



# Aviation Investigation Final Report

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<b>Location:</b>	Seminole, Oklahoma	<b>Accident Number:</b>	CEN13FA121
<b>Date &amp; Time:</b>	January 2, 2013, 12:45 Local	<b>Registration:</b>	N334AM
<b>Aircraft:</b>	Eurocopter EC130 B4	<b>Aircraft Damage:</b>	Substantial
<b>Defining Event:</b>	Loss of engine power (total)	<b>Injuries:</b>	4 Serious
<b>Flight Conducted Under:</b>	Part 91: General aviation - Positioning		

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## Analysis

The pilot reported hearing a sound like something had struck the helicopter shortly after departure while about 1,600 to 1,700 feet mean sea level. The engine lost power, and the pilot performed an autorotation to a field. While maneuvering to land, he saw a barbed wire fence obstructing the intended landing area, so he maneuvered the helicopter to clear the fence. The helicopter subsequently cleared the fence and landed hard in a field.

Engine examination revealed that the four axial compressor blades exhibited significant deformation on the outboard tips of their leading edges in the direction opposite of normal rotation consistent with the ingestion of soft body foreign object debris, such as ice. A subsequent engine run did not detect any preimpact anomalies that would have precluded normal operation. For 3 days before the accident flight, the helicopter was parked outside without its engine cover installed and was exposed to light drizzle, rain, mist, and fog. The engine inlet cover was installed the day before the accident at an unknown time. The helicopter remained outside and exposed to freezing temperatures throughout the night until 2 hours before the flight. Although the helicopter was maintained in a ready status on the helipad and maintenance personnel performed daily preflight/airworthiness checks, the inlet to the first-stage of the axial compressor was not inspected to ensure that it was free of ice in accordance with the Aircraft Maintenance Manual. Based on the weather conditions that the helicopter was exposed to during the 3 days before the accident, it is likely that ice formed in the engine air inlet before the flight and that, when the pilot increased the engine power during takeoff, the accumulated ice separated from the inlet and was ingested by the engine and damaged the compressor blades.

## 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 ice ingestion. Contributing to the accident was maintenance personnel's delayed decision to install the helicopter's engine inlet cover until after the engine had been exposed to moisture and freezing temperatures and their inadequate daily preflight/airworthiness checks, which did not detect the ice formation.

## Findings

<b>Aircraft</b>	(general) - Not specified
<b>Environmental issues</b>	Low temperature - Effect on equipment
<b>Environmental issues</b>	Drizzle/mist - Effect on equipment
<b>Environmental issues</b>	Rain - Effect on equipment
<b>Aircraft</b>	(general) - Inadequate inspection
<b>Aircraft</b>	Air intake - Inadequate inspection
<b>Environmental issues</b>	Fence/fence post - Effect on operation
<b>Personnel issues</b>	Decision making/judgment - Maintenance personnel
<b>Personnel issues</b>	(general) - Maintenance personnel

## Factual Information

### History of Flight

<b>Prior to flight</b>	Miscellaneous/other
<b>Prior to flight</b>	Preflight or dispatch event
<b>Enroute-climb to cruise</b>	Loss of engine power (total) (Defining event)
<b>Autorotation</b>	Hard landing

### HISTORY OF FLIGHT

On January 2, 2013, about 1245 central standard time, a Eurocopter EC130 B4 helicopter, N334AM, experienced a hard landing following a loss of engine power near Seminole, Oklahoma. The commercial pilot and three crew members were seriously injured. The helicopter sustained substantial damage. The helicopter was owned and operated by Air Methods, Centennial, Colorado, under the provisions of 14 Code of Federal Regulations Part 91 as a positioning flight. Visual meteorological conditions prevailed and a company visual flight rules flight plan was filed, and activated. The flight departed from the Seminole Regional Airport (KSRE), Seminole, Oklahoma, at 1242, and was en route to a hospital in Okemah, Oklahoma.

According to a statement provided by the pilot, on the morning of January 2, 2013, they received a standby call for a response to an accident scene. The pilot checked weather for the flight. He went and removed the helicopter inlet cover and the flight was requested to launch. The pilot performed a walk around inspection of the helicopter and started the helicopter normally. Shortly after takeoff, while climbing through 1,600 and 1,700 feet mean sea level (msl), the pilot heard a sound like something had struck the helicopter and the engine stopped producing power. The pilot had limited recollection of the next events but recalled that while performing an autorotation, he made a right turn to an open field. While maneuvering to land to the field he saw a previously undetected barbed wire fence. He increased the collective pitch to clear the fence, then applied aft cyclic, and increased the collective. He did not recall the landing.

A crew member on board the helicopter recalled that during the climb he heard a muffled "thud" sound. The pilot notified the crew that they had lost the engine and were going down. During the descent to the field, one crew member reported the presence of power lines which the pilot acknowledged. While approaching the field, a crew member reported the presence of a fence. The pilot reported that "...that's what we've got to get over." The pilot maneuvered the helicopter over the fence and the crew member reported seeing the sky through the forward windscreen before they impacted the ground.

### PERSONNEL INFORMATION

The pilot, age 58, held a commercial pilot certificate with ratings for airplane single engine land, helicopter, and instrument helicopter. On May 2, 2012, he was issued a second class medical certificate with the limitation that he must wear corrective lenses. His most recent flight review/Part 135 check

flight was accomplished on October 24, 2012. He satisfactorily performed all the graded flight maneuvers.

#### AIRCRAFT INFORMATION

The four-seat, single engine helicopter was manufactured by Eurocopter in December 2009. It was configured for emergency medical services and powered by a 747 shaft-horse power Turbomeca Arriel 2B1 turbine engine. The last inspection was an approved helicopter inspection program inspection, which was accomplished on December 23, 2012, at a total airframe and engine time of 1,100.75 hours.

The helicopter previously flew 1 hour and 14 minutes on December 30, 2012. No discrepancies were noted for the flight. A daily inspection of the helicopter was accomplished on December 31, 2012, and January 2, 2013, by an A&P mechanic. A daily inspection was not recorded for January 1, 2013.

#### METEOROLOGICAL INFORMATION

At 1235, an automated weather reporting facility located at the Shawnee Municipal Airport (KSNL), Shawnee, Oklahoma, reported wind from 280 degrees at 8 knots, visibility 10 miles, a clear sky, temperature 39° Fahrenheit (F), dew point 32° F, and a barometric pressure of 30.25 inches of mercury.

When the helicopter landed on December 30, the engine inlet cover was not installed until an unknown time on January 1, 2013. A review of weather information for the accident area revealed that at 2255 on December 30, drizzle and rain began to fall and the relative humidity increased to 93%. On December 31, drizzle and rain continued to fall until 1015 when mist and fog prevailed for a majority of the day and the relative humidity remained approximately 100%. On January 1, 2013, mist and fog prevailed until about 1135 when the clouds remained overcast, temperatures decreased to 32° F, and the relative humidity ranged between 93-100%. On January 2, the day of the accident flight, temperatures stayed below freezing, relatively humidity 93% or greater, and an overcast sky until 1055. From 1055 to the time of the accident, the temperature rose to 39 degrees with a decreased relative humidity.

#### WRECKAGE AND IMPACT INFORMATION

The accident site was located in an open field about 4.8 nautical miles west-northwest of KSRE. The measureable elevation was 682 feet msl. The helicopter came to rest upright on a magnetic heading of 262 degrees. The Fenestron had separated from the helicopter and was found approximately 30 feet north of the main wreckage. Three primary ground scars near to the helicopter's final resting position were consistent with contact from the tail skid and the two landing skids. The location of the ground scars relative to the final resting position of the helicopter was consistent with a clockwise rotation of approximately 180 degrees following the initial ground impact of the landing skids and the tail skid. A barbed-wire fence was located approximately 16 feet west of the single tail skid ground scar and approximately 54 feet west of the main wreckage.

All three main rotor blades remained attached to the main rotor head. The 'red' main rotor blade exhibited trailing edge separation adjacent to the blade cuff. The damage along various points on the leading edge of the 'red' main rotor blade matched that of a 45° straight-lined impact mark to the tail boom and engine exhaust duct on the right side of the helicopter. The 'blue' main rotor blade exhibited impact damage on the bottom of the blade approximately 50 inches from the blade tip end; light blue paint transfer marks were observed on some of the edges of the damaged area. The 'blue' main rotor

blade also exhibited trailing edge separation along various points of the entire length of the blade. The tip of the 'blue' main rotor blade exhibited damage that was matched to damage found on the Fenestron stators. The 'yellow' main rotor blade exhibited an area of damage on its trailing edge, beginning from 51 inches from the blade tip and extending approximately 58 inches inboard. Light blue paint transfer marks were observed on the bottom side of the blade at approximately 6 inches from the tip end of the 'yellow' main rotor blade and extended inboard approximately 46 inches. Blue paint transfer marks were observed on the leading edge of the 'yellow' main rotor blade, beginning from 32 inches from the blade tip extending approximately 4 inches inboard.

The helicopter was modified with an FDC/aerofilter air inlet barrier system. The air filter showed no evidence of substantial damage. No blockages or large pieces of debris were observed on either side of the air filter. The air intake duct remained attached to the engine and showed no evidence of cracks or fractures. The drain hole in the air intake duct showed no evidence of blockages.

The engine remained installed on the airframe. The engine's fuel, oil, and electrical connections remained intact. The presence of fuel in the engine's hydromechanical unit (HMU) was confirmed. A sample of fuel tested negative for the presence of water. Removal of the air intake duct exposed the axial compressor (the first stage of compression). Four axial compressor blades exhibited significant deformation on the outboard tips of their leading edges; the deformation was observed to be in the direction opposite of normal rotation. Deformation observed on the four axial compressor blades was consistent with ingestion of soft body debris. The power turbine blades were observed to be undamaged. The engine was removed and sent to Turbomeca's facility in Grand Prairie, Texas, for further examination.

## TESTS AND RESEARCH

### Engine run

An engine run was conducted on January 30. On the test stand, the engine experienced tailpipe fires during initial runs. The HMU was replaced and subsequently the engine operated normally to 100% RPM. A distinct whining noise was heard at idle, consistent with deformation damage observed on the first-stage axial compressor blades. The original HMU was bench tested and the fuel valve was cycled to the close position when commanded.

## ADDITIONAL INFORMATION

### Engine Type Certificate Data Sheet

TCDS Number E00054EN (Revision 8 dated July 15, 2011) for the Turbomeca Arriel engine states that the engines have 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 2 (located in the docket) contains TCDS Number E00054EN.

Air Methods EC130 B4 Preflight/Airworthiness Checklist Revision 4

The company produced an FAA-approved preflight/airworthiness checklist which contained a list of exterior checks to be performed at five different stations around the helicopter. One of the checks for station "2" stated "Engine air intake – Clear (water, snow, foreign object)." There were no additional notes associated with the check for the engine air intake. In addition, the checklist contains a note informing the pilot that the use of this preflight checklist does not eliminate the responsibility of the pilot to ensure that the preflight check is accomplished in accordance with the rotorcraft flight manual and its supplements. Attachment 3 of the Airworthiness report (located in the docket) contains a photograph of the Air Methods EC130 B4 Preflight/Airworthiness Checklist found in the accident helicopter.

On the morning of the accident, at 0900, a company mechanic recorded the completion of the airworthiness check in accordance with the Approved Airworthiness Inspection Program checklist.

#### Inspections for Operating in Cold Weather Conditions

The Eurocopter EC130 B4 Aircraft Maintenance Manual (MET) 05-40-00, Section 6-3 (dated July 4, 2012) contains instructions on procedures to take before flight in cold or extreme cold weather conditions. These instructions include a step to "manually and visually check for snow and ice inside the air intake duct up to the first stage of the compressor." Attachment 4 of the Airworthiness report (located in the docket) contains MET 05-40-00, Section 6-3.

FDC/aerofilter's Rotorcraft Flight Manual Supplement (RFMS) 1130-1200 (Revision B dated for EC130 B4 aircraft equipped with an FDC/aerofilter inlet barrier filter system contains a list of exterior checks to perform prior to the first flight of the day or prior to each flight if snow or freezing rain has fallen. The check for the engine cowling states "verify air intake to be free of snow, ice, or water, particularly under the filter." Attachment 5 of the Airworthiness report (located in the docket) contains the inspection requirements published in FDC/aerofilter's RFMS 1130-1200 Revision B.

#### 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° F or 0° C). Attachment 6 of the Airworthiness report (located in the docket) contains Information Notice No. 2302-I-00.

The FAA released SAIB SW-08-03R2 (dated January 15, 2010) regarding in-flight loss of engine power due to snow or ice ingestion. 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.

#### CORRECTIVE ACTIONS

Due to the findings from this investigation, Air Methods released a message on January 4, 2013, on their internal notice system that required acknowledgement by all pilots. The message contained information specific to engine operations in cold weather conditions and a pre-flight precaution to inspect the accessible internal surfaces of the engine air intake area, regardless of whether the engine air intake was covered.

On January 17, 2013, the FAA released SAIB SW-08-03R3 (Revision 3) with updated information regarding recommendations and precautions to take for rotorcraft operation in icing and/or snowy conditions to prevent the in-flight loss of engine power due to snow or ice ingestion. Attachment 7 contains SAIB SW-08-03R3.

On October 31, 2013, Eurocopter released Safety Information Notice No. 2645-S-30 reminding operators to inspect engine air intakes as required in the flight manuals. In addition, the installation of the engine air intake cover rapidly after engine shutdown is recommended if parking in cold weather and snowy conditions or falling rain.

On January 10, 2014, Turbomeca released General Service Letter No. 2904/13, which emphasized the release of SAIB SW-08-03R3 and recommended full compliance with the flight manual instructions concerning operations in cold weather.

## Pilot Information

<b>Certificate:</b>	Commercial; Flight instructor	<b>Age:</b>	58
<b>Airplane Rating(s):</b>	Single-engine land	<b>Seat Occupied:</b>	Left
<b>Other Aircraft Rating(s):</b>	Helicopter	<b>Restraint Used:</b>	4-point
<b>Instrument Rating(s):</b>	Helicopter	<b>Second Pilot Present:</b>	No
<b>Instructor Rating(s):</b>	Helicopter	<b>Toxicology Performed:</b>	No
<b>Medical Certification:</b>	Class 2 With waivers/limitations	<b>Last FAA Medical Exam:</b>	May 2, 2012
<b>Occupational Pilot:</b>	Yes	<b>Last Flight Review or Equivalent:</b>	October 24, 2012
<b>Flight Time:</b>	9708 hours (Total, all aircraft), 663 hours (Total, this make and model), 9500 hours (Pilot In Command, all aircraft), 40 hours (Last 90 days, all aircraft), 12 hours (Last 30 days, all aircraft)		

## Aircraft and Owner/Operator Information

<b>Aircraft Make:</b>	Eurocopter	<b>Registration:</b>	N334AM
<b>Model/Series:</b>	EC130 B4	<b>Aircraft Category:</b>	Helicopter
<b>Year of Manufacture:</b>		<b>Amateur Built:</b>	
<b>Airworthiness Certificate:</b>	Normal	<b>Serial Number:</b>	4694
<b>Landing Gear Type:</b>	Skid	<b>Seats:</b>	5
<b>Date/Type of Last Inspection:</b>	January 2, 2013 Continuous airworthiness	<b>Certified Max Gross Wt.:</b>	
<b>Time Since Last Inspection:</b>	3 Hrs	<b>Engines:</b>	1 Turbo shaft
<b>Airframe Total Time:</b>	1121 Hrs at time of accident	<b>Engine Manufacturer:</b>	TURBOMECA
<b>ELT:</b>	C126 installed, activated, did not aid in locating accident	<b>Engine Model/Series:</b>	ARRIEL 2B1
<b>Registered Owner:</b>	AIR METHODS CORP	<b>Rated Power:</b>	747 Horsepower
<b>Operator:</b>	AIR METHODS CORP	<b>Operating Certificate(s) Held:</b>	On-demand air taxi (135)
<b>Operator Does Business As:</b>		<b>Operator Designator Code:</b>	QMLA

## Meteorological Information and Flight Plan

<b>Conditions at Accident Site:</b>	Visual (VMC)	<b>Condition of Light:</b>	Day
<b>Observation Facility, Elevation:</b>	KSNL, 1073 ft msl	<b>Distance from Accident Site:</b>	20 Nautical Miles
<b>Observation Time:</b>	12:35 Local	<b>Direction from Accident Site:</b>	280°
<b>Lowest Cloud Condition:</b>	Clear	<b>Visibility</b>	10 miles
<b>Lowest Ceiling:</b>	None	<b>Visibility (RVR):</b>	
<b>Wind Speed/Gusts:</b>	8 knots /	<b>Turbulence Type Forecast/Actual:</b>	/
<b>Wind Direction:</b>	280°	<b>Turbulence Severity Forecast/Actual:</b>	/
<b>Altimeter Setting:</b>	30.25 inches Hg	<b>Temperature/Dew Point:</b>	4°C / 0°C
<b>Precipitation and Obscuration:</b>	No Obscuration; No Precipitation		
<b>Departure Point:</b>	Seminole, OK (KSRE)	<b>Type of Flight Plan Filed:</b>	Company VFR
<b>Destination:</b>	Okemah, OK	<b>Type of Clearance:</b>	VFR
<b>Departure Time:</b>	12:42 Local	<b>Type of Airspace:</b>	



## Wreckage and Impact Information

<b>Crew Injuries:</b>	4 Serious	<b>Aircraft Damage:</b>	Substantial
<b>Passenger Injuries:</b>		<b>Aircraft Fire:</b>	None
<b>Ground Injuries:</b>	N/A	<b>Aircraft Explosion:</b>	None
<b>Total Injuries:</b>	4 Serious	<b>Latitude, Longitude:</b>	35.30722,-96.580558

## Administrative Information

<b>Investigator In Charge (IIC):</b>	Aguilera, Jason
<b>Additional Participating Persons:</b>	Dan Donnelly; Federal Aviation Administration; Oklahoma City, OK Emmanuel Delbarre; Bureau d'Enquêtes et d'Analyses; Paris, France
<b>Original Publish Date:</b>	May 8, 2014
<b>Last Revision Date:</b>	
<b>Investigation Class:</b>	<a href="#">Class</a>
<b>Note:</b>	The NTSB traveled to the scene of this accident.
<b>Investigation Docket:</b>	<a href="https://data.ntsb.gov/Docket?ProjectID=85938">https://data.ntsb.gov/Docket?ProjectID=85938</a>

The National Transportation Safety Board (NTSB) is an independent federal agency charged by Congress with investigating every civil aviation accident in the United States and significant events in other modes of transportation—railroad, transit, highway, marine, pipeline, and commercial space. We determine the probable causes of the accidents and events we investigate, and issue safety recommendations aimed at preventing future occurrences. In addition, we conduct transportation safety research studies and offer information and other assistance to family members and survivors for each accident or event we investigate. We also serve as the appellate authority for enforcement actions involving aviation and mariner certificates issued by the Federal Aviation Administration (FAA) and US Coast Guard, and we adjudicate appeals of civil penalty actions taken by the FAA.

The NTSB does not assign fault or blame for an accident or incident; rather, as specified by NTSB regulation, “accident/incident investigations are fact-finding proceedings with no formal issues and no adverse parties ... and are not conducted for the purpose of determining the rights or liabilities of any person” (Title 49 *Code of Federal Regulations* section 831.4). Assignment of fault or legal liability is not relevant to the NTSB’s statutory mission to improve transportation safety by investigating accidents and incidents and issuing safety recommendations. In addition, statutory language prohibits the admission into evidence or use of any part of an NTSB report related to an accident in a civil action for damages resulting from a matter mentioned in the report (Title 49 *United States Code* section 1154(b)). A factual report that may be admissible under 49 *United States Code* section 1154(b) is available [here](#).