Accident Rpt# CEN15FA290 07/03/2015 1339	**Regis# N390LG**	**Frisco, CO**	**Apt: Summit Medical Center 91CO**
Acft Mk/Mdl AIRBUS HELICOPTERS INC AS350B3E	**Acft SN 7595**	**Acft Dmg: DESTROYED**	**Rpt Status: Factual Prob Caus: Pending**
Eng Mk/Mdl TURBOMECA ARRIEL 2D		**Fatal 1 Ser Inj 2**	**Flt Conducted Under: FAR 135**
Opr Name: AIR METHODS CORP	**Opr dba:**		**Aircraft Fire: GRD**
			AW Cert: STN

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Acft Mk/Mdl AIRBUS HELICOPTERS INC AS350B3E **Acft SN 7595** **Acft Dmg: DESTROYED** **Rpt Status: Factual** **Prob Caus: Pending**

Eng Mk/Mdl TURBOMECA ARRIEL 2D **Acft TT 487** **Fatal 1** **Ser Inj 2** **Flt Conducted Under: FAR 135**

Opr Name: AIR METHODS CORP **Opr dba:** **Aircraft Fire: GRD**

AW Cert: STN

Events

1. Takeoff - Loss of control in flight
2. Takeoff - Loss of control in flight

Narrative

The NTSB's full report is available at http://www.ntsb.gov/investigations/AccidentReports/Pages/AccidentReports.aspx. The Aircraft Accident Report number is NTSB/AAR-17/01.

On July 3, 2015, about 1339 mountain daylight time, an Airbus Helicopters AS350 B3e helicopter, N390LG, registered to and operated by Air Methods Corporation, lifted off from the Summit Medical Center Heliport, Frisco, Colorado, and then crashed into a parking lot; the impact point was located 360 feet southwest of the ground-based helipad. The pilot was fatally injured, and the two flight nurses were seriously injured. The helicopter was destroyed by impact forces and a postcrash fire. The flight was conducted under the provisions of 14 Code of Federal Regulations Part 135 on a company flight plan. Visual meteorological conditions prevailed at the time of the accident.

National Transportation Safety Board - Aircraft Accident/Incident Database

Accident Rpt# CEN14FA099	**01/05/2014 1222 MST**	**Regis# N115WF**	**Aspen, CO**	**Apt: Aspen-pitkin Co/sardy Field ASE**
Acft Mk/Mdl CANADAIR LTD CL 600 2B16-601		**Acft SN 5153**	**Acft Dmg: DESTROYED**	**Rpt Status: Factual Prob Caus: Pending**
Eng Mk/Mdl GE CF34 SERIES		**Acft TT 6750**	**Fatal 1 Ser Inj 2**	**Flt Conducted Under: FAR 091**
Opr Name: VINELAND COMPANY CORP		**Opr dba: VZ FLIGHTS SA DE CV**		**Aircraft Fire: GRD**
				AW Cert: STT

Summary
The airplane, with two flight crewmembers and a pilot-rated passenger on board, was on a cross-country flight. The departure and en route portions of the flight were uneventful. As the flight neared its destination, a high-altitude, terrain-limited airport, air traffic control (ATC) provided vectors to the localizer/distance measuring equipment (LOC/DME)-E approach to runway 15. About 1210, the local controller informed the flight crew that the wind was from 290§ at 19 knots (kts) with gusts to 25 kts. About 1211, the flight crew reported that they were executing a missed approach and then requested vectors for a second approach. ATC vectored the airplane for a second LOC/DME-E approach to runway 15. About 1221, the local controller informed the flight crew that the wind was from 330ø at 16 kts and the 1-minute average wind was from 320ø at 14 kts gusting to 25 kts.

The initial part of the airplane's second approach was as-expected for descent angle, flap setting, and spoilers. During the final minute of flight, the engines were advanced and retarded five times, and the airplane's airspeed varied between 135 kts and 150 kts. The final portion of the approach to the runway was not consistent with a stabilized approach. The airplane stayed nose down during its final descent and initial contact with the runway. The vertical acceleration and pitch parameters were consistent with the airplane pitch oscillating above the runway for a number of seconds before a hard runway contact, a gain in altitude, and a final impact into the runway at about 6 g.

The weather at the time of the accident was near or in exceedance of the airplane's maximum tailwind and crosswind components for landing, as published in the airplane flight manual. Given the location of the airplane over the runway when the approach became unstabilized and terrain limitations of ASE, performance calculations were completed to determine if the airplane could successfully perform a go-around. Assuming the crew had control of the airplane, and that the engines were advanced to the appropriate climb setting, anti-ice was off, and tailwinds were less than a sustained 25 kts, the airplane had the capability to complete a go-around, clearing the local obstacles along that path.

Both flight crewmembers had recently completed simulator training for a type rating in the CL-600 airplane. The captain reported that he had a total of 12 to 14 hours of total flight time in the airplane type, including the time he trained in the simulator. The copilot would have had close to the same hours as the captain given that they attended flight training together. Neither flight crew member would have met the minimum flight time requirement of 25 hours to act as pilot-in-command under Part 135. The accident flight was conducted under Part 91, and therefore, the 25 hours requirement did not apply to this portion of their trip. Nevertheless, the additional flight time would have increased the crew's familiarity with the airplane and its limitation and likely improved their decision-making during the unstabilized approach. Further, the captain stated that he asked the passenger, an experienced CL-600-rated pilot. to accompany them on the trip to provide guidance during the approach to the destination airport. However, because the CL-600-rated pilot was in the jumpseat position and unable to reach the aircraft controls, he was unable to act as a qualified pilot-in-command.

Cause Narrative
THE NATIONAL TRANSPORTATION SAFETY BOARD DETERMINED THAT THE CAUSE OF THIS OCCURRENCE WAS: The flight crew's failure to maintain airplane control during landing following an unstabilized approach. Contributing to the accident were the flight crew's decision to land with a tailwind above the airplane's operating limitations and their failure not to conduct a go-around when the approach became unstabilized.

Events
1. Landing - Loss of control in flight

Findings - Cause/Factor
1. Personnel issues-Task performance-Use of equip/info-Aircraft control-Flight crew - C
2. Aircraft-Aircraft oper/perf/capability-Performance/control parameters-Descent/approach/glide path-Not attained/maintained - C
3. Personnel issues-Action/decision-Info processing/decision-Decision making/judgment-Flight crew - F
4. Environmental issues-Conditions/weather/phenomena-Wind-Tailwind-Effect on operation - F
5. Aircraft-Aircraft oper/perf/capability-Aircraft capability-(general)-Capability exceeded - F
6. Personnel issues-Task performance-Use of equip/info-Use of policy/procedure-Flight crew - F
7. Environmental issues-Conditions/weather/phenomena-Wind-Tailwind-Compliance w/ procedure - F
8. Environmental issues-Physical environment-Terrain-Mountainous/hilly terrain-Contributed to outcome - F
9. Aircraft-Aircraft oper/perf/capability-Performance/control parameters-Descent/approach/glide path-Capability exceeded - F

Narrative

HISTORY OF FLIGHT

On January 5, 2014, at 1222 mountain standard time (MST)[1], a Bombardier (formerly Canadair) CL-600-2B16 Challenger, N115WF, impacted the runway during landing land on Runway 15 at Aspen-Pitkin County Airport/Sardy Field (ASE), Aspen, Colorado. The copilot was fatally injured; the captain and the passenger received serious injuries. The airplane was destroyed. The airplane was registered to the Bank of Utah Trustee and operated by Vineland Corporation Company, Panama, South America under the provisions of 14 Code of Federal Regulations (CFR) Part 91. Visual meteorological conditions prevailed for the flight, which operated on an instrument flight rules (IFR) flight plan. The flight originated from the Tucson International Airport (TUS), Tucson, Arizona, at 1004.

The departure and en route portions of the flight were uneventful. As the flight neared ASE, air traffic control (ATC) provided vectors to the localizer/distance measuring equipment (LOC/DME) approach to runway 15 at ASE. At 1210:04, the local controller at the ASE air traffic control tower (ATCT) informed the flight crew that the wind was from 290§ at 19 knots (kts), with gusts to 25 kts. At 1211:18, the crew reported that they were executing a missed approach and then requested vectors for a second attempt. ATC vectored the airplane for a second LOC/DME-E approach. At 1220:35, the local controller informed the flight crew that the wind was from 330ø at 16 kts and the 1-minute average wind was from 320ø at 14 kts gusting to 25 knots. He then cleared the flight to land. For further information about the communications between ATC and the flight crew during the first approach and the accident approach, see the Communications section of this report.

Airport surveillance video of the runway showed the airplane landing at ASE. The following sequence of events was seen in the video: the airplane above the runway in a slightly nose-down attitude, a flash of light consistent with a runway strike, the airplane in the air above the runway in a nose-down attitude, and the airplane impacting the runway in a nose-down attitude and being engulfed in light. About 4 seconds elapsed between the runway strike and the final impact.

The airplane came to rest inverted on the west side of runway 15, halfway between taxiways A5 and A6. The ASE airport operations and aircraft rescue and firefighting (ARFF) station was located on the west side of runway 15, about 0.3 miles north of the accident site. ASE ARFF had witnessed the accident occurring and responded immediately, requesting clearance onto the runway about 50 seconds after the accident occurred.

PERSONNEL INFORMATION

The captain, age 52, was a citizen of Mexico. He held a Mexican air transport pilot certificate that included an Airbus-320 type rating and ratings for airplane multi-engine land and instrument airplane. The captain also held a Federal Aviation Administration (FAA) temporary airman certificate issued on November 9, 2013. The temporary commercial pilot certificate included a CL-600 type rating and ratings for airplane single-engine land, airplane multi-engine land rating, and instrument airplane. The certificate was subject to a limitation for English proficiency. Upon FAA review of the pilot's temporary certificate after the accident, it was determined that a limitation on the pilot acting as pilot-in-command for the CL-600 should have been included on the temporary certificate; however, the limitation had been overlooked by the designated pilot examiner who issued the certificate. The limitation would have restricted the captain from serving as pilot-in-command in the CL-600 airplane with revenue passengers on board until he had acquired 25 hours of actual flight time in the CL-600 with another qualified pilot.

The captain was issued a first-class airman medical certificate on August 27, 2013, with the limitation: must have available glasses for near vision.

On November 8, 2013, the captain completed training for the CL-600 type rating at Simuflight in Dallas, Texas. According to the training records, the pilot received a "satisfactory" rating at the completion of the training checkride. During post-accident interviews, the captain stated that he did not have any trouble during his flight training other than with use of the flight management system (FMS). His flight experience in CL-601 airplanes at the time of the accident consisted of a ferry flight from Dallas, Texas, to Toluca, Mexico and a flight from Toluca, Mexico, to Eagle County Airport, Colorado, and back to Toluca, Mexico. He stated that his total flight time in the CL-601 was 12 to 14 hours, which included his flight training at Simuflight. He explained that he had accrued 8,000 hours flying the Airbus 318, 319, and 320 before flying the CL-601 and had about 17,000 hours of total flight time. The Airbus time reported was completed under his Mexican Flight Certificate and did not transfer to his FAA issued certificate.

The copilot, age 54, was a citizen of Mexico. He held a Mexican air transport pilot certificate that included an Airbus-320 type rating and ratings for airplane multi-engine land and instrument airplane. The copilot also held an FAA temporary airman certificate issued on November 14, 2013. The temporary commercial pilot certificate included a CL-600 type rating and ratings for airplane single-engine land, airplane multi-engine land and instrument airplane. The certificate was subject to a pilot-in-command limitation for the CL-600. This limitation restricted the copilot from serving as pilot-in-command in the CL-600 airplane with revenue passengers on board until he had accrued 25 hours of actual flight time in the CL-600 with another qualified pilot. The certificate was also subject to a limitation for English proficiency.

A limited first class medical certificate was issued to the copilot on December 13, 2012, with the limitation: must have available glasses for near vision. A limited first class medical is valid for 6 months from the time of issuance for operations requiring a first class medical; it is valid for 12 months from the time of issuance for operations requiring a second class medical; and, after 12 months, it is valid only for operations requiring a third class medical. At the time of the accident, 13 months after the time of issuance, the copilot's medical certificate would have been equivalent to a third class medical certificate. The copilot reported on his most recent medical certificate application that he had accumulated 20,398 total flight hours, with 31 hours in the previous 6 months. The copilot's logbook was not located during the investigation. The flight time reported on the copilot's medical certificate application was completed under his Mexican pilot certificate and did not transfer to his FAA issued certificate.

On November 9, 2013, the copilot completed training for the CL-600 type rating at Simuflight in Dallas, Texas. According to the training records, the copilot received an "Unsatisfactory" rating at the completion of the training checkride. Records indicate the copilot did not satisfactorily complete two tasks under the "missed approach" approach skills, including "from a nonprecision approach" and "engine out." On November 14, 2013, the copilot was re-tested and received a "satisfactory" rating at the completion of the second training checkride.

The pilot-rated passenger, age 52, was a citizen of Mexico. The passenger also held an FAA, foreign-based commercial pilot certificate with airplane single-engine land and airplane multi-engine land ratings. No type rating for the CL-601 was included on the FAA- issued commercial certificate. The FAA certificate was issued on the basis of and only valid when accompanied by his Mexican pilot certificate. Additionally, the FAA certificate was not valid for the carriage of persons or property for compensation or hire or for agricultural aircraft operations. The passenger held a first class medical certificate issued on December 9, 2013, with the limitation: must have available glasses for near vision. According to the captain, the passenger was his and the copilot's friend. The captain also reported that the passenger was an experienced pilot on the CL-601 and was invited to join them on the trip to "provide any recommendations" because of the "special conditions" at ASE. The passenger was sitting in the flight deck jumpseat position.

AIRCRAFT INFORMATION

The airplane, a Bombardier (formerly Canadair) CL-600-2B16 Challenger 601-3R variant, was a twin-engine corporate jet (serial number 5153) manufactured in 1994. It was powered by two General Electric, CF34-3A1 turbofan engines rated at 9,000 foot-pounds of thrust. The airplane had an occupancy of 12 passengers and 2 crewmembers, with an additional jumpseat for a cabin crewmember.

According to the information provided by the captain, the most recent inspection on the airplane's approved aircraft inspection program was completed on December 18, 2013, at an airframe total time of 6,750 hours.

According to the Canadair Challenger Airplane Flight Manual (AFM) PSP 601A-1-1, Section 3(f) Tailwind Conditions under Operating Limitations states,

"the maximum tailwind component approved for take-off and landing is 10 kts."

METEOROLOGICAL INFORMATION

The observations for ASE indicated IFR conditions with light snow in the morning with visual flight rules (VFR) conditions prevailing at the time of the accident. Immediately before the airplane's arrival in the area, the wind speeds began to increase with gusts to 28 kts. The gusty winds lasted from 1153 to 1553, and northwesterly wind gusts of 25 kts or more were reported. The National Weather Service (NWS) Terminal Aerodrome Forecast (TAF) for ASE that was current at the time of the airplane's departure from TUS indicated that the wind at the airplane's estimated time of arrival into ASE would be from 340§ at 11 kts with no gusts or low-level wind shear forecast.

The airport had a federally installed and maintained Automated Surface Observation System (ASOS) located east of the touchdown zone of runway 15. At 1153, the ASE automated ASOS reported the following weather conditions:

Wind from 310ø true at 9 kts gusting to 28 kts, wind variable from 270ø to 360§, visibility 9 miles in haze, a few clouds at 3,500 ft above ground level (agl), ceiling broken at 4,600 ft, overcast at 5,000 ft, temperature - 11ø Celsius (C), dew point temperature -20ø C, altimeter 30.07 inches of mercury (Hg). Remarks:

automated surface observation system, peak wind from 320ø at 28 kts occurred at 1150, sea level pressure 1024.3-hPa, temperature -11.1ø C, dew point -20.0ø C.

At 1220, the approximate time of the accident, the ASOS indicated:

Wind from 320ø at 14 kts gusting to 25 kts, wind variable from 280ø to 360ø, visibility 10 miles in haze, scattered clouds at 4,700 ft agl, ceiling broken at 6,000 ft, temperature - 12ø C, dew point temperature -21ø C, altimeter 30.07 inches of Hg. The remarks indicated a peak wind from 320ø at 26 kts occurred at 1204.

The ASE ASOS 1-minute data (which uses a 2-minute running average wind issued every minute) from 1218 to 1222 were:

TIME WIND GUST CROSS TAILWIND

1218 333ø 15KT 345ø 20KT 5KT 19KT

1219 323ø 15KT 339ø 22KT 0KT 22KT

1220 324ø 14KT 324ø 25KT 7KT 24KT

1221 333ø 15KT 338ø 22KT 1KT 22KT

1222 333ø 14KT 328ø 17KT 3KT 17KT Accident

An urgent pilot report (PIREP) over ASE at 1205 from a Learjet 35 flightcrew reported low-level wind shear with a 10 kt loss of airspeed on a 2-mile final to runway 15. It was undetermined if the accident airplane received this PIREP.

Several surrounding airports also reported strong gusting northwest winds during the period. Lake County Airport (LXV), Leadville, Colorado, located 25 miles east of ASE, reported IFR conditions in light to heavy snow with west-northwesterly winds gusting to 31 kts. Copper Mountain (CUU), Colorado, located 36 miles east of ASE reported westerly winds at 20 kts gusting to 46 kts during the period.

The NWS Grand Junction (GJT), Colorado, upper air sounding at 0500 depicted a shallow surface-based temperature inversion with light winds below 300 ft and northwesterly winds above that altitude with little variation in direction and increasing wind speeds. The mean wind was from 324ø at 39 kts. The wind and temperature profile supported a light-to-moderate mountain wave formation with respect to updrafts, downdrafts, and turbulence potential.

COMMUNICATIONS

The following excerpt from the FAA ATC transcription details communications between the airplane's flight crew and ATC during the first approach and the accident approach.

The ASE ATCT began communication with the airplane at 1209:31, when the flight crew reported they were "nine miles out." The remainder of the communications were as follows:

1210:04 (ATCT) Wind 290 at 19, 1-minute average wind 320 at 12 gust 25, runway 15 cleared to land.

1210:15 (N115WF) Cleared to land, roger.

1210:38 (ATCT) Falcon just reported a gain of 20 kts, use caution for low level wind shear.

1210:45 (N115WF) Roger

1211:07 (ATCT) winds 310 at 10.

1211:18 (N115WF) Okay. Missed approach. 33 kts of tailwind.

1211:26 (ATCT) Execute publish missed.

1211:30 (N115WF) Okay.

1211:37 (ATCT) Climb and maintain 16,000, expedite your climb, execute published missed. 16,000 on the missed.

1211:45 (N115WF) Executing. Climbing to 16,000.

1212:38 (ATCT) Contact departure 123.8.

1212:50 (N115WF) 123.8.

N115WF contacted Aspen ATCT terminal control (approach) following the missed approach, as follows:

1212:53 (Approach) N115WF aspen departure, say intentions.

1213:03 (N115WF) Okay. We turn back and do another approach. We got a tailwind of 30 kts.

1213:10 (Approach) Roger. Fly heading 310, vector localizer DME echo approach.

1213:16 (N115WF) 310 and vectors again got localizer 15.

1213:42 (Approach) N115WF descend and maintain 13,400.

1213:44 (N115WF) 13,400.

1214:07 (Approach) N115WF fly heading 290.

1214:10 (N115WF) Now heading 290, 115WF.

1215:12 (Approach) N115WF turn right heading 020.

1215:18 (N115WF) 020 on the heading 115WF.

1215:32 (N115WF) Confirm 15WF 020 on the heading.

1215:36 (Approach) N115WF turn right heading 060 now.

1215:40 (N115WF) 060 now.

1216:56 (Approach) N115WF, 4 miles from jargu turn right heading 120 cross jargu at 13,400, cleared localizer DME echo approach.

1217:05 (N115WF) 120 on the heading to intercept localizer DME, 115WF.

1217:10 (Approach) and N115WF that's cleared localizer DME echo approach.

1217:15 (N115WF) localizer DME approach N115WF

1218:01 (Approach) N115WF contact tower.

1218:04 (N115WF) Contact tower.

N115WF contacted Aspen ATCT (local) for the second approach into ASE. This approach was the accident approach, with the following air traffic communications:

1218:37 (Local) N115WF Aspen tower.

1219:21 (Local) N115WF Aspen tower.

1219:24 (N115WF) Go ahead.

1219:26 (Local) Runway 15 continue for N115WF.

1219:28 (N115WF) We'll continue the 115WF.

1219:42 (Local) N115WF traffic 12 o'clock, 7 miles turning westbound 9,200 ft.

1219:47 (N115WF) IFR.

1220:08 (Local) N115WF traffic no factor. Disregard, no factor, westbound now.

1220:14 (N115WF) Roger 115WF. In IFR conditions now.

1220:35 (Local) N115WF winds 330 at 16, runway 15 cleared to land. 1-minute average 320 [at] 14 gust 25.

1220:45 (N115WF) Roger, 115WF.

1222:04 (Local) Go around, go around, go around, go around. [The accident occurred here. Emergency services were dispatched and ASE was closed.]

AIRPORT INFORMATION

Aspen-Pitkin County/Sardy Field is a certificated Part 139 airport, and the field elevation is 7,838 ft. It is a towered airport operating in Class-D airspace. The airport is equipped with one runway; runway 15/33 which is 8,006 ft in length and 100-ft wide. An aircraft rescue and firefighting station is located on the airfield and responded to the accident.

Runway friction measurements were taken immediately following the accident using a Dynatest 6875 runway friction tester. The average friction for Runway 15 was 1.087mu, and the lowest reading was 0.781 mu for the section at the departure end of runway 15. According to the FAA, the minimum friction for a runway tested with the Dynatest device is 0.50mu.

At the time of the accident, there was one notice to airmen (NOTAM) in effect at ASE related to Runway 15/33. This NOTAM, issued at 0609, stated "snow swept 75-feet wide" on the runway surface.

Because of the terrain features surrounding ASE, alternate minimums (other than the standard approach minimums) were established for instrument approaches into runway 15 at ASE. Additionally, there are no IFR or visual flight rule approaches into runway 33 at ASE because of terrain limitations and noise restriction areas.

FLIGHT RECORDERS

Flight Data Recorder (FDR)

The airplane was required to be equipped with an FDR that recorded a minimum of 18 parameters, as cited in 14 CFR Part 91.609(c). The NTSB's Vehicle Recorders Lab extracted the data contained on the Loral/Fairchild F1000 (P/N S603-1000-00, S/N 00523) FDR installed on the airplane.

The FDR recording contained about 124 hours of data. The event flight was the last flight of the recording, and its duration was about 2 hours 18 minutes.

The FDR data starting at 1208:00 showed a flight pattern consistent with the missed approach. After the missed approach, at 1219:45, about 2 minutes 37 seconds before the end of the FDR recording, the airplane began its final descent from a pressure altitude of about 12,900 ft. At this time, the left and right flaps were at 28§, the autopilot was "On", and the N1 speeds of both engines were decreasing through about 73%.

Twenty-four seconds later, at 1220:09, while descending through a pressure altitude of about 12,500 ft, the autopilot transitioned to "Off" and remained off for the rest of the FDR recording. At this time, the N1 speeds of both engines were steady about 33%.

Thirty-four seconds later at 1220:43, while descending through a pressure altitude of about 11,000 ft, the left and right flaps increased to 44§. Twenty-seven seconds later, while descending through a pressure altitude of about 9,150 ft, the N1 speeds of both engines began increasing.

For the next 56 seconds, the N1 speeds of both engines varied together between a maximum of about 75% and a minimum of about 42%. Because this airplane was not equipped with an autothrottle, these changes in N1 speeds would have been commanded by a flight crewmember. Also during this time, the pitch angle oscillated between a maximum of 4.3§ nose up and a minimum of -5.2§ nose down. At 1222:06, the vertical acceleration peaked at 2.91 g (which was beyond the airplane's design envelope for load factor), and the pitch angle increased to about 5.6§.

Over the next 16 seconds, until the end of the FDR recording at 1222:22, the pitch angle increased to about 15.3 § nose up, decreased to about -13.1§ nose down, increased to about 24.7§ nose up, and then settled to about 0§. Additionally, the vertical acceleration decreased to -0.17 g, peaked at 5.76 g and then settled at -1.46 g.

Cockpit Voice Recorder (CVR)

The airplane was required to be equipped with a CVR that recorded at least the last 30 minutes of aircraft operation, as cited in 14 CFR Part 91.609(e). The NTSB's Vehicle Recorders Lab extracted the data contained on the Fairchild A100A (P/N 93-A100-83, S/N 61480) CVR installed on the airplane.

Most intracockpit communications were in Spanish and were translated into English. The translation was not word for word, rather, it was idiomatic and considered the context and meaning of the Spanish source language. The following is an excerpt from the CVR transcript of pertinent communications or events recorded:

The CVR recording began at 1152:34 as the flight crew began receiving radar vectors for the first localizer approach into ASE. At 1155:07, static similar to cell phone interference for about 25 seconds occured followed by a chime similar to a cell phone alert. At 1155:19, another sound of a chime similar to a cell phone alert was heard, and the copilot stated he "turned it off, I do not know why it is . it's Whatsapp." Static interference similar to cell phone interference continued until 1156:53.

At 1155:34, the approach controller advised the flight crew to turn left to a heading of 150 §. Between 1155:47 and 1157:16, there was discussion in the cockpit about the LOC/DME-E approach and discontent about being given delaying vectors instead of being given a slot in the landing sequence. At 11:56:29, another airplane (N7HB, a Gulfstream 280) requested to divert to Garfield County Regional Airport (RIL) in Rifle, Colorado, located about 50 miles northwest of ASE.

At 1206:32, the flight crew listened to a recording of the ASE automated terminal information service (ATIS) report hearing only those parts broadcasting NOTAM information. Then the captain asked the passenger if vertical navigation (VNAV) could be used, and the passenger responded, "yes." The captain called for 20§ of flaps. The copilot verified speed, and the flap handle was lowered.

At 1207:12, the approach controller requested that the flight crew verify they were descending to 13,400 ft. The copilot responded "yes, ah we're slowing down the aircraft." The captain and copilot discussed why the airplane was not "going down." The passenger instructed the crew to turn on VNAV.

At 1207:44, the approach controller directed the flight crew to turn left to a heading of 180 §, cross JARGU (an approach fix) at or above 13,400 ft, and cleared the flight to execute the LOC/DME-E approach.

At 1208:13, the flight crew continued to setup for the approach. The captain asked the copilot for flaps 20 §. The copilot stated, "they're there, flaps 30." Then power was reduced, followed by the landing gear being lowered. The crew discussed attempting to intercept the localizer, and the passenger explained that they had not entered it into the FMS. The copilot asked the captain if he should input flaps 30 §, the captain agreed, and the flap handle was lowered. The crew slowed the airspeed down, and the passenger remarked that the speed was 65 (165).

At 1208:51, the approach controller directed the flight crew to contact the tower. There was confusion about what altitude they needed to maintain to intercept the localizer. The captain and copilot thought they were too high, and the passenger advised "you're good." The flight crew continued to discuss being too high for the localizer.

At 1209:32, the local controller called the flight crew because they had not contacted the tower yet. The flight crew continued to discuss being too high and unsure what altitude they should be at when they crossed the next approach fix.

At 1210:00, the flight crew established contact with the local controller. The local controller advised that the wind was from 290 § at 19 kts, and the 1-minute average wind was from 320 § at 12 kts gusting to 25 kts. The local controller cleared the flight crew to land on runway 15. The copilot confirmed, "having the runway, cleared to land. And ah roger with the wind." Discussion about their altitude being too high continued in the cockpit.

At 1210:38, the local controller advised the flight crew that a Falcon had just reported a gain of 20 kts and to use caution for low-level windshear. At 1210:45, the copilot replied, "ah roger," and the flight crew continued discussing the airplane's high altitude.

The copilot said, "pull the power," and the passenger confirmed that the crew was "established." The copilot remarked, "we have a 30 knot tail wind dude," and "they had 20 tailwind gusts."

At 1211:08, the local controller announced "wind 310 at 10 kts". The copilot was repeating the winds just reported when the captain stated, "we're at 5 miles. Whoa dude the runway is right here dude." The copilot, passenger, and captain agreed the it was "impossible" to make the runway. The copilot announced a missed approach and stated, "there's 33 kts of tailwind." The flight crew executed a missed approach. The local controller cleared the flight crew to execute the published missed approach to 16,000 ft.

At 1212:38, the local controller advised the flight crew to contact approach control. No confirmation was received from the flight crew, the local controller repeated the instruction to contact approach control, and the flight crew acknowledged the frequency change.

At 1212:53, the flight crew contacted approach control, and the controller asked the flight crew their intentions. The passenger told the flight crew "to return back." The copilot informed the controller that they wanted to return for another approach and added "we had a tailwind of 30 knots." The approach controller began to provide the flight crew with vectors for the LOC/DME-E approach.

At 1213:24, the flight crew began setting up the approach in the FMS again. For about the next 4.5 minutes, the flight crew and passenger attempted to program the FMS.

At 1216:57, approach advised N115WF they were 4 miles from JARGU, fly heading 120, cross JARGU at 13,000 feet, and cleared the Localizer DME Echo approach. The copilot partially readback the clearance, with an error, and the controller corrected the error.

At 1218:01, the approach controller directed the flight crew to contact the tower. The flight crew acknowledged. The passenger began to instruct the captain through the approach, including input of flaps as well as altitude and airspeed guidance for descent.

At 1218:49, the captain said that the wind was at 26 kts and remarked that once through the mountains, the winds might decrease. The passenger replied, "don't worry" and continued to provide instructions on the approach.

At 1219:22, the local controller contacted the flight crew and instructed them to continue the approach to runway 15.

For about the next minute, the captain continued to fly the approach with some input from the passenger and copilot. There were multiple remarks that the altitude was too high and they needed to "go lower." At 1220:29, the copilot stated, "put in speed brakes, put in speed brakes." followed by pointing out, "there's the runway." The captain replied with an expletive and requested gear down.

At 1220:35, the local controller said "wind 330 at 16. Runway 15 cleared to land. One-minute average 320 at 14 kts gusting to 25 kts."

At 1220:35, the passenger called for full flaps, and the sound of an altitude alert was heard, followed shortly thereafter by the enhanced ground proximity warning system (EGPWS) alert "sink rate, sink rate." The copilot announced "tail wind is 39 kts. Like 35 kt tail wind. Careful." The passenger stated "as we get lower, I'll take out the flight spoiler for you." The EGPWS announced "sink rate, sink rate" again. The copilot told the captain to add a little power followed 10 seconds later by "take off power. Less less less less less less less." The captain replied, "wait dude because I need to control this."

At 1221:36, the copilot said, "this wind is from the tail. This is screwed." He then remarked, "maybe it will calm down by the mountain." The copilot instructed, with strain in his voice, to "follow to the center. To the center. That's it. There you go"; this was followed by the sound of a reduction in power. The passenger and copilot called out 100 ft. The passenger instructed, "put it through." In a strained tone, the copilot remarked, "oy oy, oy ah." The pilot used some expletives and then stated, "the winds are screwed." The passenger instructed the flight crew to lower the spoiler, and the copilot told him, "No no. Careful careful." The passenger instructed, "lower it, lower us." The copilot said, "no, let's go." The passenger repeated, "lower us." There was a power increase, then decrease, and the airplane contacted the runway. A warning sound of either flight spoilers extended or take-off configuration warning was heard, followed by a stall warning. The tower remarked "go around, go around, go around," followed by someone in the flight deck stating, "let's go, let's go." The recording ended at 1220:10.

WRECKAGE AND IMPACT INFORMATION

The airplane was found inverted beside the runway with fire damage on the fuselage and wings. The inside of the cockpit and cabin did not show evidence of fire. The airplane's under belly from the air driven generator to the underside of the inboard right wing had markings consistent with ground scraping. The right upper cockpit structure was partially collapsed and structurally breached. The right wing was folded beginning about 1/3 of the wingspan from fuselage. The left wing was bent downward (relative to the airplane's resting position) outboard of the outboard flap. The upper section of the vertical stabilizer, including the horizontal stabilizer, was detached from the main hull.

Both main landing gear were found in the extended position and connected only by their side stay actuators. Examination of the left and right main landing gear attachment points on the wing spars and trunions showed the pivot bushings intact and in their bore holes. The right main landing gear door link was still attached. Both main landing gear attachment fittings were found structurally intact. The nose landing gear wheel well structure was deflected upward but did not contact any flight control beam assemblies under the cockpit floor. The nose landing gear was folded about 70§ aft and 30§ to the left. The right axle for the nose landing gear was severed, and the right nose wheel tire was missing. The left nose wheel was missing a portion of the inboard hub rim. The nose landing gear lower oleo strut had markings consistent with ground scraping on the axle jack point. A portion of the nose landing gear axle fracture surface had markings consistent with ground scraping.

The flaps were found in a deployed position. The right inboard and outboard flaps were disconnected from the wing. The left inboard flap's inboard and outboard actuator screws were severed. The left outboard flap was attached to the wing by both actuators and hinges. The outboard flap screw actuator was measured from the gearbox housing aft surface (just forward of the dog stop ring) to the face surface of the ball screw assembly and found a distance of 5 3/4 inches. The exposed threads were counted and found 26 threads indicting a flap position of 45§.

The horizontal stabilizer trim actuator jack screw was examined and found intact. The measurement from the gear box upper surface to the upper gimbal lower surface was 4.85 inches, indicating a trim setting of about 4.85 (trim indicator range is from 0-9; 0 is full nose-down and 9 is full nose-up; a measurement of 7.59 inches equates to about full nose-down). The left electrical connector for the horizontal stabilizer trim noise suppressor was found pulled from its connection.

The left and right main angle of attack (AOA) vanes were found intact with no visible damage. Both vanes moved normally when a finger force was applied.

The right aux AOA vane had no visible damage; however, it did not move when a finger force was applied.

The outer cowling of the left engine, S/N 807029, did not appear to sustain any impact damage. The outside of the engine cowl, the fan inlet, and the fan blades exhibited smoke sooting. The cowls and core cowls were able to open normally. The engine under the cowls was free of soot and appeared normal. The main fuel control lever/linkage feedback match marks were aligned consistent with an engine that was in the "OFF" position. No other anomalies were noted while the engine was still mounted to the airplane. After the engine was removed from the airairplane, it was placed on the ground and further inspection was conducted. During engine removal, all engine to pylon connections were visually inspected and appeared normal. The fan blades did not sustain any visible damage. The inner surface of the fan inlet appeared bubbled and heat distressed from 0-90§ aft looking forward (ALF). The fan was free to turn by hand with no abnormal sounds noted. There were scrapes on the outside of the fan case from 270-0§ ALF. Visual inspection of all under cowl areas indicated all hardware was consistent with a normal flight engine. The fan cowls were not removed from the engine. Visual inspection of the tailpipe indicated no anomalies with the low pressure turbine.

The right engine, S/N 807136, sustained fire damage from the exterior of the airplane. The outer cowls showed burn-through from outside to inside in several areas. Melted cowl material had dropped onto the exterior of the engine cases and components. The upper cowl had to be pried and cut with a saw in order to open it. Under the cowls, the engine appeared normal with no indications of an engine fire. The main fuel control linkage feedback match marks were aligned consistent with an engine that was in the "OFF" position. No other engine anomalies were noted while the engine was still mounted to the airplane. After the engine was removed from the airplane, it was placed on the ground, and further inspection was conducted. During engine removal, all engine to pylon connections were visually inspected and appeared normal. Impact damage to the inner surface of the fan inlet showed deformation from 0-90§ ALF. The fan did not rotate by hand. Contact was noted between the fan case and fan blades, as well as molten material from the postcrash fire in the area. A handful of blades showed un-blended foreign object debris (FOD) damage; both hard and soft body damage were noted. The un-blended FOD damage consisted of tears and bent material consistent with multiple foreign objects entering the fan with the engine still producing power. Visual inspection of all under cowl areas indicated all hardware was consistent with a normal flight engine with the exception of the soot and molten material from the postcrash fire. Fan cowls were not removed from the engine. Visual inspection of the tailpipe indicated no anomalies with the low pressure turbine.

A visual inspection of the cockpit found the following:

- The flap handle was at 45§.

- The engine power levers were in the shut off position.

- The engine reverse thrust levers was in the stowed position.

- The landing gear handle was in the down position.

- The flight spoiler handle was in the retract position.

- The ground spoiler switch was in the on position.

- The right control column was bent to the left about 20§.

- The left and right control yokes were deflected to the right about 20§ and appeared to be synched.

- The pitch and roll disconnect handles were in their normally stowed position.

- The EGPWS PBAs were in their normal out positions.

- The pilot and copilot stall protection pusher switches were in the on position.

- The air driven generator was in the deployed position.

MEDICAL AND PATHOLOGICAL INFORMATION

A post mortem examination of the copilot was conducted under the authority of Rocky Mountain Forensic Services, PLLC, Loma, Colorado. The cause of death for the copilot was attributed to multiple injuries.

The FAA's Civil Aeromedical Institute performed toxicology examinations for the copilot which were negative for carbon monoxide, alcohol, and drugs. No toxicology exam was completed for the captain or the passenger.

TESTS AND RESEARCH

Crew Training Requirements

Federal Aviation Regulation (FAR) 61.64, Use of a Flight Simulator and Flight Training Device, paragraph (b), states that if an airplane is not used during the practical test for a type rating for a turbojet airplane, an applicant must accomplish the entire practical test in a Level C or higher flight simulator and the applicant must:

(1) Hold a type rating in a turbojet airplane of the same class of airplane for which the type rating is sought, and that type rating may not contain a supervised operating experience limitation;

(2) Have 1,000 hours of flight time in two different turbojet airplanes of the same class of airplane for which the type rating is sought;

(3) Have been appointed by the U.S. Armed Forces as pilot in command in a turbojet airplane of the same class of airplane for which the type rating is sought;

(4) Have 500 hours of flight time in the same type of airplane for which the type rating is sought; or

(5) Have logged at least 2,000 hours of flight time, of which 500 hours were in turbine-powered airplanes of the same class of airplane for which the type rating is sought.

Paragraph (f)(2) of this regulation states that if the applicant does not meet one of the experience requirements of paragraphs (b)(1) through (5), as appropriate to the type rating sought, then the applicant's pilot certificate will be issued with a limitation that states: "The type rating is subject to pilot in command limitations," and the applicant is restricted from serving as pilot in command in an aircraft of that type.

Paragraph (g) of this regulation explains that the limitation described under paragraph (f)(2) may be removed from the pilot certificate if the applicant complies with the following -

(1) Performs 25 hours of flight time in an aircraft of the category, class, and type for which the limitation applies under the direct observation of the pilot in command who holds a category, class, and type rating, without limitations, for the aircraft;

(2) Logs each flight and the pilot in command who observed the flight attests in writing to each flight;

(3) Obtains the flight time while performing the duties of pilot in command; and

(4) Presents evidence of the supervised operating experience to any Examiner or FAA Flight Standards District Office to have the limitation removed.

This rule applies to all pilot training accomplished for a Part 135 commuter and on-demand flight operator. The captain and copilot did not have the required 25 hours of flight time in the CL-600 airplane and therefore, did not meet the requirements of this regulation to act as pilot-in-command. However, because there were no revenue paying passengers on board the airplane, the accident flight was being operated under Part 91 as a general aviation flight. As such, the flight time requirement did not apply to the accident flight.

Aircraft Performance

An NTSB Vehicle Performance Specialist completed an airplane performance study using the data from the FDR. The study used the flight crew's calculations of the airplane's landing weight at 35,881 pounds and center of gravity (CG) at 512.6 inches.

During the last 6 minutes of flight, the airplane descended from 13,500 ft and slowed from an airspeed of 220 kts. The airplane's descent angle for the last nautical mile of flight was about 4§, and its airspeed was about 140 kts.

Runway 15 at ASE was on a magnetic heading of 151§ (160§ true); it began at an elevation of 7,680 ft and sloped upward at a gradient of 1.9%. During the last minute of flight, the airplane's track aligned with the runway heading. The wind was variable from 280§ to 360§ at 14 kts gusting to 25 kts. A 25 kt gust from 280§ equates to a 21 kt crosswind and a 12 kt tail wind on runway 15. Wind from 340§ would be a pure tailwind. The airplane's maximum tailwind component for takeoff and landing, as reported in the AFM, was 10 kts. According to the AFM, the maximum demonstrated crosswind component for landing on a dry runway was 24 kts.

ASE was a high-altitude, terrain-limited airport. For the LOC/DME-E approach, the missed approach point was 2.6 nm from the threshold. The missed approach procedure was to execute a climbing right turn to 14,000 ft on a heading of 300§. The airplane had performed a missed approach before the accident landing.

If attempting a go-around over the runway, there would be three points of high terrain (Aspen Mountain, the hill where the I-PKN localizer is installed, and Richmond Hill) beyond the end of Runway 15 to clear. Of the three, the location of the I-PKN localizer would require the steepest climb gradient from the runway threshold. To clear the I-PKN localizer, an aircraft would have to climb to 3,500 ft (to an altitude above 11,188 ft) in 31,000 ft of horizontal distance.

The Aircraft Operating Manual (AOM) provided climb data from sea level to various altitudes for different take-off weights for international standard atmospheric conditions (ISA). The temperature on the day of the accident was colder than ISA, so climb performance would have been better than this data indicates, making the following evaluation conservative. Data provided were the altitude gain, time, ground distance, and fuel burn for conditions with both engines operating; no information was provided to indicate the change in climb performance with the anti-icing systems on, but a 30% degradation was assumed using other data from the AFM. Given the information known from the FDR, AOM, and AFM and the elevations of the airfield and obstacles to clear, it was determined that the airplane should have been able to clear both Aspen Mountain and Richmond Hill if the anti-icing was off. Clearing the I-PKN localizer location would require a more optimal climb performance and less than a 25 kts tailwind. However, the climb performance data used was conservative, the atmosphere was cooler, and the winds were variable. Additionally, the weather (scattered clouds at 4,700 ft agl, and a broken ceiling at 6,000 ft) might have allowed the crew to maneuver around the worst case terrain obstacles.

ADDITIONAL INFORMATION

On January 11, 2014, based on the events of the accident, ASE ATCT changed its standard operating procedures for dissemination of wind information. The 1-minute average wind data was established to be the "official winds to be issued" to pilots at ASE. While the local controller provided the 1-minute wind average (and associated gust information) to the accident flight crew during arrival, the procedure in place at the time of the accident allowed wind reporting to be controller discretion. Local controllers at ASE could provide flight crews either the instantaneous wind readings or the 1-minute average with 10-minute gust information.

Although the ASOS continued to provide pilots with the 2-minute average wind with 10-minute gust data via the ATIS, the most updated wind data available (the 1-minute average wind data) from the stand-alone weather station (SAWS) was required to be provided by the ASE ATCT controllers.

Accident Rpt# CEN17LA047	**12/04/2016 1853 MST**	**Regis# N332SE**	**Gunnison, CO**	**Apt: Gunnison-crested Butte Airport GUC**
Acft Mk/Mdl CESSNA CITATION 500		**Acft SN 500-0332**	**Acft Dmg: SUBSTANTIAL**	**Rpt Status: Factual Prob Caus: Pending**
Eng Mk/Mdl P&W JT-15D-1A		**Acft TT 5218**	**Fatal 0 Ser Inj 0**	**Flt Conducted Under: FAR 091**
Opr Name: YATISH AIR LLC		**Opr dba:**		**Aircraft Fire: NONE**
				AW Cert: STN

Events

1. Landing-flare/touchdown - Hard landing

Narrative

On December 4, 2016, about 1853 mountain standard time, a Cessna Citation 500, N332SE, sustained substantial damage during a hard landing and runway excursion at the Gunnison-Crested Butte Airport (GUC), Gunnison, Colorado. The pilot, the sole occupant, was not injured. The airplane was registered to and operated by the pilot under the provisions of the 14 Code of Federal Regulations Part 91 as a business flight. Night visual meteorological conditions prevailed at the time of the accident, and the flight was on an instrument flight plan. The flight departed the San Jose International Airport (SJC), San Jose, California, about 1616 and Pueblo, Colorado, was the destination.

The pilot reported that he originally requested that the fixed base operator (FBO) at SJC put 100 gallons of jet fuel in each wing fuel tank. Later during his preflight, the pilot decided that more fuel was needed, so he went back into the FBO and requested that the airplane's fuel tanks be topped off with fuel. The pilot was still in the FBO when he saw the lineman fuel the airplane from the fuel truck. He paid for the fuel without looking at the receipt and then proceeded out to the airplane. The pilot reported that he did not recheck the fuel gauges before departing SJC.

The pilot reported that he departed on the flight, but it was not until about an hour after takeoff that he checked the fuel gauges. He stated that the fuel gauges were showing about 900 to 1,000 lbs of fuel per side, and he realized that the fuel tanks had not been topped off with fuel. He reduced the throttles to conserve fuel and to increase the airplane's flight endurance while he continued the flight to Pueblo, Colorado.

The pilot reported that when the fuel gauges showed about 400 to 500 lbs of fuel per side, the low fuel lights for both wing fuel tanks illuminated. About 1840, the pilot reported to air traffic control (ATC) that the airplane was low on fuel and asked to land at the nearest airport. ATC provided radar vectors to GUC and initially cleared the flight for the ILS runway 6 approach. During the approach, the pilot reported that he had the runway in sight and ATC cleared the flight for a visual approach.

The pilot reported that the airplane was high and fast on the approach. At 500 ft above ground level, the airspeed was about 120 knots. He misjudged the runway and the height above the ground and he stated, "I landed very hard on runway 24." During touchdown, the airplane bounced and then impacted the runway. The airplane's left main landing gear and nose gear collapsed and the airplane veered off the runway, resulting in substantial damage to the left wing. The pilot reported no preaccident mechanical malfunctions or failures with the airplane that would have precluded normal operation.

At 1856, the surface weather observation at GUC was: wind 340 degrees at 4 knots; visibility 10 miles; sky condition few clouds at 7,500 ft; temperature -8 degrees C; dew point -13 degrees C; altimeter 30.08 inches of mercury.

Accident Rpt# CEN14FA505 09/19/2014 847 CDT **Regis# N322QS** **Conroe, TX** **Apt: Lone Star Executive Airport CXO**
Acft Mk/Mdl EMBRAER EMB 505 **Acft SN 50500165** **Acft Dmg: SUBSTANTIAL** **Rpt Status: Factual** **Prob Caus: Pending**
Eng Mk/Mdl P&W CANADA PW535E **Acft TT 598** **Fatal 0** **Ser Inj 0** **Flt Conducted Under: FAR 091**
Opr Name: NETJETS AVIATION, INC. **Opr dba:** **Aircraft Fire: NONE**

Summary

The pilot-in-command (PIC) and second-in-command (SIC) were conducting a positioning flight. According to the dispatch flight release, the pilots planned to land on runway 14, which was assumed to be wet. Before the flight, notices to airmen (NOTAMs) had been issued, which stated that the runway 14 threshold had been displaced 3,377 ft and that the instrument landing system and RNAV instrument approaches were not available. Although the NOTAMs were included in the flight release paperwork, dispatch personnel overlooked them, which resulted in flight planning numbers predicated on the full length of runway 14.

During the approach, the pilots listened to the automatic terminal information service information and then became aware that runway 14 was shortened due to construction. Subsequently, the pilots calculated the landing distance required to land on a wet runway and chose to land on runway 1, which was the longer runway. The PIC reported that, during the approach, they encountered light rain but that the rain was moving away from the airport, which alleviated any concern regarding standing water on the runway.

A review of flight data recorder data showed that the SIC flew a stabilized approach 9 knots above the reference speed (Vref) and that the airplane touched down 903 ft from the runway threshold at a groundspeed of 118 knots. The SIC stated that he began braking with half pressure and continued to increase the brake pressure to maximum, which was the normal braking procedure, but that the airplane did not appear to be decelerating. FDR data confirmed that the SIC began applying the brakes immediately upon touchdown and progressively commanded full braking performance from the brake system.

The PIC informed the SIC that they needed to slow down, and the SIC replied that he had "no braking." The SIC then applied the emergency parking brake (EPB), but the airplane still did not slow down. FDR data indicated that the airplane achieved its maximum deceleration during the landing roll before the application of the EPB. FDR data showed that, once the SIC applied the EPB, the wheel speed dropped to 0. After determining that there was insufficient runway remaining for a go-around, the pilots realized that the airplane was going to exit the end of the runway. Subsequently, the airplane began to skid along the runway, which resulted in reverted-rubber hydroplaning, thus decreasing the stopping performance, and then exited the departure end of the runway and continued about 400 ft in soft terrain before it impacted a ditch and came to a stop.

An examination of the brake system and data downloaded from the brake control unit indicated that the brake system functioned as commanded during the landing. Analysis of the runway surface and the amount of precipitation showed that there should have been no standing water on the runway. Landing distance calculations performed in accordance with the aircraft flight manual (AFM) showed that, even though the SIC exceeded Vref, the airplane should have been able to stop on the available runway.

According to the National Transportation Safety Board's airplane performance study, the maximum wheel braking friction coefficient achieved during the portion of the ground roll before the application of the EPB was significantly less than the maximum wheel braking coefficient that would have been expected given the unfactored wet-runway landing distances published in the AFM. However, the study determined that, if the EPB had not been engaged and airplane had maintained the braking friction level attained during the landing roll before the engagement of the EPB, it would have been able to stop on the available runway. Therefore, the SIC's application of the EPB, which locked the wheels, reduced the friction level, and decreased the braking performance, prevented the airplane from stopping on the available runway.

Nonetheless, the braking friction deficit observed in this accident showed that the stopping performance of the airplane was more consistent with AFM landing distances for runways contaminated with standing water than for runways that were merely "wet" even though it was determined that the runway could not have been flooded.

Since the accident, the operator has issued a flight operations bulletin instructing pilots to conduct a landing distance assessment using the AFM contaminated runway performance data for the lowest contamination depth when the following three conditions exist: 1) the runway did not have a treated surface, 2) thrust reversers were deferred or not installed, and 3) the airport was reporting rain or heavy rain.

Accident Rpt# CEN14LA505 09/19/2014 847 CDT Regis# N322QS Conroe, TX Apt: Lone Star Executive Airport CXO
Acft Mk/Mdl EMBRAER S A EMB-505 Acft SN 50500165 Acft Dmg: SUBSTANTIAL Rpt Status: Factual Prob Caus: Pending
Eng Mk/Mdl P&W CANADA PW535E Fatal 0 Ser Inj 0 Flt Conducted Under: FAR 091
Opr Name: NETJETS SALES INC Opr dba: Aircraft Fire: NONE

Summary

The pilot-in-command (PIC) and second-in-command (SIC) were conducting a positioning flight. According to the dispatch flight release, the pilots planned to land on runway 14, which was assumed to be wet. Before the flight, notices to airmen (NOTAMs) had been issued, which stated that the runway 14 threshold had been displaced 3,377 ft and that the instrument landing system and RNAV instrument approaches were not available. Although the NOTAMs were included in the flight release paperwork, dispatch personnel overlooked them, which resulted in flight planning numbers predicated on the full length of runway 14.

During the approach, the pilots listened to the automatic terminal information service information and then became aware that runway 14 was shortened due to construction. Subsequently, the pilots calculated the landing distance required to land on a wet runway and chose to land on runway 1, which was the longer runway. The PIC reported that, during the approach, they encountered light rain but that the rain was moving away from the airport, which alleviated any concern regarding standing water on the runway.

A review of flight data recorder data showed that the SIC flew a stabilized approach 9 knots above the reference speed (Vref) and that the airplane touched down 903 ft from the runway threshold at a groundspeed of 118 knots. The SIC stated that he began braking with half pressure and continued to increase the brake pressure to maximum, which was the normal braking procedure, but that the airplane did not appear to be decelerating. FDR data confirmed that the SIC began applying the brakes immediately upon touchdown and progressively commanded full braking performance from the brake system.

The PIC informed the SIC that they needed to slow down, and the SIC replied that he had "no braking." The SIC then applied the emergency parking brake (EPB), but the airplane still did not slow down. FDR data indicated that the airplane achieved its maximum deceleration during the landing roll before the application of the EPB. FDR data showed that, once the SIC applied the EPB, the wheel speed dropped to 0. After determining that there was insufficient runway remaining for a go-around, the pilots realized that the airplane was going to exit the end of the runway. Subsequently, the airplane began to skid along the runway, which resulted in reverted-rubber hydroplaning, thus decreasing the stopping performance, and then exited the departure end of the runway and continued about 400 ft in soft terrain before it impacted a ditch and came to a stop.

An examination of the brake system and data downloaded from the brake control unit indicated that the brake system functioned as commanded during the landing. Analysis of the runway surface and the amount of precipitation showed that there should have been no standing water on the runway. Landing distance calculations performed in accordance with the aircraft flight manual (AFM) showed that, even though the SIC exceeded Vref, the airplane should have been able to stop on the available runway.

According to the National Transportation Safety Board's airplane performance study, the maximum wheel braking friction coefficient achieved during the portion of the ground roll before the application of the EPB was significantly less than the maximum wheel braking coefficient that would have been expected given the unfactored wet-runway landing distances published in the AFM. However, the study determined that, if the EPB had not been engaged and airplane had maintained the braking friction level attained during the landing roll before the engagement of the EPB, it would have been able to stop on the available runway. Therefore, the SIC's application of the EPB, which locked the wheels, reduced the friction level, and decreased the braking performance, prevented the airplane from stopping on the available runway.

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Since the accident, the operator has issued a flight operations bulletin instructing pilots to conduct a landing distance assessment using the AFM contaminated runway performance data for the lowest contamination depth when the following three conditions exist: 1) the runway did not have a treated surface, 2) thrust reversers were deferred or not installed, and 3) the airport was reporting rain or heavy rain.

Cause Narrative

THE NATIONAL TRANSPORTATION SAFETY BOARD DETERMINED THAT THE CAUSE OF THIS OCCURRENCE WAS: The second-in-command's (SIC) engagement of the emergency parking brake (EPB), which decreased the airplane's braking performance and prevented it from stopping on the available

Events

1. Landing-landing roll - Runway excursion
2. Landing-landing roll - Collision with terr/obj (non-CFIT)
3. Landing-landing roll - Landing gear collapse

Findings - Cause/Factor

1. Personnel issues-Task performance-Use of equip/info-Use of equip/system-Copilot - C
2. Aircraft-Aircraft oper/perf/capability-Performance/control parameters-Surface speed/braking-Not specified - C
3. Organizational issues-Development-Selection/certification/testing-Equip certification/testing-Manufacturer - C
4. Personnel issues-Action/decision-Info processing/decision-Decision making/judgment-Copilot - F
5. Organizational issues-Development-Selection/certification/testing-Document/info verification-Manufacturer - F
6. Aircraft-Aircraft oper/perf/capability-Performance/control parameters-Surface speed/braking-Not attained/maintained - F

Narrative

HISTORY OF FLIGHT

On September 19, 2014, about 0847 central daylight time, an Embraer EMB-505 Phenom 300 airplane, N322QS, impacted a ditch after the airplane departed the end of the runway while landing at Lone Star Executive Airport (CXO), Conroe, Texas. Neither of the two airline transport-rated pilots were injured. The airplane was substantially damaged. The airplane was being operated by NetJets Aviation, Inc. (NetJets), 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 an instrument flight rules flight plan had been filed. The flight originated from Nashville International Airport, Nashville, Tennessee, at 0706.

According to the dispatch flight release paperwork, the pilot-in-command (PIC) and second-in-command (SIC) planned to land on runway 14, which was assumed to be wet. Before the flight, notices to airmen (NOTAMs) had been issued, which stated that the runway 14 threshold had been displaced 3,377 ft and that the instrument landing system (ILS) and RNAV instrument approaches were not available. Although the NOTAMs were included in the flight release paperwork, dispatch personnel overlooked them, which resulted in flight planning numbers predicated on the full length of runway 14.

According to cockpit voice recorder (CVR) information, at 0827:04, the pilots received the automatic terminal information service (ATIS) information, which indicated that the runway 14 takeoff and landing distance was 4,111 ft and that the ILS for runway 14 was out of service. The pilots calculated the runway length required for a wet runway landing and then chose to land on runway 1, which was the longer runway. The PIC stated that, during the approach, the flight encountered light rain but that the rain was moving from the northwest to the southeast, away from the airport and that this alleviated any concern about standing water on the runway. He added that both he and the SIC had previously landed the EMB-505 in moderate-to-heavy rain with no decrease in braking ability.

The CVR recorded the pilots briefing the approach and missed approach procedures. Subsequently, the tower controller cleared the runway 1 RNAV approach, and the pilots then discussed alternate airports in the area. At 0841:30, the tower controller cleared the airplane to land and stated that moderate-to-heavy rain was at the airport. The pilots conducted the Before Landing checklist and continued the approach. While continuing the approach with the SIC flying the airplane, they saw the runway at 600 ft above ground level, and the copilot disengaged the autopilot at 400 ft. At 200 ft, the SIC reduced the power and adjusted the altitude and airspeed for a stabilized approach with a maximum airspeed during the approach of 130 knots.

In his postaccident written statement, the PIC stated that the landing appeared normal and "smooth." The SIC stated that he began braking with half pressure and continued to increase the brake pressure to maximum, which was the normal braking procedure. Sounds recorded on the CVR consistent with the airplane touching down were heard at 0837:13, followed by the pilots stating that the airplane was not slowing down. The SIC stated, "brakes. Emergency brakes," followed by "nothin' man" and "I got nothin'." The PIC stated "where's the brakes," followed by "where are they?" The PIC then said "go.don't go sideways, don't go sideways." The airplane exited the departure end of the runway and continued about 400 ft through soft/muddy terrain before coming to rest half-way down a ditch.

According to the air traffic controller who witnessed the accident, the pilots flew the RNAV runway 1 approach and broke out of the clouds at the minimums for the approach. The controller stated that the airplane touched down just past the 1,000-ft marker on the runway and did not appear to decelerate as it continued down the runway.

PERSONNEL INFORMATION

PIC

The PIC held an airline transport pilot certificate with an airplane multiengine land rating and a commercial pilot certificate with airplane single-engine land and balloon ratings. He held type ratings in Cessna 500, 650, and 750; Embraer 505; and Hawker Siddeley HS-125 airplanes. A limitation on the EMB-505 type rating was the requirement of an SIC.

The PIC's last flight check was in the EMB-505 on May 12, 2014. The PIC was issued a first-class Federal Aviation Administration (FAA) medical certificate on April 3, 2014, which contained the limitations that it was not valid for any class after October 31, 2014, and that he must wear corrective lenses. He had 13,466 hours of flight time, of which 322 hours were in EMB-505 airplanes.

SIC

The SIC held an airline transport pilot certificate with an airplane multiengine land rating and a commercial pilot certificate with an airplane single-engine land rating. He held type ratings in ATR-42, ATR-72, Cessna 750, Bombardier CL-65, and Embraer 505 airplanes. Limitations on the CL-65 type rating were SIC privileges only and circling approaches in visual meteorological conditions. A limitation on the EMB-505 type rating was the requirement of an SIC.

The SIC's last flight check was in the EMB-505 on May 12, 2014. The SIC was issued a first-class FAA medical certificate on July 22, 2014, with no limitations. He had 9,861 hours of flight time, of which 361 hours were in EMB-505 airplanes.

AIRCRAFT INFORMATION

The accident airplane was a twin-engine turbofan, low-wing airplane, serial number 50500165, manufactured in 2013. The airplane was type certificated as a 14 CFR Part 23 commuter category airplane and was configured for two flight crewmembers and seven passengers. The airplane was equipped with two Pratt & Whitney PW535E turbofan engines, each of which delivered 3,360 lbs of thrust.

The airplane was maintained in accordance with the manufacturer's inspection program. The last inspection was completed on July 2, 2014, at a total airframe time of 597.7 hours.

Brake System

The airplane's hydraulic brake system delivered hydraulic pressure to the brakes via input from the brake pedals. The hydraulic pressure to the brake system was supplied at a maximum of 3,000 pounds per square inch (psi). The SIC (right seat) brake pedals were mechanically linked to the PIC (left seat) brake pedals. Each PIC brake pedal was connected to a pedal position transducer (PPT), each of which produced two independent electrical outputs that were proportional to the respective pedal displacement to the brake control unit (BCU). The BCU controlled the main brake system, which was a brake-by-wire system with an antiskid function. The only pedal force feedback to the pilots was from a force spring installed on the pedals that provided a consistent pedal resistance regardless of the runway condition and the pressure applied.

Wheel speed information was sent to the BCU via two axle-mounted speed transducers. The BCU factored the output from the wheel speed transducers, the PPTs, and two brake line pressure transducers then sent an electrical command to the associated brake control valve.

The brake system had an antiskid function (which controls slip ratio) and a locked-wheel protection (which detects deep skids). The antiskid function worked independently on each wheel by comparing the current wheel angular speed to a reference angular speed, which was calculated based on the speed of that same wheel. The locked-wheel protection compared both main landing gear (MLG) wheel speeds and alleviated brake pressure when the slower wheel fell below 30% of the opposite wheel speed.

The airplane was equipped with an EPB to stop the airplane if the main brake system failed. The EPB was operated by a T-handle on the control pedestal, which was mechanically linked via a steel cable to the EPB valve. The antiskid function was not available when using the EPB.

An examination of the brake system and the data downloaded from the brake control unit (BCU) indicate that the brake system functioned as commanded during the landing.

Ground Spoiler Function

The airplane had a ground spoiler function that deployed the spoiler panels on the ground during landing to decrease lift, increase drag, improve braking, and reduce stopping distance. The airplane must be on the ground, the thrust levers must be in the "idle" position, and the ground spoilers must be armed for them to deploy during landing. The ground spoiler function automatically armed when the weight-on-wheels (WOW) sensors indicated "in-air" for more than 10 seconds and the airspeed was valid and greater than 60 knots indicated airspeed (KIAS).

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.

The EMB-505 was first certificated by the Brazilian regulator (the Agˆncia Nacional de Aviacao 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. Therefore, to certify the airplane in Europe, Embraer proposed to EASA that the unfactored wet-runway landing distances presented in the EMB-505 AFM would be computed as 125% of the demonstrated, unfactored dry-landing distance, and EASA accepted this proposal. 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.

The factored wet-runway distances in the EMB-505 AFM were 115% of the factored dry distances, or 192% of the unfactored dry distances. The EMB-505 AFM also provided 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 0841, the CXO automated surface observation system reported calm wind, visibility 2 miles in heavy rain and mist, a few clouds at 500 ft above ground level (agl), ceiling 8,000 ft agl broken, 10,000 ft agl overcast, temperature 23ø C, dew point 22ø C, and altimeter setting of 29.93 inches of Mercury. Remarks included the following: hourly precipitation 0.21 inch, temperature 22.8ø C, and dew point 22.2ø C.

A review of weather observations reported before and after the accident showed that the rain began at 0444. The rain varied from moderate-to-heavy intensity from 0725 until after the accident. The rain ended at 1129. The total precipitation reported between 0444 and 0847 (the time of the accident) was 0.45 inch. The total precipitation reported between 0444 and 1129 was 0.50 inch.

AIRPORT INFORMATION

CXO is located about 37 miles north of Houston, Texas. The airport is equipped with an air traffic control tower, which is operational between 0700 and 2200. The airport chart supplement lists an elevation of 245 ft and a magnetic variation of 5ø east. Runway 1/19 is 5,000 ft long and 100 ft wide, concrete, and in good condition with a threshold elevation of 230 ft and 0.2% grade. The runway has a medium-intensity approach lighting system and nonprecision runway marking. The runway also has a two-light precision approach path indicator lighting system, which was out of service.

Runway 14/32 was under construction at the time of the accident. As noted earlier, a NOTAM had been issued, which stated that the runway 14 threshold had been displaced 3,377 ft and that the ILS and RNAV instrument approaches were not available.

The dispatch Flight Release for N322QS, showed that the landing was planned for runway 14 which was assumed to be wet. The NOTAMs were included in the Flight Release paperwork, but were overlooked by dispatch resulting in flight planning numbers predicated on the full length of runway 14. The pilots became aware of the runway information during the flight and they opted to land on runway 01.

The automated terminal information service (ATIS) ZULU which was received by the crew reported the runway 14 takeoff and landing distance was 4,111 ft and the ILS for runway 14 was out of service.

WRECKAGE AND IMPACT INFORMATION

According to the FAA inspector who arrived on scene shortly after the accident, there were light tire scuffmarks on runway1, which began 1,877 ft before the departure end of the runway. There were no visible signs of rubber transfer on the runway. The airplane exited the departure end of the runway and continued about 400 ft through soft/muddy terrain before coming to rest on down-sloping terrain. The distance between the ground tracks made by the nose tire and the right MLG gear track was 18 inches, indicating that the airplane skidded after it departed the runway surface. A flat worn spot was visible on both the left and right main tires. Both tires showed evidence of reverted rubber hydroplaning.

The airplane contacted a silt/erosion control fence during the overrun. The nose landing gear collapsed and separated from the airplane just before it came to rest.

The airplane sustained substantial damage, including, but not limited to, damage to the forward bulkheads, composite ribs, forward fuselage frame, and the center fuselage area.

Power was applied to the airplane after the accident, and a ground hydraulic power stand was used to generate a hydraulic system pressure of 2,850 psi. The brakes and spoiler system were tested, and both functioned normally. The antiskid auto-startup test was completed with no faults noted.

TESTS AND RESEARCH

BCU and Central Maintenance Computer (CMC)
The BCU, serial number 276920254, was removed from the airplane and sent to Meggitt in the United Kingdom. The recorded faults were downloaded, and the BCU was functionally tested under the supervision of an investigator from the Air Accidents Investigation Branch, and it functioned normally.

Embraer downloaded the CMC messages on scene with the concurrence of the National Transportation Safety Board (NTSB) investigator-in-charge. The BCU faults and CMC faults and messages were correlated with one another and reviewed by Embraer. Although the BCU and CMC recorded four sequences of faults and messages, the data and the examination of the brake system indicated that the brake system functioned as commanded during the landing.

FLIGHT RECORDERS

The airplane was equipped with an L-3/Fairchild FA2100-3083 combination cockpit voice and flight data recorder (CVDR), serial number 000885510, which provided both flight data recorder (FDR) and cockpit voice recorder (CVR) functions. The CVDR was removed from the wreckage and examined at the NTSB Vehicle Recorder Laboratory, Washington, DC. The CVR contained 2 hours 4 minutes 14 seconds of good quality voice recordings. A CVR group was convened, and a transcript was prepared for the period from 0824:47 to 0848:01.

FDR Data

The FDR contained 222 hours of data. Timing of the FDR data is measured in subframe reference numbers (SRN), where each SRN equals 1 lapsed second. The accident flight was the last flight on the recording, and the flight duration was about 1 hour 37 minutes.

The FDR data showed the airplane initially on approach above 150 knots. From 0844:18 to 0844:38, the flap position increased from flap position "one" through to flap position "three," at which position it remained for the rest of the approach. At 0844:43, the brake pressure for the left and right MLG briefly spiked to about 3,000 psi and quickly returned to 0. During this time, the pilot brake pedal position remained near 0. The airplane continued the approach, and its approach speed steadily decreased to about 130 knots while on short final.

At 0847:09, the brake pedal position parameters became active, and they began to increase just before touchdown. One second later, the left and right main wheel spin became active and then increased rapidly. Two seconds later, the speed brakes began to extend, and they reached maximum extension at 0847:14. About the same time, all four WOW discrete parameters became true. Between 0847:14 and 0847:24, the brake pressure for both MLG remained below 1,000 psi. During this time, the pilot left and right brake pedal positions increased to about 36 millimeter (mm) of pedal travel as the indicated airspeed, groundspeed, and wheel speed for both MLG steadily decreased. At 0847:24, the EPB discrete became active. Immediately thereafter, the brake pressure for both MLG plateaued near the system's maximum value of 3,000 psi, and the wheel speed quickly decreased to about 0 knots.

Between 0847:27 and 0847:42, the brake pressure for both MLG remained plateaued about 3,000 psi. The pilot left and right brake pedal positions also remained steady about 35 mm of pedal travel as the KIAS and groundspeed continued to decrease. At 0847:24, a brake fail indicator discrete became active as the brake pressure for both MLGs dropped to 0 psi, and the pilot left and right brake pedal positions remained near the system's maximum pedal travel value while the airplane was experiencing measurable changes in tri-axis acceleration, consistent with it departing the runway surface. KIAS and groundspeed quickly dropped to about 0 knots, and the speed brake surface positions for the left and right speed brakes bleed position decreased to 0. The FDR recording ended at 1347:59 and showed the airplane at rest.

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.

According to the performance study, the airplane's approach to runway 1 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 airplane crossed the runway threshold at 121 knots (9 knots faster than Vref) and 45 ft above the runway and touched down about 903 ft from the threshold at a groundspeed of 118 knots. The headwind component at touchdown was negligible.

After touchdown, the pilot brake pedal deflections progressively increased to maximum braking in about 11 seconds, and the airplane achieved a maximum deceleration of about -0.17 G at 0847:17, about 7 seconds after touchdown. Between 0847:19 and 0847:22, the deceleration increased briefly and then decreased until about 0847:23.5, 13.5 seconds after touchdown, as the wheel speeds decreased to 0, consistent with the application of the EPB and the beginning of a full, locked-wheel skid. The wheels remained locked until the airplane came to rest. During the skid, the deceleration steadily increased, before decreasing again to as the airplane passed the end of the runway at 0847:37.4. The airplane exited the runway about 27 seconds after touchdown at a groundspeed of about 61 knots.

The performance study determined that, after the airplane touched down, the computed braking friction coefficient increased steadily as the brake pedals were depressed, reaching a peak of about 0.16 before decreasing steadily to about 0.06 after the EPB was applied and the airplane entered a full, locked-wheel skid; this decrease is consistent with research indicating that the braking friction achieved in a full locked-wheel skid (a braking slip ratio of 1.0) is significantly less than the maximum braking friction coefficient that can be achieved at lower slip ratios. However, even before the EPB was applied, the computed braking friction coefficient was significantly lower than what would have been predicated using models prescribed in 14 CFR Part 25 for computing accelerate-stop distances on a wet runway. The braking friction coefficient was also significantly lower than that implied by the unfactored, wet runway landing distances published in the EMB-505 POH, which are computed as 25% greater than the unfactored (demonstrated) landing distances on a dry runway.
"However, the braking friction coefficient achieved during the accident was consistent with the predicted braking friction coefficient using a National Aeronautics and Space Administration (NASA) model that is based on runway friction measurements taken with a Ccontinuous Ffriction Mmeasurement Eqequipment (CFME) device."

"The decrease in braking friction coefficient after the EPB was applied is consistent with research indicating that the braking friction achieved in a full locked-wheel skid (a braking slip ratio of 1.0) is significantly less than the maximum braking friction coefficient that can be achieved at lower slip ratios .."

As part of the performance study, the NTSB and the parties to the investigation conducted tests on runway 1 at CXO to measure the runway macrotexture depth and the cross slope. Based on the results of the runway tests, the performance study determined, taking into account a rainfall rate of 0.3 inch per hour and the runway macrotexture and cross slope, the accident landing gear would have encountered a maximum water depth of about 0.006 inch, which was far below the 3 mm (0.017 inch) that the EASA Acceptable Means of Compliance 25.1591 considered a "flooded" runway. Therefore, it is unlikely that the accident airplane experienced dynamic hydroplaning during the landing and that the low wheel braking friction coefficient levels resulted from viscous hydroplaning, which is associated with the buildup of water pressure due to viscosity.

The Phenom 300 Quick Reference Handbook (QRH) provided landing distance tables for various aircraft configurations and runway conditions. The QRH showed the unfactored runway distance required for a landing weight of 15,483 lbs and flaps 3 configuration to be 2,541 ft for a dry runway, 2,922 ft for a wet runway, and 4,885 ft for a contaminated runway (1/8-inch-deep water).

The performance study determined that, if the EPB had not been set and the braking friction had continued at levels attained early in the landing roll, then the airplane would have come to a stop about 4,669 ft from the threshold with 331 ft of runway remaining. The study noted that this level of braking friction is considerably lower than that underlying the wet runway landing distance in the AFM and is also lower than that specified by a wet runway model used in FAA advisory circulars (AC) and Part 25 certification regulations. Although the expected stopping distance of 4,669 ft was close to the EMB-505 AFM "contaminated (1/8 in water)" distance of 4,885 ft, the study noted that the runway characteristics and rainfall rate on the day of the accident precluded this runway condition. The study concluded that the braking friction deficit observed in this and other accidents examined during the course of this investigation showed that the airplanes' stopping performance was more consistent with AFM landing distances for runways contaminated with standing water than for runways that were merely "wet" even though it was determined that the runways involved could not have been flooded

The performance study also noted that, although the achieved braking friction was lower than that specified by the model used in the FAA regulations and ACs for a wet runway, the FAA model friction level was closer to the achieved friction than the friction level implied by the wet-runway landing distances in the EMB-505 AFM. That is, the friction implied by the AFM wet-runway landing distances was even higher than that predicted by the FAA model, whereas the FAA model itself overpredicted the friction level for this accident. Further, Embraer provided data that showed the deceleration recorded for the time interval before the EPB was applied during the accident flight was consistent with the results obtained from a simulation using the optimized performance analyzer software based on the expected brake coefficient prescribed in AMC 25.1591 for standing water contamination (3 mm) and contaminated drag based on flight test data produced for EASA certification purposes.

The performance study concluded that, based on the runway characteristics and rainfall rate at the time of the accident, the water depth on the runway was well below 3 mm but that the braking friction coefficient achieved before the EPB was engaged closely matched that modeled for a water depth greater than 3 mm. Therefore, the circumstances of this accident indicate that some wet runways may provide friction levels closer to those used to model flooded runways than to those implied in the AFM wet runway landing distances even when the runway is not flooded.

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

ADDITIONAL INFORMATION

NetJets Flight Operations Manual (FOM) and AFM Landing Distance Information
NetJets' FOM states that "every landing requires an adjustment to planned landing distance. The type of operation [that is, Part 91, 91K, or 135] dictates which adjustments are applied." The "planned landing distance" is the unfactored AFM dry landing distance for the airplane. The FOM defined a contaminated runway as one in which more than 25 percent of the required runway length, within the width being used, is covered by standing water or slush deeper than 1/8 inch or accumulation of snow or ice and a wet runway as one in which its surface is reflective.

For dispatching a flight to a runway that is expected to be wet at the time of arrival, the FOM stated that, for Part 91 flights, the required landing distance is the unfactored wet landing distance specified in the AFM's FAA-approved landing performance data or the AFM's advisory data with no safety factor applied. However, in practice, NetJets dispatchers divided the unfactored AFM distance by 0.8, which resulted in a required landing distance greater than that specified in the FOM. For Parts 91K and 135 flights, the required landing distance was the unfactored dry landing distance from the AFM, divided by a safety factor of 0.6 with an additional safety factor of 15% applied.

For all operations, the FOM also required pilots to perform a landing performance assessment to recalculate the required landing distance "if weather, runway surface condition, aircraft status, or any other relevant factor has degraded from those shown in the flight release package." An additional safety factor of 15% must then be added to the recalculated distance.

The Embraer AFM, "Landing Technique," stated that the performance data are based on the following:

- Steady three degree angle approach at Vref in landing configuration;
- Vref airspeed maintained at runway threshold;
- Idle thrust established at runway threshold;
- Attitude maintained until MLG touchdown;
- Maximum braking applied immediately after MLG touchdown;

- Antiskid system operative.

NetJets Aircraft Operations Manual Arrival Briefing Information

NetJets Aircraft Operations Manual, Section 2.3.4, "Arrival Briefing," stated that, before conducting the arrival briefing, the crew should, if able, obtain the destination weather and landing information and program the flight management system (FMS). The pilot flying should transfer aircraft control and verify the FMS inputs and brief items pertaining to the arrival, including the arrival procedure (include altitude and airspeed constraints), NOTAMS, runway conditions, and landing performance assessment. These same items are also listed on the NetJets Normal Procedures Checklist under the Arrival Briefing section.

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-

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(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 had previously issued two SAFOs that were 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 test 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:

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.

NTSB Safety Recommendations
As a result of previous accidents, the NTSB had issued Safety Recommendations A-07-57 and 61. Safety Recommendation A-07-57 asked the FAA to immediately require all 14 CFR Parts 121, 135, and 91 subpart K operators to conduct arrival landing distance assessments before every landing based on existing performance data, actual conditions, and incorporating a minimum safety margin of 15 percent. Safety Recommendation A-07-61 asked the FAA too require all 14 CFR Parts 121, 135, and 91 subpart K operators to accomplish arrival landing distance assessments before every landing based on a standardized methodology involving approved performance data, actual arrival conditions, a means of correlating the airplane's braking ability with runway surface conditions used the most conservative interpretation available, and including a minimum safety margin of 15 percent. Safety Recommendation A-07-57 is currently classified "Closed-Unacceptable Action," and Safety Recommendation A-07-61 is currently classified "Open-Unacceptable Response." See the Airplane Performance Study in the docket for this accident for additional details.
Postaccident Safety Actions

Netjets Actions

On September 11, 2015, NetJets issued Flight Operations Bulletin (FOB) 15-06, "Landing Considerations for Wet Untreated Runways." The FOB instructed pilots to determine if the runway had a treated (grooved or porous friction) overlay during the arrival briefing. It added that pilots should conduct a landing performance assessment using the AFM contaminated runway performance data for the lowest contamination depth when the following three conditions existed: 1) the runway does not have a treated surface, 2) thrust reversers are deferred or not installed, and 3) the airport is reporting rain or heavy rain.

On December 14, 2016, NetJets issued FOB 14-12, "Use of Emergency Braking." The FOB instructed pilots to continue to use normal antiskid braking unless there is a positive indication of a brake system failure, at which time, they should apply corresponding aircraft AFM or QRH procedures.

In addition, NetJets added the following to its AOM:

2.26.4 Ground Spoilers
Ground Spoilers are deployed automatically upon touchdown with thrust levers at idle.

Deployment failure of spoilers causes reduced normal braking effectiveness and may be misinterpreted as a brake failure. Do not engage the emergency brake system unless total brake failure is indicated (i.e., EICAS [engine indication and crew alerting system] message of a failed system affecting normal braking).

2.26.5 Braking
For optimum braking efficiency, smoothly apply constant brake pressure after touchdown of the main landing gear. Do not pump brakes.

On short of slippery runways, apply maximum braking. Maintain steady and increasing brake pressure, allowing the anti-skid system to function.

NetJets highlighted runway excursions as part of its flight crew training, and the factual information developed in this investigation was used as part of the training. In addition,
NetJets worked with Flight Safety International to enhance its brake and antiskid systems training.

Embraer Actions

On November 5, 2014, Embraer issued Flight Operation Letter (FOL) PHE505-018/14, "Landing Procedure Best Practices and Recommendations." Revision 1 was issued on August 14, 2015, and Revision 2 was issued on June 6, 2016. The FOL highlighted some information contained in FAA AC 91-79A and added information specific to the Phenom fleet. The letter stated 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, are mandatory.

The FOL further stated,
By definition, a wet runway is a pavement covered by less than 3mm (0.125") of water and the standing water has more than 25% of the pavement covered with more than 3mm of water.Also, be careful when evaluating a light rain over a non-grooved runway or a concrete polished surface. This may result in a slippery surface, which reduces braking action. In this case, the standing water numbers are more recommended than wet.

The FOL states, "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, then the BRK FAIL CAS message is annunciated. In these conditions, applying the landing correction factors, determinate by the QRH, are mandatory."

Accident Rpt# CEN16LA067 12/23/2015 1415 MST	Regis# XAMEX	Telluride, CO	Apt: Telluride KTEX	
Acft Mk/Mdl HAWKER 400-XP	Acft SN RK396	Acft Dmg: SUBSTANTIAL	Rpt Status: Factual	Prob Caus: Pending
Eng Mk/Mdl PRATT & WHITNEY JT15D	Acft TT 5744	Fatal 0 Ser Inj 0	Flt Conducted Under: FAR 129	
Opr Name: AEROLINEAS EJECUTIVAS S A DE CV	Opr dba:		Aircraft Fire: NONE	

Events

1. Landing-landing roll - Ground collision

Narrative

HISTORY OF FLIGHT

On December 23, 2015, about 1415 mountain standard time, a Hawker Beechcraft 400XP airplane, XA-MEX, collided with a snowplow while landing at the Telluride Regional Airport (KTEX) Telluride, Colorado. The pilot, co-pilot, five passengers, and the snowplow operator were not injured and the airplane was substantially damaged during the accident. The airplane was registered to and operated by Aerolineas Ejecutivas, Toluca, Mexico, under the provisions of 14 Code of Federal Regulations Part 129 as an air taxi flight. Instrument meteorological conditions prevailed at the time. The flight departed Monterrey, Mexico, with a planned stop in El Paso, Texas, en route to Telluride, Colorado.

Prior to departure from Monterrey, the crew obtained preflight information, including Notice to Airmen (NOTAMs) for the planned route of flight. The NOTAMs for KTEX noted several runway closure times; however, none of the closures were valid for the period during which the flight would arrive at KTEX.

The flight departed El Paso at 1220 MST and the flight crew discussed the weather conditions at their destination airport, including concern that the weather maybe below minimums and may not allow for a landing. The Montrose Regional Airport (KMTJ), Montrose, Colorado, was discussed as an alternate destination. As the flight neared their destination, the crew was in contact with a Denver en-route/center controller. The crew also listened to the Telluride's airport automated weather station.

At 1348, the controller asked the pilots to advise him when they had the weather and NOTAMS for KTEX, adding that another airplane just attempted an approach into KTEX, but had to execute a missed approach. The pilot reported that they received the weather information and planned to make the approach. The controller responded by giving the flight a heading, saying this would be for the descent and sequence into the airport.

At 1350, the airport operator entered a NOTAM via computer closing the runway (effective 1350) for snow removal, and the airport operator proceeded onto the runway.

At 1358, the controller cleared the accident airplane for the approach to the airport. The pilot then canceled his flight plan at 1402 with the airport in sight. The crew did not change radio frequency to the airport's common traffic advisory frequency (CTAF) for traffic advisories.

During the landing, the crew did not see the snowplow on the runway until it was too late to avoid a collision.

PILOT INFORMATION

The pilot sitting in the left seat held a Mexican Airline Transport License with a rating for airplane multi-engine land. The pilot held a class one medical certificate issued on July 09, 2015, with no restrictions or limitations. The pilot had 8,238 hours total flight time, with 1,412 in the accident make and model.

The pilot sitting in the right seat held a Mexican Airline Transport License with a rating for airplane multi-engine land. His class one medical certificate was issued on December 16, 2015, with no restrictions or limitations. The pilot had 7,113 hours total flight time, with 1,919 in the accident make and model.

AIRCRAFT INFORMATION

The accident airplane was a Hawker Beechcraft 400XP (BE40), which is a low wing, twin-engine business jet, powered by two Pratt & Whitney JT15D turbofan engines. The airplane was under a continuous airworthiness maintenance program, with the last inspection dated July 25, 2015. At the time of the accident, the airplane had accumulated 5,744.25 flight hours.

AIRPORT INFORMATION

The Telluride Regional Airport (KTEX) is a public-use, non towered airport, located 5 miles west of Telluride, Colorado. The airport has a single asphalt runway 9/27, that is 7,111 ft long by 100 ft wide. Pilots are to use the CTAF for communications. There is an Automated Weather Observation Station (AWOS) station located on the airfield for weather information. The AWOS recording typically has a reminder for pilots about noise abatement procedures. Due to the surrounding terrain, runway 27 is recommended for takeoff, and 09 for landing.

Authorized airport personnel manage the NOTAMs online via the FAA NOTAM Manager.

METEOROLOGICAL INFORMATION

At 1415, the Telluride AWOS recorded; wind 010 degrees at 3 knots, 1 and _ mile visibility with light snow, broken clouds at 1,100 ft, and overcast sky at 2,200 ft, temperature 23 degrees Fahrenheit (F), dew point 18 F, and a barometric pressure of 29.50 inches of mercury.

COMMUNICATIONS

After departing El Paso, Texas, the crew was in radio contract with Air Route Traffic Control Center (ARTCC) controllers along their route of flight. After the crew changed from the Albuquerque Center controller to the Denver Center controller, the crew asked and received the latest weather for KTEX. The flight changed section controllers a couple times, before contacting the final sector controller responsible for the KTEX airport.

The controller's workload was described as heavy, working multiple air traffic arrival and departures from other airports in the sector, including Montrose and Aspen.

Prior to XA-MEX approach to KTEX, the controller was in contact with a Beechcraft KingAir (call sign Foothills (FH) 122), who made an approach to the Telluride airport. About 1313, the controller asked FH122 to let him know when he had the weather and NOTAMs, adding that the weather was down [below minimum] at times. The pilot reported that he had the weather and NOTAMs, and the weather appeared good enough for an approach. About 1330, the controller cleared FH122 for the localizer-DME runway 9 approach to KTEX. Shortly afterwards the pilot acknowledged a handoff to the advisory frequency and said he would report landing. About 1340, the pilot (FH122) reported a missed approach to the controller. The controller advised the pilot to fly the published missed approach procedure, before working a clearance to the Montrose airport.

During a follow-up telephone conversation with the NTSB Investigator in Charge, the pilot of FH122 stated that he had talked on CTAF to a lady at the airport and the weather did not look that good. He then decided to do a missed approach before getting to the runway.

After the accident, the accident airplane's cockpit voice recorder (CVR) was shipped to the vehicle recorder lab in Washington, DC for download. A CVR group was convened and the recording was auditioned by a CVR group consisting of representatives from the NTSB, FAA, Mexican Direcci¢n General de Aeron utica Civil (DGAC), and a technical representative from the operator. Excerpts of communications are listed in the CVR Specialist Factual Report, which is located in the official docket for this investigation.

WRECKAGE AND IMPACT INFORMATION

The airplane's right wing collided with the rear of the snow removal equipment, about halfway down the runway. The impact separated the right wing from the fuselage near the wing root. The airplane same to rest just off the snow covered runway surface. Minor damage was reported to the snow removal equipment.

ADDITIONAL INFORMATION

The Denver center controller (sector 12) position was initially staffed with a radar controller and a radar-associate controller. Facility Operating Procedure requires controllers to issue appropriate NOTAMs to pilots. The facility added that in the past, they received a phone call from an airport operator notifying them of an upcoming NOTAM that closed the airport or a runway; however, currently, airport operators enter NOTAMs directly into the system and they do not receive the telephone calls.

When a NOTAM is entered into the Aeronautical Information System Replacement system (AISR), center automatically receives the NOTAM in the En Route Information Display System (ERIDS) at the controller's position. However, the controller is not alerted of a new NOTAM, and if the controller is on a different page on ERIDS, the NOTAM will not be visible.

One minute prior to XA-MEX being cleared for the approach, the radar associate controller moved over to the radar position. There was not a record of a position relief briefing and it was not known if a relief checklist was used.

A review of information contained in the FAA Aeronautical Information Manual (AIM),

4-1-9, Traffic Advisory Practices at Airports Without Operating Control Towers,

c. Recommended Traffic Advisory Practices

1. Pilots of inbound traffic should monitor and communicate as appropriate on the designated CTAF from 10 miles to landing. Pilots of departing aircraft should monitor/communicate on the appropriate frequency from start-up, during taxi, and until 10 miles from the airport unless the CFRs or local procedures require otherwise.

4-1-10. IFR Approaches/Ground Vehicle Operations

a. IFR Approaches. When operating in accordance with an IFR clearance and ATC approves a change to the advisory frequency, make an expeditious change to the CTAF and employ the recommended traffic advisory procedures.

b. Ground Vehicle Operation. Airport ground vehicles equipped with radios should monitor the CTAF frequency when operating on the airport movement area and remain clear of runways/taxiways being used by aircraft. Radio transmissions from ground vehicles should be confined to safety-related matters.

The airport manager reported that the snowplow was equipped with radios; the snowplow operator and the customer service representative inside the airport terminal both monitor the advisory frequency on the radio. He added that they also review a flight tracker program and reservations for potential inbound aircraft. He added that reservations are not required, nor will the flight tracker program show all traffic, but it does give them an idea of potential arrivals and departures. XA-MEX was not on the flight tracker and did not have a reservation at the airport.

Accident Rpt# CEN16FA171 05/04/2016 1002 CDT	Regis# N629JK	Reedsville, WI	Apt: N/a	
Acft Mk/Mdl MCDONNELL DOUGLAS HELICOPTER	Acft SN 0542E	Acft Dmg: SUBSTANTIAL	Rpt Status: Factual	Prob Caus: Pending
Eng Mk/Mdl ROLLS ROYCE M250-C20B	Acft TT 7688	Fatal 1 Ser Inj 0	Flt Conducted Under: FAR 133	
Opr Name: ROTOR BLADE LLC	Opr dba:		Aircraft Fire: NONE	
			AW Cert: STN	

Summary

The helicopter was being used to transport personnel and equipment in support of a power line construction project. The helicopter departed the landing zone (LZ) and transported two linemen from one power line tower to another using a 50 ft long line. When the linemen detached from the long line, the helicopter proceeded to the east where it hovered for 2 to 3 minutes. The linemen requested that the helicopter return to the tower to pick up equipment and then return to the LZ. The helicopter approached the tower, and, when the long line was nearing their reach, the linemen noticed the helicopter's sound change, and it descended suddenly. The helicopter veered to the right away from the tower, and the main rotor blades slowed noticeably as the helicopter descended into the trees and impacted terrain. The linemen climbed down from the tower and heard the helicopter's engine still producing noise, so one of them pulled the emergency fuel shutoff valve and turned the battery off.

A postaccident examination of the helicopter revealed damage to the main rotor blades and main rotor hub consistent with sudden stoppage at low rotor rpm. The tail rotor exhibited damage consistent with no rotation during impact. The engine was removed from the airframe and connected to an engine test stand for a functional test, but it would not start after several attempts. The power turbine governor (PTG) was removed, and its main drive shaft was found fractured. The original PTG was replaced with a new PTG. With the new PTG installed, the engine started normally, produced rated horsepower, and met production test specifications with no anomalies noted.

Examination of the PTG revealed that a portion of the drive shaft remained embedded in the spindle of the spool bearing assembly. The fracture surface features of the shaft were consistent with overstress. The internal elements of the spool bearing assembly were seized and would not rotate. The ball bearings and spacers were found coated with voluminous, powdery, black particulate consistent with oxidized metallic wear debris, and no grease was observed. The ball retainers were fragmented, the inner surfaces were found coated with a powdery, black particulate consistent with oxidized metallic wear debris, and no grease was observed. The inner bearing surfaces were rough and frosted, consistent with three-body abrasive wear. The examination indicated that the fractured PTG drive shaft was the result of a spool bearing that seized due to a lack of lubrication.

In 2008, a service bulletin (SB) and commercial engine bulletin (CEB) were issued by PTG and engine manufacturers, respectively, that called for replacement of the dual-spool bearing, the type installed in the accident PTG, with a single-spool bearing. The dual-spool bearing had experienced 23 previous failures that had led to either engine oscillations, uncommanded engine acceleration, or a loss of engine power. Although the SB and CEB called for replacement of the accident PTG's dual-spool bearing not later than 750 hours after the PTG was installed new, the accident PTG had accumulated 1,048.7 hours since new when the accident occurred, and the SB and CEB had not been completed. As stated in the operator's Federal Aviation Administration (FAA) approved operations specifications, the operator was required to comply with FAA Airworthiness Directives but was not required to comply with manufacturer's service bulletins. It is likely that had the SB and CEB been completed, the PTG would not have failed and the engine would not have lost power.

Cause Narrative

Events

1. Maneuvering-hover - Loss of engine power (total)
2. Maneuvering-hover - Powerplant sys/comp malf/fail

Findings - Cause/Factor

1. Aircraft-Aircraft power plant-Engine fuel and control-Turbine governor-Failure - C
2. Aircraft-Aircraft power plant-Engine fuel and control-Turbine governor-Not serviced/maintained - C

Narrative

HISTORY OF FLIGHT

On May 4, 2016, at 1002 central daylight time, an MD Helicopters 369E helicopter, N629JK, impacted trees and terrain near Reedsville, Wisconsin. The commercial-rated pilot, who was the sole occupant, was fatally injured, and the helicopter sustained substantial damage. The helicopter was registered to Padgett Ag Air, LLC, Pawleys Island, South Carolina, and operated by Rotor Blade, LLC Georgetown, South Carolina, under the provisions of 14 Code of Federal Regulations (CFR) Part 133 as an external load operation. Visual meteorological conditions prevailed at the time of the accident, and no flight plan was filed. The flight departed from the Manitowoc County Airport (MTW), Manitowoc, Wisconsin, about 0730.

The helicopter was being used to transport personnel and equipment in support of a power line construction project to replace a shield wire with a fiber optic cable. The project began on March 10, 2016, with a basic helicopter and landing zone (LZ) safety course provided by Rotor Blade for the construction employees. The project had continued without interruption except for weather delays. On the morning of the accident, the helicopter arrived at the LZ about 0800. Two job briefings were conducted, and the helicopter was to transport linemen, equipment, and materials to various power line tower structures that were about 125 ft tall using a 50 ft long line attached to the cargo hook. The helicopter flew from 0842 to 0906 and then returned to the LZ.

At 0949, the helicopter departed the LZ and transported two linemen from tower 9903 to the neighboring tower, 9904 (figure 1). When the linemen detached from the long line, the helicopter proceeded to the east and hovered for 2 to 3 minutes. The linemen requested that the helicopter come back to tower 9904 to pick up equipment and return to the LZ. The helicopter approached the tower from the southwest and faced northeast into the wind as the linemen presented hand signals to the pilot. The linemen stated that the end of the long line was about 20 ft laterally and 15 ft vertically from their reach when they noticed the helicopter's sound change and it descended suddenly. The helicopter veered to the right away from the tower, and the main rotor blades slowed noticeably. The helicopter continued into the trees and terrain south of the tower. The linemen climbed down from the tower and heard the helicopter's engine still producing noise. One lineman pulled the emergency fuel shutoff valve and turned off the battery.

Two other project employees were about 150 yards north of tower 9904 (figure 2); they stated that, as the helicopter approached tower 9904 for the final time, the main rotor blades slowed down, the engine sound decreased, and the helicopter veered right toward the ground.

PILOT INFORMATION

The pilot's logbooks were not found during the course of the investigation. Company flight log reports revealed that the pilot flew the accident helicopter from March 8 to May 3, 2016, for a total of 67 hours. The pilot also flew the accident helicopter for an estimated 2.5 hours on the morning of the accident.

HELICOPTER INFORMATION

The MD 369E features a fully articulated five-bladed main rotor system with anti-torque provided by a four-bladed semi-rigid tail rotor. The helicopter was configured to be flown from the left pilot seat (figure 3).The helicopter had accumulated 7,688.4 hours total time (TT) at the time of the accident. A review of the maintenance records revealed an annual inspection was completed on December 4, 2015, at 7,522.6 hours TT. At the time of the accident, the engine, a Roll-Royce 250-C20B, had accumulated 1,048.7 hours TT since new. On April 3, 2016, at 987.4 hours engine TT, a 150-hour engine inspection was completed, and a fuel control tube was replaced. Also replaced during the maintenance work were the engine combustion case, combustion liner, and engine bleed valve due to a power transient over-temperature of 850øC for 2 seconds.

On April 16, 2016, an inoperative power turbine speed (N2) dual tachometer was replaced. On April 26, 2016, a video was taken of the dual tachometer as the helicopter was in flight, and it showed that the dual tachometer indicated about 475 rotor rpm and about 60% N2 rpm. The Rotor Blade ground crewman who took the video stated that the pilot wanted him to send the video to a Rotor Blade mechanic to show him that there was still an issue with the dual tachometer. The Rotor Blade mechanic stated that he watched the video, but it was not sent directly to him. He stated that he told the pilot not to fly the helicopter if there was a problem. The mechanic and the pilot discussed that it was likely only an indicating issue.

The engine was installed new on the helicopter on November 21, 2007. The engine's accessories, including power turbine governor (PTG) model AL-AA2, part number 2549170-1, serial number HR48214, were installed new with 0.0 hours TT. No records indicated any maintenance completed on the PTG after initial installation. The records revealed that all applicable Federal Aviation Administration (FAA) Airworthiness Directives had been completed.

Weight and balance calculations for the helicopter revealed that the center of gravity was within limits, the gross weight at the time of the accident was 2,097 lbs, and the maximum gross weight was 3,550 lbs.

The operator was authorized by the FAA to conduct class A, B, and C external load operations. The helicopter was equipped with an Onboard Systems hydraulic hook kit and Rotor Blade, LLC, H500 side hook assembly.

On May 3, 2016, the company fuel truck was fueled with 211.3 gallons of Jet-A at MTW. The fuel logs revealed that, before the 0800 departure from the LZ, the helicopter was refueled at the fuel truck and departed with 260 lbs of fuel. Before the final departure at 0949, the helicopter was refueled and departed with 240 lbs (35.29 gallons) of fuel, which was estimated to provide 1 hour 10 minutes of flight time.

METEOROLOGICAL INFORMATION

WRECKAGE AND IMPACT INFORMATION

The helicopter came to rest in a wooded area about 125 ft south of tower 9904 (figure 4/5). The surrounding trees were 50 to 75 ft tall, and several of them were broken or showed signs of recent scaring and damage, consistent with the helicopter's impact sequence. All of the major components of the helicopter were found at the accident site. The long line remained attached to the cargo hook and trailed north toward the tower. There was an odor of Jet-A fuel around the main wreckage, and fuel was observed leaking from the helicopter. On-scene documentation was completed, and the wreckage was recovered to a secure examination facility.

On May 5, 2016, a postaccident examination of the wreckage was completed by the investigation team. The main transmission and its mounting revealed no exterior impact damage. The transmission fluid level was verified full using the sight glass. The upper and lower transmission chip detectors were removed and were clear of debris. The gearbox was rotated by hand and exhibited movement to indicate that the transmission internal gearing and the main rotor drive shaft were continuous. The engine drive shaft remained connected at both ends and appeared undamaged. Drive continuity from the engine to the main rotor and tail rotor output pinion was verified. The overrunning clutch was found to be functional.

All five main rotor blades remained attached to the hub and were cut or removed during the examination. The blades exhibited impact damage with minimal signatures of preimpact rotation.

The aft section of the tail boom was fractured and remained attached by the electrical conduit and wiring. The forward section of the tail boom remained attached to the fuselage. There was no evidence of a main rotor blade strike to the tail boom. The tail rotor gearbox and tail rotor swashplate operated smoothly when rotated by hand. The tail rotor gearbox chip detector was clear of debris. The tail rotor blades were manipulated by hand, and the control linkages and mechanisms responded appropriately. The right horizontal stabilizer was crushed inward.

Lateral cyclic control continuity was established through the main rotor head. Longitudinal cyclic control continuity was established to the fractures in the interconnecting torque tube and one-way lock attachment. Beyond the fractures, control continuity was established to the rotor head. The trim actuators were near center position. The actuators could not be electrically tested due to circuit breaker damage. The trim actuators were removed, and the actuators measured between mounting centers. Collective control continuity was established through the main rotor head. Anti-torque control continuity was established from the upper control column bellcrank to the control mechanism fractures under the cockpit floor and back to the fracture in the tail rotor control tube. All breaks in control continuity were consistent with impact damage.

The instrument console and slant panel were still in place but sustained damage primarily on the right side of the slant panel that housed the circuit breaker panel. Although several circuit breaker housings were cracked and some circuit breakers did not appear to reset properly, battery power was applied to evaluate the caution/warning panel lights. The caution/warning lights were functionally tested and illuminated when the push-to-test button was depressed. The engine out warning functioned normally. The trim motors and N2 beep did not function due to impact damage.

An engine fuel vacuum check was performed and revealed a slow leak on the engine side; the system held vacuum on the airframe side. No vacuum check isolation procedure was performed on the engine side since the engine was removed for additional examination. The fuel start pump inlets and the fuel tank sump area were found clean and unobstructed. Fuel was noted within the fuel pump inlet port and at the fuel nozzle. The fuel sender electrical wire was verified to be wrapped around the fuel line preventing interference with the fuel gauge sending unit. About 6 gallons of fuel were drained from the fuel tank sump. The fuel appeared clean with no contaminants observed. The low fuel warning light was functional.

The engine and accessories exhibited minimal external damage, and the engine mounts appeared undamaged. All pneumatic, oil, and fuel lines displayed no damage or evidence of leakage, and all "B" nut connectors were at least finger tight. The compressor inlet and visible stages of blades and vanes revealed no evidence of foreign object debris damage. Upon removal of the engine from the airframe, manual rotation of the gas generator drive train revealed that it was rotationally free and continuous from the starter generator pad to the compressor. Manual rotation of the power turbine drive train revealed that it to be free and continuous from the power take off gear to the stage four turbine wheel. The upper and lower engine chip detectors were clear of debris.

MEDICAL AND PATHOLOGICAL INFORMATION

Manitowoc County Coroner's Office, Fond du Lac, Wisconsin, completed an autopsy on the pilot, and the cause of death was blunt force trauma to the head and chest. The pilot was wearing an MSA LH250 flight helmet during the accident. The Bioaeronautical Research Laboratory at the FAA's Civil Aerospace Medical Institute conducted toxicology testing, which revealed the presence of amlodipine and atorvastatin and was negative for other substances.

Amlodipine (brand name Norvasc) is a prescription medication used to treat high blood pressure. Atorvastatin (brand name Lipitor) is a prescription medication used for lowering high blood cholesterol. The pilot had previously reported these medications to the FAA.

TESTS AND RESEARCH

The engine was shipped to a Rolls-Royce facility and connected to an engine test stand for a functional test. Several attempts to start the engine were made, but the engine did not start. The fuel system was checked, and fuel was noted throughout the system, up to and including the fuel nozzle where normal spray patterns and pressures were observed. The fuel control unit was removed and replaced with a new fuel control unit; subsequent engine start attempts were unsuccessful. The governor servo pressure (Py) line between the PTG and fuel control unit was removed, and its fittings were capped off to test operation of the PTG. A successful engine start was made in this condition. The PTG was removed, and its main drive shaft was found fractured. The original PTG was replaced with a new PTG, and the original fuel control was reinstalled on the engine. With the new PTG installed, the engine started normally, produced rated horsepower, and met production test specifications with no anomalies noted.

On August 9, 2016, the PTG, which was designed and manufactured by Honeywell, was disassembled and examined at a Honeywell facility under the auspices of the NTSB. A functional performance test could not be performed due to the internal damage. The examination revealed that the governor pressure (Pg) lever clevis fork was bent, and the spool bearing assembly was loose within the drive body cavity (figure 6). The drive shaft guide post was fractured and trapped within the spool bearing bushing. Metallic debris was found within the interior of both the drive body and the drive body cover. The internal bearing elements of the spool bearing assembly were seized and would not rotate. One flyweight was bent and did not pivot freely. The drive shaft was found fractured at the guide post and at the drive spline. The PTG was sent to the NTSB Materials Laboratory, Washington, DC, for further examination.

On September 16, 2016, the NTSB examination of the PTG revealed that a portion of the fractured drive shaft remained embedded in the spindle of the spool bearing assembly. The fracture surface features of the shaft were consistent with overstress. The outer cap of the spool bearing assembly was removed, and the ball bearings and spacers were found coated with voluminous, powdery, black particulate. Much of the powder fell from the assembly upon removal of the cap. No grease was observed. Disassembly of the bearings revealed that the ball retainers were fragmented, the inner surfaces were found coated with a powdery, black particulate, and no grease was observed. The inner bearing surfaces were rough and frosted. Figure 7 shows the disassembled pieces of the spool bearing.

ADDITIONAL INFORMATION

14 CFR Part 133 Operations Specifications
The Operations Specifications for Rotor Blade, LLC, as approved by the FAA, states:
The owner or operator of the aircraft identified in the certificate holder or operator' s aircraft listing is primarily responsible for maintaining that aircraft in an airworthy condition as required by 14 CFR 91.403(a) and Part 39.

PTG Information

According to the component maintenance manual, the model AL-AA2 PTG is an element of the engine fuel controlling system. The function of the governor is to maintain the speed of the power turbine (N2) by resetting the main fuel control; the PTG supplements the main fuel control. This resetting establishes the gas producer speed (N1) required to supply N2. The PTG is mounted on the accessory case and senses N2 speed through reduction gearing. When an N2 off-speed condition is sensed by the PTG, it supplies a signal to the fuel control to change N1 speed to eliminate the off-speed condition. A complete description of the PTG is available in the public docket for this accident.

In 2003, Honeywell introduced a dual-spool bearing for the PTG to lower cost of ownership and commonize the design. The bearing installed in the accident PTG was the dual-spool bearing. The dual-spool bearing replaced the legacy design single-spool bearing; the legacy design had no previous service issues. Honeywell reported that the dual-spool bearing had experienced a total of 23 field failures before this accident. The spool bearing failures led to either engine oscillations, uncommanded engine acceleration, or a loss of engine power.

Honeywell Service Bulletin (SB) GT-73-344

Honeywell issued SB GT-73-344, Revision 2, on October 30, 2008, to replace the bearing assembly on PTGs used on Rolls-Royce 250 series engines in order to increase PTG reliability. The SB applied to several PTG models including the AL-AA2 model on the accident engine. Revision 1 was issued March 7, 2008.

Rolls-Royce Commercial Engine Bulletin (CEB) 1402

Rolls-Royce issued CEB 1402 on April 21, 2008, to increase PTG reliability by incorporating a new bearing assembly. The CEB referenced Honeywell SB GT-73-344 and specified compliance times. The SB and CEB were issued after the accident PTG was installed new, and the SB and CEB were applicable to it. According to the CEB compliance times, the accident PTG's dual-spool bearing should have been replaced with a single-spool bearing no later than 750 hours TT since new.

As a result of this investigation, Rolls-Royce issued a Commercial Service Letter (CSL), revision 1, on November 11, 2016, to remind customers that there are engines operating in the field that have not complied with CEB 1402 and other CEBs. The CSL recommends that customers should review the referenced CEBs to determine if they are applicable to their engine. The CSL also states: "Rolls--Royce has been involved in investigations where failure of the user to comply with the identified bulletins resulted in an uncommanded engine power reduction. It is the owner/operator's sole responsibility to comply with the identified bulletins within the specified timeframe or risk a potential for loss of aircraft or loss of life. Rolls-Royce is not responsible for an owner/operator's failure to comply."