Accident Rpt# GAA17CA385	**07/02/2017 1040 CDT**	**Regis# N6135P**	**Edna, TX**	**Apt: N/a**
Acft Mk/Mdl AIR TRACTOR INC AT 502-B		**Acft SN 502B-0286**	**Acft Dmg: SUBSTANTIAL**	**Rpt Status: Factual Prob Caus: Pending**
Eng Mk/Mdl PRATT & WHITNEY PT6A-34		**Acft TT 9429**	**Fatal 0 Ser Inj 0**	**Flt Conducted Under: FAR 137**
Opr Name: COASTAL FLYING SERVICE INC		**Opr dba:**		**Aircraft Fire: NONE**
				AW Cert: SPR

Events

1. Maneuvering - Controlled flight into terr/obj (CFIT)

Narrative

The pilot reported that, while maneuvering at low altitude over a field during an aerial application flight, he was focused on the top of the electrical poles that paralleled the field. He added that he crossed between the electrical poles and was focused on the pole to the right of the airplane. Once he crossed the top wire he focused his attention forward, but added that he "was staring at a 30-ft tower just to the left of the nose" of the airplane. The airplane struck the tower and then impacted the ground.

The airplane sustained substantial damage to the empennage.

The pilot reported that there were no preaccident mechanical malfunctions or failures with the airplane that would have precluded normal operation.

Accident Rpt# WPR16FA029 11/18/2015 1623 PST	**Regis# N711BE**	**Carlsbad, CA**	**Apt: Mc Clellan-palomar CRQ**
Acft Mk/Mdl AIRBUS HELICOPTERS AS350B3E	**Acft SN 7934**	**Acft Dmg: SUBSTANTIAL**	**Rpt Status: Factual Prob Caus: Pending**
Eng Mk/Mdl TURBOMECA ARRIEL 2D	**Acft TT 35**	**Fatal 2 Ser Inj 0**	**Flt Conducted Under: FAR 091**
Opr Name: BRUCE A ERICKSON	**Opr dba:**		**Aircraft Fire: GRD**
			AW Cert: STN

Summary

The private pilot and the pilot-rated passenger departed for a flight in the pilot's newly purchased helicopter. The pilot practiced several landings in a field during the flight and then flew back to the departure airport, where the approach and hover taxi to the ramp were uneventful. The pilot made a landing attempt on a dolly but landed only partially on the dolly, which caused the helicopter to pitch nose up and strike the ground with its tail. The helicopter hit the dolly with such force that the dolly broke free from the chocks securing it and spun around. The helicopter climbed and spun upwards aggressively but stabilized after rotating 270ø to the right.

The pilot then landed the helicopter in an abnormal location that straddled the ramp and a taxiway. Ground crew personnel re-secured the dolly with chocks, and, after about 2 1/2 minutes, the pilot again attempted to land on the dolly, this time from the opposite direction. He made two unsuccessful attempts but was unable to maintain a stabilized approach each time. Although the pilot had the option to land on the ramp, he persisted in attempting to land on the dolly. On his third attempt, he again landed partially on the dolly, and the helicopter rocked back and forth striking the ground with its tailskid, before violently climbing and pitching nose down, while rolling right. The helicopter spun 180ø to the left and pitched up steeply, and the tail rotor and vertical stabilizer struck the ground and separated. The helicopter hit the ground left side low, bounced, and rotated another 360ø before landing hard on its belly. The main rotor blades continued to spin and the engine continued to operate; the helicopter spun on its belly at a rate of about one revolution per second for more than 5 minutes, while gradually sliding about 530 ft along the ramp. The tailboom and horizontal stabilizer then separated, and the helicopter violently rolled onto its side, shed its main rotor blades, and came to rest.

Onboard video showed that the pilot became incapacitated during the final ground collision. The passenger remained conscious after the impact and reached for the throttle on the pilot's collective control shortly after the helicopter started to spin, but the throttle position remained unchanged. He then attempted to brace himself against the glare shield, but he eventually became incapacitated after about 2 minutes due to his injuries, the forces imposed by the spinning helicopter, or both. He did not make any attempt to reach up for the engine-start selector or the fuel shutoff lever.

Postaccident examination did not reveal any anomalies with the helicopter's airframe or engine that would have precluded normal operation.

In the weeks preceding the accident, the pilot had expressed concern to multiple flight instructors that he was having difficulty adjusting to the flight characteristics of the helicopter. In particular, he found dolly-landings challenging.

Although the pilot had many years of experience flying a Bell 407 helicopter, there were two significant differences between the Bell 407 and the accident helicopter. First, their main rotor systems rotated in opposite directions; therefore, the foot pedal inputs required to counteract changes in torque during takeoff and landing were opposite. (The pilot's difficulty adapting to this difference was evidenced during most of the previous takeoffs captured by the onboard video when the helicopter yawed significantly after lifting off.) Second, the tips of the landing skids, which were used as a visual reference during landing, were forward of the pilot in the Bell 407 but just aft of the pilot in the accident helicopter. This change in visual reference would have been particularly significant during dolly landings, which require landing on a specific point directly below the pilot's field of view.

The pilot had received about 11 hours of flight instruction in the helicopter, and, despite the fact that his instructors advised him not to fly without an instructor, he opted to fly with a passenger instead of an instructor on the accident flight. Although the passenger held a helicopter rating, he was not an instructor or professional helicopter pilot and had about 180 hours total in helicopters. Furthermore, it was likely that he had little or no experience in the accident helicopter make and model.

The pilot's instructors reported a mobility problem with the pilot's left arm that affected his ability to reach overhead, but this problem likely did not contribute to the accident, because he had no need to reach overhead during landing. Postmortem toxicology testing identified amlodipine, valsartan, and rosuvastatin as well as diphenhydramine at 0.538 ug/ml and alprazolam at less than 0.05 mg/l in the pilot's blood. The pilot had heart disease and hypertension and used amlodipine, valsartan, and rosuvastatin for their treatment; however, these conditions and medications most likely did not contribute to the accident as they do not affect judgment or decision-making. Alprazolam is a significant central nervous system (CNS) depressant with the lower end of the therapeutic range at 0.0060 mg/l. The exact amount of alprazolam in the pilot could not be determined by testing and may have been very low.

The therapeutic range for diphenhydramine is 0.0250 to 0.1120 ug/ml. However, diphenhydramine undergoes postmortem redistribution, and postmortem central blood levels may increase by about three times. When divided by three or four, the pilot's postmortem level suggests that he had therapeutic levels at the time of the crash. Compared to other antihistamines, diphenhydramine causes marked sedation and is also a CNS depressant. In addition, it may cause altered mood and impaired cognitive and psychomotor performance. The use of two CNS depressants simultaneously typically results in cognitive impairment which is magnified well beyond the simple addition of the effects, even when the amount of one of them may be low. Therefore, the pilot's decision-making, judgment, and psychomotor performance were most likely impaired by the combination of CNS depressants, diphenhydramine and alprazolam.

Cause Narrative

THE NATIONAL TRANSPORTATION SAFETY BOARD DETERMINED THAT THE CAUSE OF THIS OCCURRENCE WAS: The pilot's loss of control during landing on a dolly. Contributing to the accident were the pilot's decision to conduct the flight without an instructor despite multiple flight instructors' recommendations to the contrary, his failure to land on the ramp when he experienced difficulty landing on the dolly, and his impaired decision-making, judgment, and psychomotor performance, due to his use of a combination of two psychoactive drugs.

Events

1. Landing-flare/touchdown - Loss of control in flight
2. Landing-flare/touchdown - Landing area undershoot
3. Landing-flare/touchdown - Attempted remediation/recovery
4. Landing-flare/touchdown - Collision during takeoff/land

Findings - Cause/Factor

1. Personnel issues-Task performance-Use of equip/info-Aircraft control-Pilot - C
2. Aircraft-Aircraft oper/perf/capability-Performance/control parameters-Directional control-Not attained/maintained - C
3. Personnel issues-Action/decision-Info processing/decision-Decision making/judgment-Pilot - F
4. Personnel issues-Experience/knowledge-Experience/qualifications-Total experience w/ equipment-Pilot - F
5. Personnel issues-Physical-Impairment/incapacitation-Prescription medication-Pilot - F

Narrative

HISTORY OF FLIGHT

On November 18, 2015, at 1623 Pacific standard time, an Airbus Helicopters AS350B3E, N711BE, departed controlled flight while landing on a dolly at Mc Clellan-Palomar Airport, Carlsbad, California. The private pilot and the pilot-rated passenger were fatally injured; the helicopter sustained substantial damage. The pilot, who was the owner, was operating the helicopter under the provisions of 14 Code of Federal Regulations Part 91. The local personal flight departed Carlsbad at 1412. Visual meteorological conditions prevailed, and no flight plan had been filed.

The purpose of the flight was for the pilot to gain familiarity with the helicopter, which he had recently purchased. The entire accident sequence was captured on a series of airport security cameras and the mobile phone cameras of multiple witnesses.

About 2 hours before the accident, the helicopter departed from its dolly on the east end of the Premier Jet fixed base operator (FBO) ramp, which was located midfield on the south side of runway 6/24. After departure, line crew moved the dolly to the west end of the ramp.

Upon returning, the helicopter approached the airport from the northeast and was cleared to land on runway 24. It descended to midfield, turned left at taxiway A3, and approached the ramp in a low hover via the parallel taxiway A. The helicopter then began an approach to the dolly from the east, directly toward the sun. The helicopter landed short of, and partially on, the dolly with the center of its skids contacting the dolly's aft edge. The helicopter immediately rocked back, pitching nose up, and its tailskid struck the ground. The helicopter then began a series of fore and aft oscillations, and the dolly broke free from its front left chock, rotated to the right, and pivoted around its rear right wheel. The helicopter spun rapidly with the dolly for the first quarter of the turn and then quickly spiraled upward 270ø to the right. The dolly came to rest to the north, having rotated 180ø. The pilot repositioned the helicopter and landed it on the ground, straddling the ramp and taxiway A. Just before landing, the pilot was queried by the air traffic control tower controller and responded, "yeah, they didn't chock my cart, and I was like a skateboard out here," The tower controller then requested that the pilot switch to the ground control frequency.

During the next 2 1/2 minutes, the line crew re-secured the dolly, installing chocks on three of the four wheels. The pilot then took off and climbed the helicopter to about 20 ft while it yawed to the left, and he repositioned it for an approach to the dolly now from the west. During the next 4 1/2 minutes, the pilot made three landing attempts, getting the helicopter to within about 5 ft vertically of the dolly on the first two attempts. After the first attempt, the pilot repositioned the helicopter by circling back around the dolly. After the second attempt, the pilot performed a hovering climb and backed the helicopter into position. A video of

the third and final landing attempt was captured by a witness, who was located about 130 ft to the south. The witness was initially watching the helicopter from his airplane on the ramp, but he was concerned that the helicopter might crash, so he exited the airplane and positioned himself behind a car at the corner of the FBO's hangar.

The video revealed that the helicopter hovered over the dolly for about 60 seconds and then landed short, teetering on the aft edge of the dolly (Image 1). The tailskid almost struck the ground, and the helicopter then rapidly pitched forward (Image 2) and then aft again. The tailskid then struck the ground (Image 3), and the helicopter pitched forward, rolled right (Images 4 and 5), and climbed out of view behind the hangar. Security cameras revealed that the helicopter then spun 180ø to the left, and the nose pitched up to a 45ø attitude. The tail rotor and vertical stabilizer assembly then struck the ground and separated, and the helicopter hit the ground left side low, bounced, and rotated another 360ø before landing hard on its belly. Once on the ground, the main rotor blades continued to spin, while the helicopter started spinning on its belly, as the engine continued to operate (Image 6).

The helicopter continued spinning at a rate of about one revolution per second for the next 5 minutes while incrementally sliding about 530 ft east along the ramp. The tailboom and horizontal stabilizer then separated, and the helicopter rolled onto its side, shedding the main rotor blades. The engine continued operating for another 30 seconds while the fire crew doused the helicopter. White smoke billowed from the engine's exhaust after the helicopter came to rest, but there was no fire.

PERSONNEL INFORMATION

The pilot was seated in the front right seat, and the pilot-rated passenger was seated in the front left seat.

Pilot

The pilot held a private pilot certificate with ratings for airplane single-engine land and sea, multiengine land, instrument airplane, and rotorcraft-helicopter. He also held a type rating for the Cessna Citation Jet (CE-525S).

The pilot held a third-class medical certificate issued on January 19, 2015, with the limitation that he must have available glasses for near vision.

No personal flight records were located for the pilot. At the time of his last medical application, he reported a total flight time of 25,000 hours, with 200 hours logged in the last 6 months. The pilot reported the same numbers on three other applications over the 5-year period preceding the accident, and 25,400 hours total time on his application dated January 18, 2011. His helicopter rating was issued in May 2001, at which time he reported on his rating application a total flight time of 14,000 hours in airplanes.

The pilot had previously owned and flown a Cessna Citation business jet airplane and a Bell 407 helicopter. His 2001 helicopter checkride flight took place in a Bell 206B3. At the time of the accident, he was receiving recurrent training for the Citation, with the most recent flight 2 days before the accident. The pilot purchased the accident helicopter on October 29, 2015, and had flown demonstration and familiarization flights in it since September 20. According to the helicopter's flight logs, those flights totaled about 8.8 hours and were all conducted with a flight instructor present. The pilot then flew the helicopter with another instructor for an additional 2 hours on November 13.

According to the two instructors who had flown with the pilot for the familiarization flights and the flight instructor who provided training in the Citation, the

accident flight was the first time the pilot had flown in an AS350 without an instructor present. All had recommended that the pilot gain further instruction before flying without an instructor, and the pilot had concurred.

The three instructors shared similar insights into the pilot's flying skills, reporting that, while he appeared to have extensive flying experience, he was anxious about the handling characteristics of the AS350 compared to the Bell 407, particularly during landing. The pilot said that he was having difficulty anticipating flight control forces because the helicopter controls felt "backwards" due to the opposing rotor direction of the AS350 compared to the Bell 407. Furthermore, he was having trouble landing on the dolly partly because the tips of the skids were just behind his seating location in the AS350, as opposed to the Bell 407, where he could see the skids just forward and below. Both helicopter instructors reported performing multiple dolly and simulated dolly landings with the pilot, stating that, although the pilot was not completely at ease, he was able to ultimately land on the dolly unaided. The pilot told the Citation instructor that, although he had practiced many landings in the helicopter, he still did not feel proficient and thought that the helicopter was very unstable close to the ground, especially when it was close to the dolly.

One of the helicopter instructors reported that the pilot wanted to enable the helicopter's stability augmentation system (SAS) for landings because he had been told it would help his landings. The instructor stated that he wanted the pilot to be able to fly the helicopter proficiently without the use of the SAS. However, for demonstration purposes, they did two landings with the SAS enabled. During those attempts, the pilot appeared to be "fighting" against the SAS control inputs, with unsatisfactory results, and he did not understand how to use the SAS release button on the cyclic to override the SAS control inputs. Therefore, the pilot and instructor decided to turn the system off.

Both helicopter instructors reported that the pilot appeared to have suffered an injury that restricted movement of his left arm. He could use his left arm to operate the flight controls and reach the lower sections of the flight panel, but he could not reach the upper controls, including the engine start selector panel, without the supportive aid of his right arm. One instructor stated that because of the injury, the pilot was unable to climb up onto the helicopter to perform preflight examinations of the rotor head. One helicopter instructor and the Citation instructor stated that the pilot's hands often shook and that it was particularly obvious when he held a pen, although once he grasped the flight controls the shaking stopped.

Both helicopter instructors suggested that the pilot take formal factory-approved flight training, and one instructor stated that he had declined to provide any further instruction until the pilot had taken training at the Airbus Helicopters flight school. According to Airbus Helicopters, in early October, the pilot had signed up for a "B3 Pilot Transition Class" scheduled for November 2, but 2 days before the class he called to defer the training. No further communication from the pilot was received by Airbus Helicopters.

The Citation instructor, who had known the pilot for 6 years, reported that the pilot was becoming concerned that age was starting to affect his reaction time when flying. The instructor had observed the pilot's degrading flight performance and had conversations with him about how maintaining proficiency through regular flying could help. He stated that the pilot was no longer fully proficient in the Citation, that his reaction times were becoming slower, and that he would often let the airplane get ahead of him. As such, the instructor recommended that the pilot always fly with him. He stated that the pilot mentioned that he was going to fly the helicopter for practice with a friend on the day of the accident.

The pilot confided in all three instructors that, due to the difficulties he was having mastering the AS350, he was most likely going to sell it and buy another Bell 407. All three instructors stated that they had never seen the pilot's logbooks and had, therefore, never made any entries.

Pilot-Rated Passenger

The pilot-rated passenger held a private pilot certificate with ratings for airplane single-engine land and rotorcraft-helicopter. His first rating was for rotorcraft-helicopter, and it was issued in December 2004 following a checkride in a Bell 206B3. He was issued his airplane single-engine land rating in December 2014, and, at that time, he reported on his rating application a total rotorcraft flight time of 179.6 hours, including 163 solo hours.

He held a third-class medical certificate issued on May 29, 2014 with no limitations.

No personal flight records for the pilot-rated passenger were located, and his currency or recent flight experience could not be determined. At the times of issuance of his two prior FAA medical examinations in 2008 and 2012, he reported total flight times of 185 and 200 hours respectively, with no flight time in the preceding 6 months on both occasions.

HELICOPTER INFORMATION

The helicopter was manufactured in 2014 and equipped with a Turbomeca Arriel 2D engine. The helicopter had dual collective, cyclic, and foot pedal controls, with primary flight control intended from the right seat.

The helicopter was maintained under a continuous airworthiness program and had accrued 35.2 hours of total time since new when the accident occurred. The last inspection took place 20.6 flight hours before the accident on August 15, 2015.

The helicopter had undergone a series of twenty-three upgrades in May 2015, including the installation of an auxiliary side locker fuel tank, full length skid shoes, a radar altimeter, and a Genesys Aerosystems HeliSAS stability augmentation system and two-axis (pitch and roll) autopilot.

The HeliSAS system provided attitude stabilization and force feedback to the cyclic control, via electro-mechanical servo actuators connected in parallel to the flight controls. The systems technical overview documentation stated:

"The HeliSAS system is designed to be engaged at all times: "SAS" on before takeoff, and "SAS" off after landing. The "force feel" (force trim) feature enhances handling characteristics and mitigates inadvertent cyclic control inputs that could result in dangerous attitudes. The pilot may override the HeliSAS at any time with manual cyclic inputs. Only 3.5 lbs of pilot force in the pitch axis, and 3.0 lbs in the roll axis, at the cyclic control is required to override the system for pilot desired maneuvering when either the SAS or autopilot modes are engaged."

The helicopter was serviced with the addition of 70 gallons of Jet A fuel on the morning of the accident.

METEOROLOGICAL INFORMATION

According to the U.S. Naval Observatory's Astronomical Applications Department, the altitude of the sun when viewed from Carlsbad at 1620 would have been 4.3ø, with an azimuth (E of N) of 243.7ø.

FLIGHT RECORDERS

The helicopter was equipped with an Appareo Vision 1000 flight data monitor. The unit was capable of recording video, audio, GPS coordinates, and pitch, roll, yaw and acceleration data. The unit was mounted in the aft center ceiling of the cockpit.

The unit was sent to the NTSB Vehicle Recorders Division for data extraction, and a video group consisting of the NTSB investigator-in-charge and technical representatives from Turbomeca and Airbus Helicopters was convened to review the data.

The unit had recorded video and audio data, along with GPS coordinates for the entire flight. The field of view included over-the-shoulder video images of the forward cockpit, which included both cyclic controls and the right-seat collective and foot pedal controls, along with most of the instrument panel and a view out the lower forward portion of the windscreen. The unit did not record any radio or microphone audio. Only loud engine and transmission noises could be heard for the duration of the recording.

The video recording began at 1406:52 and depicted the helicopter stationary on the dolly at the east end of the FBO's ramp, with the engine running and the pilot configuring the avionics system. Six minutes later, the helicopter departed.

GPS data indicated that for the next 27 minutes the helicopter flew generally to the east and approached an open field at an elevation of about 4,500 ft mean sea level (msl), 4.5 miles south of the peak of Palomar Mountain. The helicopter then performed a left downwind landing approach into the field, lined up on final from the south, and landed at the far end of the field just short of the tree line. Twenty seconds after landing, the pilot turned on the SAS system. The pilot then initiated a hover, and the helicopter lifted off the ground and immediately yawed about 25ø to the left, before setting back onto the ground. Thirty seconds later, the pilot began another hovering maneuver, and, after lifting off the ground, the helicopter immediately spun about 150ø to the right before setting back onto the ground.

About 40 seconds later, at 1443:09, the helicopter lifted off the ground up uneventfully, and departed toward the southeast. For the next hour, the helicopter

took a route toward the Salton Sea, then north along the coastline toward La Quinta, where it turned inland and began to track back to Carlsbad. During the period after departing from the field, the pilot turned the SAS system from active to standby mode multiple times and occasionally engaged the autopilot. Helicopter control was handed back and forth between the two pilots as they performed various tasks including activating the auxiliary fuel tank transfer pump, viewing their personal electronic devices, and referencing the helicopter's flight manual.

About 1610, the helicopter approached the airport from the east, conducted a straight-in approach, and crossed the threshold of runway 24 at 1612:05. The SAS system was in standby mode, and, as the helicopter approached the runway, the passenger lifted his right hand over his face in an apparent effort to shield himself from sun glare. The pilot appeared to be wearing sunglasses. The helicopter flew along the runway and then turned left, crossed the runway 6-24 hold short line, and entered taxiway A3 while in a low hover. The helicopter proceeded along taxiway A, approaching the landing dolly, which, having been relocated, was now at the west end of the FBO's ramp.

The helicopter approached the dolly, but, due to sun glare, minimal outside references were visible in the recording. Over the next 30 seconds, the occupants appeared to have been jostled in their seats, the helicopter pitched nose down, and the cockpit instruments registered a right roll of about 25ø. The helicopter then yawed to the right and began maneuvering toward taxiway A and the ramp. It landed straddling the ramp and taxiway, and the pilot then entered the ground control frequency in the avionics system. About that time, an incoming call was received on the pilot's phone; he picked up the phone, ignored the call, and put the phone back down again.

After about 2 minutes, the pilot initiated a hover, and, as soon as the helicopter broke ground, it immediately yawed about 30ø to the left. The pilot maneuvered the helicopter west along taxiway A and performed a left turn, toward the east, bringing the helicopter in line with the dolly. During the following three landing attempts, the dolly passed in and out of view in the left side of the lower portion of the helicopter's chin bubble. The pilot's cyclic control inputs were pronounced as the dolly came in and out of view. On the second attempt, as the dolly disappeared from view, both occupants appeared to rock forward. The pilot then backed up the helicopter in a low hover, and the dolly came back into view.

With the dolly still visible, the helicopter again rocked back and forth and slowly descended, while both occupants again rocked forward. The needle displayed on the first limit indicator on the instrument panel dropped rapidly as the pilot quickly lowered the collective control. Comparison of the onboard video with the security camera video indicated that, about this time, the tailskid struck the ground, and the helicopter pitched up and rotated 180ø before the tail again struck the ground. During this time, the pilot was still holding the cyclic and collective controls, and his feet were on the foot pedals. Both occupants then moved aggressively back and forth and from side to side, until the helicopter landed hard on its nose, and both occupants violently rocked to the right. The pilot slumped over to the right and remained motionless, and the helicopter began to spin.

As the spin progressed, the pilot-rated passenger reached down to the throttle control on the pilot's collective with his right hand. His hand remained on the control for about 3 seconds, but the control did not move out of the "FLIGHT" detent position. The passenger then moved his right hand to the glare shield lip where it remained for about the next 2 minutes. The passenger then appeared to loosen his grip on the glare shield, and he remained motionless, while the helicopter continued to spin. Eventually a loud "bang" was recorded, and the helicopter stopped violently and came to rest on its right side. Neither occupant moved as first responder personnel arrived and began the process of entering the cabin.

MEDICAL AND PATHOLOGICAL INFORMATION

Pilot

At the time of his most recent FAA medical examination, the pilot reported hypertension and the use of medications including nebivolol (blood pressure medication), pantoprazole (heartburn medication), and rosuvastatin (cholesterol lowering medication).

According to the autopsy performed by the County of San Diego Office of the Medical Examiner, the pilot's cause of death was multiple injuries, and the manner of death was accident.

The autopsy report noted significant intracranial injuries with bilateral subdural and subarachnoid hemorrhage more pronounced on the right side and the base of the brain extending into the foramen magnum and cervical canal. Intraventricular hemorrhage without parenchymal contusions was also noted. In addition, hemorrhage of the anterior cervical ligament associated with fractures of the body of C6 (and possibly C7) with associated subdural hemorrhage surrounding the cervical spinal cord was identified.

The pilot's heart was enlarged, and mild coronary artery disease with 50% stenosis was also described.

Toxicology testing by the medical examiner detected amlodipine (0.34 mg/l) and alprazolam (less than 0.05 mg/l) in peripheral blood.

Toxicology testing by the FAA's Bioaeronautical Sciences Research Laboratory, identified amlodipine, valsartan, rosuvastatin, and diphenhydramine (0.538 ug/ml) in heart blood. In addition, the FAA laboratory found alpha-hydroxyalprazolam (0.044 ug/ml) and salicylate in urine.

Amlodipine and valsartan are blood pressure medications and, along with rosuvastatin, are generally considered non-impairing. Alpha-hydroxyalprazolam is a metabolite of alprazolam, a potentially impairing anxiety medication. Alprazolam is commonly marketed under the name Xanax, and it carries the warning: "Because of its CNS (central nervous system) depressant effects, patients receiving alprazolam tablets should be cautioned against engaging in hazardous occupations or activities requiring complete mental alertness such as operating machinery or driving a motor vehicle. For the same reason, patients should be cautioned about the simultaneous ingestion of alcohol and other CNS depressant drugs during treatment with alprazolam tablets." Diphenhydramine is a sedating antihistamine that has been shown to significantly impair performance at routine doses.

Pilot-Rated Passenger

The pilot-rated passenger reported no chronic medical problems and no medications at the time of his most recent FAA medical examination.

According to the autopsy performed by the County of San Diego Office of the Medical Examiner, the pilot-rated passenger's cause of death was multiple injuries, and the manner of death was accident.

His injuries included bilateral subdural and subarachnoid hemorrhages, ligamentous instability at C1/C2, and fracture at C6/C7 with associated subdural hemorrhage but without obvious spinal cord injury. In the torso, there was a fracture of the sternum along with multiple rib fractures, some associated with retroperitoneal hemorrhage. There were widely open fractures of both bones of the lower left leg. He was found to have an enlarged heart with thickened walls and minimal coronary artery disease.

Toxicology testing by the FAA's Bioaeronautical Sciences Research Laboratory identified ranitidine (a non-impairing heartburn medication) in the pilot-rated passenger's urine.

WRECKAGE AND IMPACT INFORMATION

Postaccident examination of the helicopter did not reveal any anomalies with the airframe or engine that would have precluded normal operation. The throttle was found in the "FLIGHT" detent, and the left and right throttle controls could both be moved in concert with each other smoothly between the control detents.

Dolly

The primary structure of the dolly was composed of a 14-ft-wide and 12-ft-long red-painted steel frame, with two castering wheels at the front, and two fixed wheels at the rear. A steel, V-shaped hinged tow bar was attached to the front of the dolly. The landing deck surface was about 12 inches off the ground and made of wood planks coated with light-grey non-slip paint. No manufacturer's label or data plate could be found on the dolly. Standard operating procedures dictated that the helicopter approach the dolly from the rear and land with the tow bar at the front of the helicopter, thereby allowing clearance from the towing vehicle.

Examination revealed two indentations on the rear side of the dolly frame spaced 7 ft 3 inches apart or about the width separating the helicopter's left and right landing skids. The indentations contained freshly detached paint chips that exposed shiny uncorroded steel. Crush marks were present on the wood planks adjacent to the indentations.

Security camera video footage and statements provided by the FBO line crew indicated that, for the first landing approach, the dolly's rear right and front left wheels were chocked. In the video footage, a line crewmember could be seen checking the security of the chocks after initially setting both wheels. For the accident approach, the rear right and both front wheels were chocked. The chocks were standard triangular-shaped rubber aviation chock pairs that were

attached to one another with a short length of rope.

The slope of the ramp at the dolly location for the final landing attempts was about 3ø down from right to left when viewed from the approach direction. The helicopter's flight manual indicated a maximum sideways landing slope of 8ø.

Seats

Both front seats were of the energy attenuating type designed to absorb vertical impact loads. The seats were equipped with four-point belt harnesses.

The front left seat did not exhibit evidence of vertical displacement (stroking). The left side of the front right seat did not exhibit evidence of stroking; the right side of the seat exhibited a vertical stroke of about 1 inch downward.

Accident Rpt# GAA17CA369	**06/26/2017 1645 PDT**	**Regis# N183TC**	**Entiat, WA**	**Apt: N/a**
Acft Mk/Mdl BELL 206B-B		**Acft SN 1805**	**Acft Dmg: SUBSTANTIAL**	**Rpt Status: Factual** **Prob Caus: Pending**
Eng Mk/Mdl ALLISON 250-C20 SER			**Fatal 0** **Ser Inj 0**	**Flt Conducted Under: FAR 137**
Opr Name: JP HELICOPTERS		**Opr dba:**		**Aircraft Fire: NONE**
				AW Cert: STN

Events

1. Prior to flight - Miscellaneous/other

Narrative

The pilot of the helicopter reported that, while maneuvering at a low altitude for an aerial application flight, a clipboard that was on the seat next to him fell and became lodged under the anti-torque peddles. Unable to free the clipboard, the pilot chose to land. During landing, the pilot "lost tail rotor authority" about 5-10 ft. above the ground. He added that, "after about two rotations", he was able to land the helicopter. During the touchdown, the main rotor blades contacted and separated the tail boom.

The helicopter sustained substantial damage to the tail boom.

The pilot reported that there were no preaccident mechanical malfunctions or failures with the helicopter that would have precluded normal operation.

Accident Rpt# CEN17FA100	**02/06/2017 1909 CST**	**Regis# N978RH**	**Galveston, TX**	**Apt: N/a**
Acft Mk/Mdl BELL 206B-III		**Acft SN 4075**	**Acft Dmg: DESTROYED**	**Rpt Status: Factual Prob Caus: Pending**
Eng Mk/Mdl ALLISON (ROLLS-ROYCE) 250-C20J		**Acft TT 15287**	**Fatal 1 Ser Inj 0**	**Flt Conducted Under: FAR 135**
Opr Name: REPUBLIC HELICOPTERS, INC.		**Opr dba:**		**Aircraft Fire: NONE**
				AW Cert: STN

Summary

The non-scheduled passenger helicopter flight departed from an oil tanker ship that was anchored in a bay. The pilot reported that the departure had been delayed, but, when the helicopter did depart, the weather was "good." He said he had more than 6 miles visibility, that and he could see the moon above and the water below, and that his en route altitude was between 700 and 800 feet. He added that as the flight approached the shore at 500 feet, he could see the city lights and lights off the water. The next thing he remembered was being in the water. He and the two passengers were subsequently found by the US Coast Guard about 1hour later. The nearest weather observation station, located 8 miles east of the accident site, reported an overcast ceiling of 400 feet and 5 miles visibility in mist about 17 minutes before the accident. TAFs and AIRMETs issued about 1.5 hours and 1 hour before the accident, respectively, forecast instrument meteorological conditions (IMC). Postaccident examination of the helicopter wreckage was consistent with a relatively level impact, and no pre-impact mechanical anomalies were noted that would have precluded normal operation. It is likely that the flight encountered IMC at night and that the pilot did not properly gauge the distance of the helicopter from the water, which led to its collision with the water.

Cause Narrative

THE NATIONAL TRANSPORTATION SAFETY BOARD DETERMINED THAT THE CAUSE OF THIS OCCURRENCE WAS: The pilot's failure to recognize the flight had encountered instrument meteorological conditions at night, which resulted in an unrecognized descent and collision with water.

Events

1. Enroute-descent - Controlled flight into terr/obj (CFIT)

Findings - Cause/Factor

1. Personnel issues-Psychological-Perception/orientation/illusion-Perception-Pilot - C
2. Personnel issues-Action/decision-Action-Incorrect action performance-Pilot - C
3. Personnel issues-Action/decision-Info processing/decision-Identification/recognition-Pilot - C
4. Personnel issues-Experience/knowledge-Knowledge-Knowledge of meteorologic cond-Pilot - C
5. Environmental issues-Conditions/weather/phenomena-Ceiling/visibility/precip-Drizzle/mist-Effect on operation - C

Narrative

HISTORY OF FLIGHT

On February 6, 2017, at 1906 central standard time, a Bell 206B-III, N978RH, impacted the waters of West Bay near Galveston, Texas. One passenger was fatally injured. The pilot and a second passenger were seriously injured. The helicopter was destroyed. The helicopter was registered to and operated by Republic Helicopters, Santa Fe, Texas, under the provisions of 14 Code of Federal Regulations (CFR) Part 135 as a non-scheduled domestic passenger flight. Instrument meteorological conditions (IMC) prevailed at the time of the accident. Company flight following was being utilized. The flight originated from the oil tanker Eagle Vancouver, anchored in Galveston Bay, at 1837, and was en route to Republic's Helicopters, Inc., Heliport (2TE1), Santa Fe, Texas.

According to the operator, this was the helicopter's third flight of the day. It departed 2TE1 at 1404 and flew to the Eagle Vancouver, landing at 1457. The pilot shut down and the two passengers, both employees of Societe Generalde Surveillance (SGS), disembarked and began their work on the tanker. The helicopter had originally been scheduled to depart at 1600 but was delayed. The helicopter finally took off at 1837. Official sunset was at 1802. It was scheduled to arrive at 2TE1 at 1910. The last radio communication Republic Helicopters Operations had with the helicopter was at 1906 when the pilot reported, "I have the lights of the shore."

The helicopter was equipped with a GPS SkyRouter fast tracking system that reports the helicopter's position every 2 minutes. The last data point received from the GPS SkyRouter system was at 1906, when the helicopter was about 0.27miles from the Galveston Island coastline at 494 feet and 127 mph. Republic Helicopters An "Inactive" signal was received from the Blue Sky GPS by Republic Helicopters Operations 10 minutes after this last contact, or 1916, and the U.S. Coast Guard was alerted. Based on time and distance from the last data point to the accident location with an approximate helicopter speed of 120 mph, the time of the accident was computed to be 1909.

On February 22, 2017, at 1100, two Federal Aviation Administration inspectors from the Houston Flight Standards District Office interviewed the pilot at the University of Texas Medical Branch in Galveston. Also present was Republic's Director of Safety and the pilot's wife. The pilot confirmed there had been a

delay in departure, but when they did depart, the weather was "good." He said he had more than 6 miles' visibility and he could see the moon above and the water below. He contacted Republic Operations, established his flight plan, received a weather update and got the current altimeter setting. His en route altitude was between 700 and 800 feet. He said that as he approached Galveston Island State Park, he had visual reference with the lights from Galveston and lights off the water. The next thing he remembered was being in the water.
he didn't. They had to throw the line again. When they got me to the deck, I just flopped down on the deck. I was so cold. I just don't understand why it took so long for someone to rescue us."

The accident site was at N29ø14.39' W94ø59.44' -- 4.3 miles from the last Blue Sky data point at an azimuth of 326.95ø and 8 miles, or 283ø from Scholes International Airport (KGLS), Galveston. It was 6.96 miles on a heading of 325.73ø from 2TE1. The accident site was in an area with little or no ground lights.

PERSONNEL INFORMATION

The 30-year-old pilot held an airline transport pilot certificate with a rotorcraft-helicopter rating, and private pilot privileges with airplane single-engine land and instrument ratings. He was hired by Republic Helicopters on March 31, 2015. His first-class airman medical certificate, dated March 16, 2016, contained no waivers, limitations, or restrictions.

According to Republic Helicopters records, as of September 7, 2016, the pilot had logged a total of 1,702 flight hours, of which 1,552 hours were in rotorcraft, 1,452 hours were in the Bell 206, and another 600 hours in Bell models 222, 230, and 430. He had also logged 220 hours were under simulated instrument conditions, and 4 hours were in actual instrument conditions. He had also logged 150 hours in single-engine airplanes. No night flying time was noted in any category. His last FAA and company proficiency check was accomplished on March 1, 2016, in the Bell 206.

AIRCRAFT INFORMATION

N978RH, serial number 4075, a model 206B-III, was manufactured by the Bell Helicopter Corporation in 1989. It was powered by an Allison (now Rolls-Royce) 250-C20J turboshaft engine, serial number CAE 270491, rated at 450 shaft horsepower.

The last airframe annual inspection was performed on August 31, 2016, at 15,138.9 total hours. At the time of the accident, the airframe had accrued 15,287.2 total hours. The transponder and pitot-static system were IFR-certified on September 30, 2016 (FAR 91.413 and 91.411). At the last 100-hour inspection, the engine had accumulated 13,645.4 total hours and 24,394 cycles. The last compressor and turbine overhauls were accomplished at 11,872.8 and 13,118.3 hours, respectively.

METEOROLOGICAL INFORMATION

According to Meteorology Group Chairman's Factual Report, AIRMET (Airmen's Meteorological Information) Sierra was issued at 1445 CST, well before the accident flight departure time, and valid at the accident time for the accident site. The AIRMET forecast IFR conditions due to mist developing between 1500 and 1800 CST. The Area Forecast (FA) issued at 1345 CST and valid at the accident time and departure time forecasted a broken ceiling at 2,000 feet with tops at 5,000 feet. The KGLS Terminal Aerodrome Forecast (TAF), valid at the time of the accident, was issued at 1906 CST and was valid for a 23-hour period beginning at 1900 CST. It forecasted the wind to be from 150ø at 10 knots, 5 statute miles visibility, mist, and an overcast ceiling at 400 feet agl. The KGLS TAF valid before the departure time was issued at 1726 CST and was valid for a 24-hour period beginning at 1800 CST. It forecasted the wind to be from 150ø at 14 knots, 6 statute miles visibility, haze, and scattered clouds at 1,000 feet agl. The 1726 CST KGLS TAF forecast did not forecast L (low) IFR conditions until 2000 CST.

The report noted the phase of the moon was "Waxing Gibbous with 78% of the Moon's visible disk illuminated. The moonlight would have likely been visible above the cloud tops. Below 3,000 feet near the accident site at the accident time would have been instrument meteorological conditions with no moonlight visible."

WRECKAGE AND IMPACT INFORMATION

The helicopter was recovered from West Bay on February 8, 2017, by T&T Marine Salvage, Inc, and was examined at their facilities at Teichman Point, Galveston, on February 8 and 9, 2017. T&T Marine Salvage reported the water depth at the accident site was approximately 7 to 8 feet, and all recovered wreckage was found in a radius of 80 to 100 feet.

Damage was consistent with a relatively level water impact. The fuselage was separated into several sections. The cabin and cockpit area was extensively damaged. The main rotor had departed the helicopter. There was evidence of mast bumping. The mast fracture was consistent with the rotating main rotor blades striking the water. Three main rotor blades strikes to the fuselage were noted. Both main rotor blades bore impact damage, with one blade missing two-thirds of its span to the tip. The other main rotor blades had an intact spar, but the spar was bent forward -- consistent with sudden stoppage. Transmission continuity was observed. The last two tail rotor driveshaft segments on the tail boom were missing and evidence indicated that the driveshaft was struck by a main rotor blade at impact. The tail rotor gearbox rotated freely. The helicopter was equipped with STC (supplemental type certificate) Van Horn tail rotor blades. They turned freely , and the hub and blades were relatively intact. Free T/R pitch change was present through the T/R hub. The flight controls exhibited much damage in the cockpit and vertical tunnel areas. No pre-impact anomalies were observed in any airframe systems.

Examination of the instrument panel revealed the following: altimeter, 900 feet; Kollsman window, 29.92 inches of mercury; heading indicator, 220ø; Hobbs meter, 4,143.8. Examination of the annunciator panel revealed no stretching of any of the bulb filaments. Examination of the position lights revealed no filament stretching of the red or white lights. The green light and landing lights were destroyed.

MEDICAL AND PATHOLOGICAL INFORMATION

The pilot and right rear seat passenger were both seriously injured and were found by the U.S. Coast Guard approximately one hour after the accident, clinging to a section of fuselage. The pilot had sustained stomach and intestinal trauma, several lumbar fractures, and abrasions on his shoulders, consistent with rubbing of the shoulder harness. The left front seat passenger was fatally injured and was found about 100 meters from the wreckage.

Accident Rpt# GAA17CA390 07/07/2017 34 CDT	**Regis# N650HP**	**Topeka, KS**	**Apt: Philip Billard Muni TOP**
Acft Mk/Mdl BELL 407-NO SERIES	**Acft SN 53665**	**Acft Dmg: SUBSTANTIAL**	**Rpt Status: Factual Prob Caus: Pending**
Eng Mk/Mdl ROLLS ROYCE 250-C47B	**Acft TT 2752**	**Fatal 0 Ser Inj 0**	**Flt Conducted Under: FAR PUBU**
Opr Name: KANSAS HIGHWAY PATROL	**Opr dba:**		**Aircraft Fire: NONE**
			AW Cert: STN

Events

2. Landing - Hard landing

Narrative

The pilot of the helicopter reported that, during a hover taxi under night vision goggles, he "pedal turned facing the west to line up with [the] landing lines painted on the ramp". He added that, he looked under his goggles and observed the right painted mark under the right skid, and noted that he estimated that they were about 6 ft above the ground. He then looked back into his goggles to land the helicopter. The tactical field officer that was on board the helicopter advised the pilot that they needed to move forward. The pilot further reported that he "tried to move forward but nothing happened at which time [he] felt a sudden jolt and then [heard] the noise of the tail rotor strike". The helicopter impacted a building then impacted the ground.

The helicopter sustained substantial damage to the fuselage.

The pilot reported that there were no preaccident mechanical malfunctions or failures with the helicopter that would have precluded normal operation.

Accident Rpt# WPR16FA054	**01/18/2016 1000 MST**	**Regis# N711BX**	**Cedar Fort, UT**	**Apt: N/a**
Acft Mk/Mdl CESSNA 525		**Acft SN 525-0299**	**Acft Dmg: DESTROYED**	**Rpt Status: Factual Prob Caus: Pending**
Eng Mk/Mdl WILLIAMS INTERNATIONAL FJ 44		**Acft TT 2304**	**Fatal 2 Ser Inj 0**	**Flt Conducted Under: FAR 091**
Opr Name: DONALD L BAKER		**Opr dba:**		**Aircraft Fire: UNK**
				AW Cert: STN

Summary

The airline transport pilot and passenger departed on a cross-country flight in instrument meteorological conditions in the light business jet. About 1 minute after departure, air traffic control instructed the pilot to climb and maintain an altitude of 14,000 ft mean sea level (msl). About 3 minutes later, the pilot stated that the airplane's flight management system (FMS) had failed. Shortly thereafter, he requested a climb and stated that he was "trying to get to clear skies." Over the next several minutes, the controller provided the pilot with headings and altitudes to vector the airplane into visual meteorological conditions. During this time, and over the course of several transmissions, the pilot stated that he was "losing instruments," was hand-flying the airplane (likely indicating the autopilot was inoperative), and that he wanted to "get clear of the weather."

Radar data indicated that, during the 10-minute flight, the airplane conducted a series of climbs and descents with large variations in airspeed. About 2 minutes before the loss of radar contact, the airplane entered a climbing right turn, reaching its highest altitude of about 21,000 ft, before it began a rapidly descending and tightening turn. Performance data revealed that, during this turn, the airplane entered a partially-inverted attitude, exceeded its design maneuvering speed, and reached a peak descent rate of about 36,000 ft per minute. Radar contact was lost at an altitude of about 16,000 ft msl, and the airplane subsequently experienced an inflight breakup. The wreckage was distributed over a debris path that measured about 3/4-mile long and about 1/3-mile wide.

Postaccident examination and testing of various flight instruments did not indicate what may have precipitated the inflight anomalies that the pilot reported prior to the loss of control. Additionally, all airframe structural fractures were consistent with ductile overload, and no evidence of any preexisting condition was noted with the airframe or either engine.

The airplane was equipped with three different sources of attitude information, all three of which were powered by separate sources. It is unlikely that all three sources would fail simultaneously. In the event the pilot experienced a dual failure of attitude instrumentation on both the pilot and copilot sides, airplane control could have been maintained by reference to the standby attitude indicator. Further, the pilot would have been afforded heading information from the airplane's standby compass.

Although the pilot did not specifically state to the controller the nature of the difficulties he was experiencing nor, could the investigation identify what, if any, anomalies the pilot may have observed of the airplane's flight instruments, the pilot clearly perceived the situation as one requiring an urgent ascent to visual conditions. As a single pilot operating without the assistance of an additional crewmember in a high-workload, high-stress environment, the pilot would have been particularly susceptible to distraction and, ultimately, a loss of airplane control due to spatial disorientation.

Cause Narrative

THE NATIONAL TRANSPORTATION SAFETY BOARD DETERMINED THAT THE CAUSE OF THIS OCCURRENCE WAS: The pilot's loss of control due to spatial disorientation while operating in instrument meteorological conditions, which resulted in an exceedance of the airplane's design stress limitations, and a subsequent in-flight breakup. Contributing to the accident was the pilot's reported inflight instrumentation anomaly, the origin of which could not be determined during the investigation.

Events

1. Enroute-climb to cruise - Unknown or undetermined
2. Enroute-climb to cruise - Loss of control in flight
3. Uncontrolled descent - Aircraft structural failure
4. Uncontrolled descent - Part(s) separation from AC
5. Uncontrolled descent - Collision with terr/obj (non-CFIT)

Findings - Cause/Factor

1. Personnel issues-Psychological-Perception/orientation/illusion-Spatial disorientation-Pilot - C
2. Personnel issues-Task performance-Use of equip/info-Aircraft control-Pilot - C

Narrative

On January 18, 2016, about 1000 mountain standard time, a Cessna 525, N711BX, was destroyed following a loss of control and in-flight breakup while maneuvering at altitude near Cedar Fork, Utah. The airline transport pilot and his sole passenger sustained fatal injuries. Instrument meteorological conditions prevailed in the area, and an instrument flight rules (IFR) flight plan was filed for the personal cross-country flight, which was operated under the provisions of 14 Code of Federal Regulations Part 91. The flight departed Salt Lake City International Airport (SLC), Salt Lake City, Utah, about 0950, with an intended destination of Tucson International Airport (TUS), Tucson, Arizona.

According to air traffic control voice communication and radar information, the pilot contacted the SLC departure controller at 0951:59 and reported that he was climbing through 7,500 ft mean sea level (msl) for 10,000 ft (all altitudes are expressed as msl unless otherwise noted). The controller then cleared the pilot to climb to and maintain Flight Level 230 (FL230), and to delete speed restrictions; the pilot confirmed the clearance. At 0952:21, the controller instructed the pilot to maintain 14,000 ft, to delete all speed restrictions, and asked him what speed he was climbing at; the pilot confirmed the clearance and stated that he was climbing at 200 knots (kts).

At 0955:01, while approaching 14,000 ft the pilot reported that he had a failure with his Flight Management System (FMS), that he was "switching to NAV for a second," and would be exceeding the assigned altitude. This was followed by an unintelligible transmission. At 0955:16, the controller instructed the pilot to descend and maintain 14,000 ft and to fly his present heading. About 10 seconds later, the pilot advised the controller that he had an autopilot failure, and requested a climb to visual meteorological conditions. The controller instructed the pilot to climb and maintain FL180. At 0955:47, the pilot responded by confirming the climb to FL180. The controller then asked the pilot if he needed assistance. The pilot did not immediately respond, and the controller asked him a second time. At 0956:16, the pilot responded "negative," saying that he was "just trying to get to clear skies," and was climbing to FL180. The pilot stated that his "number 2" was working, and that his "altitude" had failed. The pilot concluded the transmission by saying, ".so, uh, my number two is working, climbing to one eight thousand."

At 0956:32, the controller advised the pilot that traffic would be crossing above him at FL190, and that it was important that he level the airplane at FL180; the pilot replied, "We'll be watching." At 0956:45, the controller advised the pilot of two areas of light precipitation directly ahead of the airplane, and asked the pilot if he would need vectors to clear the weather. At 0956:59, the pilot responded that he would appreciate any vectors possible. Shortly thereafter, at 0957:06, the controller asked the pilot to "...paint a picture for me of where you think the clearest skies would be. I can vector you wherever you need to go." At 0957:12, the pilot replied that he was heading to TUS, his altitude would not hold, and that he was hand flying the airplane. About this time, radar showed the airplane beginning a right turn from its previously-established southerly heading to a southwesterly heading, though the airplane had neither been cleared to do so by the controller nor had the pilot informed the controller of the deviation. About 0957:20, the pilot transmitted that he would appreciate any vectors possible. About 15 seconds later, the controller advised the pilot that he was showing him at 17,500 ft, directed the pilot to fly his present heading, and stated that the airplane would be clear of the precipitation in about 4 miles. About 17 seconds later, the pilot transmitted, "...ok, MAYDAY. I do need to get up higher. I am losing different instruments. I'd really like to get clear of weather." At 0958:01, the controller issued the pilot a clearance to climb and maintain FL230, which the pilot confirmed. About 0958:26, the controller amended the previous clearance and instructed the pilot to climb to and maintain FL310, which the pilot initially confirmed, but shortly thereafter stated, "...yeah. I can't even dial that in. Still climbing, passing twenty thousand, so I'm just going to be reading it out to be sure my second is operating correctly."

At 0958:46, the controller stated that he was showing the airplane climbing through 20,200 ft, and asked the pilot if he wanted to continue to TUS; the pilot replied, "That is affirmative." At 0958:53, when the airplane was at 20,700 ft, the controller issued the pilot a no-gyro turn to the left for vectors to the southeast; this occurred about 1 minute 41 seconds after the airplane had turned southwest. Radar data showed that the pilot initiated a right turn from a southwesterly heading at an altitude of 20,700 ft. At 0959:12, the airplane reached an altitude of 21,300 ft. msl, and was still in the right turn. At 0959:13, the controller stated, "November one bravo x-ray. I show you in a right turn. Can you turn left?" At 0959:17, while climbing out of 21,300 ft, the pilot replied that he was "trying to climb."

About 0959:47, the controller advised the pilot that he had lost the airplane's altitude readout, and asked the pilot the airplane's altitude. There were no further transmissions received from the pilot. Between 0959:49 and 0959:58, the airplane descended from an altitude of 21,300 ft to 16,000 ft, with its rate of descent during this time increasing from 9,600 ft per minute (fpm) to 36,000 fpm.

The Utah County Sheriff's Office collected four witness statements. One witness heard a loud boom and about 45 seconds later heard a motor sputtering, followed by seeing a piece of the airplane falling; the piece that he observed was on fire, but the witness could not identify what it was. The witness stated that he heard the plane crash but never saw it. A second witness said he heard a boom but did not report seeing [the airplane]. Another witness heard an explosion

while in his house, then went outside and saw debris falling from the sky. The fourth witness reported hearing a loud explosion and heard the airplane descend, but did not hear the impact.

Within hours of the accident, a Federal Aviation Administration (FAA) inspector responded to the accident site. The inspector reported that he did not observe ice accumulation on any of the airplane's surfaces during his onsite examination. The inspector stated that it was snowing at the accident site throughout the day.

PERSONNEL INFORMATION

The pilot was issued an airline transport pilot certificate with an airplane multiengine land rating on April 8, 2008, which included commercial privileges for single-engine land airplanes, and a A/CE-525S type rating for single-pilot operations.

A review of the pilot's personal logbook revealed that, at the time of the accident, he had accumulated a total flight time of 3,336 hours, of which 3,138 hours was as pilot-in-command, and 2,015 hours was multiengine time. The pilot had 1,588 total hours of turbojet time, all in the accident airplane. The pilot had flown 8.8 hours, 8.8 hours, and 7.9 hours in the last 90, 60, and 30 days respectively. The pilot was current and qualified to operate the airplane in single-pilot flight operations.

On December 1, 2014, the pilot was issued an FAA third-class airman medical certificate with the restriction, "Must wear corrective lenses." At the time of the application, the pilot reported a total flight time of 3,232 hours, of which 55 hours was accumulated in the previous 6 months.

Records provided by FlightSafety International's (FSI) San Antonio Learning Center, San Antonio, Texas, revealed that, since 2011, the pilot had attended CE-525 recurrent training on a semi-annual basis. The pilot attended his most recent CE-525 recurrent training from August 7, 2015 through August 9, 2015. At the time of his training, the pilot reported a total time of 3,113 hours, with 1,563 hours of turbo-jet time in multiengine airplanes. The FSI recurrent training course consisted of 12.5 ground training hours, and 6 hours of flight simulator time, each of which the pilot completed satisfactorily.

As annotated on the FSI Client Information Sheet, the pilot reported under Type of Flight Director: [Garmin] G750; dual Garmin GTN 750 units were installed in the accident airplane in October 2014. According to the FSI Director of Training Operations, FSI does not possess any Citation simulators configured with this avionics suite. Further, the Director of Training stated that FSI did not provide the accident pilot with training specific to the operation and use of the two Garmin GTN 750. At the time of the accident, the pilot had accumulated a total of 97.8 hours of flight time in the accident airplane since the modification had been completed. Additionally, and in a telephone conversation with the NTSB IIC, the FAA Certificate Management Office, which is located in Wichita, Kansas, and who manages the FSI certificate, reported that while recommended to do so, FSI was not required to provide the pilot with specific training for the Garmin 750 and GTX 33 equipment.

AIRCRAFT INFORMATION

The airplane, serial number 525-0299, had a low-wing, T-tail configuration, with retractable tricycle landing gear. The cabin was pressurized, and the airplane was capable of operating at a maximum pressure altitude of 41,000 ft. The airplane was configured for up to 7 occupants, including the pilot(s). It was approved for single-pilot operations provided the pilot-in-command held a CE525 (single-pilot) type rating. The airplane was equipped with two Williams International FJ44-1A medium-bypass turbofan engines installed on the rear fuselage pylons, each of which produced 1,900 lbs. of thrust.

Maintenance

According to Cescom Maintenance Transaction Records provided by Textron Aviation, the airplane's most recent maintenance occurred on January 4, 2016, when the left and right horizontal stabilizer deice boots were replaced at Mesa Citation Service Center, Mesa, Arizona. At the time of the inspection, the airframe had accumulated 2,301.9 hours, the #1 (left engine) 2257.1 hours, and the #2 (right engine) 2205.4 hours. At the time of the accident, the airplane had accumulated about 3 hours since this inspection.

Avionics

During the investigation Sierra Industries provided the following information relative to the Garmin GTN 750 flight management system as installed in the

accident airplane:

In October 2014, Sierra Industries installed a Dual Garmin GTN 750 system into a Cessna Citation Jet, Model 525, Serial Number 525-0299. The Garmin GTN 750 is a fully integrated Global Positioning System (GPS), Navigation (NAV), Communication (COMM), and Multi-Functional Display (MFD) system. The installation was approved under FAA Form 337, dated 10/10/2014.

The Garmin GTN 750 is a fully integrated GPS/NAV/COM/MFD system. Each unit is 6.25-inch-wide x 6-inch-high and provides an 800 x 600-pixel display on a 6.9-inch diagonal color liquid crystal display (LCD) screen with touchscreen controls. The unit simplifies pilot workload by providing a visual display of controls and functions. The GTN 750 system has its own Global Positioning System/Satellite-based augmentation system (GPS/ SBAS) and navigator and flight planning function. In addition, the GTN 750 provides VHF Com and VHF Nav radios. The GTN 750 is a certified component with an FAA TSO C146c, and is certified for primary domestic, oceanic, and remote navigation, including en route, terminal, and non-precision approaches, and approach in vertical guidance, such as localizer performance with vertical guidance (LPV), lateral navigation (LNAV), and vertical navigation (VNAV).

The airplane was equipped with a Honeywell SPZ-5000 integrated flight guidance system (IFGS), which provided, in part, flight director guidance, an altitude alerting system, and autopilot. For engagement of the autopilot and yaw damper, the autopilot system requires a single directional gyro and two vertical gyro sources; the VG-14A vertical gyro is the primary source for the flight guidance system. This system comprised a display guidance computer (IC-500), air data system, attitude and heading reference (vertical and directional gyros), electronic attitude director indicator (EADI), electronic horizontal situation indicator (EHSI), autopilot controller, mode selector, and autopilot servos. The IC-500 display guidance computer (DGC) was the focal point for the flow of information within the IFGS. It received information from various sensors and control system inputs, and converted this information to pilot-selected formats for display on the pilot's EADI and EHSI.

The #1 VG-14A supplied data to the IC-500 for the pilot's side EADI and EHSI. The #2 VG-14A provided data to the IC-500 for comparison to the #1 VG-14A data and supplied data directly to the co-pilot's side attitude indicator. A cockpit panel-mounted switch allowed the pilot to switch between the #1 VG-14A and the #2 VG-14A to display information on the pilot's side EADI/EHSI.

The two AC inverters provided power to the two VG-14A gyros. The #1 inverter supplied power to the #1 VG-14A, and the #2 inverter supplied power to the #2 VG-14A. Should one of the inverters fail, both gyros can be powered by one inverter when the pilot switches to the inverter that remains powered. The airplane was also equipped with a standby jet gyro attitude indicator with a separate power supply, which supplied emergency power for 30 minutes.

A review of the airplane's maintenance records showed that during October 2014, several avionics components were removed. The replacement avionics consisted of several Garmin GA55 antennas, a Skylight Converter, dual Garmin GTN 750s, which incorporated a Global Positioning System, Navigation and Communication capabilities, a Multi-Functional Flight Display, a Garmin GDL69A XM Weather and Radio remote sensor, a Shadin ADC-200 Fuel Flow Indicator, and dual Garmin GTX33 transponders.

The airplane was also equipped with two AM-250 Barometric altimeters as part of the reduced vertical separation minimums (RVSM) modification. The pilot's AM-250 supplied ARINC 429 air data information to the Number 1 Garmin GTX33 transponder (XPDR 1) and to the IC-500 DGC; it also supplied ATC encoded altitude data to the IC-500 DGC. The co-pilot's AM-250 supplied air data information to the Number 2 Garmin GTX33 transponder (XPDR 2).

Additionally, the airplane was equipped with one encoding altimeter, P/N 44929-013, S/N 1783. This altimeter was found installed within the left or (pilot's side) instrument panel located below the vertical speed indicator. The altimeter indicated 5,280 feet, and a barometric setting of 30.09 inHg, which was observed at the accident site.

METERROLOGICAL INFORMATION

At 0954, the weather reporting facility at the Provo Municipal Airport (PVU), Provo, Utah, which was located about 16nm southeast of the accident site, reported wind calm, visibility 10 miles, scattered clouds at 3,000 ft above ground level (agl), broken clouds at 3,500 ft agl, overcast clouds at 4,000 ft agl, temperature 0øC, dew point -3øC, and an altimeter setting of 30.11 inches of mercury.

At 0955, the weather reporting facility at the South Valley Regional Airport (U42), Salt Lake City, Utah, which was located about 18nm north-northeast of the accident site, reported wind calm, visibility 10 miles, scattered clouds at 3,800 ft agl, broken clouds at 4,300 ft agl, overcast clouds at 4,900 ft agl, temperature

2øC, dew point -1øC, and an altimeter setting of 30.09 inches of mercury.

In a review of the weather conditions that the pilot may have encountered during the 10-minute flight, an NTSB Senior Meteorologist reported that the airplane would have ascended through an icing layer during the climb to FL210, with solid instrument meteorological conditions (IMC) likely from 9,000 ft msl through FL250. The flight would have then encountered layered clouds from FL250 through FL320; however, there were no pilot reports available to provide further information regarding the locations of cloud layers between these altitudes. The accident flight was also operating in a layer with super-cooled large drop (SLD) icing and ice crystals. Additionally, AIRMETs for icing conditions and mountain obscuration were valid for the area of the accident site at the time of the accident. No reports of lightning strikes were recorded near or around the accident site at the time of the accident.

WRECKAGE AND IMPACT INFORMATION

Investigators from the NTSB and FAA, accompanied by representative from Textron Aviation, examined the wreckage site the day following the accident.

The wreckage was located in open, flat pasture ground, about 1 nautical mile (nm) southeast of Cedar Fort, Utah, and about 28 nm south-southwest of SLC. The onsite examination revealed that the airplane had experienced an in-flight breakup, with all structural components located at the accident site. Various airframe components were found scattered throughout a rectangular area measuring about 4,000 ft long and about 1,500 ft wide on an approximate 247ø magnetic heading.

The main wreckage consisted of the fuselage with attached cockpit assembly and two seats, the cabin area with all five seats, the center wing section, and the aft fuselage extending aft to, but not including the empennage. The center wing section was located near the main wreckage and was separated outboard of the main landing gear on the right wing, and inboard of the landing gear on the left wing. The inboard section of the right wing displayed evidence of extensive thermal damage. The right flap remained attached to the wing, with extensive thermal damage to the bottom of the flap. Additionally, the inboard section of the right wing displayed evidence of extensive thermal damage. The left flap had separated from the wing, and was found upright in the ground next to the main wreckage. The right main landing gear and the nose landing gear were observed in the UP position. The left main landing gear was found separated from the landing gear housing, but remained near the main wreckage. The actuator was observed in the extended position, with damage to the actuator housing near the wing attachment point noted. The wreckage came to rest inverted, slightly on its left side, and oriented on a measured magnetic heading of 42ø.

All airframe components, except for both engines, were located northeast of the main wreckage site. They consisted primarily of the outboard sections of both left and right wings, the outboard sections of the left horizontal stabilator, and the airplane's empennage.

The left outboard wing section was located about 3,000 ft northeast of the main wreckage, and was bent and twisted. The left aileron remained partially attached to the wing. About 4 ft of the outboard section of the wing was separated and not recovered. The upper interspar skin was separated from the main body of the wing. The spoiler/speed brake actuator measured 2.25 inches from the center of the bolt to the face of the actuator, with .1 inches of chrome showing. The fuel cap was secure.

The right outboard wing section was located about 4,700 ft northeast of the main wreckage and exhibited top wing skin separation, with the aileron separated mid-span at the outboard attach point. The spoiler/speed brake actuator measured 2.25 inches from the center of the bolt to the face of the actuator, with .5 inches of chrome showing. The fuel cap was secure.

The empennage was located about 1,700 ft east of the main wreckage and was intact, except for its left outboard horizontal stabilator and elevator sections. The separated outboard horizontal stabilator and elevator section was located about 4,100 ft northeast of the main wreckage, and exhibited deformation where it had separated from its mating surface. The leading edge of the vertical stabilizer exhibited a downward-oriented crease about mid-span. The rudder remained attached to the vertical stabilizer at all attach points. The rudder trim actuator measured 1 inch.

The right engine and carry-through beams were located about 300 ft north of the wreckage. Fragments of the airframe hardware were found attached to the engine. The outer cowling displayed evidence of impact damage. Fan blades did not display rotational scoring. An initial onsite inspection revealed no catastrophic anomalies with the engine.

The left engine was not located during the initial onsite examination. However, on April 9, 2016, the engine was located about 3,000 ft west-northwest of the main wreckage. The outer cowling displayed heavy impact damage. The engine was subsequently recovered to a secured storage facility in Phoenix, Arizona

for further examination.

An examination of the flight control system revealed that the control cables either remained attached to their respective attach fittings or had separated in a manner consistent with tension overload. In addition, several control cables were cut by the recovery personnel.

On March 2 and 3, 2016, under the supervision of the NTSB IIC, and technical support provided by field representatives for Williams International, Honeywell, and Textron Aviation, a detailed examination of the engine and airframe was performed at the facilities of Air Transport, Phoenix, Arizona. Additionally, on April 27, 2016, under the supervision of the NTSB IIC, and with the support of a Williams International field technician, the airplane's left engine was examined in detail. The results of the examinations revealed no mechanical anomalies with the airframe or either engine that would have precluded normal operation. (For additional information, refer to the NTSB Summary of Airplane Accident report, which is appended to the docket for this accident.)

MEDICAL AND PATHOLOGICAL INFORMATION

The Office of the Medical Examiner, Utah Department of Health, Salt Lake City, Utah, performed an autopsy on the pilot. The results of the examination revealed that the pilot was fatally injured due to total blunt force injuries.

The FAA's Bioaeronautical Sciences Research Laboratory, Oklahoma City, Oklahoma, conducted forensic toxicology examinations of specimens from the pilot, and reported that no ethanol was detected in muscle or brain, with no testing performed for carbon monoxide and cyanide. Valsartan (Diovan) was detected in the liver and kidney. Valsartan is a prescription medication used alone or in combination with other medications to treat high blood pressure.

TESTS AND RESEARCH

During the investigation numerous avionics system components were tested with no evidence of
any malfunctions or anomalies that would have precluded normal operation. (Refer to the NTSB System's Group Chairman's Factual Report, which is appended to the docket for this accident, which provides detailed information relative to the operation of each individual component, and its accompanying examination.)

At the request of the NTSB IIC, and under the supervision of an NTSB air safety investigator, on January 17, 2017, the airplane's standby attitude indicator (PN: 5010-1197-09, SN: 6494, Model: AI-804AH) was examined at the facilities of Air Transport, Phoenix, Arizona. The examination, which was performed by a Honeywell Aerospace engineer, revealed no evidence to indicate that the component was not operating normally prior to impact with terrain. (Refer to the Honeywell Standby Display - Disassembly and Examination Report, which is appended to the docket for this report, for a detailed explanation of the examination.)

Airplane Performance

After departing SLC about 09:50:30, the airplane flew a track of about 180ø for the first seven minutes of flight. About 09:57, it began a tightening right turn that ended in a final radar return at 09:59:58.

The airplane climbed in three distinct segments. The first was after takeoff from 4,200 ft msl (SLC elevation) to 14,800 ft, after which it descended to 14,000 ft between 09:55:30 and 09:55:49. The airplane's equivalent airspeed during this climb was increasing, but less than 190 kts. During the descent, the airspeed increased to over 240 kts. During the second climb segment, which was from 14,000 ft to 18,000 ft, the airspeed continuously decreased to 170 kts. Following the second climb, which ended at 09:57:07, the airplane held its altitude for 14 seconds before descending briefly to 17,400 ft. During the descent, the airplane's speed increased to near 230 kts. The airplane completed its third climb to 21,000 ft, during which its airspeed dropped to about 140 kts. As the airplane leveled from 09:59:03 until 09:59:44, its airspeed increased to 200 kts. The airplane then entered a rapid descent, and the final radar return was at 16,000 ft.

During the second climb, the airplane initiated a right turn at a rate of less than 1ø per second. During the third climb, the rate of turn began about 1.75ø per second and increased throughout the turn, which necessitated an increased angle of bank. The smoothed bank angle increased rapidly to near 90ø before the loss in altitude. The straight calculated bank angle, which anticipates the airplane flying through the next radar point, was 122ø of right bank, consistent with a partially-inverted attitude. The next radar point, 4.5 seconds later, recorded an 800-ft loss of altitude.

According to the Aircraft Flight Manual (AFM), "full application of rudder and aileron controls, as well as maneuvers that involve angles-of-attack near the stall, should be confined to speeds below maximum maneuvering speed." For a pressure altitude of 21,000 ft, maneuvering speed (Va) for the airplane could be between 145 and 182 kts depending on whether the airplane was operating at a low gross weight or high gross weight, respectively. Weight and balance calculations indicated that the airplane was operating about 415 pounds below its maximum gross takeoff weight at the time of departure.

ADDITIONAL INFORMATION

The Pilot's Abbreviated Emergency/Abnormal Procedures Checklist for the Citation 525, EFIS FAILURE (FLT GUIDANCE COMPUTER FAILURE), states that if a red X appears on either the EADI and/or the EHSI, or both displays are blank, and after having checked and reset the Flight Guidance System circuit breaker and both screens still display a red X, or both are blank, to "Continue the flight by referring to the standby gyro and the pilot's air data and NAV instruments, and cross referencing the copilot's attitude and heading. The autopilot will be inoperative."

According to FAA Advisory Circular AC 60-4A, "Pilot's Spatial Disorientation," tests conducted with qualified instrument pilots indicated that it can take as long as 35 seconds to establish full control by instruments after a loss of visual reference of the earth's surface. AC 60-4A further states that surface references and the natural horizon may become obscured even though visibility may be above VFR minimums, and that an inability to perceive the natural horizon or surface references is common during flights over water, at night, in sparsely-populated areas, and in low-visibility conditions.

The FAA Civil Aeromedical Institute's "Intro to Aviation Physiology" defines spatial disorientation as a loss of proper bearings or a state of mental confusion as to position, location, or movement relative to the position of the earth. Factors contributing to spatial disorientation include changes in acceleration, flight in instrument meteorological conditions (IMC), frequent transfer between visual meteorological conditions (VMC) and IMC, and unperceived changes in aircraft attitude. The publication states that pilots flying in IMC are more susceptible than usual to the stresses of flight, such as fatigue and anxiety, and any event that produces an emotional upset is likely to disrupt the pilot's mental processes, making them more vulnerable to illusions and false sensations.

According to the FAA's Pilot's Handbook of Aeronautical Knowledge (FAA-H-8083-25A), "Va" is referred to as the airplane's calibrated design maneuvering speed. This is the maximum speed at which the limit load can be imposed (either by gusts or full deflection of the control surfaces) without causing structural damage. Operating at or below maneuvering speed does not provide structural protection against multiple full control inputs in one axis or full control inputs in more than one axis at the same time.

Accident Rpt# GAA18CA070	**12/06/2017 1045 MST**	**Regis# N790AM**	**Tucson, AZ**	
Acft Mk/Mdl EUROCOPTER AS 350 B3-B3		**Acft SN 4298**	**Acft Dmg: SUBSTANTIAL**	**Rpt Status: Prelim** **Prob Caus: Pending**
			Fatal 0 **Ser Inj 0**	**Flt Conducted Under: FAR PUBU**
Opr Name:		**Opr dba:**		**Aircraft Fire: NONE**

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Prepared From Official Records of the NTSB By:
Air Data Research
9865 Tower View, Helotes, Texas 78023
210-695-2204 - info@airsafety.com - www.airsafety.com

Incident Rpt# DCA17IA202B	**09/21/2017 1920 EDT**	**Regis# R20087**	**Hoffman Island, NY**	**Apt: N/a**
Acft Mk/Mdl SIKORSKY UH60		**Acft SN Unknown**	**Acft Dmg: MINOR**	**Rpt Status: Factual Prob Caus: Pending**
			Fatal 0 Ser Inj 0	**Flt Conducted Under: FAR ARMF**
Opr Name: US ARMY		**Opr dba:**		**Aircraft Fire: NONE**

Summary

The United States Army UH-60M helicopter was operating under visual flight rules within Class G airspace about 300 ft above mean sea level (msl) when it collided with a privately owned and operated DJI Phantom 4 small unmanned aircraft system (sUAS). The helicopter sustained minor damage and landed uneventfully; the sUAS was destroyed. Although the pilot flying the helicopter saw the sUAS before impact and immediately applied flight control inputs, there was insufficient time to avoid the collision.

The sUAS pilot was operating the aircraft recreationally and did not hold a Federal Aviation Administration (FAA) Remote Pilot certificate. Hobby and recreational pilots are expected to operate their aircraft in accordance with Title 14 Code of Federal Regulations Part 101, which includes maintaining visual contact with the aircraft at all times and not interfering with any manned aircraft. There are no training or certification requirements for model aircraft pilots.

During the incident flight, the pilot of the sUAS intentionally flew the aircraft 2.5 miles away, well beyond visual line of sight and was just referencing the map on his tablet; therefore, he was not aware that the helicopter was in close proximity to the sUAS. Although the pilot stated that he knew that the sUAS should be operated at an altitude below 400 ft, flight logs revealed that he had conducted a flight earlier on the evening of the incident, in which he exceeded 547 ft altitude at a distance of 1.8 miles, which was unlikely to be within visual line of sight. In addition, even though the sUAS pilot indicated that he knew there were frequently helicopters in the area, he still elected to fly his sUAS beyond visual line of sight, demonstrating his lack of understanding of the potential hazard of collision with other aircraft. In his interview, the sUAS pilot indicated that he was not concerned with flying beyond visual line of sight, and he expressed only a general cursory awareness of regulations and good operating practices.

A Temporary Flight Restriction (TFR) was in effect for the area of the flight; the helicopter was authorized for flight within this area. The helicopter was operating over water and not in the vicinity of any vessels; therefore, its operating altitude was in accordance with FAA regulations and Army guidance. The sUAS pilot was unaware of the active TFRs in the area that specifically prohibited both model aircraft and UAS flight. Further, the sUAS pilot relied only on the DJI GO4 app for airspace awareness. Although the TFR airspace awareness functionality in the DJI app (GEO) was not active at the time of the incident, this feature is intended for advisory use only, and sUAS pilots are responsible at all times to comply with FAA airspace restrictions. Sole reliance on advisory functions of a non-certified app is not sufficient to ensure that correct airspace information is obtained. Had the functionality been active, the sUAS pilot would still have needed to connect his tablet to the internet before the flight in order to receive the TFR information. Since the sUAS pilot's tablet did not have cellular connection capability, it is unlikely that he would have been able to obtain TFR information at the time of the flight. Because the pilot solely relied on the app to provide airspace restriction information; he was unaware of other, more reliable methods to maintain awareness.

The collision occurred 2 minutes before the end of civil twilight. Although modeler (recreational) sUAS pilots may fly at night under certain conditions, when asked about night flight, the incident pilot only stated that he had built-in position lights; thus he was likely unaware of any guidelines or practices for night operations.

There was no evidence of any mechanical or software problems with the sUAS relevant to the flight. The pilot did not report any anomalies, and stated the recorded information on the flight logs accurately reflected the incident flight. The sUAS operated as expected at all times. Although the recorded data showed a 9-second gap in telemetry, this was likely due to distance from the remote controller.

Cause Narrative

THE NATIONAL TRANSPORTATION SAFETY BOARD DETERMINED THAT THE CAUSE OF THIS OCCURRENCE WAS: the failure of the sUAS pilot to see and avoid the helicopter due to his intentional flight beyond visual line of sight. Contributing to the incident was the sUAS pilot's incomplete knowledge of the regulations and safe operating practices.

Events

1. Enroute - Midair collision

Findings - Cause/Factor

Narrative

HISTORY OF FLIGHT

On September 21, 2017, at 1920 eastern daylight time, a Sikorsky UH-60M Black Hawk helicopter, R20087, operated by the U.S. Army as CAVM087 ("Caveman 87"), collided with a privately owned and operated D…-Jiang Innovations (DJI) Phantom 4 small unmanned aircraft system (sUAS). The collision occurred about 300 ft above mean sea level (msl) and 1 mile east of Midland Beach, Staten Island, New York, in the vicinity of Hoffman Island. The helicopter received minor damage, and the sUAS was destroyed. There were no injuries or ground damage.

The incident helicopter was the lead aircraft of a flight of two, and was operating as a local orientation flight for the Hudson Class B Airspace Exclusion and the United Nations General Assembly Temporary Flight Restriction (TFR) operations. The flight had flown south along the Hudson River, then turned east at the Verrazano-Narrows Bridge toward Coney Island, New York. The crew then decided to make a right turn toward the west and return to their base at Linden Airport (LDJ), Linden, New Jersey. Air traffic control (ATC) radar obtained from the Federal Aviation Administration (FAA) showed the flight heading toward LDJ between 200 and 300 ft msl. The crew reported that the flight had just passed Hoffman Island when the lead helicopter made contact with what appeared to be a sUAS. Recorded data from the helicopter indicated that it was flying at an altitude of 274 ft msl at the time of the collision.

The helicopter co-pilot was the pilot flying when the collision occurred. He reported that he immediately and rapidly reduced the collective as the sUAS suddenly came into his view in close proximity to the helicopter. The pilot-in-command took the controls and recommended that they return to LDJ. Radar data indicated that the flight proceeded to LDJ, climbing to about 800 ft as it passed over the shore and overflew more populated areas. The flight landed uneventfully, and the air mission commander subsequently reported the collision to the air traffic control tower at Newark Liberty International Airport.

The sUAS pilot was unaware that a collision had taken place until he was contacted by the NTSB. The pilot reported that he initiated the pleasure flight from the shore adjacent to Dyker Beach Park, southeast of the Verrazano-Narrows Bridge, in the Fort Hamilton neighborhood of Brooklyn, New York, and that he intended to fly "over the ocean." Data logs from the control tablet provided by the pilot indicated that the sUAS took off at 1911:34 and, after takeoff, climbed to a recorded altitude of 89 meters (292 ft). The sUAS altitude is based on height above the takeoff point ("home point"); the elevation of the park is about 7 ft msl.

The sUAS then proceeded on a straight, southwesterly course toward Hoffman Island, about 2.5 miles from the takeoff location. The data log showed the aircraft briefly paused over the ship channel and completed some yawing turn maneuvers, consistent with the pilot looking through the camera view at points of interest, then resumed the straight course toward the island.

At 1914:30, ATC radar indicated the flight of helicopters was travelling south-southeasterly from the Verrazano-Narrows Bridge toward Coney Island at 400 ft (Figure 1). The helicopters passed the sUAS pilot's position from his right to left about 1 mile from his location. The sUAS was about 1 1/2 miles from the sUAS pilot at that time and along a common line of sight. Shortly afterward, at 1915:30, data logs indicated the sUAS paused and hovered northeast of Hoffman Island for about 2 minutes before resuming a southwesterly track toward the island. During this time, the helicopters were flying east along the Coney Island shoreline about 300 ft msl.

Figure 1: Approximate route of flight of the UH-60 and sUAS

At 1919:15, the sUAS pilot pressed the return-to-home (RTH) button on the control tablet, and the aircraft turned around and began tracking northeast toward the home point. The helicopters had completed a turn toward LDJ, and were just west of Coney Island at 300 ft. At 1919:51, the sUAS battery endurance warning activated, indicating that only enough charge remained to return directly to the home point. The pilot did not have visual contact with the sUAS or the helicopters at that time. As the sUAS was tracking northeast, telemetry data dropped out for about 9 seconds but returned just before the collision. The position of the aircraft was near the maximum range of the remote controller. At 1920:17.6, the data logs ended. The last position and altitude logged correlated with the position and altitude of the incident helicopter's recorded data and ATC radar information; about 300 ft west of Hoffman Island. The sUAS pilot reported that he lost signal with the aircraft and assumed it would return home as programmed. After waiting about 30 minutes, he assumed it had experienced a malfunction and crashed in the water.

The airspace in the area of the flight is Class G, underlying a shelf of the New York Class B airspace. A Notice to Airmen (NOTAM 7/4755), issued by the FAA Flight Data Center, was in effect at the time of the incident flight. The NOTAM established a Temporary Flight Restriction (TFR)due to the United Nations General Assembly meeting. The TFR restricted operations within the lateral limits of the New York Class B airspace from the surface up to 17,999 ft msl, and included a prohibition on model aircraft and unmanned aerial systems (UAS).

Additionally, another NOTAM (7/8423) was in effect establishing a VIP Presidential TFR within 30 nautical miles (nm) of Bedminster, New Jersey, from the surface up to 17,999 ft msl, which also included a prohibition on model aircraft and unmanned aerial systems (UAS). The incident sUAS launch point was 30.35 nm from the center of that TFR; Hoffman Island was 29.22 nm from the center point.

DAMAGE TO AIRCRAFT

A 1 1/2-inch dent was found on the leading edge of one of the UH-60's main rotor blades, surrounded by various scratches and material transfer. Some cracks were observed in the composite fairing and window frame material.

The Phantom 4 sUAS was destroyed and several components were lodged in the helicopter.

PERSONNEL INFORMATION

The helicopter flight crew comprised two pilots and two crew chiefs. The pilot-in-command had 1,570 hours of experience in the UH-60, and the co-pilot had 184 hours. The crew reported that they had no previous encounters with sUAS in flight and no outside knowledge or experience with sUAS.

The sUAS pilot stated he was a recreational operator, and that he flew only for enjoyment. He did not hold an FAA Remote Pilot certificate or a manned aircraft pilot certificate. He flew only DJI products, and he did not have experience with conventional radio-control airplanes. He said he had "a lot" of experience with sUAS; the data logs provided by him indicated that he had flown 38 flights in the previous 30 days. He had owned the incident sUAS for about one year and owned a Phantom 3 and another Phantom 4 before purchasing the incident sUAS. Five days after the collision, he purchased a Phantom 4 Pro. He had registered with the FAA as a model aircraft operator during the time period that the registration requirement was in effect. He had taken no specific sUAS training other than the tutorials that are included in the DJI GO4 operating application (app). At the time of the collision, there were no training or certification requirements for hobbyist or modeler pilots.

The pilot said that he was familiar with the area and had flown there many times before. He said that he had flown at night before, and that his sUAS did not have any extra lighting, stating that, "it has four lights."

When asked about specific regulations or guidance for sUAS flights, he stated that he knew to stay away from airports, and was aware there was Class B airspace nearby. He said that he relied on "the app" to tell him if it was OK to fly. He stated he knew that the aircraft should be operated below 400 ft. When asked about TFRs, he said he did not know about them; he would rely on the app, and it did not give any warnings on the evening of the collision. He said he was not familiar with the TFRs for the United Nations meeting and Presidential movement.

When asked, he did not indicate that he was aware of the significance of flying beyond line of sight and again stated that he relied on the app display. He said he did not see or hear the flight of helicopters involved in the collision but said that helicopters fly in the area all the time.

AIRCRAFT INFORMATION

The UH-60M is a four-bladed, twin-engine, medium utility helicopter manufactured by Sikorsky Aircraft. It is widely used by the US military for many missions.

The Phantom 4 is a small unmanned aircraft system of quadcopter configuration, about 13 inches in diameter. It is powered by four electric, brushless motors and a 4-cell, 15.2-volt lithium-polymer battery. The maximum takeoff weight is 3 pounds; maximum altitude is about 19,685 ft msl. Maximum endurance is 28 minutes. Specified maximum range of the remote controller is 3.1 miles. The aircraft is equipped with a GPS/GLONASS navigation system and a flight controller enabling various automated functions. The aircraft is equipped with a 12-megapixel digital camera capable of still or video recording and first-person view display. Aircraft telemetry and video is transmitted to the remote controller in the 2.4 gHz band and displayed on a smartphone or tablet of the pilot's choice using an app supplied by the manufacturer or various third-party app developers. The pilot used a Samsung tablet with wi-fi but no cellular data

capability. He did not use any third-party apps to control the aircraft.

The Phantom 4 includes a feature called Geospatial Environment Online (GEO), which is designed to aid pilots in avoiding certain types of airspace. When available, the pilot receives a message on the control smartphone or tablet advising of the type of airspace and other information. According to DJI:

"GEO provides pilots with up-to-date guidance on areas where flight may be limited by regulation or raise safety concerns. In addition to airport location information, flyers will have real-time access to live information on temporary flight restrictions [and] locations such as prisons, nuclear power plants and other sensitive areas where flying may raise non-aviation security concerns. The GEO system is advisory only. Each user is responsible for checking official sources and determining what laws or regulations might apply to his or her flight."

The GEO system categorizes features into one of four zones: Warning, Enhanced Warning, Authorization, and Restricted zones. Temporary Flight Restrictions are typically coded as Authorization Zones, which appear yellow in the DJI GO4 map. Users will be prompted with a warning and flight is limited by default. A user with appropriate authorization may unlock the Authorization Zone by using a DJI-verified account. This is called "self-unlocking" and can be accomplished before the flight via DJI's website for a period of up to three days, or at the time of flight if the user has an internet connection in the field.

The incident pilot's tablet did not have a cellular data connection, so the GEO system information regarding the TFRs would not download in real time at the takeoff location. In order for the system to have warned the pilot, he would have had to connect to the internet at some point while the TFR was active; however, at the time of the incident, the TFR system within DJI GEO and displayed to customers through DJI GO4 was not active. During August 2017, an issue was identified with the GEO function that inadvertently and intermittently rendered the self-unlock feature for certain TFRs ineffective for some users. After a significant number of complaints about the problem, DJI decided to temporarily disable the TFR functionality in GEO until the feature was investigated and confirmed to be working properly. Therefore, at the time of the incident, no TFR information was available in GEO. Since GEO is meant to be an advisory system to pilots, DJI decided it was better to disable this feature until the problem could be corrected to enable authorized users to support recovery efforts and other authorized missions across the country, including firefighting response and demonstrations at air shows. There was no notice or advisory to users that this advisory function had been disabled. The TFR functionality in GEO was restored in October 2017.

METEOROLOGICAL INFORMATION

The LDJ surface observation at 1915 reported clear skies, 10 miles visibility and light northeasterly winds. Sunset was at 1855 and the end of civil twilight occurred at 1922.

FLIGHT DATA

Flight data was extracted from the incident helicopter's Health and Usage Management System (HUMS) by the Army Combat Readiness Center and provided to the investigation. Altitude and other flight data is cited in the History of Flight section of this report.

The Phantom 4 records full flight parameters on non-volatile memory on board the aircraft. This data was not available to the investigation, as the aircraft flight controller circuit boards were not located, presumably destroyed and in the water. The DJI GO4 app records select telemetry parameters to the pilot's display tablet. The sUAS pilot provided his data logs to the investigation for analysis. Data from the incident flight is cited in the History of Flight section of this report. The logs also included a flight the sUAS pilot made earlier on the evening of the incident, and indicated that he flew toward the Seagate area of western Coney Island, about 1.8 miles from the takeoff point, up to an altitude of 547 ft above takeoff elevation.

WRECKAGE INFORMATION

One motor and a portion of an arm of the sUAS was recovered from the helicopter. Debris was found in the engine oil cooler fan by Army maintenance personnel. The components were transferred by the US Army to a representative of the FAA Teterboro, New Jersey, Flight Standards District Office, then to the NTSB. Manufacturing serial number information inscribed on the motor enabled sales records provided by the manufacturer to aid in identifying the pilot, as the sUAS was purchased directly from the manufacturer. The remainder of the sUAS was not recovered.

ADDITIONAL INFORMATION

The investigation reviewed pertinent regulations and guidance regarding helicopter and sUAS operation.

Helicopter Operating Altitude

14 Code of Federal Regulations (CFR) Part 91.119 states in part:

Except when necessary for takeoff or landing, no person may operate an aircraft below the following altitudes:

(c) Over other than congested areas.An altitude of 500 feet above the surface, except over open water or sparsely populated areas. In those cases, the aircraft may not be operated closer than 500 feet to any person, vessel, vehicle, or structure..(d) Helicopters,. If the operation is conducted without hazard to persons or property on the surface - (1) A helicopter may be operated at less than the minimums prescribed in paragraph (b) or (c).

Statutes, Regulations, and Guidelines applicable to sUAS

Public Law 112-95 section 336(c) (Feb. 14, 2012) defines "model aircraft" as an unmanned aircraft that is:

(1) Capable of sustained flight in the atmosphere;

(2) Flown within visual line of sight of the person operating the aircraft; and

(3) Flown for hobby or recreational purposes.

14 CFR 1.1 (and 101.1) state in part:

Model aircraft means an unmanned aircraft that is:

(2) Flown within visual line of sight of the person operating the aircraft; and

(3) Flown for hobby or recreational purposes.

14 CFR 101.41 states in part:

Applicability.

This subpart prescribes rules governing the operation of a model aircraft that meets all of the following conditions .

(a) The aircraft is flown strictly for hobby or recreational use;

(b) The aircraft is operated in accordance with a community-based set of safety guidelines;.

(d) The aircraft is operated in a manner that does not interfere with and gives way to any manned aircraft.

The Academy of Model Aeronautics (AMA) publishes such safety guidelines. The AMA Safety Code states in part:

9. The pilot of an RC model aircraft shall:

(a) Maintain control during the entire flight, maintaining visual contact without enhancement other than by corrective lenses prescribed for the pilot.

Temporary Flight Restrictions

According to the FAA, TFRs are tools used by the FAA to restrict aircraft operations within designated areas. [In recent] years, TFRs, along with Air Defense Identification Zones and Flight Restriction Zones, have been widely used to restrict overflights through certain airspace for reasons of national security. Two TFRs were in effect in the area and time of the incident, as noted in the History of Flight section above.