the API gravity was measured to be 43 at 38 degrees F; when corrected back to standard day temperature of 59 degrees F, the gravity was 44.9. The API gravity for jet fuel, either Jet A or Jet A-1, should be between 37.5 and 50.5.

Eurocopter AS350B2 Engine Air Intake Information

Engine Air Intake Inspection Requirements

The Eurocopter AS350 B2 flight manual contains preflight checks in Section 4.1, titled "Operating Procedures." These preflight checks are separated into five different stations around the helicopter, typically performed in sequential order. Station No. 2 states the engine air intake must be clear. The AS350 B2 flight manual also contains flight manual supplement SUP.4, titled "Instructions for Operation in Cold Weather." In Paragraph 5 ("Preparation for Flight") of SUP.4, under "Powerplant", instructions are provided for removal of snow and ice accretion in the vicinity of the air intake, on either side of the screen, and to manually and visually check the air intake duct up to the first stage of the [engine] compressor for snow and ice. In Paragraph 9 ("Check After Last Flight of the Day") of SUP.4, it is recommended that the air intake cover and exhaust nozzle blank are installed. According to Eurocopter and Soloy, SUP.4 applies regardless of the engine model installed and the associated engine air inlet configuration.

Soloy Rotorcraft Flight Manual Supplement (RFMS) No. S2020H, dated January 3, 2012, contains preflight checks in Section 4.1, titled "Operating Procedures." These preflight checks are similar to that of those listed in the AS350 B2 flight manual. Station No. 2 states the engine air intake must be clear, and in parentheses it lists water, snow, and foreign matter. According to Soloy, the AS350 B2 flight manual supplement SUP.4 would remain applicable on the actions to take during cold weather operation. According to the operator, both RFMS No. S2020H and SUP.4 were contained in the flight manual of the accident helicopter.

AS350B2 Original Engine Air Intake Design

The AS350B2 equipped with the Turbomeca Arriel engine has an air intake duct mounted to the forward end of the engine, adjacent to the first stage compressor. An air inlet screen is installed in a cutout on the top side of the engine cowling. The area of the air inlet screen is about the same size as the opening of the air intake duct. When the engine cowling is closed, a seal on the upper side of the air intake duct contacts the outer perimeter of the air inlet screen. The air intake duct remains continuous until the first stage compressor and contains a drain hole near the bottom of the duct to allow for drainage of water.

AS350B2 (With Soloy STC SR01647SE) and AS350D Engine Air Intake Design

The AS350B2 equipped with the Honeywell LTS101 engine and the AS350 D has an air intake duct extension that is mounted to the top end of the upper air inlet scroll. A flat blanking plate is installed on the top side of the engine cowling to cover the original cutout for the Turbomeca Arriel engine air inlet screen. According to Soloy, the blanking plate for the AS350 D is a two-piece plate whereas the blanking plate for STC SR01647SE is a one-piece plate. An air inlet screen is installed, with about half of the air inlet screen overlapping the blanking plate and the other half covering the remainder of the engine cowling cutout. While the aft end of the engine cowling remains horizontally flat, the air inlet screen is angled slightly upward, resulting in an opening at the aft end of the air inlet screen which is left unprotected. This slope also results in a gap in the area where the air inlet screen and blanking plate overlap; moisture or debris could pass through the screen but remain in the gap between the air inlet screen and the blanking plate. By opening the engine cowling, portions of the overlapping area could be touched with a tactile inspection. The lower air inlet scroll contains a drain hole at the two lowest points of the scroll to allow for drainage of water.

Engine Ice Ingestion Information

Engine Ice Ingestion Requirements for the Honeywell LTS101-Series Engine

Type certificate data sheet (TCDS) No. E5NE (Revision 20 dated October 24, 2011) for the Honeywell LTS101 engine states that the engine had not been tested to evaluate the effects of bird and ice ball ingestion (reference Note 11 of the TCDS). The TCDS further states that "the bird and ice ball ingestion characteristics of the airframe air inlet and engine combinations are to be evaluated prior to approval of the engine installation." According to Honeywell, at the time of Federal Aviation Administration (FAA) certification, the LTS101-700D-2 engine met the requirements of 14 CFR Part 33.77 (Foreign object ingestion – ice) via similarity to the LTS101-600A-3A engine.

Engine Ice Ingestion Requirements for the Turbomeca Arriel-Series Engine

TCDS No. E00054EN (Revision 8 dated July 15, 2011) for the Turbomeca Arriel engine states that the engines had not been tested to evaluate the effects of foreign object ingestion other than rain water (reference Note 6 of the TCDS). The TCDS further states that "the helicopter air intake design shall be such to prevent instantaneous ingestion of ice, snow, and water in excess of maximum quantities defined in the Installation and Operating Manual. A protective grid, as defined in the Installation and Operation Manual shall be installed to limit the ingestion of foreign matter in the engine." Attachment 9 contains TCDS No. E00054EN

Engine Ice Ingestion Requirements for the Eurocopter AS350-Series Helicopter

TCDS No. H9EU (Revision 21 dated September 12, 2012) for the Eurocopter AS350-series helicopter states that for compliance with applicable powerplant ice protection requirements, the helicopter must be equipped during all operations with engine air inlet conforming to Eurocopter drawing number 350A58-1608 for aircraft fitted with Lycoming engines (reference Note 4 of the TCDS). According to Eurocopter, drawing number 350A58-1608 is for the air inlet screen for the LTS101 engine installation. According to Soloy, because the design of the air intake system for STC SR01647SE is virtually identical to that of the AS350 D, additional testing for ice ingestion limits was not performed and the STC was approved by the FAA without testing and via similarity.

Additional Information

Notices Related to Operating in Cold Weather Conditions

Eurocopter released Information Notice No. 2302-I-00 (Revision 0 dated April 5, 2011) regarding engine flameout or damage when the aircraft had previously been subjected to cold weather in snowy or rainy conditions and parked in the open. The Information Notice states that "a turbine engine is susceptible to a 'sudden quantity' of water, snow, or ice, because this quantity (even limited) corresponds to a very high instantaneous concentration exceeding its absorption capacities." The Information Notice contains recommendations for the prevention of this issue and precautions to be taken in cold weather when temperatures are close to or below freezing (32 Degrees° F or 0 Degrees C).

The FAA released Special Airworthiness Information Bulletin (SAIB) No. SW-08-03R3, dated January 17, 2013, regarding in-flight loss of engine power due to snow or ice ingestion. The FAA released SAIB No. SW-08-03R3 in response to the NTSB's findings of an accident on January 2, 2013 involving a Eurocopter EC130 B4 which experienced an in-flight loss of engine power. The SAIB describes that snow or ice can accumulate in the engine intakes and plenums while the aircraft is on the ground with the engine(s) not operating or at a low power setting for an extended period of time. When the pilot increases the engine power during takeoff, the accumulated snow and ice can separate from the engine air inlet and be ingested by the engine, resulting in a decrease in power or a complete loss of engine power. The SAIB also contains recommendations for the prevention of this issue.

Post Accident Safety Actions

Due to the findings from this investigation, EagleMed has painted the blanking plate adjacent to the air intake screen a matte black color to enhance detection of moisture, including ice formation, which may accumulate on the flat plate. The inspection of the engine air intake was modified such that any signature of moisture on the flat plate would result in additional inspections to the air intake area, including opening the engine cowling to ensure a thorough inspection of the air inlet scrolls.

EagleMed has also begun to carry engine air intake covers at all times. This is an effort to reduce the accumulation of moisture and ice in the area of the air inlet and air inlet scrolls in case the helicopter is forced to park outside during rainy or snowy weather conditions.

Honeywell released Pilot Advisory Letter No. PAL TS-01 (dated October 8, 2013) recommending all pilots, chief pilots, and flight operations managers review FAA SAIB No. SW-08-03R3.

Eurocopter has released Safety Information Notice No. 2645-S-30 (Revision 0 dated October 31, 2013) regarding ice and rain protection recommendations.

The FAA Rotorcraft Directorate released SAIB No. SW-08-03R4 (dated November 26, 2013) for continued emphasis on precautions to take for rotorcraft operations during icing and snowy conditions.

Note: The type certificate holder for the Eurocopter AS350B2 was changed to Airbus Helicopters Inc., on January 1, 2014.

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