Aviation Investigation Final Report

Location:	Big Grand Cay,	**Accident Number:**	ERA19FA210
Date & Time:	July 4, 2019, 01:53 Local	**Registration:**	N32CC
Aircraft:	Agusta AW139	**Aircraft Damage:**	Substantial
Defining Event:	Loss of control in flight	**Injuries:**	7 Fatal
Flight Conducted Under:	Part 91: General aviation - Personal		

Analysis

The pilot-in-command (PIC) and second-in-command (SIC) were conducting a personal flight from the Bahamas to Fort Lauderdale, Florida, with five passengers onboard. The night flight was conducted under visual flight rules. About 2324 the day before the accident, the helicopter and company owner contacted the PIC, who was his friend and confidante, and told him that he needed him to conduct the flight to transport his daughter and her friend from Big Grand Cay, Abaco, Bahamas, to the United States for medical treatment. About 20 minutes later, the PIC contacted the SIC telling him he needed him to conduct the flight with him.

The flight from Florida landed in Big Grand Cay at 0142. At 0145, the PIC filed an instrument flight rules flight plan, but it was not activated. While the flight crew was on the ground, the cockpit voice recorder (CVR) did not record them conducting a formal preflight instrument flight briefing. The flight crew's pretakeoff conversation was limited to discussing flight plan information, including altitude, heading, and navigation; programming the flight computer; and the number of passengers expected on board. They did not discuss how to take off in night, visual meteorological conditions over water or their roles and responsibilities. The flight crew had a short discussion about the use of the flight controls and their automated functions during takeoff. Thus, their limited planning and communication for the takeoff from Big Grand Cay was indicative of inadequate crew resource management (CRM).

According to flight data recorder data, the helicopter departed about 0152. The helipad from which they departed was brightly lit with floodlights, but then the helicopter proceeded over water in dark night conditions with no visible moon, likely zero ambient illumination, and no visible horizon, which would necessitate the pilots' reliance on the instruments in order to fly because of the very limited outside cues. After takeoff, the PIC, who was the pilot flying, manipulated the cyclic and antitorque control pedals, engaged the collective pitch trim, and began the helicopter's first climb to about 190 ft. The cyclic force trim release (FTR) switch was engaged and remained engaged for the entire flight, indicating that the pilot was controlling the cyclic motion. Subsequently, the helicopter began to descend and the airspeed increased, all while the cyclic's position continued to move forward to a more nose-down attitude. The

first of numerous enhanced ground proximity warning system (EGPWS) warnings began and continued during the descent. About 0152:50, while at an altitude of about 110 ft descending about 1,380 ft per minute (fpm), one of the pilots engaged the autopilot in the altitude acquire (ALTA) mode with indicated airspeed hold, which set a vertical speed reference target of +1,000 fpm and an airspeed reference target of about 110 knots. Nearly simultaneous to the ALTA mode activation, the collective FTR switch was momentarily activated. Because the helicopter was descending at that time and the target altitude for ALTA was above the helicopter's current altitude, the ALTA rate of climb was reset to +100 fpm (per system design), where it remained for the rest of the flight. Despite the repeated EGPWS warnings, the PIC continued commanding forward cyclic and the helicopter continued to descend.

About 0152:51, with the helicopter about 52 ft above the water, the PIC pulled the cyclic back and initiated a second climb. He then asked the SIC for the altitude, and, not receiving a response, stated that the helicopter was at 300 ft, and the SIC advised him that the helicopter was not at 300 ft and that it was "diving." It is likely that the PIC confused the vertical speed indication with the altitude indication, as the helicopter was at 116 ft radio altitude but was climbing about 300 fpm at the time. Subsequently, multiple EGPWS warnings annunciated until the helicopter climbed above 150 ft and the warnings stopped. Although the PIC and SIC each made comments during the remainder of the flight, there did was no apparent coordination or troubleshooting between them, further indicative of a lack of CRM.

When near the top of the climb, the collective pitch trim increased about 5% per second, with a corresponding increase in engine torque and power index (PI) values. After activation of ALTA mode, the PI levels began to increase to a point where the PI limiting function, as part of the flight director, began restricting collective movement, which prevented the ALTA mode from maintaining a positive vertical speed and climb to the set altitude. Because the PIC was manually controlling the cyclic, the flight director was unable to compensate for the high PI levels, such as reducing airspeed; thus, the flight director had to reduce collective to prevent a PI level exceedance. Given the lack of discussion about the negative vertical speed or any attempts by the PIC to manually manipulate the collective, it is likely neither pilot was adequately monitoring the vertical speed and altitude trends, which led to a loss of altitude.

About 0153:13, as the helicopter began to descend from 212 ft because the cyclic was moved forward again to command a nose-down attitude and the EGPWS warnings began to annunciate again, the SIC stated that "this is exactly what happened" in a fatal accident in the United Kingdom in which the accident was caused by somatogravic illusion and subsequent spatial disorientation. The PIC did not respond to the SIC, likely due to his continued confusion about the helicopter's position in space and his misunderstanding of the information on the helicopter's flight instruments. The helicopter then entered a left descending turn in a nose-down attitude with airspeed and engine torque increasing, significant forward cyclic being applied, the descent rate increasing, and EGPWS warnings continuing. The PIC repeatedly asked for a heading and once for altitude, but the SIC did not respond. As the helicopter continued descending toward the water, the flight crew did not communicate the helicopter's attitude, energy state, and steps needed to recover from the descent. Given that postaccident examination indicated the helicopter's flight instruments were operational (and they were operational for the flight to the Bahamas), they had information available to them to understand the helicopter's flightpath. However, about 0153:22, the helicopter impacted water at high speed while in a nose-down, left-bank attitude.

As the pilot transitioned the helicopter to forward flight by commanding forward cyclic, the flight crew appeared initially unaware of the helicopter's first descent until multiple EGPWS warnings annunciated. The PIC likely perceived that the accelerations associated with the helicopter's increasing forward airspeed was the helicopter pitching up and he provided control inputs that caused the helicopter to descend. These improper control inputs during the second descent were consistent with the onset of a type of spatial disorientation known as somatogravic illusion, and the PIC likely did not effectively use his instrumentation during the departure to recognize the helicopter's flightpath and orientation. The CVR indicated that the SIC recognized and announced the helicopter's first descent to the PIC. In response, the PIC likely selected ALTA, which contributed to the recovery of the altitude lost from the first descent. However, the PIC continued to command forward cyclic (using the FTR switch), leading to the helicopter's second descent. Again, numerous EGPWS warnings annunciated, but the PIC continued decreasing the helicopter's pitch attitude while the airspeed and descent rate increased; these inputs were also consistent with spatial disorientation and a failure to rely on the helicopter's instruments.

Based on the sequence of events and the flight crew's actions and comments, they lost awareness of the helicopter's flightpath after takeoff over water during dark night conditions, which likely led to spatial disorientation and the subsequent collision with water.

The PIC's night flight experience and instrument currency could not be determined. The SIC was reportedly night current but it could not be determined if he was night current in the helicopter make and model. Further, the PIC and the SIC had never flown to Big Grand Cay at night. Given both pilots' many hours of flight experience, it is likely the PIC recognized the risk associated with the intended flight and contacted the SIC to make the flight with him. The PIC's comfort flying with the SIC likely contributed to his decision to take the flight. Further, the urgency of the mission and the direct communication from the helicopter owner likely created external pressure on the flight crew, which can affect decision-making and create a sense of pressure to complete a flight. However, no records were found that the flight crew evaluated or planned for the impact of external pressure on their flights to and from Big Grand Cay in dark night conditions to transport ill passengers to a hospital. It is likely that they allowed the external pressure to affect their decision to conduct the flight even though neither of them had ever flown to Big Grand Cay at night.

Examination of the helicopter's flight control system including autopilot system, structures, main and tail rotor system, and engines revealed no evidence of any preimpact mechanical failures or malfunctions that precluded normal operation. Although one of the four separated sections of tail rotor blades was not recovered, analysis of the recorded flight data as well as the CVR showed no evidence of anomalous operation of the tail rotor prior to impact. All observed damage was consistent with the helicopter's impact with the water.

Probable Cause and Findings

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

The pilots' decision to takeoff over water in dark night conditions with no external visual reference, which resulted in spatial disorientation and subsequent collision with the water. Also causal was the pilots' failure to adequately monitor their instruments and respond to multiple EGPWS warnings to arrest the helicopter's descent. Contributing to the pilots' decision was external pressure to complete the flight. Contributing to the accident was the pilots' lack of night flying experience from the island and their inadequate crew resource management.

Findings

Personnel issues	Decision making/judgment - Flight crew
Personnel issues	Spatial disorientation - Flight crew
Personnel issues	Monitoring equip/instruments - Flight crew
Aircraft	(general) - Incorrect use/operation
Environmental issues	(general) - Contributed to outcome
Personnel issues	CRM/MRM techniques - Flight crew
Personnel issues	(general) - Flight crew
Environmental issues	Dark - Effect on operation

Factual Information

History of Flight

Initial climb	Loss of control in flight (Defining event)
Other	Miscellaneous/other
Uncontrolled descent	Collision with terr/obj (non-CFIT)

On July 4, 2019, about 0153 eastern daylight time, an Agusta S.p.A. AW139 helicopter, N32CC, was substantially damaged when it was involved in an accident near Big Grand Cay, Abaco, Bahamas. The two pilots and five passengers were fatally injured. The helicopter was operated as a Title 14 *Code of Federal Regulations* Part 91 personal flight.

According to pilot-in-command's (PIC) cellphone records, the owner of helicopter (who also owned the company the PIC flew for) called him about 2324 on July 3. The owner reportedly called the PIC to inform him that he needed the PIC to fly his daughter and her friend from the Bahamas to the United States for medical treatment. About 8 minutes later, the PIC contacted a friend of the owner who was also on the Island. The friend reported that the PIC told him that he would be flying from Florida to Big Grand Cay and that he would need lights to illuminate the private helipad at Big Grand Cay. About 2338, the PIC called back the friend and reported that he had "to get someone to come with him" for the flight. The PIC called the second-in-command (SIC) about 2343 to notify him that he was needed for the flight. The SIC's wife reported that, after being notified about the flight, the SIC began to check the weather and looked at landing sites.

According to data from the combination cockpit voice recorder (CVR) and flight data recorder (FDR), the flight departed Palm Beach International Airport (PBI), West Palm Beach, Florida, about 0055 on July 4, destined for Big Grand Cay. During the flight, the PIC was the pilot flying (PF) from the right seat, and the SIC was the pilot monitoring (PM) from the left seat. At 0059:09, the PIC stated, "ah, it's gonna be darker than # out here," and the SIC responded that he was trying to dim some of the cockpit lights. (The symbol # in quotes from the CVR indicate an expletive.) At 0101:52, the SIC asked the PIC if he had ever flown to the island at night, and the PIC replied, "no." At 0103:02, the PIC again asked the SIC to dim the lights. While en route to Big Grand Cay, the SIC stated that he "was night current" and had "done a lot of night flying" and that he had landed "off airport" at night and was used to doing it. About 0124:13 the SIC mentioned not to "fixate on one light and start to go spa…" but the word was not completed; about 5 seconds later he stated "you won't get spatially disoriented with two of us on board." He then added that a night landing in a black hole "can be tricky."

The friend of the owner who had spoken to the PIC before the flight reported that he arranged two golf carts with flood lights to light the helipad but had them pointed so they would not distract the pilots. According to the FDR data, the helicopter landed at the private helipad at Big Grand Cay about 0142. While the helicopter was on the ground with the engines running, the CVR recorded the PIC discussing flying into Fort Lauderdale/Hollywood International Airport (FLL), Fort Lauderdale, Florida; flight plan

information; and the need for an ambulance to meet the flight. The individual who arranged to light the helipad reported that three of the five passengers self-boarded the helicopter while the remaining two passengers were carried and loaded into the helicopter and strapped into their seats. He told the owner that medical help would be waiting at FLL when they landed.

At 0145, the PIC filed an instrument flight rules (IFR) flight plan with ForeFlight for a flight from Walker's Cay Airport (MYAW), Walker's Cay, Abaco, Bahamas, about 5 nautical miles (nm) west-northwest of the departure helipad, to FLL. The flight plan noted that the flight would depart at 0200, that five people were onboard (although there were actually seven people on board), and that sufficient fuel was onboard for 2 hours 16 minutes of flight. The flight plan was not activated.

About 0150, the CVR recorded the SIC talking about initial altitude and heading information, and the PIC responding that he would enter the flight plan information into the flight management system (FMS). At 0152:13, the SIC stated, "our initial heading is going to be one eight zero…." According to FDR data, at 0152:17, the helicopter lifted off; the cyclic force trim release (FTR) switch was engaged and remained engaged for the entire flight and the collective FTR switch was engaged until 0152:28 when the collective stabilized about 70%.

At 0152:31, while the helicopter was about 62 ft above the ground, with no forward airspeed and in a slight nose-up pitch attitude, the SIC stated, "alright airspeed coming up no it's not coming up so push that nose forward get some airspeed." Shortly thereafter, while the helicopter was climbing, the FDR recorded nose-down cyclic control input and changes in pitch attitude that became negative about 0152:36; the helicopter continued to climb and began to gain forward airspeed.

At 0152:42, while at 184 ft, 53 knots forward airspeed, and a pitch attitude about 12° nose down, the SIC stated, "watch your altitude." The helicopter climbed to 190 ft at an indicated airspeed of 68 knots; the collective position was 72%. At 0152:44, the helicopter began to descend with a nose-down pitch attitude, the airspeed increasing, and the collective relatively constant near 72%. It also began a left turn and twice momentarily returned to a no bank condition before continuing until water impact. At 0152:48, while in a descent with the cyclic positioned about 69% forward, the CVR recorded a "sink," "warning terrain," and "one fifty feet" from the enhanced ground proximity warning system (EGPWS). About 0152:50, at an altitude of about 110 ft while descending about 1,380 ft per minute (fpm) with the collective pitch at 75%, the autopilot flight director was engaged in altitude acquire (ALTA) and indicated airspeed (IAS) modes while the FTR switch on the cyclic was active; this indicated the PIC was manually commanding cyclic movement throughout the flight. The selected altitude for ALTA to capture was 1,000 ft and the default rate of climb was 1,000 fpm. IAS mode automatically engages with ALTA and is meant to generate pitch commands to maintain airspeed. (See the "Helicopter Information" section of this report for more information about ALTA mode.) Nearly simultaneous to the ALTA mode activation, the collective FTR switch was momentarily activated. Because the helicopter was descending when the collective FTR switch was activated, and the target altitude for ALTA was above the current altitude, the ALTA rate of climb was reset to +100 fpm (per system design) and remained at that value for the remainder of the flight. The cyclic was pulled back to 52% at 0152:51 and the helicopter pitched up, reaching a minimum altitude of 52 ft before beginning to climb. From 0152:51 to 0153:05, the EGPWS issued nine "warning terrain" warnings.

At 0152:56 while climbing through 78 ft, the PIC asked, "how high are you," but the SIC did not reply

(At 0152:58 the helicopter's vertical speed was +300 fpm). About three seconds later while at 116 ft, the PIC stated, "three hundred feet." Subsequently, the SIC stated, "we're not," to which the PIC replied, "that's what it says over here." At 0153:05, the SIC stated that the helicopter had been "diving," followed by an expletive from the PIC and the continuation of multiple EGPWS warnings until the helicopter climbed above 150 ft. As the helicopter climbed, the collective input lowered from 75% at 0152:53 to a minimum value of 46% at 0153:09 as the autopilot attempted to limit the vertical speed to ALTA reference target.

During the second climb, the longitudinal cyclic had been moving forward to near 68%, and at 0153:11, the helicopter, which had been nose up or level since 0152:51, again pitched nose down. The helicopter's rate of climb dropped below 100 fpm and collective began to increase at a rate of about 5% per second. The helicopter reached a maximum altitude of 212 ft while banking left 30° then began descending with EGPWS warnings occurring.

At 0153:13, the helicopter again began to descend, and the SIC stated, "there was a fatal accident in the United Kingdom and this is exactly what happened there." (EGPWS warnings continued through this time.) Two seconds later, with the collective control about 70%, the rate of collective increase slowed as power index (PI) values increased to about 80%. Over the next 8 seconds, the collective position gradually increased to about 75% and PI values increased to about 86%. While descending in a nose-down attitude with the airspeed increasing, the PIC asked the SIC multiple times for headings and once for altitude, but the SIC did not respond. According to an NTSB performance study, the helicopter impacted the water about 0153:22 while in a 7°-nose-down and 12°-left-bank attitude. The CVR recorded no aural master cautions or warning annunciations during the flight. Figure 1 shows the cockpit annunciations recorded on the CVR and select times and altitudes.

Figure 1. Cockpit annunciations recorded on CVR with select times and altitudes (Figure contained in the NTSB Performance Study)

A witness located about 1.6 nm southwest of the wreckage location reported that there was no moon visible when the helicopter departed. He also reported that, as the helicopter began descending, he heard a "whoosh whoosh whoosh" sound and then lost sight of the helicopter. He heard the helicopter impact the water and said that the engines sounded good. He immediately called the "caregiver" at Big Grand Cay and described what he had seen and heard then he and another individual departed in his spotlight-equipped boat between 0205 and 0207 to where he had thought the helicopter had crashed. They searched for the wreckage but did not locate it. He called the caregiver about 0400 and was told the helicopter would have made it to the United States safely.

At 1415, a company pilot was notified that the helicopter had not arrived at FLL. About 1 minute later,

he called U.S. Customs and Border Protection at FLL and was advised that the helicopter had not cleared customs. At 1429, he called Leidos Flight Service and informed them that the flight was overdue, and the Federal Aviation Administration (FAA) issued an alert notice. The company pilot reported that he departed PBI in a company float-equipped airplane between 1600 and 1615 and searched a direct line from FLL to Big Grand Cay; however, he did not locate the wreckage. The witness who went out immediately after the accident again searched the area and found the wreckage between 1600 and 1700.

According to Bahamas Air Navigation Services Division, the PIC requested no air traffic services nor did they provide any services between 2200 on July 3 and 0200 on July 4.

The investigation was originally under the jurisdiction of the Air Accident Investigation Department (AAID) of the Bahamas. On July 6, 2019, the AAID requested delegation of the investigation to the NTSB, which the NTSB accepted on July 8, 2019.

Pilot Information

Certificate:	Commercial	**Age:**	56,Male
Airplane Rating(s):	Single-engine land; Single-engine sea; Multi-engine land	**Seat Occupied:**	Right
Other Aircraft Rating(s):	Helicopter	**Restraint Used:**	Lap only
Instrument Rating(s):	Helicopter	**Second Pilot Present:**	Yes
Instructor Rating(s):	None	**Toxicology Performed:**	Yes
Medical Certification:	Class 2 With waivers/limitations	**Last FAA Medical Exam:**	December 4, 2018
Occupational Pilot:	Yes	**Last Flight Review or Equivalent:**	November 16, 2018
Flight Time:	2241.3 hours (Total, all aircraft)		

Co-pilot Information

Certificate:	Airline transport; Commercial	**Age:**	52,Male
Airplane Rating(s):	None	**Seat Occupied:**	Left
Other Aircraft Rating(s):	Gyroplane; Helicopter	**Restraint Used:**	Lap only
Instrument Rating(s):	Helicopter	**Second Pilot Present:**	Yes
Instructor Rating(s):	None	**Toxicology Performed:**	Yes
Medical Certification:	Class 2 Without waivers/limitations	**Last FAA Medical Exam:**	April 25, 2019
Occupational Pilot:	Yes	**Last Flight Review or Equivalent:**	November 16, 2018
Flight Time:	12200 hours (Total, all aircraft), 3.4 hours (Last 24 hours, all aircraft)		

PIC Flight Experience

According to the chief pilot of Challenger Management LLC, the company that operated the accident flight, the PIC was a friend and confidante of the helicopter owner. The PIC had operational control of the accident flight. According to the chief pilot, the PIC logged his flight time on an iPad. Two iPads were found in the wreckage; however, damage precluded accessing their data, and the company flight log sheets did not include the time of day for flights or whether they were conducted in instrument conditions; therefore, the PIC's night flight experience and instrument currency could not be determined.

The PIC's girlfriend reported that he did not like to fly at night and that he "rarely did it." To her knowledge, the accident flight was his first night flight to the Bahamas. She said the PIC told her that night flying was "a whole different ballgame." She added that he had informed her that the owner had been texting him all night and that he did not know if he had to fly to Big Grand Cay but that he hoped he did not have to return.

The PIC's airman certificate application, dated October 17, 2017, indicated that he had received night flying experience in both rotorcraft and airplanes. At that time, he had reported that he received about 42 hours of night instruction, of which 3 hours were in rotorcraft; he had conducted 123 night takeoffs and landings, 103 of which were as PIC and 73 were in rotorcraft; and he had flown 157 hours at night as PIC, of which 110 hours were in rotorcraft.

SIC Flight Experience

The SIC's wife reported that he had accumulated more than 1,450 hours of night-flying experience and that, from November 21, 2018, to May 25, 2019 (which was when he conducted his last night flight before the flight to the Bahamas and the accident flight), he had accumulated about 27 hours of night-flying experience. It could not be determined how many of those hours were flown in the accident helicopter type.

From November 29, 2017, to July 3, 2019, the PIC and SIC conducted 14 flights together in the accident helicopter; the last flight before the flight to Big Grand Cay occurred on February 22, 2019. Ten of the flights were flown to Big Grand Cay island during the day. During the 14 flights, the PIC was the PF, and the SIC was the PM.

Flight Crew Training

From August 28 to October 11, 2017, the PIC and SIC were paired together while receiving their initial type rating training in the AW139 helicopter, which included 60 hours of ground and flight training in the accident helicopter, which addressed basic flight maneuvers and various types of instrument procedures. The flight training consisted of 8 hours of visual flight rules (VFR) flight and 6 hours of simulated IFR flight. Both pilots received their type rating in the AW139 at the end of the training. During both their initial and recurrent flight training, the PIC and SIC conducted instrument takeoffs and unusual attitude recovery. The unusual attitude recovery exercises included training to recognize spatial disorientation. One instructor reported that he would give trainees "a lot of vectors" as a way to simulate the onset of spatial disorientation.

The PIC and SIC were taught to complete the manufacturer recommended departure briefing (VFR/IFR), which included the departure profile to be flown; the actions required by each pilot, including appropriate callouts; the use of automation by whom and when; and the actions to be taken in the event of an emergency during the departure. In addition, they received training on the type of information to be briefed for an IFR departure, which included, in part, the profile to be followed, the automatic flight control system (AFCS)/flight director (FD) modes and IAS to be used during the departure, and a detailed description of the departure profile, including altitudes.

PIC Training

During the initial type rating training, the PIC was trained in the PF and PM roles. Regarding his first flight, the flight instructor commented, “steep turns were off on entry with nose up pitch causing airspeed and altitude to deviate.” Regarding his third flight, the instructor commented “flying and FMS is improving. Still slow with the FMS but gets there.” Regarding his fourth flight, the instructor commented, "needs to continue to fly dual pilot to get more comfortable with using copilot to supplement pilot duties." The PIC received a satisfactory rating for flight and instrument maneuvers.

Between November 12 and 16, 2018, the PIC received recurrent training. The PIC’s training consisted of 12 hours of ground training and 8 hours of flight training in a level-D, full-flight simulator. The simulator training included 4.5 hours of flight time conducted under IFR and included night flying, and 3.5 hours of flight time conducted under VFR. He received a below average rating on Airman's Skill-Decisiveness. His overall evaluation was below average. During this time, he also received a Part 61 checkride and proficiency check, which included 3 hours of flight time in the AW139 simulator; he passed both on November 16. The instructor commented that the “progressive training/checking was halted and changed to traditional 61.58 training due to the applicant not reaching the required proficiency and failed more items than required.”

SIC Training

The SIC received the same initial flight training as the PIC. Regarding his second flight, which was conducted under VFR, the instructor commented that the SIC "struggled some with FMS entries, some [crew resource management (CRM)] issues as well, and wanting to fly single pilot, especially during emergency training." He received a below average rating on resource management. The instructor also commented that "too much single pilot mentality caused him to get overwhelmed with weather, air traffic control, and flying." Regarding the SIC’s performance during the flights conducted under IFR, the instructor commented, "great understanding of instrument procedures and FMS, but not always using checklist led to momentary loss of situation awareness during the flight." The SIC was evaluated as average for flight and instrument maneuvers.

The SIC also received recurrent training between November 12 and 16, 2018. The SIC’s recurrent training included 12 hours of ground training and 8 hours in the simulator. The simulator training included 2.5 hours of flight time conducted under VFR, 4.5 hours of flight time conducted under IFR and included night flying, and 1 hour of VFR/IFR flying. The SIC received 1 hour of additional training conducted under VFR, and his overall evaluation was average. The SIC also received a Part 61 checkride and proficiency check, which included 3 hours of flight time in the AW139 simulator; he

passed both on November 16.

Flight Crew 72-hour History

A review of the flight crew's preaccident activities, excluding the flight from the United States to the Bahamas and the accident flight, revealed that, during the 72 hours before the accident, they had regular routines and were well rested. The PIC's girlfriend reported that he took a nap on July 3. The SIC's wife reported that he took 2- to 3-hour-long naps each day in the 3 days before the accident.

On July 3, the PIC's cell phone activity began at 0721 and ended at 2359, with extended breaks between 1427 and 1612 and 1959 and 2324. On the same day, the SIC's text messaging began at 0903 and ended at 1526, his cell phone activity began at 2347 and ended at 2358, and he had extended breaks between 0913 and 1322 and 1323 and 1435.

Aircraft and Owner/Operator Information

Aircraft Make:	Agusta	**Registration:**	N32CC
Model/Series:	AW139 No Series	**Aircraft Category:**	Helicopter
Year of Manufacture:	2007	**Amateur Built:**	
Airworthiness Certificate:	Transport	**Serial Number:**	31112
Landing Gear Type:	Retractable - Tricycle	**Seats:**	10
Date/Type of Last Inspection:	June 28, 2019 Continuous airworthiness	**Certified Max Gross Wt.:**	14110 lbs
Time Since Last Inspection:	4 Hrs	**Engines:**	2 Turbo shaft
Airframe Total Time:	2158 Hrs at time of accident	**Engine Manufacturer:**	Pratt & Whitney Canada
ELT:	C126 installed	**Engine Model/Series:**	PT6C-67C
Registered Owner:	Challenger Management LLC	**Rated Power:**	1531
Operator:	Challenger Management LLC	**Operating Certificate(s) Held:**	None

The helicopter's last flight log sheet was recovered from the wreckage, and it documented two flights of 1.5 hours total flight time on July 3. The PIC of the accident flight flew solo both flights.

The helicopter was equipped with an integrated avionics system, which included an AFCS that controlled the FD and the four-axis autopilot.

FTR switches were present on both the pilot and copilot cyclic controls, collective controls, and pedals. When the autopilot's attitude-hold mode or an FD mode was active, a pilot could press a flight control's FTR switch to override the autopilot and hand-fly that control axis while the FTR switch remained depressed. Pressing the cyclic FTR switch allowed a pilot to hand-fly both the longitudinal (pitch) and

lateral (roll) cyclic control axes at the same time. Once the FTR was released, the autopilot would re-engage the previously active attitude-hold or FD mode, but would reset its reference attitude (for attitude-hold mode) or desired target values (such as speed and altitude) based on when the FTR switch was released. For example, while in flight, the pilot could set the FD to acquire a desired altitude using the ALTA mode. Once the desired (target) altitude was set, if the altitude was greater than the helicopter's current altitude, the ALTA mode would command the helicopter to initiate a climb at a default vertical speed (VS) of 1,000 fpm. The pilot could change the VS by using the collective FTR switch to manually manipulate the collective control to increase or decrease the rate of climb. Upon releasing the collective FTR switch, the ALTA mode would continue commanding a climb to the desired altitude, but at the VS at the time the collective FTR switch was released. Alternatively, the pilot could use the collective trim beep switch to gradually increase or decrease the VS used by the ALTA mode to achieve the desired altitude. In a situation when the ALTA mode was engaged and the target altitude was above the helicopter's altitude, if the pilot used the collective FTR switch to manually change VS to descend the helicopter, upon release of the collective FTR switch, the ALTA mode would set a minimum climbing VS of 100 fpm in order to reach the target altitude.

When a flight director mode of the autopilot is controlling the collective axis, collective movement by the AFCS is limited, based on power index (PI) values, by a PI limiting function, also known as a PI limiter, which is designed to avoid engine exceedances. According to the AW139 Rotor Flight Manual (RFM), supplement 34, when all engines were operating, the maximum PI value was 97% when the helicopter was above 60 knots indicated airspeed (KIAS). Further, the RFM stated that, if the PI limiting was active and the IAS was engaged and the reference for the enabled collective mode (for example, ALTA or VS) cannot be achieved, the FD would reduce the airspeed automatically while the autopilot was controlling the cyclic axes to achieve the collective mode reference. If the collective mode reference could not be maintained and the airspeed reached a minimum of 80 KIAS, the FD would maintain that airspeed and reduce the collective mode reference.

After the accident, data from the No. 1 engine data collection unit (DCU) could not be downloaded, but data from the No. 2 engine DCU, which also recorded remote parameters of the No. 1 engine, were successfully downloaded. The data indicated that the DCU recorded no events or faults during the 3.4 hours before the accident.

The helicopter was equipped with four actuator input/output with processor (AIOP) modules that continuously monitored performance to positively identify any internal failure. The fault data downloaded from the four AIOP modules revealed that none of them recorded any faults between takeoff and water impact.

Meteorological Information and Flight Plan

Conditions at Accident Site:	Visual (VMC)	**Condition of Light:**	Night/dark
Observation Facility, Elevation:	MYGF,8 ft msl	**Distance from Accident Site:**	46 Nautical Miles
Observation Time:	20:00 Local	**Direction from Accident Site:**	207°
Lowest Cloud Condition:	Few / 2500 ft AGL	**Visibility**	10 miles
Lowest Ceiling:	Broken / 25000 ft AGL	**Visibility (RVR):**	
Wind Speed/Gusts:	4 knots /	**Turbulence Type Forecast/Actual:**	/
Wind Direction:	160°	**Turbulence Severity Forecast/Actual:**	/
Altimeter Setting:	29.95 inches Hg	**Temperature/Dew Point:**	29°C / 25°C
Precipitation and Obscuration:	No Obscuration; No Precipitation		
Departure Point:	Big Grand Cay, OF	**Type of Flight Plan Filed:**	IFR
Destination:	Fort Lauderdale, FL (FLL)	**Type of Clearance:**	None
Departure Time:	01:52 Local	**Type of Airspace:**	

According to records from ForeFlight, the pilots obtained standard route briefings, which included weather conditions at 0145 for a flight from MYAW to FLL.

The southeast section of the National Composite Radar Mosaic for 0155, which included Big Grand Cay, depicted an isolated echo south of the accident site; no other echoes were detected along the route.

From 2200 to 0200, the National Weather Service had no SIGMET, Convective SIGMET, Center Weather Advisory, or Airmen's Meteorological Information current for the area between Florida and the Bahamas. At the time of the accident over the accident site, the sun and the moon were more than 15° below the horizon and provided no illumination.

Wreckage and Impact Information

Crew Injuries:	2 Fatal	**Aircraft Damage:**	Substantial
Passenger Injuries:	5 Fatal	**Aircraft Fire:**	None
Ground Injuries:	N/A	**Aircraft Explosion:**	None
Total Injuries:	7 Fatal	**Latitude, Longitude:**	27.238056,-78.304443

The helicopter came to rest inverted in about 16 ft of water about 1.2 nm north-northeast of the departure helipad. All the helicopter's main components were recovered. The wreckage was transported to Jacksonville, Florida, for examination.

The cockpit area exhibited significant bending, buckling, and crushing throughout, consistent with water impact, and the left and right main landing gear actuators were found extended, consistent with being down and locked.

The aft fuselage remained attached to the main fuselage. The aft fuselage's aft section exhibited some deformation, but the floor structure appeared to be relatively straight. A portion of the roof panel was missing from the aft tailboom fracture. The remaining roof panel was buckled. The upper left and lower right tailboom attachment points were present and contained remnants of the attachment bolt.

The tailboom was separated from the aft fuselage and was recovered in multiple pieces. Examination of the tailboom pieces revealed evidence of main rotor blade contact to several components.

Most of the left and right sides of the horizontal stabilizers were recovered, and they were found in multiple pieces. Examination of the main rotor revealed that all the main rotor blades were separated from the main rotor hub and exhibited varying degrees of impact damage. Examination of the tail rotor revealed that all four blades were fractured; three of the four separated sections of blades were found.

Examination of the No. 1 engine revealed that several of the 1st-stage compressor blades exhibited different types of bending in the direction opposite of rotation, and evidence of rubbing was found between the blades and the 1st-stage shroud. The centrifugal impeller exhibited evidence of rubbing at the exducer portion of the blades with corresponding contact marks observed on the impeller shroud. The 1st-stage power turbine blades and disk showed evidence of light rotational scoring on the downstream side, and the blade tips exhibited light rubbing on the upstream side. The 2nd-stage power turbine blade knife edges exhibited evidence of rubbing against the shroud, and the upstream tips of the shrouded blades had rubbed against the backside of the shroud. The downstream side of the 2nd-stage power turbine blades exhibited evidence of rubbing against the No. 3 bearing cover.

Examination of the No. 2 engine revealed that three of the 1st-stage compressor blades were bent in the direction opposite of rotation. The 1st-stage compressor blades exhibited evidence of rubbing against their shroud, and circumferential rub marks were present on the shroud. The exducer portion of the centrifugal impeller blades showed evidence of rubbing against their shroud. All blades from the 1st- and 2nd-stage power turbines were present. The downstream side of the 1st-stage power turbine blade platforms exhibited rubbing against its respective stator inner shroud. The upstream side of the 2nd-stage power turbine blade platforms showed evidence of rubbing against their respective stator. The 2nd-stage power turbine blade tips exhibited evidence of rubbing against their respective shroud.

No evidence of any preimpact mechanical malfunctions or failures were found with the airframe, flight control systems, or engines that would have precluded normal operation.

Five cell phones were found in the wreckage, four of which sustained internal water damage and corrosion, which precluded recovery of data, and the fifth of which powered on normally but did not contain any accident-related data.

Medical and Pathological Information

Forensic toxicology testing on specimens from both the PIC and SIC was performed by the FAA's Bioaeronautical Sciences Research Laboratory. The PIC's toxicology report stated that an unquantified amount of N-propanol was detected in the urine and that 20 mg/dL and 55 mg/dL of ethanol were detected in the urine and cavity blood, respectively. The SIC's toxicology report stated that an unquantified amount of N-butanol was detected in the blood and urine and that 25 mg/dL and 11 mg/dL of ethanol were detected in the urine and cavity blood, respectively. Ethanol is an intoxicant, which, after absorption, is uniformly distributed throughout all tissue and body fluids. It can also be produced in postmortem tissue by microbial action, often in conjunction with other alcohols, including N-propanol and N-butanol. Thus, it is likely that the ethanol was produced postmortem.

Tests and Research

PI Limiter Simulation Study

A simulation study of the collective PI limiter behavior was conducted. The study compared the behavior of the PI limiter outputs (that is, their effects on the collective servo commands) using the accident flight parameters. The study showed a strong correlation between the accident flight collective servo position and the simulation collective servo commands. During the final 8 seconds of the simulation flight, the PI limiter decreased the rate of increasing collective servo commands to prevent the PI from reaching and exceeding the upper limit, which functioned as designed.

Full-motion Flight Simulator Testing

Simulator testing using a full-motion flight simulator was conducted to demonstrate the functionality and pilot use of the relevant features of the AFCS. The testing included 10 pilot-in-the loop scenarios that focused on the pilot's ability to use various flight modes while manipulating cyclic, collective, and antitorque pedal flight controls. The scenarios also included observing visual and aural crew alerts related to flightpath management during takeoff, night environment flight, and flight over water after takeoff. The simulator was configured like the accident helicopter before simulator sessions, but the lighting was subsequently adjusted by the test pilots for their preference. The testing for all scenarios revealed that the aural and visual annunciations functioned as designed.

Helicopter Performance Study

A helicopter performance study was conducted, and it indicated that the helicopter began the initial climb nose up, but as the longitudinal cyclic was pushed forward, the nose lowered, and the cyclic was commanding nose down. Despite the descents and nose-down attitudes greater than 10° while approaching terrain, the longitudinal cyclic stayed forward throughout the flight and was only briefly less than 60% throughout the EGPWS warnings and the two descents.

Review of Prior Flight Collective And Cyclic Input, PI values, and Attitude

A review of the first minute of flight for the 10 flights before the accident indicated that, during the accident flight, the initial altitude and speed increases were not unusual but that the collective input and PI were higher during most of the first 30 seconds of the flight. The accident flight's pitch attitude was about 10° more nose down during the two descents, but the cyclic input for the accident flight was comparable to the 10 prior flights.

Organizational and Management Information

The PIC and the owner of Challenger Management LLC managed the helicopter flight operations, and the chief pilot managed the fixed-wing flight operations. The chief pilot reported that the PIC was responsible for determining flight, duty, and rest times for the helicopter operations. At the time of the accident, the owner would call either the company scheduler or directly contact the PIC to schedule a flight in the helicopter; however, the scheduler reported that the owner directly contacted the PIC about 95% of the time to arrange a helicopter flight. Although the PIC had operational control of the helicopter during flights that he conducted, the chief pilot reported that he did want to know the whereabouts of aircraft and personnel.

The chief pilot reported that flight crew schedules usually included 8 to 10 hours of flying time during a 12-hour day, but this varied based on the needs of the owner. He added that the company did not have an established protocol for crew scheduling and that it was not uncommon to be contacted by the owner at different times of the day and night, because pilots were on-call to receive phone calls or texts from him. That practice was subsequently changed and the owner was directed to contact another company employee for scheduling, although as previously reported the owner contacted the PIC directly about 95% of the time.

The company did not have a safety management system, nor were they required to have one. The chief pilot handled communication about risks at the company concerning the fixed-wing aircraft. He required pilots to discuss with him any fatigue or safety concerns and any operational issues with the aircraft. However, the chief pilot could not recall any specific situations when pilots discussed with him any safety, fatigue, or operational issues, and neither the PIC nor the SIC did so on the day of the accident, although that would not have been expected because he did not have any control over the helicopter

operation. He added that no separate system existed for pilots to report fatigue other than using "common sense." If a pilot was fatigued, the chief pilot would have told them not to fly. He added that, at the time of the accident, the company did have a verbal general operating manual but that he also had a paper copy from a different company. The chief pilot reported that the company did not provide its pilots training on spatial disorientation, CRM, distractions, or workload management.

Additional Information

Spatial Disorientation

The FAA Civil Aeromedical Institute's publication, "Introduction to Aviation Physiology," defined spatial disorientation as a "loss of proper bearings; 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 IFR conditions, frequent transfer between VFR and IFR conditions, and unperceived changes in aircraft attitude.

The FAA's *Airplane Flying Handbook* (FAA-H-8083-3B) described some hazards associated with flying when the ground or horizon are obscured. The handbook stated, in part, the following:

The vestibular sense (motion sensing by the inner ear) in particular can and will confuse the pilot. Because of inertia, the sensory areas of the inner ear cannot detect slight changes in airplane attitude, nor can they accurately sense attitude changes that occur at a uniform rate over a period of time. On the other hand, false sensations are often generated, leading the pilot to believe the attitude of the airplane has changed when, in fact, it has not. These false sensations result in the pilot experiencing spatial disorientation.

Accident Cited By SIC At Start of Second Descent

The accident that the SIC mentioned at the start of the helicopter's second descent occurred on March 13, 2014, and involved an Agusta Westland AW139 near Gillingham Hall, Norfolk, United Kingdom, which resulted in four fatalities (EW/C2014/03/02). The accident report indicated that the helicopter departed from a private site at night in fog with little or no external visual clues. After takeoff, the helicopter began to climb almost vertically to about 32 ft above ground level (agl), pitched nose down, and accelerated while continuing to climb. About 120 ft agl, while in a 15° nose-down pitch attitude, the CVR recorded the copilot say "nose down," followed by his applying more forward cyclic (nose-down) input. Subsequently, the helicopter began to descend with increasing groundspeed, and the copilot repeated, "nose down," and again applied more forward cyclic. The nose-down pitch attitude started to reduce from the peak value of 35° nose down as the helicopter descended through 100 ft agl. The accident report concluded that the flight crew may have experienced somatogravic illusion caused by the helicopter's flightpath and the lack of external visual cues.

Bahamas Regulations Regarding Night VFR Operations and Helipad Information

According to the Bahamas accredited representative, Bahamas Civil Aviation Regulations prohibited VFR night flight in the Bahamas; only IFR night flight was allowed at specific airports. Further, section 1.8 (a) of the Bahamas Aeronautical Information Publication (AIP), which is considered regulatory, stated the following:

No aircraft shall takeoff or land at any aerodrome in the Bahamas between the hours of sunset and sunrise unless that aerodrome has been designated by the General Manager of Bahamas Air Navigation Services Division BANSD [Bahamas Air Navigation Services Division] as being available for takeoffs and landings between the hours of sunset and sunrise.

Section 1.8 (f) of the Bahamas AIP stated the following:

Aircraft Operators, in the event of an emergency, may land at an aerodrome closed to takeoffs between the hours of sunset and sunrise. The Aircraft Operator shall, within 48 hours of the emergency landing, provide a written report to the General Manager of BANSD and to the Air Accident Investigation Department explaining the circumstances concerning the emergency landing.

The Bahamian accredited representative added that the Aerodromes and Ground Aids section of the Safety Oversight Department was unaware of Challenger Management LLC's helicopter operations at Big Grand Cay; therefore, no approvals had been granted to the company for night operations for that site.

Administrative Information

Investigator In Charge (IIC):	Monville, Timothy
Additional Participating Persons:	Patrick D Lusch; FAA AVP-100; Washington, DC Giorgio Dossena; Leonardo Helicopters (Technical Advisor); Cascina Costa Merryn Spielman; Pratt & Whitney Canada (Technical Advisor); Longueuil Delvin R Major; Air Accident Investigation Department; Nassau N.P. Marc Hamilton; TSB of Canada (Accredited Representative) Alvaro Neves; EASA (Technical Advisor); Cologne Mikael Amura; ANSV (Accredited Representative) Bill Gill; Honeywell; Olathe, KS
Original Publish Date:	May 27, 2021
Last Revision Date:	
Investigation Class:	Class 2
Note:	The NTSB traveled to the scene of this accident.
Investigation Docket:	https://data.ntsb.gov/Docket?ProjectID=99766