

N122ES

#### HISTORY OF FLIGHT

On October 23, 2014, about 1537 eastern daylight time, a Cirrus SR22 airplane, N122ES, operated by a private individual, and a Robinson R44 II helicopter, N7518Q, operated by Advanced Helicopter Concepts, collided in midair approximately 1 mile southwest of the Frederick Municipal Airport (FDK), Frederick, Maryland. The airplane departed controlled flight after the collision, the ballistic parachute system was deployed, and the airplane landed nose-down in a thicket of low trees and brush. The helicopter also departed controlled flight, descended vertically, and was destroyed by impact forces at ground contact. The private pilot on board the airplane was not injured, and his passenger sustained a minor injury. The flight instructor, commercial pilot, and a passenger in the helicopter were fatally injured. Visual meteorological conditions prevailed, and an instrument flight rules (IFR) flight plan was filed for the airplane, which departed Cleveland, Tennessee, on a personal flight about 1247. No flight plan was filed for the helicopter, which departed FDK on an instructional flight about 1535. The flights were conducted under the provisions of Title 14 Code of Federal Regulations (CFR) Part 91.

Witnesses on the ground watched the aircraft approach each other at the same altitude and saw the collision. One witness said the helicopter appeared to be in a stationary hover as the airplane closed on it and the two collided. She said neither aircraft changed altitude as they approached each other.

A flight instructor for the helicopter operator in a company Robinson R22 helicopter followed the accident helicopter in the traffic pattern for landing abeam runway 30 in the infield sod at FDK. He said his helicopter had just completed the turn onto the crosswind leg of the traffic pattern when the accident helicopter came into his view to his front at about the point where it would turn to the downwind leg of the pattern. At the same time, the airplane appeared in his field of view as it "flew through the rotor system" of the helicopter.

Radar and voice communication information from the Federal Aviation Administration (FAA), as well as interviews conducted with air traffic controllers, revealed the following:

At 1534:10, the accident airplane first contacted the FDK tower and was about 10 miles west of the field at 3,000 feet. The local controller (LC) acknowledged the pilot's transmission and instructed him to report 3 miles west for a left downwind to runway 30. At 1534:31, the pilot of the accident airplane acknowledged and read back the controller's instructions.

At the time the accident airplane contacted the LC, other traffic being handled by the tower included two helicopters (two company helicopters N2342U and N444PH) in the VFR traffic pattern, one airplane conducting practice instrument approaches to runway 23, another airplane inbound from the southeast, and a business jet (N612JD) with its IFR clearance on request.

At 1535:02, the LC then cleared the accident helicopter for take-off from alpha taxiway as requested and issued the current winds, and the call was acknowledged.

At 1536:02, the LC contacted the pilot of N612JD and advised she was ready to issue the airplane's instrument clearance. From 1536:06 to 1536:49 (43 seconds), the controller issued the clearance.

At 1536:49, the pilot of N612JD read back his clearance as required. Also at 1536:49, during the read back from N612JD, the pilot of the accident airplane reported on local frequency that he was 3 miles out on a 45-degree entry for runway 30, which the LC did not hear because she was listening to the read back from N612JD on ground control frequency.

At 1537:09, the LC transmitted to helicopter N444PH, "...four papa hotel option to the grass at your own risk use caution and on uh next go around stay at a thousand feet. I have traffic in the downwind."

At 1537:22, the LC instructed the accident airplane to report midfield left downwind for runway 30 and said "I have three helicopters below ya in the uh traffic pattern". At 1537:30, the pilot of the accident airplane acknowledged the request to report midfield downwind and stated he had two of the helicopters in sight. Immediately after that transmission, at 1537:34, the LC said "Alright uh two echo sierra, I have ya in sight runway three zero, maintain your altitude to...until turning base, cleared to land."

At 1537:41, cries were heard over the local frequency, and, at 1537:49, the pilot of a helicopter in the traffic pattern reported that an airplane and helicopter were both "down."

The pilot of the accident airplane was interviewed and provided written statements. His recollection of the flight was consistent with voice, radar, and aircraft data. The pilot stated that as he descended and slowed for the traffic pattern entry, he set the flaps to 50 percent.

The pilot stated that, about the time the airplane entered the downwind leg of the traffic pattern, the tower controller issued a landing clearance, and, "out of nowhere...I saw a helicopter below me and to the left..." The pilot initiated an evasive maneuver, but he "heard a thump," and the airplane rolled right and nosed down. The pilot deployed the ballistic recovery system, and the airplane's descent was controlled by the parachute to ground contact.

## PERSONNEL INFORMATION

The airplane pilot held a private pilot certificate with ratings for airplane single-engine land and instrument airplane. His most recent FAA second-class medical certificate was issued April 31, 2014. He reported 959 total hours of flight experience, of which 804 hours were in the accident airplane make and model.

The flight instructor on board the helicopter held commercial pilot and flight instructor certificates with ratings for rotorcraft-helicopter and instrument helicopter. His most recent FAA second-class medical certificate was issued April 31, 2014. Examination of his logbook revealed 832 total hours of flight experience, of which 116 hours were in the accident helicopter make and model.

The helicopter pilot held commercial pilot and flight instructor certificates with ratings for airplane single-engine land, multiengine land, rotorcraft-helicopter and instrument helicopter. His most recent FAA second-class medical certificate was issued April 29, 2013, and he reported 2,850 total hours of flight experience on that date. Excerpts of a pilot logbook for his helicopter time revealed 1,538 total hours of helicopter experience. A review of records revealed that he stopped flying as a helicopter tour pilot in 1994. During the years following, he logged five or fewer helicopter flights per year. Between 2004 and 2011, he logged one flight per year, none in 2011, and one in 2012. In 2014, he logged two flights in September, and two in October prior to the accident flight.

#### AIRCRAFT INFORMATION

According to FAA records, the airplane was manufactured in 2006. Its most recent annual inspection was completed June 13, 2014, at 1,289.8 total aircraft hours.

The helicopter was manufactured in 2004. Its most recent 100-hour inspection was completed October 2, 2014, at 1,758 total aircraft hours.

#### METEOROLOGICAL INFORMATION

The 1553 weather observation at FDK included scattered clouds at 4,800 feet, 10 miles visibility, and wind from 330 degrees at 16 knots gusting to 21 knots.

The was 26 degrees above the horizon, and the sun angle was from 225 degrees.

#### AIR TRAFFIC CONTROL

The air traffic control (ATC) group was formed on October 23, 2014. The group consisted of the group chairman from operational factors and a representative from the FAA compliance services group.

The group reviewed radar data provided by the FAA from Potomac TRACON (PCT), ATC voice recordings, controller training and qualification records, facility logs, standard operating procedures (SOP), letters of agreement (LOA), controller work schedules, and other related documentation. Additionally, the group conducted interviews with the LC who provided services at the time of the accident and the off-duty controller who witnessed the accident and assisted with initial notifications and the after-action response. Tenant operators on the airport were interviewed, including the operator of the accident helicopter. The group also held discussions with the air traffic manager (ATM) at FDK.

When asked what the traffic pattern altitudes (TPAs) were at FDK, both controllers, as well as the ATM, stated that the altitudes were 900 feet mean sea level (msl) for helicopters, 1,300 feet msl for small fixed-wing airplanes, and 1,800 feet msl for large fixed-wing airplanes and twins. When asked the origin of these TPAs and where they were published, the LC stated that they were published in the SOP and airport/facility directory (AFD). The witnessing controller thought the helicopter TPA was published in the local noise abatement procedures, but not in the AFD, but that the fixed-wing TPAs were in both. The ATM stated that only the fixed-wing TPAs

were published in the AFD and that the helicopter TPA had been inadvertently left out without them realizing. The ATM stated that helicopter TPA was agreed upon during meetings with tower personnel, airport management, and airport tenants prior to the tower's commissioning. The facility was unable to produce any documentation that these meetings were ever held, and they were also unable to produce any documentation of the 900-foot msl helicopter TPA they had mentioned. The only documentation that was found was from old, locally produced noise abatement procedures.

According to FAA Order 7210.3Y, minutes of the meeting were to be taken and distributed to "the appropriate Service Area" office and to each attendee. These minutes were neither recorded nor distributed.

In an interview, the helicopter operator was asked for a copy of his flight school's SOP. He stated there was none. The policies and procedures were made by him, and distributed by word of mouth in periodic meetings. During an initial discussion, the operator stated that the helicopter TPA was between 900 and 1,000 feet msl, and 1,200 feet msl for autorotations. When asked how he decided upon the TPA of 900 feet msl for his pilots and students. He said, "It just kind of morphed into that. The airplanes are at 1,300 feet msl, and we thought we should be below that. They never published that in the AFD, and I wish they would."

According to the chief pilot for the helicopter operator, a 14 CFR Part 141 application would soon be submitted and an SOP would be published concurrent with the application.

#### AERODROME INFORMATION

FDK was at an elevation of 306 feet and was tower controlled. The tower was an FAA contract tower and was not radar-equipped.

Runway 5/23 was 5,219 feet long and 100 feet wide, and was located along the east side of the field. Runway 12/30 was 3,600 feet long, 75 feet wide, and located on the north side of the field. The two runways intersected at the approach end of runways 23 and 30.

The published TPA in the AFD for single-engine and light-twin airplanes was 1,300 feet msl, and 1,800 feet msl for heavy multiengine and jet airplanes. The traffic pattern was a standard left-hand pattern.

There was no published traffic pattern or TPA for helicopters in the AFD at the time of the accident. According to the FAA's Aeronautical Information Manual (AIM), in the absence of a published TPA for helicopters, the helicopter TPA was 500 feet agl, or about 800 feet msl at FDK.

A pamphlet produced by the City of Frederick, Maryland, depicted the airport traffic patterns and identified the helicopter TPA as 1,100 feet msl.

A poster of the pamphlet's depiction was posted around the airport, and it also identified the helicopter TPA as 1,100 feet msl.

The SOP for the contract operator of the tower had no TPAs published. However, when interviewed, the LC on duty at the time of the accident stated the TPA for helicopters was 900 feet per the SOP.

As a result of the investigation, the AFD was updated on January 8, 2015, with a recommended TPA for helicopters of 1,106 ft msl/800 feet agl.

#### Radar Data

Radar data for the flights was obtained by the FAA from several radar sites in the area surrounding FDK. Radar data recorded the flight track of the accident airplane until seconds before the accident; however, no data were recorded for the accident helicopter.

At the time of the accident, the floor of the Potomac TRACON radar coverage in the area surrounding FDK appeared to be about 1,200 feet msl. The helicopter never climbed into radar coverage, and the collision between the helicopter and the airplane occurred below the area of radar coverage.

#### WRECKAGE INFORMATION

The helicopter wreckage and its associated debris came to rest in a self-storage complex between two buildings, with parts and debris scattered in and around the complex. All major components were accounted for at the scene. The main wreckage came to rest largely upright, and the cockpit, cabin area, fuselage, tailboom, engine, transmission, with main and tail rotors attached. All components were significantly damaged and deformed by impact forces. The "blue" main rotor blade was fractured near its root, and the outboard 11 feet of main rotor spar was located 50 feet from the main wreckage with no honeycomb or blade skin afterbody material attached.

Control continuity could not be established due to numerous fractures in the system, but all fractures exhibited features consistent with overload.

The airplane came to rest nose down, in a dense thicket of brush and low trees, wedged between tree trunks, and held in that position. All major components were accounted for at the scene, except for the right wing flap, aileron, and right landing gear wheel and tire assembly which were located between the helicopter and airplane sites. Examination of the airplane revealed that the trailing edge of the right wing was impact-damaged, and that the flap and aileron hinges were significantly damaged and twisted, and the surrounding sheet metal displayed "saw-tooth" fractures, consistent with overload. ~~The structural cable between the wing strut and the empennage was still attached at each end, but missing a 5-foot section in the middle. The two severed ends displayed features consistent with overload. The empennage displayed a vertical opening and parallel slash marks.~~

Examination of the cockpit revealed the flap switch handle was in the "50 percent" position; however, the flaps and the flap actuator were positioned consistent with a flaps-up position. Because power was applied to all systems throughout the flight and after ground contact, the flap

position could not be determined prior to the collision.

## MEDICAL AND PATHOLOGICAL INFORMATION

The Office the Chief Medical Examiner for the State of Maryland performed autopsies on the helicopter flight instructor and helicopter pilot. The autopsy reports listed the cause of death for each as "blunt impact injuries."

The FAA's Bioaeronautical Sciences Research Laboratory, Oklahoma City, Oklahoma, performed toxicological testing of the helicopter flight instructor and helicopter pilot. The tests for each were negative for the presence of carbon monoxide, cyanide, and ethanol.

## TESTS AND RESEARCH

### Avidyne Primary Flight Display (PFD) Description

The PFD unit from the accident airplane included a solid state Air Data and Attitude Heading Reference System (ADAHRS) and displayed aircraft parameter data including altitude, airspeed, attitude, vertical speed, and heading. The PFD unit had external pitot/static inputs for altitude, airspeed, and vertical speed information. Each PFD contained two flash memory devices mounted on a riser card. The flash memory stored information the PFD unit used to generate the various PFD displays. Additionally, the PFD had a data logging function, which was used by the manufacturer for maintenance and diagnostics. Maintenance and diagnostic information recording consisted of system information, event data and flight data.

The PFD sampled and stored several data streams in a sequential fashion; when the recording limit of the PFD was reached, the oldest record was dropped and a new record was added. Data from the Attitude/Heading Reference System (AHRS) was recorded at a rate of 5 Hz. Air data information such as pressure altitude, indicated airspeed, and vertical speed was recorded at 1 Hz. GPS and navigation display and setting data were recorded at a rate of 0.25 Hz, and information about pilot settings of heading, altitude, and vertical speed references were recorded when changes were made.

According to the data, at 15:34:30, about 9 miles from the airport, the airplane initiated a descent out of 3,000 feet msl. The descent rate varied between 500-1000 fpm. The descent stopped at 1,600 feet pressure altitude (1,582 feet indicated) for about 10 seconds, at 15:36:40. The airplane then continued its descent at an approximate rate of 700 fpm.

As the descent continued, the airplane entered a right bank of about 15 degrees about 1.5 miles from the airport. While descending and turning right, pitch, vertical, longitudinal, and lateral acceleration experienced a loading event simultaneously at 15:37:36.

When this occurred, the aircraft was 0.75 miles from the field at 1,045 feet pressure altitude (1,027 feet indicated) and 100 kts indicated airspeed. Following the loading, the aircraft rolled a full 360 degrees to the right, pitch recorded extremes of 21 degrees nose- up to 80 degrees nose-down, and heading spun nearly 720 degrees to the right.

Following the loading, altitude was maintained for about 3 seconds before dropping at a maximum recorded rate of 5,470 fpm. The aircraft came to rest at 15:37:52 at 330 feet pressure altitude in a 75-degree nose-down attitude with the wings rolled 46 degrees to the left. The recording ended with the aircraft static in these conditions.

## ADDITIONAL INFORMATION

### Traffic Advisory System

The accident airplane was fitted with an L-3 Avionics SKYWATCH Traffic Advisory System (TAS). As installed, the system included an L-3 Avionics SKY 497 transmitter/receiver unit and an L-3 Communications antenna. The traffic information developed by the SKY 497 system was displayed in the cockpit and provided an audio alert.

According to the manufacturer, the SKYWATCH TAS monitored the airspace around the aircraft for other transponder-installed aircraft by querying Mode C or Mode S transponder information. These data would then be displayed visually to the pilot in the cockpit. The system also provided aural announcements on the flight deck audio system. The audio alert would be inhibited at 50 percent and 100 percent flap settings.

If an intruder aircraft's transponder did not respond to interrogations, the TAS would not establish a track on that aircraft. The system was not equipped with recording capability.

The SKYWATCH system operated on line-of-sight principles. If an intruder aircraft's antenna was shielded from the SKYWATCH system antenna, the ability of the SKY 497 to track the target would be affected. If a SKY 497-equipped aircraft was located directly above an intruder, the airframe of one or both of the aircraft could cause the SKY 497's interrogations to be shielded, depending on antenna location (top-mounted on the accident airplane). The SKY 497 also had the capability to coast (predict) an intruder's track to compensate for a momentary shielding.

In an interview with state police immediately after the accident, the pilot explained the operation of the system to the trooper conducting the interview, and stated he did not receive a traffic alert prior to the collision.

### FAA Advisory Circular 90-48c

"Pilots should also be familiar with, and exercise caution, in those operational environments where they may expect to find a high volume of traffic or special types of aircraft operation. These areas include Terminal Radar Service Areas (TRSAs), airport traffic patterns, particularly at airports without a control tower; airport traffic areas (below 3,000 feet above the surface within five statute miles of an airport with an operating control tower..."

N7518Q

#### HISTORY OF FLIGHT

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#### WRECKAGE INFORMATION

The helicopter wreckage and its associated debris came to rest in a self-storage complex between two buildings, with parts and debris scattered in and around the complex. All major components were accounted for at the scene. The main wreckage came to rest largely upright, and the cockpit, cabin area, fuselage, tailboom, engine, transmission, with main and tail rotors attached. All components were significantly damaged and deformed by impact forces. The "blue" main rotor blade was fractured near its root, and the outboard 11 feet of main rotor spar was located 50 feet from the main wreckage with no honeycomb or blade skin afterbody material attached.

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According to the data, at 15:34:30, about 9 miles from the airport, the airplane initiated a descent out of 3,000 feet msl. The descent rate varied between 500-1000 fpm. The descent stopped at 1,600 feet pressure altitude (1,582 feet indicated) for about 10 seconds, at 15:36:40. The airplane then continued its descent at an approximate rate of 700 fpm.

As the descent continued, the airplane entered a right bank of about 15 degrees about 1.5 miles from the airport. While descending and turning right, pitch, vertical, longitudinal, and lateral acceleration experienced a loading event simultaneously at 15:37:36.

When this occurred, the aircraft was 0.75 miles from the field at 1,045 feet pressure altitude (1,027 feet indicated) and 100 kts indicated airspeed. Following the loading, the aircraft rolled a full 360 degrees to the right, pitch recorded extremes of 21 degrees nose- up to 80 degrees nose-down, and heading spun nearly 720 degrees to the right.

Following the loading, altitude was maintained for about 3 seconds before dropping at a maximum recorded rate of 5,470 fpm. The aircraft came to rest at 15:37:52 at 330 feet pressure altitude in a 75-degree nose-down attitude with the wings rolled 46 degrees to the left. The recording ended with the aircraft static in these conditions.

## ADDITIONAL INFORMATION

### Traffic Advisory System

The accident airplane was fitted with an L-3 Avionics SKYWATCH Traffic Advisory System (TAS). As installed, the system included an L-3 Avionics SKY 497 transmitter/receiver unit and an L-3 Communications antenna. The traffic information developed by the SKY 497 system was displayed in the cockpit and provided an audio alert.

According to the manufacturer, the SKYWATCH TAS monitored the airspace around the aircraft for other transponder-installed aircraft by querying Mode C or Mode S transponder information. These data would then be displayed visually to the pilot in the cockpit. The system also provided aural announcements on the flight deck audio system. The audio alert would be inhibited at 50 percent and 100 percent flap settings.

If an intruder aircraft's transponder did not respond to interrogations, the TAS would not establish a track on that aircraft. The system was not equipped with recording capability.

The SKYWATCH system operated on line-of-sight principles. If an intruder aircraft's antenna was shielded from the SKYWATCH system antenna, the ability of the SKY 497 to track the target would be affected. If a SKY 497-equipped aircraft was located directly above an intruder, the airframe of one or both of the aircraft could cause the SKY 497's interrogations to be shielded, depending on antenna location (top-mounted on the accident airplane). The SKY 497 also had the capability to coast (predict) an intruder's track to compensate for a momentary shielding.

In an interview with state police immediately after the accident, the pilot explained the operation of the system to the trooper conducting the interview, and stated he did not receive a traffic alert prior to the collision.

### FAA Advisory Circular 90-48c

"Pilots should also be familiar with, and exercise caution, in those operational environments where they may expect to find a high volume of traffic or special types of aircraft operation. These areas include Terminal Radar Service Areas (TRSAs), airport traffic patterns, particularly at airports without a control tower; airport traffic areas (below 3,000 feet above the surface within five statute miles of an airport with an operating control tower..."