National Transportation Safety Board - Aircraft Accident/Incident Database

Accident Rpt# GAA17CA360	**06/22/2017 1600**	**Regis# N700LA**	**Portales, NM**	**Apt: N/a**
Acft Mk/Mdl AIR TRACTOR INC AT 502-B		**Acft SN 502B-0700**	**Acft Dmg: DESTROYED**	**Rpt Status: Factual Prob Caus: Pending**
Eng Mk/Mdl P&W CANADA PT6A-34AG		**Acft TT 6435**	**Fatal 0 Ser Inj 0**	**Flt Conducted Under: FAR 137**
Opr Name: KING AG AVIATION INC.		**Opr dba:**		**Aircraft Fire: GRD**
				AW Cert: SPR

Events

3. Maneuvering-low-alt flying - Loss of control in flight

Narrative

The pilot reported that, during an aerial application flight while maneuvering at the destination field in a left turn, he realized that the airplane was not going to be able to climb over transmission lines in his flight path. He added that he lowered the nose to fly under the transmission lines, but the "airspeed was still too low" and the airplane impacted an embankment, slid across the ground for about 100 ft., and nosed over.

The airplane was destroyed by the impact and a post-crash fire.

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

An automated weather observation station, 10 nautical miles north of the accident, about 5 minutes before the accident, reported the wind as calm, temperature 102øF (39øC), dewpoint 43øF (6øC), and barometric setting of 29.77" Hg. The calculated density altitude was 8,200 ft.

According to the Federal Aviation Administration Koch Chart, when considering the surrounding temperature and field elevation, the airplane would have likely experienced a 65% decrease in the normal climb rate.

Accident Rpt# WPR16LA188 09/12/2016 1345 PDT **Regis# N6181A** **Rockport, WA** **Apt: N/a**

Acft Mk/Mdl BELL 206B-III **Acft SN 4277** **Acft Dmg: SUBSTANTIAL** **Rpt Status: Factual** **Prob Caus: Pending**

Eng Mk/Mdl ROLLS ROYCE 250-C20 R4 **Acft TT 7513** **Fatal 0** **Ser Inj 0** **Flt Conducted Under: FAR PUBU**

Opr Name: HI LINE HELICOPTERS, INC. **Opr dba: HI LINE HELICOPTERS, INC** **Aircraft Fire: NONE**

AW Cert: STN

Events

1. Standing-engine(s) operating - Miscellaneous/other

Narrative

On September 12, 2016, about 1345 Pacific daylight time, a high skid-equipped Bell 206BIII helicopter, N6181A, sustained substantial damage after landing in remote mountainous terrain on Mount Prophet in the North Cascades National Park, about 30 miles northwest of Rockport, Washington. The commercial pilot and the sole passenger sustained no injury. The helicopter was registered to, Tony's Trucking, Inc. Darrington, Washington, and operated by Hi Line Helicopters, Inc., Darrington, as a public aircraft flight under contract to the National Park Service (NPS). Visual meteorological conditions prevailed at the time of the accident, and company flight following procedures were in effect. The flight originated from a helicopter landing zone near Diablo Lake about 8 miles south of the accident site, about 1330.

The pilot reported in the National Transportation Safety Board (NTSB) Accident/Incident Reporting Form 6120.1 that the purpose of the flight was to conduct external load operations into the Firn Lake and Skymo Lake areas on Mount Prophet. She reported that a NPS employee was onboard, where his duty was to depart the helicopter after landing, and assist with external load operations from the ground by attaching a long line to the helicopter and then wait to receive the external load. The helicopter arrived at Firn Lake about 1340 and the pilot conducted a high reconnaissance to locate a suitable area for landing and to also identify a suitable spot to place the external load. The pilot reported she selected a landing spot on the south end of the lake in a flat area. After the landing, the pilot brought the throttle to idle and the NPS employee departed the helicopter from the left seat in the cockpit. While the NPS employee was securing the cockpit door closed, the pilot reported the helicopter started to move with lateral oscillations. The pilot adjusted the flight controls, increased the throttle, and the lateral oscillations ceased. The pilot shut down the engine and a postflight inspection was conducted which revealed substantial damage to the transmission system. The pilot reported that the wind condition at the accident site was variable, 5 to 10 knots, and gusting plus or minus 5 knots. The pilot verified that there were no preimpact mechanical failures or malfunctions with the airframe or engine that would have precluded normal operation.

During a telephone interview with the NTSB investigator-in-charge (IIC) on October 12, 2016 the pilot stated this was her first time landing at Firn Lake. After conducting the high reconnaissance, she executed an approach to a spot but did not fully set the helicopter down due to suitability concerns with the terrain. The pilot then repositioned the helicopter about 180 degrees to a different spot which was "fairly flat" and landed the helicopter. After the landing and reducing the throttle to idle with the cyclic centered, she discussed with the NPS employee for a few minutes their plan of action for the external loads and he departed the helicopter. The oscillations started as he was securing the cockpit door closed. The pilot stated she then moved the cyclic slightly forward to cease the oscillations, which appeared to make the oscillations worse. The throttle was increased, the oscillations ceased, and the engine was shut down.

An air safety investigator (ASI) from the Department of Interior Office of Aviation Services (DOI OAS) reported to a NTSB ASI on September 23, 2016 that the operator was conducting a "call-when-needed" mission for the NPS when the accident occurred. The DOI OAS ASI further reported that after the accident, the helicopter was secured and transported as an external load via helicopter back to the operator's hangar in Darrington. The DOI OAS ASI also submitted on September 29, 2016 a written statement from the NPS employee who reported that the landing area utilized was flat and covered with vegetation and interspersed with basketball-sized boulders. The NPS employee further reported that while he was securing the cockpit door closed, the helicopter "bounced and lurched" and he visually confirmed that the tail rotor system did not strike an object or terrain.

On September 21, 2016, an airworthiness inspector from the DOI OAS traveled to the operator's hangar to conduct an inspection of the airframe and engine. In a written report submitted to the DOI OAS, the inspector reported that he was not given full access by the operator to conduct a thorough airframe and engine inspection. The inspector performed a limited inspection and noted substantial damage sustained to the main rotor mast and to the transmission system.

METEOROLOGICAL INFORMATION

The closest official weather observation station is located at the Bellingham International Airport, Bellingham, Washington, about 55 miles to the west of the accident site. At 1353, an Aviation Routine Weather Report (METAR) was reporting, and stated in part: Wind 340 degrees at 6 knots; visibility 10 statute miles; clouds and sky condition, clear; temperature 75 degrees F; dew point 36 degrees F; altimeter 30.17 inHg.

WRECKAGE AND IMPACT INFORMATION

The damage photographs supplied by the DOI OAS displayed substantial damage to the main drive shaft forward coupling along with the forward boot separated from the coupling. The main drive shaft appeared to have contacted the forward firewall and coupling grease was scattered throughout the aft transmission area. The forward coupling contacted the top of the isolation mount and various metal shavings were present.

The transmission drag pin spike mount was sheared from the lower transmission housing, and the four drag pin retaining studs were sheared off. The aft transmission deck was damaged. The drag pin spike witness ring retaining rivets were sheared from the transmission deck and the aft drag pin spike witness hole was torn from the transmission deck.

The main rotor mast had contact with the main rotor static stops as contact marks were present.

The repair station assigned to repair the helicopter reported on November 3, 2016 in an inspection report that the main rotor pitch links made contact with the cowling and the swashplate inner ring made contact with the sleeve.

TESTS AND RESEARCH

Pylon Mount Assembly Testing

The pylon mount assembly (Bell part number 206-030-539-101, Lord Corporation part number LB9-1301-1-1-V, serial number LK8458) was subjected to testing consistent with the dynamic requirements of the production acceptance testing produce at Lord Corporation in Erie, Pennsylvania with two aviation safety inspectors present from the Federal Aviation Administration Allegheny Flight Standards District Office (Pittsburgh, Pennsylvania). After the production acceptance testing procedure, a visual examination and disassembly was then performed.

Lord Corporation reported that based on the dynamic testing and visual examination of the elastomer and contact area on the top cover, there was no fault found with this component. The dynamic testing results were acceptable considering the calendar age of the elastomer and the dynamic testing did not create additional damage to the part. Lord Corporation further reported that there was no elastomer debonding on the non-damaged top and bottom cover plate surface and there was no elastomer damage on any other molded surface of the bonded assembly.

Pylon Mount Assembly History

The pylon mount assembly was installed on the accident helicopter on May 17, 2011 (with a helicopter time in service of 6,634.9 hours). According to the aircraft maintenance log supplied by the operator, the pylon mount assembly was installed due to the previous isolation mount assembly being out of tolerance.

ADDITIONAL INFORMATION

Ground Mast Bumping

A97W0130 (Transportation Safety Board of Canada), a Bell 206B accident, discusses ground mast bumping in the Bell 206 series. This report states in part:

The Bell 206B helicopter is fitted with an underslung, semi-rigid, teetering, two-blade main rotor system. The teetering design allows the main rotor blades to flap to compensate for asymmetrical lift during flight. One static stop is mounted on either side of the main rotor hub to physically limit the amount of blade flapping. A condition known as mast bumping occurs if the static stops contact the mast, due to excessive blade flapping, during ground operations or in flight. During ground operations with the rotor turning, the main rotor may be affected by wind gusts and flap to its limits resulting in a light static stop to mast contact. In such an event, mast bumping may manifest itself as a light shudder felt throughout the helicopter. The more extreme the flapping, the more severe the shudder. Mast bumping will also occur during ground operation, if the cyclic is incorrectly positioned or is moved sufficiently to tilt the rotor disc to an extreme position. If the static stop to mast contact is severe, pronounced helicopter oscillations may develop and the helicopter can sustain substantial damage. The appropriate corrective action is to immediately reposition the cyclic, toward or near the neutral position so that the rotor disc resumes a flat position. On the ground, at idle RPM, the rotor disc is less stable and more susceptible to larger deviations due to flapping.

Pylon Whirl and Spike Knock Conditions

GAA15LA296, a Bell 206B accident, identified the pylon whirl and spike knock conditions that the Bell 206 series can be susceptible to. Background information on these two conditions can be found in the factual report for GAA15LA296.

Slope Limitations

According to Bell, there are no slope limitations for the Bell 206 series. The operator's manual for the U.S. Army OH-58A/C (a single engine, observation type military helicopter produced by Bell, similar to the Bell 206 series), Technical Manual 55-1520-228-10, discusses the OH-58A/C slope landing/takeoff limitations. This manual states in part:

Slope operations shall be limited to slopes of 8 degrees or less.

Caution is to be exercised for slopes greater than 5 degrees since rigging, loading, terrain, and wind conditions may alter slope landing capability.

Incident Rpt# WPR17IA189 **08/28/2017 1900 PDT** **Regis# N503UP** **San Jose, CA** **Apt: Norman Y Mineta San Jose Intl SJC**
Acft Mk/Mdl CESSNA 560XL-ENCORE **Acft SN 560-5326** **Acft Dmg: MINOR** **Rpt Status: Prelim** **Prob Caus: Pending**
Eng Mk/Mdl P&W CANADA PW545 SER **Fatal 0** **Ser Inj 0** **Flt Conducted Under: FAR 135**
Opr Name: WHEELS UP **Opr dba:** **Aircraft Fire: NONE**
AW Cert: STT

Events

1. Landing-landing roll - Landing gear collapse

Narrative

On August 28, 2017, about 1900 Pacific daylight time, a Cessna 560XL, N503UP, veered to the right during landing roll at the Norman Y. Mineta San Jose International Airport (SJC), San Jose, California. The pilot subsequently corrected to the runway centerline and came to a stop on the taxiway. The two airline transport pilots and three passengers were not injured. The airplane sustained minor damage to the right wing main wheel well area. The airplane was registered to Textron Financial Corp., and operated by the Gama Aviation Inc., under the provisions of 14 Code of Federal Regulations Part 135 as an on-demand air taxi flight. Visual meteorological conditions prevailed and an instrument flight rules flight plan was filed. The flight originated at Tucson International Airport (TUS), Tucson, Arizona, with a destination of SJC.

The flight crew reported that during the landing roll, the airplane veered to the right and the pilot corrected back to the runway centerline. They thought it was a flat tire on the right main landing gear due to the veering during landing roll and the right wing was positioned lower than the left. They completed the flight by parking on a taxiway, clear of the runway. The tower controller was contacted to report their situation and to ask for assistance in relocating the airplane. After the passengers disembarked and the luggage removed from the airplane, the flight crew examined the damage to the landing gear and right wing.

Initial examination of the airplane by a Federal Aviation Administration inspector revealed that the aft portion of the right main landing gear trunnion pivot pin was not in place. The separated aft portion of the right main gear trunnion protruded through the top of the wing and the landing gear strut and wheel were positioned out and aft in about a 45-degree angle from its original position. The trunnion pivot pin remained in the rear support and the pivot pin retaining bolt that was intended to restrain the pivot pin was in place and secured with a nut and cotter pin.

The wreckage was recovered to a secure location for further examination.

Events

3. Landing - Collision during takeoff/land

Narrative

HISTORY OF FLIGHT

On November 21, 2014, about 1010 central standard time, an Embraer EMB-500 (Phenom 100) airplane, N584JS, overran the runway after landing at Sugar Land Regional Airport (SGR), Sugar Land, Texas. The airline transport-rated pilots were not injured and the airplane was substantially damaged. The airplane was being operated by Superior Air Charter, LLC, Irvine, California (doing business as JetSuite Air), as a 14 Code of Federal Regulations (CFR) Part 91 positioning flight. Instrument meteorological conditions existed at the airport at the time of the accident, and the flight operated on an instrument flight rules flight plan. The flight originated from William P. Hobby Airport (HOU), Houston, Texas.

According to the pilots, the purpose of the flight was to reposition the airplane from HOU to SGR. During the approach to SGR, the tower controller provided the pilots vectors to the airport and then told them to expect the instrument landing system (ILS) 35 approach at SGR. After the accident, the copilot reported that the tower controller cleared the flight to land and that there was no standing water on the runway. The copilot added that, during the approach, there was a tailwind of 15 kts that decreased to 9 kts on touchdown.

After landing, the pilot, who was flying the airplane, applied the brakes and noted no appreciable deceleration. She then pulled the emergency brakes twice, but the airplane continued past the end of the runway and onto a grassy area. The airplane then crossed a service road and came to rest in a drainage ditch facing opposite the direction of travel with the empennage section partially submerged in water.

A review of flight data recorder (FDR) data revealed that, while on the ILS approach to runway 35, the airplane slowed to 120 knots (kts) and that it maintained that airspeed until about 155 ft mean sea level (msl), at which point it slowed to about 118 kts. The airplane remained on the glideslope until about 380 ft msl, when the cockpit voice recorder (CVR) recorded an electronic voice stating "autopilot," consistent with autopilot disconnection. Shortly after, the airplane descended below the glideslope. The airplane crossed the displaced threshold about 100 ft msl and at 112 kts indicated airspeed (KIAS), and touched down at 1010:37, about 1,040 ft from the threshold, at an airspeed of 104 KIAS. During the landing roll, the CVR recorded the pilots concern about the airplane's lack of deceleration.

About 1.6 seconds after touchdown, the nose landing gear touched down, and the pilot's brake pedal increased, with intermediate oscillations, over a period of 7.5 seconds and reached full pedal deflection. About 4 seconds later, the emergency/parking brake (EPB) was applied, at which point the wheel speed dropped from 70 to 0 kts, consistent with a locked-wheel skid. Concurrently, the FDR recorded an engine indication and crew alerting system ANTI-SKID FAIL message, consistent with the application of the EPB and locking of the wheels. The airplane departed the runway at 1011:15 at a groundspeed of about 30 KIAS. Shortly after, the FDR recorded accelerations consistent with the impact and airplane coming to a stop.

PERSONNEL INFORMATION

Pilot

The pilot held an airline transport pilot certificate with airplane single-engine land, multi-engine land, and instrument ratings. Additionally, she held an instructor's certificate with airplane single-engine and instrument ratings. She reported that she had 6,311 total flight hours and 1,110 hours in the accident airplane make and model. The captain was issued a Federal Aviation Administration (FAA) first-class medical certificate on July 29, 2014.

Copilot

The copilot held an airline transport pilot certificate with airplane single-engine land, multi-engine land, and instrument ratings. He reported that he had 4,232 total flight hours and 814 hours in the accident airplane make and model. The copilot was issued an FAA first-class medical certificate on July 26, 2014, with the restriction, "must wear corrective lenses."

AIRCRAFT INFORMATION

The Embraer EMB-500 Phenom 100 is included in the very light jet (VLJ) class of airplane. The Phenom 100 can seat four passengers in its normal configuration, but it can be configured to carry up to seven passengers. The airplane is equipped with two Pratt & Whitney Canada PW617-F turbofan engines each rated at a takeoff thrust of 1,695 lbs. The accident airplane's serial number was (S/N) 50000140 and was certified as a 14 CFR 23 normal category airplane. The EMB-500 is not equipped with thrust reversers, and prior to serial # 50000325 not equipped with spoilers. All EMB-500s from serial # 50000325 onwards are equipped with spoilers when delivered from the factory. The accident airplane was not equipped with spoilers.

Brake System

The Phenom 100's hydraulic brake system delivers hydraulic pressure to the brakes via input on the brake pedals. The hydraulic pressure to the brake system is supplied at a maximum of 3,000 pounds per square inch (psi). The copilot's (right seat) brake pedals are mechanically linked to the pilot's (left seat) brake pedals. Each pilot brake pedal is connected to a pedal position transducer (PPT), each of which produces two independent electrical outputs to the brake control unit (BCU) that were proportional to the respective pedal displacement. The BCU controls the main brake system. The brake system is a brake-by-wire system with an antiskid function. There are no hydraulic components on the brake control; therefore, the only pedal force feedback to the pilots is from a force spring installed on the pedals. This provides a consistent pedal resistance regardless of the runway condition and the pressure applied.

Wheel speed information is sent to the BCU via two axle-mounted speed transducers. The BCU uses the output from the wheel speed transducers, the PPTs, and two brake line pressure transducers to generate an electrical command to the associated brake control valve (BCV).

Anti-skid protection is provided when the BCU detect a skid by monitoring the two-wheel speed transducer signals. If a skid is detected, the BCU sends a signal to the BCV to reduce pressure to the brakes. The antiskid protection cannot be turned off in the cockpit.

The Phenom 100 is equipped with an EPB to stop the airplane if the main brake system fails and to provide means to keep the aircraft parked even when the hydraulic power system is turned off. The EPB is operated by a T-handle on the control pedestal. The handle is mechanically linked to the emergency brake valve.

Upon using the EPB, the pressure applied is proportional to the handle displacement. No anti-skid protection is available.

Certification

In general, 14 CFR Part 23 certification regulations require that dry-runway landing distances be published in airplane flight manuals (AFM) and that they be based on performance demonstrated during flight tests on smooth, dry, hard-surfaced runways. Certification regulations do not require the publication of landing distances on other-than-dry runways, although certification applicants may choose to present this information to the regulator. If the applicant provided this information, it would not necessarily be based on flight tests (largely because of the difficulty of achieving a consistent "wet" or "contaminated" runway surface) but rather derived by calculations based on assumptions agreed to by the regulator.

an airsafety.com e-product
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The EMB-500 was first certified by the Brazilian regulator (the Agˆncia Nacional de Avia‡ao Civil), which, like the FAA, does not require the publication of landing distances on other-than-dry runways. However, the European Aviation Safety Agency (EASA) does require the publication of landing distances on other-than-dry runways if the airplane is to be operated on such runways. The unfactored landing distance is the actual distance from the runway threshold required to land the airplane and stop it without any safety factors applied. The factored landing distance is the actual distance from the runway threshold required to land the airplane and stop increased by a safety factor.

Therefore, to certify the airplane in Europe, Embraer proposed to EASA that the unfactored wet runway landing distances presented in the EMB-500 AFM would be computed as 125% of the demonstrated, unfactored dry-landing distance, and EASA accepted this proposal.

The factored wet-runway landing distances in the EMB-500 AFM are 115% of the factored dry distances or 192% of the unfactored dry distances. The EMB-500 is certified in the "normal" category, not the "commuter" category; therefore, 135.385(c) did not apply to the accident airplane. However, in practice, JetSuite operates the EMB-500 in compliance with 135.385(c).

The EMB-500 AFM also provides a table of landing distances for landings on runways covered with standing water, slush, or wet snow at depths of 0.125, 0.250, and 0.375 inches.

METEOROLOGICAL INFORMATION

At 1012, the SGR automated weather observation system (AWOS) reported wind from 130ø at 8 kts, 6 miles visibility, light rain and mist, broken clouds at 3,300 ft and an overcast ceiling at 4,200 ft, temperature 66øF, dew point 64øF, and a barometric pressure of 30.15 inches of mercury.

At 1025, the SGR AWOS reported wind from 130ø at 8 kts, 10 miles visibility, few clouds at 600 ft, and broken clouds at 1,800 ft and an overcast ceiling at 4,400 ft.

AIRPORT INFORMATION

SGR is a public-use, towered airport, located 17 miles southwest of Houston, Texas. SGR has a single concrete runway, 35/17, which is 8,000 ft long and 100 ft wide. Runway 17 has a 380 ft displaced threshold; runway 35 has a 1,984 ft displaced threshold. Runway 35 touchdown zone elevation is 78 ft.

FLIGHT RECORDERS

The CVR were removed from the airplane and examined at the National Transportation Safety Board's Vehicle Recorder Lab in Washington, DC. The FDR data file was downloaded by the operator and sent to the NTSB's Vehicle Recorder Lab.

WRECKAGE AND IMPACT INFORMATION

The airplane came to rest about 100 ft beyond the end of runway 35 down a small embankment in a drainage creek filled with water. The airplane had spun around about 148ø opposite the direction of travel with the front of the airplane on the embankment The aft section of the airplane was submerged in water, and the tail cone was partly broken and separated from the empennage. The right main landing gear had collapsed, and the right-wing tip and aileron were damaged.

TESTS AND RESEARCH

BCU

The BCU was removed from the airplane and sent to the unit's manufacturer's facility in Ohio. No visual defects were noted, and the BCU was functionally tested, and it functioned normally. Data were downloaded from the BCU, and no abnormities were noted with the braking system.

Airplane Performance Study

The NTSB conducted an Airplane Performance Study for the accident flight to determine the airplane's position and orientation during the relevant portion of the flight and its responses to control inputs, external disturbances, ground forces, and other factors that could affect its trajectory. The study used various data sources, including FDR and airplane thrust and aerodynamic performance information.

According to the performance study, the airplane's approach to runway 35 complied with the operator's stabilized approach criteria, with the airplane tracking the RNAV final approach course and glideslope at an airspeed of about 130 knots.

The CVR recorded the copilot, who was the pilot monitoring (PM), call "1000 . stable" at 1009:10.3 when the airplane was at an indicated altitude of 1,103 ft (1,021 ft above the field elevation (AFE) of 82 ft) and about 147 KIAS, or 27 kts above the approach speed (Vap of 120 kts. Per JetSuite's Standard Operating Procedures (SOPs, the PM would have been required to call "1000 continue, speed" because the speed exceeded Vap + 5 kts.

As the airplane descended below an indicated altitude of 800 ft msl (about 722 ft above the touchdown zone elevation [TDZE] of 78.4 ft) while on the ILS approach to runway 35, it slowed to 120 kts, which is the flaps 3 Vap (approach speed) specified in JetSuite's SOPs. During the final approach, the airplane remained on the glideslope until about 380 ftmsl (302 ft above TDZE), when the CVR recorded an electronic voice stating "autopilot," indicating that the autopilot had been disconnected. Shortly after, the airplane descended below the glideslope. The airplane maintained 120 kts until about 155 ft msl (about 77 ft above TDZE), then slowed to about 118 kts at 50 ft above TDZE, and then slowed to 104 KIAS at touchdown.

The airplane crossed the runway 35 displaced threshold at an indicated altitude of about 100 ft msl (22 f above TDZE) and about 112 KIAS, and it touched down at 1010:37.4, 1,040 ft from the threshold at a groundspeed of 111 kts with about a 7 tailwind.

The CVR did not record the pilots making any speed callouts between 500 ft above field elevation (AFE and 50 ft above TDZE, even though at least one speed callout in this band is required by the SOPs. In addition, the EMB-500 AFM specified that at the landing weight of about 8950 lbs, the flaps 3 Vref is 101 kts. The SOPs required pilots to go-around if the airspeed at 50 ft above TDZE exceeded about 111 kts. As noted above, at an indicated altitude of 50 ft above TDZE (128 ftmsl), the indicated airspeed was about 118 kts, 7 kts, above the approximate 111-kts limit.

The landing distances published in the EMB-500 AFM are predicated on the airplane slowing to reference speed (Vref at 50 ft over the threshold. During the accident landing, the speed at 50 ft exceeded Vref by about 17 kts and resulted in an increased runway distance required to stop. Runway 35, even with the higher threshold crossing speed and assuming that the airplane braking performance implied in the AFM landing distances could be achieved, had an available landing distance of 6,016 ft, which met JetSuite's General Operations Manual (GOM) wet-runway dispatch ("planning") requirement of 1.92 times the unfactored dry landing distance, which for this landing would have been 2,695 ft times 1.92 or 5,174 ft.

About 1.6 seconds after touchdown, the nose landing gear touched down, and the pilot's brake pedal increased, with intermediate oscillations, over a period of 7.5 seconds and reached full pedal deflection at about 1010:46.6. During this time, the airplane maintained a deceleration (longitudinal load factor, nx) that oscillated between -0.05 and -0.10 G's; and averaged about -0.07 G's. At 1010:49.7, 3.1 seconds after the brake pedals reached maximum deflection, the nx suddenly decreased to a minimum (i.e., a maximum deceleration) of -0.162 G's. Between 10:10:50 and 10:10:58, the nx oscillated between about -0.11 and -0.14 G's. At 10:10:50.7, the Emergency / Parking Brake (EPB) was applied, and the right and left wheel speeds decreased to 0 at 1010:55.2 and 10:10:58.2, respectively. After both wheel speeds reached zero, the nx increased (indicating decreased deceleration) to between about -0.08 and -0.11 G's until about 1011:11, when the airplane started to yaw to the left and drift to the right. The airplane departed the runway at 1011:15, at a groundspeed of about 30 knots, and came to rest in a drainage ditch about 500 feet past the end of the runway.

For about the first 12 seconds after touchdown, the computed braking coefficient oscillated about a value of 0.03 (the assumed unbraked, rolling braking coefficient) with peaks between 0 and about 0.1. The braking coefficient remained at this low value even as the brake pedals were depressed and then jumped to an average of between 0.13 and 0.14 at 1010:50, coincident with the decrease in nx (that is, increased deceleration).

As part of the performance study, in May 2015, the NTSB and the parties to the investigation conducted tests on runway 35 at SGR to measure the runway macrotexture depth, cross-slope, and friction characteristics. The tests did not indicate any discontinuity or sudden change in the runway friction that could explain the computed braking coefficient jump. Further, the rainfall rate at the time of the accident and the runway's measured macrotexture and cross-slope characteristics precluded the possibility that dynamic hydroplaning caused the braking coefficient jump. The investigation was unable to determine the reason why the airplane's antiskid system, which normally controls the slip ratio, maintained a low slip ratio even as the braking command from the pedals was increasing.

The airplane manufacturer provided a possible explanation noting that the EMB-500 antiskid system is a wheel deceleration control algorithm (MABS proprietary), not a slip ratio control algorithm; therefore, slip control is indirect and may be affected by wheel dynamics other than the ratio between wheel speed and aircraft ground speed.

Embraer also notes that the EMB-500 antiskid system is sensitive to pedal input variations, as the input variation will immediately cause a pressure variation, so its effectivity is directly affected by the pilot inputs. At pedal deflections greater than 90% and above, the brake system considers full brake application. Pedal variations above the 90% threshold have no effect on the system.

Brake pedals variations below 90% were observed throughout landing until actuation of the emergency brakes, therefore not allowing the antiskid system to reach maximum efficiency. The Embraer landing technique recommended in AFM is to apply and maintain full brake pedal application upon touchdown.

The decrease in braking coefficient after the EPB was applied and the wheel speed dropped to zero is consistent with research indicating that the braking friction achieved in a full locked-wheel skid is significantly lower than the maximum braking coefficient that can be achieved at lower slip ratios. Examination of the airplane's tires revealed evidence of reverted-rubber hydroplaning, which is also consistent with a locked-wheel skid and reduction in braking coefficient.

The findings in this accident and similar accidents investigated by the NTSB confirm that the actual braking coefficient that can be achieved on a wet runway may be significantly lower than the braking coefficient predicted by industry-standard models or the braking coefficient required to match the manufacturer's published unfactored, wet-runway landing distances. The results are also consistent with an Embraer Flight Operations Letter that states that the AFM landing distances corresponding to "standing water" contaminated runways may be more indicative of the airplane performance than the AFM "wet runway" landing distances, even for runways that would not normally be considered flooded (for example, even in the case of "light rain over a non-grooved runway or a concrete polished surface.") In this case, the AFM braking performance was not achieved because the actual braking coefficient generated between the tires and the runway was far less than the braking coefficient implied by the wet runway landing distances published in the AFM.

In the comments on the draft Aircraft Performance Study for this case, Embraer disagreed with the NTSB's interpretation of Flight Operations Letter (PHE500-002/15) regarding the AFM landing distances on wet and flooded runways, as outlined above. Instead Embraer stated that "the "FOL highlights the difficulty in assessing the runway conditions (especially between "wet" and "standing water contaminated") and recommends operators to take a conservative approach to calculate the required landing distance.

If the EPB had not been set and the braking friction had continued at levels attained early in the landing roll, then the airplane should have been able to stop on the remaining runway (about 795 ft from the runway threshold). Before landing, the pilots received a report from an air traffic controller that there was "no visible standing water on the runway." Given such a report, it would have been reasonable for the pilots to assume that the AFM wet runway landing distances, rather than the standing water distances, were more appropriate, when in fact the opposite was true. This scenario seems to indicate that, in the absence of prior experience on a given wet runway, if the runway is known or reported to be anything but dry, then the most conservative assumptions about the required landing distance should be used.

See the Airplane Performance Study in the public docket for this accident for additional details.

ADDITIONAL INFORMATION

JetSuite's P100 STANDARD OPERATING PROCEDURES (SOP) and General Operations Manual (GOM) excerpts:

P100 STANDARD OPERATING PROCEDURES

1.5 Briefings

1.5.2 Descent & Approach

In addition to the elements of the approach procedure required for safe operations the following items must also be covered prior to any arrival:

- Configuration - Planned Landing FLAPS, ICE PROTECTION, and approach type (NPA or Precision-like).

- Runway - sufficient for the planned settings.

- ATIS - Allows for the planned operation and settings.

- Fuel - Amount remaining allows for the planned operation with sufficient reserves.

- Terrain/Threats - Dominating terrain and any other considerations that may affect decision-making.

2.9 Before Landing

For all approaches, there are a minimum of three occasions when the PM is required to verbalize his/her assessment of the stability of the approach. All three occasions are required to ensure the approach does not become destabilized. The first is at 1,000' AFE, at which point any combination of the 4 parameters may be out of limits. The second is at 500' AFE, at which point SPEED is the only parameter that is allowed to be outside limits. This allows a decelerating approach to be flown. The third is at not less than 50' Above TDZE, at which point SPEED must be no greater than Vref +10. This ensures that SPEED is within limits prior to touchdown.

At 1000' AFE: If any of the following criteria are outside the stated limits, the PM will use the callout "1000 Continue" and add the quoted descriptor to make the PF aware of the items requiring correction:

"FLAPS": Not indicating the briefed Landing Configuration.

"GEAR": Not indicating 3 Green DN indications.

"PROFILE": Outside 1 dot laterally/vertically if IMC, or visual equivalent.

"SPEED": Mean speed above Vap + 5 knots.

At 500' AFE: If any of the following criteria are outside the stated limits, the PM will use the callout "500 Go-Around":

"FLAPS": Not indicating the briefed Landing Configuration.

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"Gear": Not indicating 3 Green DN indications.

"Profile": Outside 1 dot laterally/vertically if IMC, or visual equivalent.

If the speed is outside the following stated limits, the PM will use the callout "500 Continue, SPEED" to make sure the PF is aware that a speed correction is required:

"SPEED": Means speed above Vap + 5 Knots.

Between 500' AFE and 50' Above TDZE:

The callout "REF +/-____" will be made at least once prior to reaching 50" Above TDZE. This call may be made as often as necessary to aid the PF ensuring that SPEED is not excessive, and will be within limits prior to touchdown.

At 50' Above TDZE: If the mean speed is greater than Vref + 10 Knots, the PM will make the callout "Go-Around".

NOTE: Speeds in excess of Vref + 10 at 50' Above TDZE require a mandatory Go-Around.

4.8 CW [Cold Weather] Before Landing

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Conduct a positive landing to ensure initial wheel spin-up and initiate firm ground contact upon touchdown, achieving wheel load as quickly as possible. Such technique avoids hydroplaning on wet runways and reduces the strength of any ice bond that might have been formed on brake and wheel assemblies during flight. The factors that influence the occurrence of hydroplaning are high speed, standing water and poor runway macro texture. When hydroplaning occurs, it causes a substantial loss of tire friction and wheel spin-up may not occur. Icy runways can be very slippery at all speeds depending on temperature. Stopping the airplane with the least landing run must be emphasized when landing on wet or slippery runways.

•Anticipate the approach procedures and speeds: A well-planned and executed approach, flare and touchdown minimize the landing distance.

•Lower nose wheel immediately to the runway. It will decrease lift and will increase main gear loading.

•Apply brakes with moderate-to-firm pressure, smoothly and symmetrically, and let the anti-skid do its job.

•If no braking action is felt, hydroplaning is probably occurring. Do not apply PARKING BRAKE, as it will remove anti-skid protection.

•Maintain runway centerline and keep braking until airplane is decelerated.

GENERAL OPERATIONS MANUAL (GOM)

ALL OPERATIONS - WET OR SLIPPERY RUNWAY CRITERIA: A runway is considered wet (or slippery) when conditions indicate:

•Showers or occasional showers.

•Heavy drizzle.

•Continuous light rain, moderate or heavy rain, freezing rain of any intensity.

•Snow of any intensity other than "light" with surface temperature below 28ø F.

•A runway is considered contaminated if it cannot be defined as dry or wet.

NOTE: THE FAA HAS TAKEN THE POSITION THAT A RUNWAY DOES NOT HAVE TO BE REFLECTIVE TO BE CONSIDERED WET. IF A RUNWAY IS CONTAMINATED OR NOT DRY IT IS CONSIDERED WET. REF: AC 91-79 APPENDIX 4.

ALL OPERATIONS - "WET RUNWAY" EFFECTIVE LENGTH REQUIREMENT: If required by the type of operation, the additional 15% for wet or slippery runways and 15% for visibility conditions below 3/4 mile or RVR 4000 is not cumulative. Adding 15% to the dry runway length requirement satisfies either or both requirements. Although alternate airports are not always subject to the "wet runway" rule, to avoid inadvertent errors, JetSuite Air has chosen to enforce the "wet runway" rule at all alternate airports.

EXECUTION - ALL OPERATIONS: All JetSuite Air P100 flight operations will use an additional 1000 feet operating margin to account for minor variations in aimpoint, Vref, negative slope, flare technique and delayed or insufficient braking. No pilot will land a JetSuite Air P100 aircraft if that weight exceeds:

•Maximum landing weight in JS Logbook, OPERA, or the AFM.

•A weight that will allow a full stop landing within the effective length of the most suitable runway for the following conditions:

•Dry runways = dry performance +1000 feet.

•Wet non-RFSC/AFSC = dry performance +25%+1000 feet.

•Wet RFSC/AFSC runways = 6500 feet minimum.

•Contaminated runways = applicable contaminated value + 1000 feet.

For contaminated runways of any kind, the landing distance available must be the greater of dry distance * 1.67 * 1.15 or, the applicable contaminated value + 1000 feet.

JetSuite pilots in the P100 will:

- Use Flaps 3 for planning and execution on all wet runways.

- Apply the brakes in one continuous application for approximately five seconds or until an appropriate level of deceleration is felt.

- If no deceleration is felt after 5 seconds, pilots will initiate a go-around.

14 CFR Part 23 Certification Regulations

In accordance with 14 CFR Part 23 Section 23.75, "Landing distance,"

The horizontal distance necessary to land and come to a complete stop from a point 50 feet above the landing surface must be determined, for standard temperatures at each weight and altitude within the operational limits established for landing, as follows:

(a) A steady approach at not less than VREF, determined in accordance with ⊥23.73 (a), (b), or (c), as appropriate, must be maintained down to the 50 foot height and-

(1) The steady approach must be at a gradient of descent not greater than 5.2 percent (3 degrees) down to the 50-foot height.

(2) In addition, an applicant may demonstrate by tests that a maximum steady approach gradient steeper than 5.2 percent, down to the 50-foot height, is safe. The gradient must be established as an operating limitation and the information necessary to display the gradient must be available to the pilot by an appropriate instrument.

(b) A constant configuration must be maintained throughout the maneuver.

(c) The landing must be made without excessive vertical acceleration or tendency to bounce, nose over, ground loop, porpoise, or water loop.

(d) It must be shown that a safe transition to the balked landing conditions of ⊥23.77 can be made from the conditions that exist at the 50 foot height, at maximum landing weight, or at the maximum landing weight for altitude and temperature of ⊥23.63 (c)(2) or (d)(2), as appropriate.

(e) The brakes must be used so as to not cause excessive wear of brakes or tires.

(f) Retardation means other than wheel brakes may be used if that means-

(1) Is safe and reliable; and

(2) Is used so that consistent results can be expected in service.

(g) If any device is used that depends on the operation of any engine, and the landing distance would be increased when a landing is made with that engine inoperative, the landing distance must be determined with that engine inoperative unless the use of other compensating means will result in a landing distance not more than that with each engine operating.

Section 23.1587, "Performance Information," stated the following:

(a) For all airplanes, the following information must be furnished.

(3) The landing distance, determined under ⊥23.75 for each airport altitude and standard temperature, and the type of surface for which it is valid;

(4) The effect on landing distances of operation on other than smooth hard surfaces, when dry, determined under ⊥23.45(g); and

(5) The effect on landing distances of runway slope and 50 percent of the headwind component and 150 percent of the tailwind component.

FAA Safety Alert for Operators (SAFO)

The FAA has previously issued two SAFOs relevant to the circumstances of this accident.

SAFO 06012, "Landing Performance Assessments at Time of Arrival (Turbojets)," dated August 31, 2006, stated the following:

This SAFO urgently recommends that operators of turbojet airplanes develop procedures for flightcrews to assess landing performance based on conditions actually existing at time of arrival, as distinct from conditions presumed at time of dispatch. . Once the actual landing distance is determined an additional safety margin of at least 15% should be added to that distance.

SAFO 06012 noted that the dry-runway landing distances established during flight tests and that are the basis for the factored landing distances used by dispatch are shorter than the landing distances achieved in practice. In addition, AFM landing distances for wet and contaminated runways may also be based on the minimum dry distances obtained during flight tests. Consequently, landing distances on wet or contaminated runways computed from AFM data with little or no additional safety margin may be too short for normal operations. The SAFO recommended a conservative approach to assessing the landing distance requirements, including using the most adverse reliable braking action report or expected conditions for the runway and using values for air distances and approach speeds that are representative of actual operations. The SAFO recommended that a 15% safety margin then be added to the computed (unfactored) landing distance because "the FAA considers a 15% margin between the expected actual airplane landing distance and the landing distance available at the time of arrival as the minimum acceptable safety margin for normal operations."

SAFO 15009, "Turbojet Braking Performance on Wet Runways," dated August 11, 2015, warned that "the advisory data for wet runway landings may not provide a safe stopping margin under all conditions" and stated the following:

Several recent runway landing incidents/accidents have raised concerns with wet runway stopping performance assumptions. Analysis of the stopping data from these incidents/accidents indicates the braking coefficient of friction in each case was significantly lower than expected for a wet runway as defined by the Federal Aviation Administration (FAA) in Federal Air Regulation (FAR) 25.109 and Advisory Circular (AC) 25-7C methods. These incidents/accidents occurred on both grooved and un-grooved or non-Porous Friction Course overlay (PFC) runways. The data indicates that applying a 15% safety margin to wet runway time-of-arrival advisory data as recommended by SAFO 06012, may be inadequate in certain wet runway conditions

The root cause of the wet runway stopping performance shortfall is not fully understood at this time; however, issues that appear to be contributors are runway conditions such as texture (polished or rubber contaminated surfaces), drainage, puddling in wheel tracks and active precipitation. Analysis of this data indicates that 30 to 40 percent of additional stopping distance may be required in certain cases where the runway is very wet, but not flooded. Possible methods of applying additional conservatism when operating on a runway which experience has shown degraded when very wet are assuming a braking action of medium or fair when computing time-of-arrival landing performance or increasing the factor applied to the wet runway time-of-arrival landing performance data.

Advisory Circular 91-79A

The FAA issued AC 91-79A, "Mitigating the Risks of a Runway Overrun Upon Landing," on September 17, 2014. The AC stated the following:

Section 6 - DISCUSSION - HAZARDS ASSOCIATED WITH RUNWAY OVERRUNS

j. A Wet or Contaminated Runway. Landing distances in the manufacturer-supplied AFM provide performance in a flight test environment that is not necessarily representative of normal flight operations. For those operators conducting operations in accordance with specific FAA performance regulations, the operating regulations require the AFM landing distances to be factored to ensure compliance with the pre-departure landing distance regulations. These factors should account for pilot technique, wind and runway conditions, and other items stated above. Pilots and operators should also account for runway conditions at the time of arrival (TOA) to ensure the safety of the landing. Though the intended audience of SAFO 06012 is turbojet airplanes, it is highly recommended that pilots of non-turbojet airplanes also follow the recommendations in SAFO 06012.

(4) Know you can stop within the landing distance available. The cumulative effect of the conditions that extend the airplane's landing distance, plus the 15 percent safety margin, can be a substantial increase to the AFM/POH data, unless the pilot is aware of the items presented, and possesses the knowledge and flying discipline to mitigate the risk of a runway overrun.

Embraer Actions

On June 6, 2016, Embraer issued Revision 2, Flight Operations Letter PHE505-018/14 Landing Procedure Best Practices and Recommendations," which highlight some information contained in FAA AC91-79A in and add information specific to the Phenom fleet.

The letter state that due to the antiskid function, the BCU will automatically calculate the maximum pressure delivered to the brakes based on the pavement condition. As a result, pilots will notice lower deceleration on a contaminated runway compared to a dry runway.

The FOL contained the following:

CAUTION: The emergency parking brake will always deliver worse performance when compared to the normal brakes with anti-skid protection. Its use is only recommended on abnormal conditions, when the BRK FAIL CAS message is annunciated. In these conditions, applying the landing correction factors, determinate by the QRH [Quick Reference Handbook], are mandatory.

Accident Rpt# ANC17LA051 09/02/2017 948 PDT | **Regis# N304FD** | **Tujunga, CA** | **Apt: N/a**

Acft Mk/Mdl LEONARDO AW139 | **Acft SN 41528** | **Acft Dmg: SUBSTANTIAL** | **Rpt Status: Prelim** | **Prob Caus: Pending**

Eng Mk/Mdl PRATT & WHITNEY CANADA PT6C-67C | **Acft TT 122** | **Fatal 0** | **Ser Inj 0** | **Flt Conducted Under: FAR PUBU**

Opr Name: LOS ANGELES FIRE DEPARTMENT | **Opr dba:** | **Aircraft Fire: NONE**

AW Cert: STN

Events

1. Maneuvering-low-alt flying - Unknown or undetermined

Narrative

On September 2, 2017, about 0948 Pacific daylight time, a Leonardo (formerly AugustaWestland Philadelphia) AW139 helicopter, N304FD, sustained substantial damage after impacting trees while conducting aerial firefighting operations in a residential area in Tujunga, California. The pilot and crewmember sustained no injuries. The helicopter was registered to the City of Los Angeles and was operated by the Los Angeles Fire Department as a public use visual flight rules aerial firefighting flight, operating as Fire 4. Visual meteorological conditions with moderate smoke were present in the area at the time of the accident and flight following procedures were utilized by the operator. The helicopter departed from the Van Nuys Airport, Van Nuys, California about 0815 to conduct the aerial firefighting operations for the day.

The operator reported that the helicopter was in support of the La Tuna wildfire, that was spreading throughout the Verdugo Mountains. The helicopter was tasked with structure protection for a residential complex on a ridgeline, about one half mile northeast of Interstate 210, known as the Foothill Freeway. The pilot was stationed in the right seat, and a helicopter pilot crewmember, who was not type rated in the AW139 model, was stationed in the left seat. The helicopter was operating with several other firefighting helicopters, which were all supporting the structure protection for the residential complex via water drops. The team of helicopters were operating out of the Green Verdugo helispot, which is located next to the Green Verdugo reservoir about 2 miles northwest of the residential complex.

Once on station, the pilot performed a high reconnaissance orbit over the residential complex, with the intent of conducting a water drop from the south to the north. During the high reconnaissance, the pilot noted the prevailing wind, the smoke conditions, the ground obstructions, and his intended approach and departure route for the water drop. The pilot reported the wind condition was variable and originated from the east.

When the pilot was flying from south to north to drop the water in a descending profile, about 100 feet above the trees and about 40 knots, and about 200 feet away from the residential complex, the helicopter began an uncommanded yaw to the right and the vertical descent increased. The pilot released the water and the helicopter continued to yaw to the right and descend rapidly. The pilot reported he had little positive control of the helicopter. The crewmember verbally called out the trees located on the left side of the helicopter. The main rotor blades impacted a eucalyptus tree, following with the tailboom and tail rotor system impacting a pine tree. After the tree impacts, the uncommanded yaw appeared to decrease and the pilot regained control of the helicopter. The pilot departed from the residential complex area by initiating a climbing turn to the northwest and initiated a mayday call. The pilot flew about 1 mile north, and made a landing at a school athletic field without further incident.

The helicopter was equipped with a Simplex Aerospace model 326 GII aerial firefighting belly-mounted tank that has the capability to hold 450 gallons of water via a supplemental type certificate.

The pilot reported that there were no preimpact mechanical failures or malfunctions with the airframe or engine that would have precluded normal operation.

The helicopter sustained substantial damage to the left stabilizer, the right stabilizer, and the tailboom. The heliocopter was secured and is pending transportation to the manufacturer's repair station for a comprehensive damage assessment.

The cockpit voice recordings, the flight data recordings, the terrain awareness and warning system data, and the flight tracking system data were secured for future download of the various data parameters.

Accident Rpt# ERA17LA263 **08/02/2017 720 EDT** **Regis# N971SK** **Jupiter, FL** **Apt: William P. Gwynn 06FA**

Acft Mk/Mdl SIKORSKY S-97A-NO SERIES **Acft SN 0001** **Acft Dmg: SUBSTANTIAL** **Rpt Status: Prelim** **Prob Caus: Pending**

Eng Mk/Mdl GENERAL ELECTRIC YT706-GE-700R **Acft TT 104** **Fatal 0** **Ser Inj 0** **Flt Conducted Under: FAR 091**

Opr Name: SIKORSKY AIRCRAFT CORP **Opr dba:** **Aircraft Fire: NONE**

AW Cert: SPE

Events

1. Taxi-to runway - Flight instrument malf/fail

Narrative

On August 2, 2017, about 0720, eastern daylight time, a experimental Sikorsky S-97, N971SK, experienced a hard landing while hovering at the William P Gwinn Airport (06FA), Jupiter, Florida. Both airline transport pilots received minor injuries. The test flight was conducted under the provisions of 14 Code of Federal Regulations Part 91. Visual meteorological conditions prevailed and no flight plan was filed for the local flight. The aircraft sustained substantial damage.

The helicopter was recovered from the accident site and retained for further examination.

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