National Transportation Safety Board
Aviation Accident Final Report

Location:	Raton, NM	**Accident Number:**	CEN18FA078
Date & Time:	01/17/2018, 1800 MST	**Registration:**	N658H
Aircraft:	BELL UH-1H	**Aircraft Damage:**	Destroyed
Defining Event:	Controlled flight into terr/obj (CFIT)	**Injuries:**	5 Fatal, 1 Serious
Flight Conducted Under:	Part 91: General Aviation - Personal		

Analysis

The commercial pilot, a pilot rated passenger and four passengers departed in the helicopter on a cross-country flight in dark night visual meteorological conditions. According to the sole surviving passenger, the flight proceeded normally until it impacted the ground in level flight and came to rest inverted.

The pilot initially survived the accident but succumbed to his injuries en route to the hospital. A witness who spoke to the pilot before he was transported from the accident site reported that the pilot said that he had flown into terrain.

Overhead imagery revealed that the area surrounding the accident site comprised unpopulated ranchland grass and sparse, low brush. The imagery showed a reduced amount of visual terrain features in the area of the accident site during night conditions and there were no sources of ground lighting or illumination in the vicinity. The pilot's familiarity with the route of flight could not be determined.

The wreckage was located on a nearly-level mesa that rose about 100 ft above the surrounding mountainous terrain. A postaccident examination did not reveal any preimpact anomalies that would have precluded normal operation of the helicopter, and ground scars at the site were consistent with impact in a level attitude.

Toxicology testing indicated a therapeutic level of diphenhydramine in the pilot's blood at the time of the accident, which likely impaired him to some degree; however, it could not be determined if psychomotor slowing from the diphenhydramine contributed to his inability to recognize and/or avoid the terrain.

FAA Advisory Circular (AC) 61-134, General Aviation Controlled Flight into Terrain Awareness, defines controlled flight into terrain (CFIT) as when an airworthy aircraft is flown, under the control of a qualified pilot, into terrain (water or obstacles) with inadequate awareness on the part of the pilot of the impending collision. Professional aviation articles on CFIT state that

during night conditions where the height above terrain may be misperceived by a pilot, controlled flight into terrain can occur, even to experienced pilots.

Given the lack of mechanical anomalies and the level impact attitude of the helicopter, it is likely that the pilot failed to maintain adequate altitude during cruise flight and subsequently impacted rising terrain.

Probable Cause and Findings

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

The pilot's failure to maintain adequate altitude above mountainous terrain during cruise flight in dark night conditions, which resulted in controlled flight into terrain.

Findings

Aircraft	
Personnel issues	Aircraft control - Pilot (Cause) Flight planning/navigation - Pilot
Environmental issues	Terrain - Effect on personnel (Cause) Dark - Contributed to outcome (Cause)

Factual Information

History of Flight

Enroute-cruise	Controlled flight into terr/obj (CFIT) (Defining event)

On January 17, 2018, about 1800 mountain standard time, a Bell UH-1H helicopter, N658H, impacted terrain near Raton, New Mexico. The helicopter was subsequently consumed by a postimpact fire. The commercial pilot, a pilot-rated passenger, and three other passengers were fatally injured. One passenger sustained serious injuries. The helicopter was destroyed. The helicopter was registered to and operated by Sapphire Aviation LLC as a Title 14 *Code of Federal Regulations* Part 91 personal flight. Night visual meteorological conditions prevailed in the area about the time of the accident, and no flight plan was filed. The flight originated from the Raton Municipal Airport/Crews Field (RTN), near Raton, New Mexico, about 1750 and was destined for Folsom, New Mexico.

According to a statement taken by Federal Aviation Administration (FAA) Inspectors, the surviving passenger stated that the group of passengers boarded a private airplane in Houston, Texas and the airplane flew them to Raton, New Mexico. They subsequently boarded a company helicopter. The purpose of the helicopter flight was to take the group to personal function in Folsom, New Mexico. The passenger reported that the takeoff was normal. As they were flying east, the sun had gone down, and the stars were very bright. The passenger reported no turbulence during the flight. There were no unusual noises, no observed warning lights in the cockpit, and the pilot and copilot were calm; everything appeared normal. The passenger recalled that they were in level flight and when she heard a big bang as the helicopter hit the ground. After ground contact, the helicopter rolled forward coming to a stop upside down. The passenger was hanging from the seat belt, the door was not present, and jet fuel was pouring on her. She released her seat belt and egressed the helicopter. The helicopter was on fire and subsequent explosions followed. The passenger called 9-1-1 and waited for emergency responders.

According to a first responder, he arrived at the accident site about 2000 and paramedics arrived there about 2015.

The pilot initially survived the accident but succumbed to his injuries en route to a hospital. A witness stated that he was with the pilot before he was loaded in the rescue helicopter and asked the pilot what happened. The pilot replied that the accident was his fault and that he had flown into terrain.

Pilot Information

Certificate:	Commercial	**Age:**	57, Male
Airplane Rating(s):	Single-engine Land	**Seat Occupied:**	Right
Other Aircraft Rating(s):	Helicopter	**Restraint Used:**	Unknown
Instrument Rating(s):	Helicopter	**Second Pilot Present:**	Yes
Instructor Rating(s):	None	**Toxicology Performed:**	Yes
Medical Certification:	Class 2 With Waivers/Limitations	**Last FAA Medical Exam:**	12/07/2017
Occupational Pilot:	Yes	**Last Flight Review or Equivalent:**	
Flight Time:	(Estimated) 6416 hours (Total, all aircraft)		

Pilot-Rated Passenger Information

Certificate:	Commercial	**Age:**	67, Male
Airplane Rating(s):	None	**Seat Occupied:**	Left
Other Aircraft Rating(s):	Helicopter	**Restraint Used:**	Unknown
Instrument Rating(s):		**Second Pilot Present:**	Yes
Instructor Rating(s):		**Toxicology Performed:**	Yes
Medical Certification:	Class 2 With Waivers/Limitations	**Last FAA Medical Exam:**	12/11/2017
Occupational Pilot:		**Last Flight Review or Equivalent:**	
Flight Time:	(Estimated) 3140 hours (Total, all aircraft)		

The pilot held a commercial pilot certificate with airplane single-engine land, rotorcraft-helicopter, and instrument helicopter ratings. He held an FAA second-class medical certificate issued on December 7, 2017. The pilot reported on the application for his medical certificate that he had accumulated 6,416 hours of total flight time and 44 hours in the six months before the examination. His medical certificate was issued with the limitation that he must wear corrective lenses for distant, have glasses for near vision. The pilot reported on an insurance questionnaire that he had accumulated 2,065 hours of total flight time in UH-1 helicopters.

The pilot rated passenger held a commercial pilot certificate with a rotorcraft-helicopter rating. He held a second-class medical certificate issued on December 11, 2017. The pilot-rated passenger reported on the application for his medical certificate that he had accumulated 3,140 hours of total flight time and 30 hours in the six months before the examination. His medical certificate was issued with the limitations that he must wear corrective lenses, and that the certificate was not valid for any class after December 31, 2018. The pilot-rated passenger reported on an insurance questionnaire that he had accumulated 120 hours of total flight time in UH-1 helicopters.

Aircraft and Owner/Operator Information

Aircraft Make:	BELL	**Registration:**	N658H
Model/Series:	UH-1H	**Aircraft Category:**	Helicopter
Year of Manufacture:	2007	**Amateur Built:**	No
Airworthiness Certificate:	Restricted	**Serial Number:**	67-17658
Landing Gear Type:	Skid;	**Seats:**	
Date/Type of Last Inspection:		**Certified Max Gross Wt.:**	9500 lbs
Time Since Last Inspection:		**Engines:**	1 Turbo Shaft
Airframe Total Time:	4420.5 Hours	**Engine Manufacturer:**	LYCOMING
ELT:		**Engine Model/Series:**	T53-L-703
Registered Owner:	SAPPHIRE AVIATION LLC	**Rated Power:**	1300 hp
Operator:	SAPPHIRE AVIATION LLC	**Operating Certificate(s) Held:**	None

N658H, was registered as a Bell UH-1H, helicopter with serial no. 67-17658. However, the current type certificate holder for that serial number is Rotorcraft Development Corporation.

The helicopter was manufactured in 1967 and according to a representative of the type certificate holder (Rotorcraft Development Corporation), was added to the type certificate on August 13, 2007. The helicopter was a single-engine helicopter powered by a Honeywell (formerly Lycoming) T53-L-703 turbo shaft engine with serial number LE-10462Z, which drove a two-bladed main rotor system and a two-bladed tail rotor. T53 engines are a two-spool engine. The gas generator spool consists of a five-stage axial compressor followed by a single-stage centrifugal compressor, and a two-stage high pressure turbine. The power turbine spool consists of two stages. The engine has a maximum continuous rating of 1,300 shaft horsepower at an output shaft speed of 6,634 rpm.

According to information received from the FAA, the accident helicopter was released from the General Services Administration in May 1996 and was owned and operated by seven other civilian operators before Sapphire Aviation, LLC, purchased it on February 10, 2017.

FAA records showed the helicopter was certificated as a restricted category aircraft for external load operations. Title 14 *CFR* 91.313 states in part that no person may be carried on a restricted category civil aircraft unless that person is a flight crewmember, is a flight crewmember trainee, performs an essential function in connection with a special purpose operation for which the aircraft is certificated, or is necessary to accomplish the work activity directly associated with that special purpose.

According to an inspection data sheet, updated on January 9, 2018, the helicopter had accumulated 4,420.5 hours of total time.

Meteorological Information and Flight Plan

Conditions at Accident Site:	Visual Conditions	**Condition of Light:**	Night
Observation Facility, Elevation:	KRTN, 6349 ft msl	**Distance from Accident Site:**	11 Nautical Miles
Observation Time:	1753 MST	**Direction from Accident Site:**	282°
Lowest Cloud Condition:	Clear	**Visibility**	10 Miles
Lowest Ceiling:	None	**Visibility (RVR):**	
Wind Speed/Gusts:	10 knots /	**Turbulence Type Forecast/Actual:**	/ None
Wind Direction:	30°	**Turbulence Severity Forecast/Actual:**	/
Altimeter Setting:	30.26 inches Hg	**Temperature/Dew Point:**	1°C / -18°C
Precipitation and Obscuration:	No Obscuration; No Precipitation		
Departure Point:	RATON, NM (RTN)	**Type of Flight Plan Filed:**	None
Destination:	Folsom, NM	**Type of Clearance:**	None
Departure Time:	1750 MST	**Type of Airspace:**	

At 1753, the recorded weather at RTN was: Wind 030° at 10 kts; visibility 10 statute miles; sky condition clear; temperature 1° C; dew point -18° C; altimeter 30.26 inches of mercury.

According to U.S. Naval Observatory Sun and Moon Data, the end of local civil twilight was 1735 and local moonset was at 1754. The observatory characterized the phase of the moon as "waxing crescent with 0% of the moon's visible disk illuminated."

Wreckage and Impact Information

Crew Injuries:	1 Fatal	**Aircraft Damage:**	Destroyed
Passenger Injuries:	4 Fatal, 1 Serious	**Aircraft Fire:**	On-Ground
Ground Injuries:	N/A	**Aircraft Explosion:**	On-Ground
Total Injuries:	5 Fatal, 1 Serious	**Latitude, Longitude:**	36.704444, -104.286667 (est)

The main wreckage (fuselage) came to rest on a heading about 15° magnetic on a flat mesa about 10.7 nautical miles and 102° from RTN at an elevation about 6,932 ft mean sea level (msl). The mesa consisted mostly of small rocks and prairie grass. The area around the main wreckage was discolored and charred, consistent with a postaccident ground fire. There were no observed sources of ground light or illumination in the vicinity of the accident site.

The initial observed point of terrain contact was a parallel pair of ground scars, consistent with the width of the helicopter's skids, which led directly to the main wreckage on a 074° magnetic bearing. The distance from the start of the parallel ground scars to the wreckage was about 474 ft. About 18 ft past the end of the ground scars was a 25-ft-long ground scar consistent with a main rotor blade slap, which ran perpendicular to the path of travel. The entire main rotor came to rest about 60 ft beyond the blade slap signature. The tail rotor and tail rotor gear box were resting nearby. The helicopter's main wreckage was located about 66 ft beyond the main rotor. It came to rest upside down and the entire cabin section between the cockpit and tail boom was destroyed by fire.

The right side of the cockpit sustained thermal damage. The cyclic and collective on the left side of the cockpit were in place. The left cockpit side anti-torque pedals were present and connected to their under-deck push-pull tubes. The collective had broken away from its mount. Its twist grip linkage was present and connected. The twist grip's under-deck push-pull tubes moved when the grip's linkage was manipulated by hand. The push-pull tube sections located between the seats were been destroyed.

The collective control on the right side of the cockpit was separated from the floor deck. The right cyclic was not located. The right cockpit side's left anti-torque pedal was separated from it mount and the right anti-torque pedal was not located. Their connecting push-pull rod end were fractured into segments consistent with overload. All controls tubes aft of the cockpit were destroyed by fire.

Cockpit instruments and avionics exhibited discoloration, charring, and deformation consistent with thermal damage. Two altimeters were located. The altimeter on the left side of instrument panel read 6,760 ft (Kollsman window indicated 30.18). The other altimeter had separated from its instrument panel. The altimeter's 100-ft needle detached from its instrument face. However, the 1,000-ft needle pointed at 6,000 ft (Kollsman window indicated 30.28).

The transmission and main rotor mast were present forward of the engine and laying on its right side. The transmission's case had been consumed by fire, revealing the main drive gear and planetary gear train. The main drive gear was intact with no mechanical gear/tooth damage evident. The engine drive/sprag clutch was aligned with the transmission where a fragment of the KaFlex coupling was attached and was consistent in appearance with an overload fracture. Fragments of the KaFlex and torque tube were located in the debris field and displayed signatures consistent with overload fractures. The stationary swashplate was present with one servo connection present. The other two control servo connection horns were destroyed by thermal damage. Three flight control hydraulic servos were located. All aluminum hardware connecting each end of each servo had been melted or destroyed. The rotating swashplate was present with one scissor attached and the other scissor exhibited thermal damage. One main rotor blade damper remained attached to the rotor mast. The other blade damper was located in the debris field near the main rotor assembly. The mast had separated at the rotor head with a circumferential fracture consistent with torsional overload.

The engine compressor cases, accessory gearbox housing, and inlet housing were consumed by fire. The output reduction carrier and gear assembly, which attaches to the inlet housing, was

intact and recovered as a loose component. Gears within the accessory gearbox were recovered as loose components. There were no penetrations of the combustor plenum. The exhaust tail pipe was disassembled from the engine while on scene to document the second-stage of the power turbine. There were metal spray deposits on the suction side of the second-stage power turbine stator vanes. There was no damage to leading edge of either the second-stage power turbine stator vanes or the second-stage power turbine rotor blades.

The left horizontal stabilizer had separated from the tail boom at its root. The right horizontal stabilizer remained attached to the tail boom.

Four of the 5 tail rotor drive shaft segments were aligned with the transmission and positioned along the top of the tail boom. The first drive shaft that spanned the space beneath the engine was not located; however, the steel end coupling was present at the aft end of the transit tube. All the drive shaft segments had detached from their coupling hanger bearings, except for the shaft connecting to the lower section of the intermediate (42°) gear box. The shaft extending upward from the 42° gear box had separated along with the tail rotor gear box. The 42° gear box remained attached to the tail boom. Oil was present in the case, and the gears could be rotated by hand. Tail rotor control push-pull tube was separated at the forward end of the tail boom. Control continuity was established from the forward section of the tail boom to the tail rotor gearbox mount. Control continuity from the forward section of the tail boom to the horizontal stabilizer was established. The tail rotor gear box, the attached drive shaft, tail rotor head, and both blades had been separated from the vertical tail and were located in debris field near the main rotor assembly. Oil was present in the tail rotor gear box. The tail rotor assembly remained intact. The pitch links were attached from the pitch horns to the cross head. Rotor head balance weights remained attached. The tail rotor shaft moved freely by hand, no binding in the gear box. The tail rotor red blade tip leading edge was peeled back, and the tip cap sheared off. The opposite blade had been bent outboard about 30° about midspan along the chord line.

The main rotor separated from the rotor mast at the bottom of the rotor head and showed a fracture surface consistent with torsional overload. Both main rotor blades (red and white) remained attached to their main rotor head blade grips. The stabilizer bar assembly had separated from the main rotor head and was located near the main rotor assembly. The pitch change links, the control tubes, and the mixing lever remained connected to the stabilizer bar assembly.

The majority of the red main rotor blade's fiberglass and honeycomb blade afterbody had separated from its blade spar. Portions of the afterbody panels were discolored black and brown consistent with exposure to fire. The length of the red blade was about 21 ft 8 in. The outboard tip portion of the red blade had separated. The outboard 5 ft of the blade exhibited a broomstraw appearance. The drag brace remained connected. The pitch horn had sheared off the blade grip at its mounting pad.

The majority of the white main rotor blade's fiberglass and honeycomb blade afterbody had buckled and separated from the spar at 4 locations. The white blade's tip had sheared from its blade at a 45° angle. The length of the white blade was about 20 ft. The outboard tip portion of the blade had separated. The outboard 1 ft of the blade exhibited a broomstraw appearance.

The drag brace remained connected. The pitch horn had sheared off the blade grip at its mounting pad.

Medical And Pathological Information

The New Mexico Office of the Medical Investigator, Albuquerque, New Mexico, performed an autopsy of the pilot. The pilot's cause of death was blunt force trauma with atherosclerotic and hypertensive cardiovascular disease as contributing conditions. The autopsy revealed that the pilot's heart was enlarged, and both ventricles were thickened. Severe coronary artery disease was identified with up to 75% stenosis of the left anterior descending coronary artery and up to 40% stenosis of the left circumflex coronary artery. In addition, there was microscopic evidence of previous ischemia.

The FAA Bioaeronautical Sciences Research Laboratory, Oklahoma City, Oklahoma, performed toxicology testing on specimens of the pilot. Etomidate was detected in heart blood, and 0.032 µg/mL of diphenhydramine was detected in femoral blood. Diphenhydramine was also detected in liver.

Review of postaccident treatment records indicated that the pilot was administered etomidate by paramedics following the accident.

Diphenhydramine is used for the treatment of the common cold and hay fever. It carries the following Federal Drug Administration warning: may impair mental and/or physical ability required for the performance of potentially hazardous tasks (e.g., driving, operating heavy machinery). The therapeutic range for diphenhydramine is 0.0250 to 0.1120 µg/ml. Diphenhydramine can cause marked sedation, altered mood, and impaired cognitive and psychomotor performance. In a driving simulator study, a single 50 mg dose of diphenhydramine impaired driving ability more than a blood alcohol concentration of 0.100 gm/dl.

Tests And Research

A cellphone and iPad were located in the wreckage and sent to the National Transportation Safety Board Vehicle Recorders Laboratory to be examined for data pertinent to the accident. The devices were found locked so no data was retrieved.

The NTSB conducted terrain mapping and viewpoint flights of the impact area using a small unmanned aircraft system. Video from the drone flights was overlaid with cockpit imagery from an exemplar helicopter as a visualization aid. The overlay showed that fewer visible terrain features were present near the accident area during night conditions than during day conditions. The UAS Aerial Imagery Factual Report is in the docket for this accident.

A review of local terrain revealed that, if the helicopter had flown directly from RTM to the destination, the terrain along the route would have been about 450 ft lower. The accident site was located about 4 nautical miles south of this route.

Additional Information

A witness at the ranch in the Folsom, New Mexico, area was asked if he knew the route of flight for previous helicopter flights to the ranch. He reported that the few times that the pilot would have flown to the ranch would have mainly been from Perry Stokes Airport, near Trinidad, Colorado. He was not familiar with how many trips the pilot would have made from RTN to the ranch, but indicated that "it was probably minimal."

FAA Advisory Circular (AC) 61-134, General Aviation Controlled Flight into Terrain Awareness, defines controlled flight into terrain (CFIT) as when an airworthy aircraft is flown, under the control of a qualified pilot, into terrain (water or obstacles) with inadequate awareness on the part of the pilot of the impending collision.

An Australian Transport Safety Bureau Aviation Research and Analysis Report stated that at night, the absence of peripheral visual cues, especially below the aircraft, can give an illusion of height, and result in the pilot inadvertently flying lower than necessary.

An article in The Journal of the Human Factors and Ergonomics Society, published in September 2008, titled *Visual Misperception in Aviation: Glide Path Performance in a Black Hole Environment,* stated that no pilot was immune from visual [spatial disorientation]. Pilots with more experience tended to fly even lower than those with less experience.

Preventing Similar Accidents

Controlled Flight Into Terrain in Nighttime Visual Conditions

Controlled flight into terrain (CFIT) by both instrument flight rules (IFR)-rated and visual flight rules (VFR) pilots operating under visual flight conditions at night in remote areas have occurred, in many of these cases, when the pilots were in contact with air traffic controllers at the time of the accident and receiving radar service. The pilots and controllers involved all appear to have been unaware that the aircraft were in danger. Increased altitude awareness and better preflight planning would likely prevent these types of accidents.

CFIT accidents are best avoided through proper preflight planning. Terrain familiarization is critical to safe visual operations at night. Use sectional charts or other topographic references to ensure that your altitude will safely clear terrain and obstructions all along your route. In remote areas, especially in overcast or moonless conditions, be aware that darkness may render visual avoidance of high terrain nearly impossible and that the absence of ground lights may result in loss of horizon reference. A global positioning system (GPS)-based terrain awareness unit can improve your safety of flight.

When planning a nighttime VFR flight, follow IFR practices such as climbing on a known safe course until well above surrounding terrain. Choose a cruising altitude that provides terrain separation similar to IFR flights (2,000 ft above ground level in mountainous areas and 1,000 ft above the ground in other areas.)

When receiving radar services, do not depend on air traffic controllers to warn you of terrain hazards. Although controllers will try to warn pilots if they notice a hazardous situation, they may not always be able to recognize that a particular VFR aircraft is dangerously close to terrain. When issued a heading along with an instruction to 'maintain VFR,' be aware that the heading may not provide adequate terrain clearance. If you have any doubt about your ability to visually avoid terrain and obstacles, advise air traffic control (ATC) immediately and take action to reach a safe altitude if necessary. ATC radar software can provide limited prediction and warning of terrain hazards, but the warning system is configured to protect IFR flights and is normally suppressed for VFR aircraft. Controllers can activate the warning system for VFR flights upon pilot request, but it may produce numerous false alarms for aircraft operating below the minimum instrument altitude--especially in en route center airspace.

For improved night vision, the Federal Aviation Administration recommends the use of supplemental oxygen for flights above 5,000 ft. If you fly at night, especially in remote or unlit areas, consider whether a GPS-based terrain awareness unit would improve your safety of flight.

See http://www.ntsb.gov/safety/safety-alerts/documents/SA_013.pdf for additional resources.

The NTSB presents this information to prevent recurrence of similar accidents. Note that this should not be considered guidance from the regulator, nor does this supersede existing FAA Regulations (FARs).

Administrative Information

Investigator In Charge (IIC):	Edward F Malinowski	**Adopted Date:**	07/08/2019
Additional Participating Persons:	Steve Poiani; Federal Aviation Administration; Albuquerque, NM Marlin J Kruse; Honeywell Aerospace; Phoenix, AZ Fred Hodgdon; Rotorcraft Development Corporation; Hamilton, MT Stuart Hawkins; AAIB, UK; FN		
Publish Date:	07/08/2019		
Note:	The NTSB traveled to the scene of this accident.		
Investigation Docket:	http://dms.ntsb.gov/pubdms/search/dockList.cfm?mKey=96626		

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The Independent Safety Board Act, as codified at 49 U.S.C. Section 1154(b), precludes the admission into evidence or use of any part of an NTSB report related to an incident or accident in a civil action for damages resulting from a matter mentioned in the report.