Aviation Investigation Final Report

Location:	Pylesville, Maryland	**Accident Number:**	ERA20LA160
Date & Time:	April 25, 2020, 12:40 Local	**Registration:**	N9159F
Aircraft:	Hughes 369	**Aircraft Damage:**	Substantial
Defining Event:	Fuel starvation	**Injuries:**	1 None
Flight Conducted Under:	Part 133: Rotorcraft ext. load		

Analysis

The commercial helicopter pilot was attempting, via a long line, to move a conductor wire while it remained in contact with the ground, which is classified as a Class C rotorcraft-load combination (RLC) operation. According to the pilot, while he maneuvered the helicopter about 150 ft above ground level, he pitched the helicopter nose up about 5° to 10°, with no lateral banking, for about 10 to 15 seconds. The engine then experienced a total loss of engine power. In the autorotation, which the pilot estimated to be about 4 to 5 seconds, the pilot was only able to release one of two mechanisms that secured the long line to the helicopter. As a result, just before touchdown, the long line became taut and caused the helicopter to roll over onto its left side. The tailboom, main rotor, and tail rotor sustained substantial damage, and the pilot was uninjured.

Postaccident examination of the helicopter found 146 lbs of fuel onboard. The pilot later reported that the helicopter had about 200 lbs of fuel (slightly less than half of a full load) when he began the flight about 1.5 hours before the accident. An engine test run found no evidence of mechanical malfunctions that would have precluded normal operation of the engine.

The investigation identified four previous accident investigation reports that extensively documented loss of engine power due to fuel starvation on MD369 series helicopters while they were maneuvered in Class C RLC long line operations. In these past accidents, the remaining fuel on board ranged between 93 to 151 lbs. The investigations of these accidents found varying levels of pitch up and/or lateral banking (common maneuvers during Class C RLC operations) could interrupt normal fuel flow to the engine (that is, unport) at fuel levels well above the standard fuel minimums required for visual flight rules operation.

Based on information provided by the helicopter manufacturer, with 146 lbs of fuel onboard, a 28.5° positive pitch attitude, with no lateral banking, could unport the fuel supply to the engine in static conditions. Therefore, in dynamic conditions, such as maneuvering, unporting could occur at lower pitch attitudes.

The operator's operating limitations at the time of the accident stated that for any Class C RLC operation, the flight must begin with a full fuel load and last no more than 1 hour and explains the policy by citing the risk of uncovering the fuel port due to lateral banking during these operations. The accident pilot believed that, similar to the operation he had completed earlier in the flight, moving the conductor wire was a Class B operation because it would not require any lateral banking of the helicopter. Because the pilot misconstrued the RLC class of operation he was performing, he erroneously believed that he only needed a minimum of 100 lbs of fuel at landing, which is the fuel minimum he selected on the operator's job hazard analysis form before beginning the accident flight; the form contained no references to RLC classes.

As a result of the accident, the operator updated its minimum fuel policies on its job hazard analysis form and in its RLC flight manual. The policies now provide specific references to Class B and C long line operations and detailed examples to help pilots' understanding of which fuel minimums apply for specific operations.

Thus, without evidence of malfunctions that would preclude the engine from producing or maintaining power and given the occurrence of fuel starvation during other Class C RLC long line operations with similar levels of fuel onboard, it is likely that the accident helicopter's maneuvering and nose-up attitude during the pilot's attempt to move the conductor wire led to unporting of the remaining fuel, which resulted in fuel starvation and the loss of engine power.

Additionally, it is possible that the pilot could have successfully landed the helicopter following the loss of engine power had the long line been released. The pilot had to pull two separate release mechanisms to detach the long line because the helicopter was previously configured for human external cargo (HEC) long line operations, although the specific operation being performed when the accident occurred did not involve HEC and redundancy to secure the long line was not needed (HEC operations were being performed earlier in the flight). As a result, the pilot did not have sufficient time to activate both release mechanisms, and the helicopter was substantially damaged during the attempted landing.

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 fuel starvation as a result of unporting of the fuel tank supply pickup while the helicopter was maneuvered to move a conductor wire. Contributing to the accident was the helicopter's inappropriate configuration for the type of operation being conducted, which impeded the pilot's ability to release the long line and perform a successful emergency landing.

Findings

Aircraft	Fuel - Fluid level
Aircraft	(general) - Capability exceeded
Aircraft	Configuration - Incorrect use/operation
Organizational issues	(general) - Not specified
Personnel issues	Knowledge of procedures - Pilot

Factual Information

History of Flight

Maneuvering-hover	Fuel starvation (Defining event)
Autorotation	External load event (Rotorcraft)
Autorotation	Collision with terr/obj (non-CFIT)

On April 25, 2020, at 1240 eastern daylight time, a Hughes 369D helicopter, N9159F, was substantially damaged when it was involved in an accident near Pylesville, Maryland. The pilot was not injured. The helicopter was operated under the provisions of Title 14 *Code of Federal Regulations* (*CFR*) Part 133 as a rotorcraft external load operation.

The pilot reported that while he was performing human external cargo (HEC) long line operations, he heard on the radio that ground personnel were having difficulty moving a conductor power line (wire) nearby. He proceeded to the landing zone, which was about 300 to 400 ft from the area requiring assistance, and dropped off the HEC. Then, while hovering, he picked up a conductor hook via the long line (with assistance from ground personnel) and continued to the area that needed support.

He reported that after the hook was attached to the conductor wire, he began maneuvering for about 10 to 15 seconds to move the wire a short distance laterally, as a crane was supporting the weight of the wire. According to the pilot, while maneuvering, he applied "slight aft and up pressure" to move the conductor wire and there was no lateral banking. He believed the pitch attitude during the maneuvering was about 5° to 10° nose up. After the conductor wire was moved to the desired area, the pilot maneuvered to remove the hook from the wire, but before the hook was free, the helicopter entered a left yaw and the engine began "spooling down."

The pilot reported that he subsequently heard the "engine out alarm" and entered an autorotation by "slamming the collective down." The pilot reported that the loss of engine power occurred about 150 ft above ground level (agl) and that he immediately pulled the belly band release lever—one of two levers needed to release the long line (the belly band was a secondary cable support system the operator used for HEC operations to provide redundancy in the event of an inadvertent release of the cargo hook; see figure). The pilot stated that he did not have sufficient time to pull the second (mechanical release) lever on the cyclic control to release the long line.

As the helicopter entered the flare, the pilot pulled the collective up to complete the autorotative landing, but the long line, which remained attached to the helicopter and conductor wire, became taut and caused the helicopter to roll onto its left side. The main rotor blades impacted the ground.

Multiple witnesses on the ground reported that they heard the helicopter's engine lose power while the pilot was maneuvering, and they subsequently observed the helicopter begin a rapid descent. One witness stated that when the helicopter was about 3 ft from the ground, “the long line got tight and started to tip the aircraft over.”

The following figure shows the belly band around the fuselage, the main hook, and long line.

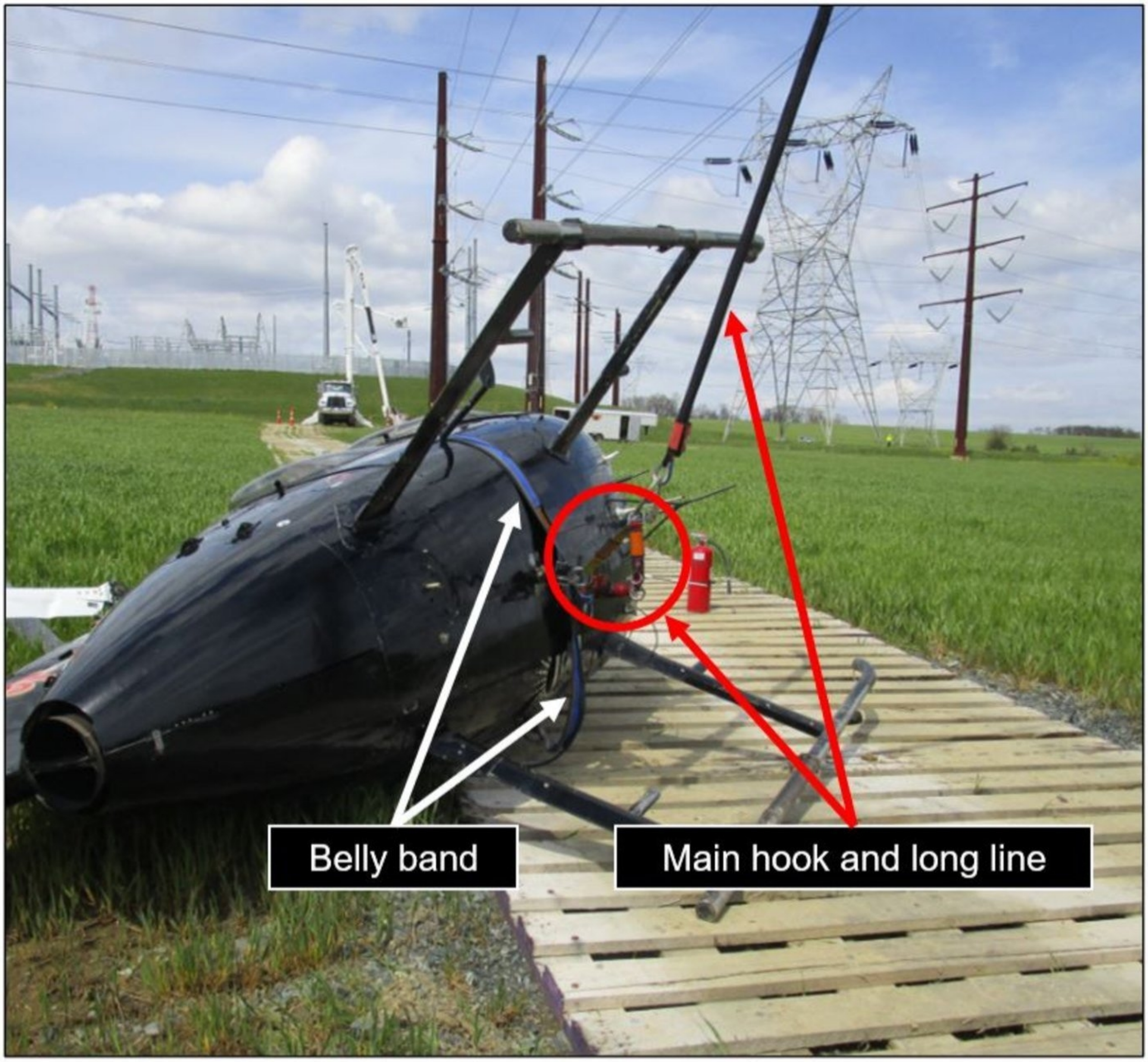

Figure. View of the helicopter at the accident site

Pilot Information

Certificate:	Commercial	**Age:**	34,Male
Airplane Rating(s):	None	**Seat Occupied:**	Left
Other Aircraft Rating(s):	Helicopter	**Restraint Used:**	4-point
Instrument Rating(s):	None	**Second Pilot Present:**	No
Instructor Rating(s):	None	**Toxicology Performed:**	No
Medical Certification:	Class 2 Without waivers/limitations	**Last FAA Medical Exam:**	April 19, 2019
Occupational Pilot:	Yes	**Last Flight Review or Equivalent:**	March 8, 2020
Flight Time:	12549 hours (Total, all aircraft), 8736 hours (Total, this make and model), 12500 hours (Pilot In Command, all aircraft), 141 hours (Last 90 days, all aircraft), 101 hours (Last 30 days, all aircraft), 1.7 hours (Last 24 hours, all aircraft)		

Aircraft and Owner/Operator Information

Aircraft Make:	Hughes	**Registration:**	N9159F
Model/Series:	369 D	**Aircraft Category:**	Helicopter
Year of Manufacture:	1979	**Amateur Built:**	
Airworthiness Certificate:	Normal	**Serial Number:**	1090605D
Landing Gear Type:	None; Skid	**Seats:**	5
Date/Type of Last Inspection:	April 6, 2020 100 hour	**Certified Max Gross Wt.:**	3000 lbs
Time Since Last Inspection:		**Engines:**	1 Turbo shaft
Airframe Total Time:	17015 Hrs as of last inspection	**Engine Manufacturer:**	Allison Gas Turbine (Rolls-Royce)
ELT:	C126 installed, not activated	**Engine Model/Series:**	250-C20B
Registered Owner:	TVPX AIRCRAFT SOLUTIONS INC.	**Rated Power:**	420 Horsepower
Operator:	Haverfield International Incorporated	**Operating Certificate(s) Held:**	Rotorcraft external load (133)
Operator Does Business As:	Haverfield Aviation	**Operator Designator Code:**	

The accident helicopter's fuel system was composed of two interconnected fuel tanks installed beneath the passenger seats. Fuel was delivered to the engine from a fuel pick-up port on the left side of the left tank. The rotorcraft flight manual stated that the total usable fuel was 421.9 lbs.

Manufacturer Guidance

In November 2015, MD Helicopters, the type certificate holder at the time, published Operational Safety Notice OSN2015-002, "Fuel Starvation Due to Unporting of Fuel Supply Pick-Up."

The notice warned operators that when the helicopters are used to conduct operations with a "long line" attached to pull or tow objects on the ground, a significant side load can be placed on the helicopter. These side loads can create high fuselage pitch and roll angles as well as uncoordinated flight, which in turn can increase the amount of unusable fuel and result in fuel starvation due to unporting of the fuel supply pick-up.

The notice further stated in part: MDHI Helicopters are not specifically certified for operations with the potential for sustained high fuselage pitch and roll angles in uncoordinated flight, such as powerline stringing operations. To help mitigate the possibility of fuel starvation and the potential safety risk, consider modifying fuel management procedures for such operations. Instead of allowing such operations with minimum fuel safety margins associated with normal flight attitudes during coordinated flight, consider increasing minimum fuel level requirements when operations will involve high deck angles in pitch and roll during uncoordinated flight.

Meteorological Information and Flight Plan

Conditions at Accident Site:	Visual (VMC)	**Condition of Light:**	Day
Observation Facility, Elevation:	THV,486 ft msl	**Distance from Accident Site:**	26 Nautical Miles
Observation Time:	12:53 Local	**Direction from Accident Site:**	301°
Lowest Cloud Condition:		**Visibility**	10 miles
Lowest Ceiling:	Broken / 3600 ft AGL	**Visibility (RVR):**	
Wind Speed/Gusts:	6 knots /	**Turbulence Type Forecast/Actual:**	None / None
Wind Direction:	120°	**Turbulence Severity Forecast/Actual:**	N/A / N/A
Altimeter Setting:	30.04 inches Hg	**Temperature/Dew Point:**	16°C / 8°C
Precipitation and Obscuration:	No Obscuration; No Precipitation		
Departure Point:	Pylesville, MD (NONE)	**Type of Flight Plan Filed:**	None
Destination:	Pylesville, MD	**Type of Clearance:**	None
Departure Time:	12:30 Local	**Type of Airspace:**	Class G

Wreckage and Impact Information

Crew Injuries:	1 None	**Aircraft Damage:**	Substantial
Passenger Injuries:		**Aircraft Fire:**	None
Ground Injuries:	N/A	**Aircraft Explosion:**	None
Total Injuries:	1 None	**Latitude, Longitude:**	39.697223,-76.392776(est)

Photographs provided by a Federal Aviation Administration (FAA) inspector who examined the helicopter at the accident site found that the helicopter had rolled over and come to rest on its left side, and the long line remained attached from the main hook on the helicopter to the power line. The tail boom and main/tail rotors sustained substantial damage. There was no evidence of fuel spillage at the accident site.

Additional examination of the helicopter supervised by the NTSB investigator-in-charge found that the cyclic, collective, and throttle each had continuity through the full range of motion. The main hook release lever opened the hook normally when activated.

There were no obstructions observed in the turbine air inlet. The oil filter and fuel filters were clear of any remarkable debris. Pressure and leak tests were performed on the engine's pneumatic and fuel system; no leaks were observed on either system. The electrical fuel pump (start pump) would not activate when electrical power was supplied to the helicopter. A replacement electrical fuel pump was installed on the helicopter and functioned normally. With the new electrical fuel pump installed, a total of 146 lbs (21.5 gallons) of fuel was pumped from the helicopter. This volume was consistent with the fuel gauge, which displayed about 150 lbs.

The engine was subsequently removed and test run under the supervision of the NTSB investigator-in-charge. The engine produced idle through takeoff power, with no anomalies observed, and all engine parameters remained within tolerances throughout the test run.

For a portion of the test run, the positive pressure fuel supply was eliminated to simulate conditions similar to an electrical fuel pump failure. The engine continued to produce takeoff thrust consistent with the previous data when positive fuel pressure was available.

Tests and Research

As part of this investigation, MD Helicopter provided the NTSB a computer model that outlined a combination of static pitch and roll angles and corresponding fuel levels at which the fuel pick-up point may become unported. According to this information, with about 21.5 gallons of fuel onboard, at 0° lateral banking, the pitch up attitude required to unport the fuel pick up was 28.5°. The computer model could not account for dynamic flight operations that may affect the movement of fuel in the tanks (for example, maneuvering, turbulence, or uncoordinated flight, which would allow for fuel to move freely within the fuel tank).

A search of the NTSB's aviation accident database for 14 *CFR* Part 133 fuel starvation events involving any rotorcraft type performing Class C RLC operations found three reports relevant to this investigation.

In 1990, the NTSB investigated a helicopter accident involving a MD369D that was conducting external long line operations (LAX91LA054). The report stated that by duplicating the helicopter's pitch attitude and fuel load of 115 lbs postaccident, the fuel pick-up point became unported at fuel quantity levels at or below 115 lbs. The exact pitch attitude was not specified in the report.

In 2012, the NTSB investigated a helicopter accident involving an MD369E that was conducting external long line operations (WPR12LA328). The report stated that 117 lbs of fuel remained on board and previous investigations of similar accidents determined that the fuel tank supply pickup can become unported with a fuel load of less than 151 lbs when pitch-and-roll attitudes approach 20°.

In 2017, the NTSB investigated a helicopter accident involving an MD369E that was conducting external long line operations (ERA17LA209). The report stated that 14 gallons (93 lbs) of fuel remained on board and that the low fuel level light illuminated when pitch up attitudes similar to those during the accident were duplicated.

Additionally, in 2008, the Australian Transport Safety Bureau investigated a helicopter accident involving a MD369ER (Aviation Occurrence Investigation AO-2008-025) that was conducting power line stringing operations. The investigation found through testing that it was possible to introduce air into the fuel system through the fuel tank pick-up point when fuel quantity was less than 85L (151 lbs) and subjected to a 20° nose up and 20° right roll attitude.

Organizational and Management Information

The accident helicopter operator's FAA-approved RLC flight manual (RLCFM) and corporate policy manual required that for all flight operations, the MD 500D helicopter land with no less than 100 lbs of fuel. For Class C RLC operations, the RLCFM specifically required the following:

> Always start any Class C external load with a full tank of fuel. As the aircraft leans over in a steep bank to the right, this may easily uncover the fuel sump. There should be a maximum of one hour of flight time while performing any Class C external load.

The operator required that its Job Hazard Analysis form be completed before each flight. The "Fuel Check Off and Limitations" section of the form contained two options for the MD 500: 100 lbs Landing Minimum" and

> Wire/ Rope Pull and Wreck Out Operations: Maximum 1 hr (45 min F/FF_ flight time with max fuel load. The form completed before the accident flight indicated that the option for 100 lbs landing fuel minimum had been selected.

The form contained no references to RLC classes.

During postaccident interviews, the pilot reported the following concerning his understanding of when the more restrictive fuel minimums (maximum 1 hour of flight time with a maximum fuel load) would be required:

> …when we are doing Side Pull Operations. This is for when the hook is relocated from the bottom of the aircraft and installed on the side. This would be for pulling of rope or a small steel cable for powerline construction. There is a lot of right lateral banking when pulling the rope and steel cable during this flight profile.
>
> This operation that we were conducting on the accident day was more in line with Class B operations. I understand when you have a load attached to a fixed object it becomes a C Load, but this situation did not fit that flight profile (hook on side and a high right lateral bank). The flight profile was more along the lines of a slight nose up attitude, no lateral or banking took place.

After this accident, the operator updated the Job Hazard Analysis form and the RLCFM to specifically associate fuel minimums with RLC classes (for example, Class B or C). In addition, specific examples of long line operation (for example, water bucket, lifting/moving wire, rope pull) are provided in the fuel minimum policies.

The operator also reported that safety briefings were held with relevant operational staff to ensure their understanding with the revised fuel minimum policies.

Additional Information

FAA Regulations and Guidance

Advisory Circular (AC) 133-1B, Rotorcraft External-Load Operations, provided the following two definitions for Class B and C Rotorcraft-load combinations (RLC):

Class B RLC. The external load is jettisonable, carried above or below the skids, and lifted free of land or water during the rotorcraft operation. An air conditioner unit being lifted onto the roof of a tall building is an example of a Class B load (§ 1.1).

Class C RLC. The external load is jettisonable and remains in contact with land or water during the rotorcraft operation. Wire stringing, dragging a long pole, and boat towing are some examples of Class C loads (§ 1.1).

AC 133-1B does not contain minimum fuel standards based on the specific type of RLC class to be flown.

Part 133 requires no additional fuel minimums beyond that required in 14 *CFR* 91.151, Fuel Requirements for Flight in VFR Conditions.

Administrative Information

Investigator In Charge (IIC):	Gerhardt, Adam
Additional Participating Persons:	Steven O'Rourke; FAA/ FSDO; Baltimore, MD Jack Johnson; Rolls-Royce Corp; Indianapolis, IN Joan Gregoire; MD Helicopters; Mesa, AZ Todd Tuttle; Haverfield Aviation; Gettysburg, PA Randall Breitzman; MD Helicopters; Mesa, AZ
Original Publish Date:	July 15, 2021
Last Revision Date:	
Investigation Class:	Class 3
Note:	The NTSB did not travel to the scene of this accident.
Investigation Docket:	https://data.ntsb.gov/Docket?ProjectID=101207