SIKORSKY
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Sikorsky Submission to NTSB

NTSB REPORT NUMBER: DCA20MA059

OPERATOR: Island Express Helicopters

MODEL: S-76B **AIRCRAFT: 760379**

FAA registration: N72EX

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Date of Accident: 26 Jan 2020

Location of Accident: Calabasas, CA

Report Date: 15 July 2020

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I. INTRODUCTION

The purpose of this report is to present factual observations on the condition of the accident aircraft prior to and after the accident in order to determine whether the aircraft condition played a role in the cause of the accident. All aspects of a safety investigation were explored to identify primary cause factors that may have contributed to this accident in an attempt to prevent the same accident from occurring again.

The National Transportation Safety Board (NTSB) was the cognizant investigating authority. Bill English, NTSB HQ, was the Investigator-In-Charge. The FAA Office of Accident Investigation, Office of Rotorcraft Standards, and the Van Nuys Field Service District Office (FSDO) also participated. Sikorsky (SIK), Pratt & Whitney Canada (PWC), and Island Express Helicopters (IEX) were also parties to the investigation. The Federal Bureau of Investigation (FBI) assisted with evidence collection. The LA County Fire Department, LA County Sheriff's Office, Montrose Search and Rescue, and LA County Coroner's Office all participated during the on-site phase of the investigation.

This report is based on the on-site wreckage inspection that was conducted in Calabasas, CA on 27-28 Jan 2020 and the wreckage layout conducted in Phoenix, AZ on 30-31 Jan 2020. This report is preliminary and is subject to change as the investigation progresses.

II. BACKGROUND

A. Mission

The flight was intended as a 14 CFR Part 135 on-demand charter flight carrying several passengers from John Wayne – Orange County airport (SNA) to Camarillo Airport (CMA) in Camarillo, CA. The flight departed SNA at approximately 09:06 PST. No flight plan was filed with the FAA, nor was one required. The flight was conducted under day VFR and SVFR rules. There were eight passengers and one pilot on board the aircraft.

B. Accident Site Description

The accident site was a north facing, shrub and grass-covered hillside in Calabasas, CA. The debris field was along an approximate 340° bearing about 233 feet from initial impact to the main rotor head.

The initial impact GPS coordinates were latitude 34° 08.198' N by longitude 118° 41.538' W.

The aircraft wreckage was recovered via Bell 407 and four-wheel drive utility vehicles. It was then trucked to Air Transport, an aircraft salvage company in Phoenix, AZ, for further evaluation. The wreckage was secured in accordance with NTSB policy and was undisturbed until the NTSB-led Airworthiness Group arrived on 30 Jan 2020.

C. Weather

Weather at the time of the accident was day Instrument Meteorological Conditions (IMC). The sky was reportedly overcast at 1100' MSL and visibility was 2½ miles. Van Nuys airport (VNY) is the closest FAA weather reporting station to the accident location, about 12.5 miles away. (See Appendix IV for detailed weather information)

D. Accident Sequence

The aircraft departed from John Wayne – Orange County Airport (SNA) at approximately 09:06 PST on 26 Jan 2020. Data from ADS-B[1] indicated the aircraft flew north from SNA at approximately 700 feet MSL, then entered a hold east of Burbank (BUR) controlled airspace, near the LA Zoo. The hold was flown as three 360° turns to the left, followed by three 360° turns to the right.

The aircraft was then cleared to transit through BUR Class C and VNY Class D airspace at approximately 1400-1500 feet MSL following first the I-5 freeway, then the CA-118 freeway, and then following the CA-101 Pacific Coast Highway towards Camarillo.

The VNY Local-1 controller asked if the aircraft was in VFR conditions, and the pilot replied in the affirmative.

Shortly thereafter, the aircraft was handed off from VNY to Southern Cal Terminal Radar Control (SCT). On initial contact the SCT controller asked the pilot if he was going to stay down low while transitioning to CMA. The pilot responded yes, and the controller advised that he would lose radar and radio contact, thus unable to provide flight following services, and advised the pilot to squawk VFR and contact CMA tower when able.

About three minutes and 50 seconds later, the pilot stated that 'we gonna go ahead and start our climb to go above the layers'. The SCT controller asked where, and the pilot responded, 'just west of VNY'. The controller then asked the pilot to IDENT[2], and then stated that the pilot was transmitting a 1200 (VFR) squawk code and asked if the pilot was requesting flight following. The pilot stated yes. The controller then issued instructions to two commercial airliners, SWA4051 and SWA2080, both on approach to BUR. The controller then asked the pilot of 72EX to state his intentions. The pilot responded, 'we're climbing to 4000 feet'. The controller asked, 'and what are you going to do when you get to altitude?' There was no response from the pilot.

The controller was unable to contact the aircraft by radio after this point. The ADS-B data indicated the aircraft entered a climb up to about 2300 feet in a left turn, followed by a rapid descent (>3000 fpm) leading to impact in hilly terrain in Calabasas at approximately 09:45 PST.

[1] ADS-B is the FAA's Automated Dependent Surveillance – Broadcast system (NextGen). It is described at https://www.faa.gov/nextgen/programs/adsb/

[2] IDENT is a transponder code that momentarily 'flares' the blip on the controller's display to identify an aircraft.

III. EVALUATION

A. Aircraft Configuration

The aircraft was an S-76B. The cockpit was 'EFIS/DAFCS' equipped, with four cathode ray tube (CRT) screens for EFIS and navigation displays, and the remainder analog, circular 'steam' gauges. It was equipped with instrument flight rules (IFR) -capable instrumentation and was certified for IFR flight. The cabin was fitted with an executive eight passenger interior with four aft-facing and four forward-facing divan seats.

The aircraft's weight & balance (W&B) data was recovered from the accident site. According to that data, the basic operating weight was 8381.5 lbs at 208.27 inches, which provides a moment/1000 of 1745.615 lb-in. The W&B sheet for this flight on file with the operator showed a basic operating weight of 8417 lbs at 207.28 in for a mom/1000 of 1744.582. The pre-flight calculated takeoff weight and CG (using reported passenger weights) was 11,008 lbs and 202.57 in. The calculated landing weight was 10,508 lbs and 201.85 in. The weight and CG was calculated to remain within limits throughout the flight.

B. Aircraft History

The aircraft was delivered to United Technologies Corporation (UTC), the original owner, on 06 June 1991. It was owned by one other operator prior to being transferred to IEX on 17 August 2015. At the last logbook entry (26 Jan 2020) in the aircraft flight logbook, the aircraft had accumulated 4716.1 hours of total time and 11,239 takeoff and landing cycles prior to the accident.

C. Aircraft Maintenance

The aircraft was primarily maintained by Rotorcraft Support, Inc for Island Express using the manufacturer-approved Maintenance Manual.

The Maintenance Group performed a review of the maintenance records for the aircraft. All applicable Airworthiness Directives (ADs) had been complied with, and no discrepancies were noted. No open maintenance issues were noted.

The most recent scheduled maintenance actions were the 25 & 50 hour airframe inspections and the engine 50 hour inspection, which were all conducted on 01 Jan 2020 at 4701.7 airframe flight hours.

The most recent unscheduled maintenance was conducted on 22 Jan 2020. It included replacement of the Black and Yellow TR boots, tail rotor light on wheels balance check, replacement of the #2 Yaw SAS actuator, replacement of the landing light bulb, updated the GPS database, and inspection of safety equipment (fire extinguisher, ELT, life vest, and jet emergency battery). All discrepancies were identified and corrected prior to the aircraft release from maintenance.

D. Aircraft Analysis

The aircraft was destroyed and highly fragmented during the accident.

1. Airframe

The airframe was destroyed. Fragments of belly skin and the right MLG door were found at the initial impact site.

Both pitot tubes were found nearly intact at the initial impact site.

Both glass-laminated forward windscreens and all of the other aircraft acrylic windows were destroyed. Fragments of windscreens and windows were located throughout the site.

The nose landing gear was found separated from the airframe, just beyond the initial impact site.

The right and left main landing gear (MLG) were both separated from the airframe and recovered. The RMLG was found in the initial impact area, the LMLG was in the central, burned area.

The tail cone and vertical pylon were separated and located just downhill and left of the initial impact site. The TGB separated from the pylon and was located nearby. The IGB remained in its installed position. The stabilizer panels were fractured but were in the immediate area.

Numerous unburned seat cushions and interior panels were also recovered.

2. Rotor Blades

Main Rotor Blades

The majority of the main rotor blades (MRB) were recovered. The Yellow blade, out to blade station[3] (BS) 84 remained on the main rotor head. The Red, Blue, and Black blades fractured from BS16-20. All blade attachment bolts were intact at the cuff.

a) **Red Blade:** The Red MRB was fractured at BS18, bent at BS 96, (leading edge fractured at BS84, fractured at BS137. A section of leading edge was separated at BS134 to 158 was recovered separately. The relatively intact tipcap was recovered separately and positively matched.

b) **Blue Blade:** The Blue MRB was fractured at BS16, fractured at BS92, fractured at BS200. Several outboard sections of leading edge were highly damaged, but were positively matched to this section. The Blue tip cap was not recovered. The pocket from BS16 to BS 92 was attached and relatively intact. Pocket from BS92-200 was damaged but remained attached. Pocket from BS200 to tip was recovered and positively matched.

c) **Yellow Blade:** The Yellow MRB had a partial fracture at BS29, with pocket damage. It was fractured at BS87. The pocket from BS70-176 was recovered separately and positively matched. Pocket from BS176-tip was still attached to the spar. An accordion-damaged tip cap was positively matched to this blade.

[3] Main rotor blade station (BS) is measured in inches, from the blade cuff outboard.

d) **Black Blade:** The Black MRB was fractured at BS20, BS120, and BS192. A tentative match to an accordion-impact damaged tip cap was made, but it is possible that it could be the Blue tip cap as well. The pocket was mostly intact and attached from BS20-120. The pocket sections from BS120-192 and BS192-tip were recovered separately and positively matched.

Tail Rotor Blades

The four tail rotor blades (TRB) were recovered. Approximately seven pieces of TRB had been recovered and placed together prior to the arrival of the investigators. Both cross-spars had fractured at the center plug, and two were additionally fractured near mid-span. The Yellow cuff remained attached to the inboard remnant of paddle, and the Red/Yellow spar remnant extended past the center hub towards the Red paddle, which was mostly intact, except that the cuff had separated. The Red cuff was not recovered. The Blue/Black cross-spar was fractured more cleanly than the Red/Yellow spar at the hub center plug. One paddle was nearly intact, the other was fractured slightly outboard of mid-span. It was not possible to identify which was Blue and which was Black.

3. Rotor Heads

Main Rotor Head

The main rotor head (MRH) was intact, unburned, and remained attached to the fractured main gearbox. It was found in a drainage gully, about 230 feet along a vector of 340° from the initial impact point. There was evidence of powered MRB impacts with the ground. The aircraft was equipped with a 3P bifilar[4], and all four arms and weights were retained. Three of the arms were bent downward. One bifilar weight (between Blue and Yellow) was fractured at the lead bolt, there was also some recovery damage in this area. The lag bolt retained the weight in place. The aircraft was not equipped with a 5P bifilar. The damper reservoir was fractured. The swashplate and uniball were intact and rotated and moved smoothly (through a limited range of motion). The rotating scissors link was separated from the rotating swashplate as its mounting bolt had fractured. The stationary scissors assembly was intact.

a) **Red Arm:** The Red spindle and tie rod were intact. The Red blade was fractured at BS18. There was a heavy spindle-to-hub impact mark at clock angle of 2:30 to 3:30. There were no other hard metal-to-metal contact marks. The elastomeric bearing was intact. The droop stop mount was fractured at the two upper bolts, but the droop stop remained free and intact with no evidence of hard impact. The lead side spring was present, but separated, the lag side spring was intact. The flap stop and return spring were intact, but motion could not be verified as the weight of the head was on the Red arm. The Red damper was fractured in tension at the rod end threads with visible cup/cone separation. The Red pitch change rod (PCR) was intact.

[4] A bifilar is a dynamic vibration absorber consisting of oscillating weights mounted on the top of the main rotor head. These weights are tuned to absorb various rotor head vibration frequencies, i.e. 3 per revolution.

b) **Blue Arm:** The Blue spindle and tie rod were intact. The Blue blade was fractured at BS16. There was a hard spindle-to-hub impact mark at a clock angle of 1:00. There were no other hard metal-to-metal contact marks. The elastomeric bearing was intact. The droop stop mount was fractured at the two upper bolts. The lead spring was missing and the lead flyweight was bent. The lag spring and flyweight were intact. The flap stop and return spring were intact and moved freely. The Blue damper was fractured in tension at the rod end thread. The Blue PCR was intact.

c) **Yellow Arm:** The Yellow spindle and tie rod were intact. The Yellow blade was fractured at BS87. There was a hard spindle-to-hub impact mark at clock angle of 2:00 to 2:30. There were no other hard metal-to-metal contact marks. The elastomeric bearing was intact, but impact damaged. The droop stop was free and intact with no evidence of hard impact. The lag spring flyweight was broken and the lag spring was missing. The flap stop and return spring were intact and moved freely. The Yellow damper was fractured in tension at the rod end. The Yellow PCR was intact.

d) **Black Arm:** The Black spindle and tie rod were intact and had no dirt in the hub arm. The Black blade was fractured at BS20. There was a spindle-to-hub impact mark at clock angle of 11:00 to 1:00 and another at 8:30. There were no other hard metal-to-metal contact marks. The elastomeric bearing was intact. The droop stop was free and intact with no evidence of hard impact. Both springs were intact, leading flyweight was deformed slightly. The flap stop and return spring were intact, but the weight of the MRH was resting on the Black arm and prevented check of motion. The Black damper was intact. The Black PCR was intact.

Tail Rotor Head

The tail rotor head (TRH) was recovered from below and left of the initial impact area. It was relatively intact, with the TR primary servo and both Yaw SAS actuators still attached. The Red and Blue rod ends remained on the pitch change beam as both links fractured at the beam-end threaded connection. The Yellow pitch change link remained attached to the pitch change beam, and the blade-side rod end had separated from the fractured Yellow pitch horn trunnion. The Black pitch change link remained attached to the pitch beam and fractured at the blade-side rod end threaded connection.

4. Transmissions and Driveshafts

a) **Main Gearbox (MGB):**
The main gearbox separated from the airframe via multiple fractures of the magnesium upper housing. All four mounting feet and all eight mounting bolts were separated. The magnesium rear cover was destroyed by fire. The left hand (as confirmed by the presence of the TTO drive spur gear) helical gear and spiral bevel pinion assembly and the presumed left hand spiral bevel gear and spur pinion assembly were recovered near each other, and completely separated from the MGB. The right hand helical gear/spiral bevel pinion was located in a separated piece of upper housing. The presumed right hand spiral bevel gear/spur pinion assembly was not located. Mechanical continuity could not be confirmed due to the extent of damage. Visual inspections, where possible, showed no evidence of any loss of drive. The tail takeoff rotor brake disk was separated from its mount and was retained loosely on the flange. The disk radial vent lines were intact, which indicates that the rotor brake was not overheated. Both rotor brake calipers were recovered separately and neither showed any evidence of damage or overheating.

b) **Tail Rotor Driveshafts (TRDS):**
The #1 TRDS was fractured at 8” aft of the TTO flange. The flexible coupling at the TTO was intact but wavy. The forward part of the 30” long aft section of #1 shaft was melted. There was little distortion at the aft coupling. The #2, #3, and #4 hanger bearings were all damaged, but retained their respective shafts within the bearing housings. The #2 TRDS was mostly intact with a dent about 14” aft of the coupling. The shaft was pulled out of the aft flange in nearly pure tension. The aft flexible coupling was distorted. The #3 TRDS was mostly intact. The aft flexible coupling was not distorted. The #4 TRDS was fractured 48” aft of the coupling. About 12” remained attached to the IGB input section, which showed some circumferential scoring. The pylon (#5) TRDS at the IGB showed circumferential scoring and remained attached to the IGB output flange. The upper flange pulled out of the #5 shaft in combined torsion/tension from the shaft as the TGB departed the airframe.

c) **Intermediate Gearbox (IGB):**
The IGB remained in its proper location in the tail pylon. Continuity and smooth rotation of the IGB was verified in situ and at the wreckage layout. The chip detector was clean.

d) **Tail Rotor Gearbox (TGB):**
The TGB was separated from the vertical pylon and was located nearby. The TR servo and SAS servos remained attached. Continuity and smooth rotation of the TGB was verified in situ and at the wreckage layout. The chip detector was clean.

5. Propulsion

Engines: The engines were located inverted in the central wreckage area, about 150 feet from the initial impact. The #1 engine had accumulated 4506.3 hours and 9513 cycles and the #2 engine had accumulated 4680.5 hours and 9678 cycles as of 26 Jan 2020, according to aircraft maintenance records. Both engines were found inverted in the main wreckage impact area. Both engines were burned in the post-crash fire.

The engines were disassembled and reviewed by PWC and NTSB personnel in Phoenix. Both engines appeared to have been producing power, and no adverse findings were noted.

Fuel System: Both main fuel tanks were destroyed at impact. There was no fire damage to any of the fuel tank structure. Both internal fuel level probes were recovered intact and unburned. The take-off fuel quantity was estimated to be 1200 lbs in the main tanks (of a total capacity of 286 gallons [~1944 lbs]).

Engine Controls: The throttle quadrant was destroyed. One T-handle with one fuel control lever was recovered separately. Four push-pull engine speed and fuel control cables were recovered with mechanical impact damage.

Due to the level of destruction, no continuity of controls could be observed.

6. Flight Control Systems – Hydraulic/Mechanical

The mechanical flight control system was completely destroyed. Mechanical continuity was not able to be determined because of the level of destruction.

Portions of both cyclic sticks and grips, portions of both collective stick and grips, and portions of both sets of rudder pedals were recovered. Sections of various control tubes were recovered, but the level of destruction prohibited a full control system reconstruction. The three primary main rotor servos remained attached to the fragmented MGB upper housing. The Forward Servo input control arm was fractured at the rod end. The lower linkage was torque striped. It no longer retained torque following the impact, however, the threads and jam nut were in good condition. The Lateral Servo follow-up arm was fractured on both sides of the 'A' Frame. The Aft Servo appeared intact, and its control arm had separated.

The upper deck was damaged by impact and by post-crash fire. Three of the four SAS actuators were recovered. The forward pitch SAS (~6" adapter) was fire damaged, the aft pitch SAS (~8" adapter) was slightly charred and impact damaged. The aft roll SAS (~4" adapter) was unburned and was impact damaged. The forward roll SAS was not recovered. The Pedal Damper/Trim Actuator was recovered with heavy fire damage. The Collective, Pitch and Roll trim servos were recovered with light fire damage (charring) and heavy impact damage to their housings.

The tail rotor cables were fractured at the tail cone separation. Damage at the fairleads at STA 300 indicated that both cables were intact and tensioned at the time of separation. The right cable fractured, after cutting through about 2¾" of airframe in a downward and to the left direction. The left cable remained intact, with about 12 feet aft of STA 300 and 19 feet forward of STA 300. The right cable was not located in the STA 300 area. Two sections of TR cable, about 15 feet, 9 feet with a section of forward quadrant, and 2 feet long, were recovered separately. The Yaw SAS actuators and Tail Rotor Servo remained on the TGB in their proper locations.

7. Flight Control System – Electrical

The aircraft was equipped with a Honeywell SPZ-7000 Digital Automatic Flight Control System (DAFCS)[5]. The SPZ-7000 is a fully coupled, four axis (pitch, roll, yaw and collective) flight control system combining autopilot and flight director functions. The system also incorporates several additional features to reduce pilot workload: auto trim, heading hold, automatic turn coordination, and auto level.

[5] This partial description of the SPZ-7000 is paraphrased from the S-76B RFM Supplement 2, SA 4047-76B-1-1 Part 2, Section 1, Page 1-1.

The autopilot provides two basic modes of operation: Stability Augmentation System (SAS) and Attitude Retention (ATT). The SAS mode provides short-term rate damping during hands-on flying while the ATT mode is used for hands-on or coupling to the flight director.

The flight director provides steering commands which can be manually flown by the pilot or can be coupled to the autopilots for fully automatic flight path control.

The system consists of two FZ-700 flight control computers, a PC-700 autopilot controller, two MS-700 flight director mode selectors, two AZ-649 air data sensors, and an AL-300 command display. It is integrated to a variety of avionics equipment such as NAV receivers (short range and long range), gyros, radar altimeters and cockpit indicators including Electronic Flight Instrument System (EFIS) to provide pilot workload relief.

Aircraft control inputs are achieved through the use of series actuators in pitch, roll and yaw. There are three series actuators per system, each with a linear stroke of ±8 mm which is equivalent to ±5 percent of total control authority per actuator. Series actuator position is displayed on an AFCS indicator panel located in the pedestal.

Auto trim is achieved through parallel rotary actuators in pitch and roll with 100 percent authority [However, trim actuators are rate limited to less than 10% per second]. These actuators also provide magnetic brake and artificial feel functions. A similar rotary actuator also provides collective control and trim. An electro-hydraulic pedal damper/trim actuator provides yaw trim.

Autopilot malfunctions are annunciated on a DAFCS caution panel located on the instrument panel. Either pilot can override the AFCS functions.

8. Flight Instrumentation

The instrument panel was destroyed. Most of the instrument faces were damaged by impact or post-crash fire. One barometric altimeter was relatively undamaged, with the glass face intact. The Kollsman window settings were 30.16 inHg and 1021 Mb. The VNY altimeter setting at the time of the accident was 30.16 inHg. While on site, the altimeter read ~1400', and in Phoenix it read ~1000'. No other instruments were readable. Several of the 'black boxes' and instrumentation were recovered and sent to the NTSB lab for review to determine if any data or other observations could be recovered.

E. Cockpit Voice/Flight Data Recorder (CVFDR)

The aircraft was not equipped (nor required to be equipped) with any type of CVR/FDR, nor any other known source of non-volatile memory (NVRAM), with the exception of a Universal Flight Management System, which was removed from the wreckage to allow evaluation of potential NVRAM data. The aircraft was, however, initially equipped with a Fairchild A100 Cockpit Voice Recorder upon delivery from Sikorsky to the initial operator of the aircraft. It was subsequently removed, as permitted by FAA regulation.

F. Enhanced Ground Proximity Warning System (EGPWS)

The aircraft was not equipped (nor required to be equipped) with any type of terrain warning system. It should be noted that Sikorsky has since 2004 made the Honeywell Mark XXII EGPWS standard equipment in all new S-76™ and S-92A™ aircraft. It is Sikorsky's opinion that EGPWS would not have been a factor in prevention of this particular accident. EGPWS is intended to prevent *Controlled* Flight into Terrain. EGPWS is also available for retrofit into S-76™ helicopters.

G. Survivability

This impact was non-survivable. Impact forces greatly exceeded design impact criteria and human G-load tolerance. A livable volume was not maintained around any of the occupants. The aircraft was fragmented into small pieces.

All occupants were fatally injured by impact trauma. None of the occupants sustained any thermal injuries.

There was a small but intense post-crash fire in the area of the MGB lower aft housing. None of the airframe fuel tank structure was burned. The fuel probes were also recovered intact and unburned.

The aircraft was equipped with an Artex 406MHz Emergency Locator Transmitter (ELT). The ELT was recovered from the scene, it had completely detached from both its mount and its antenna connection. No transmission of any ELT signal was reported. The case was intact and unburned, with some impact damage in the central front panel which obscured both the part and serial numbers. The unique hexadecimal identification number was still visible.

IV. FINDINGS

A. Observations

All observed damage was consistent with a high-energy impact with terrain at a steep impact angle.

The radar data and video observations are consistent with spatial disorientation and subsequent loss of control in-flight (LOC-I). Inadvertent entry into Instrument Meteorological Conditions (IIMC) is a primary driver of helicopter fatal accidents.

The impact was non-survivable.

B. Conclusions

Sikorsky concludes that the probable cause of this accident was spatial disorientation of the pilot, and subsequent loss of control following entry into instrument meteorological conditions.

APPENDICES

APPENDIX I: Acronyms and Abbreviations

ADS-B	Automated Dependent Surveillance – Broadcast
AGL	Above Ground Level (absolute altitude, in feet)
CRT	Cathode Ray Tube
CVR	Cockpit Voice Recorder
CVFDR	Cockpit Voice and Flight Data Recorder (combined digital unit)
DAFCS	Digital Automatic Flight Control System
DFDR	Digital Flight Data Recorder
EFIS	Electronic Flight Information System
ELT	Emergency Locator Transmitter
FAA	Federal Aviation Administration
GPS	Global Positioning System
HSI	Horizontal Situation Indicator
IGB	Intermediate Gearbox
IFR	Instrument Flight Rules
IIC	Investigator in Charge
IMC	Instrument Meteorological Conditions
LH	Left Hand
M&P	Material and Processes
MGB	Main Gearbox
MLG	Main Landing Gear
MRB	Main Rotor Blade
MRH	Main Rotor Head
MSL	Mean Sea Level (barometric altitude, in feet)
N_1	Gas Generator Turbine Speed
N_2	Power Turbine Speed
N_R	Rotor (Main) Speed
NDI	Non–Destructive Inspection
NLG	Nose Landing Gear
NTSB	National Transportation Safety Board
NVRAM	Non-Volatile Random Access Memory
PAC	Pilot at the Controls
PCR	Pitch Change Rod
PIC	Pilot in Command
PPH	Pounds per hour (fuel consumption)
PT	Power Turbine
PWC	Pratt & Whitney Canada
RH	Right Hand
T_5	Turbine Inlet Temperature
TBD	To Be Determined
TBO	Time Between Overhaul
TGB	Tail Gearbox
TRB	Tail Rotor Blade
TRH	Tail Rotor Head

APPENDIX II: Investigation Personnel

NTSB Personnel and other Parties to the Investigation

NTSB

[redacted] .....Investigator-in-Charge, NTSB HQ
[redacted] .....Board Member on Scene
[redacted] .....Board Member on Scene (Training)
[redacted] .....Group Chairman, Airworthiness
[redacted] .....Group Chairman, Operations
[redacted] .....Group Chairman, Maintenance
[redacted] .....Logistics Manager
[redacted] .....Systems Investigator
[redacted] .....Propulsion Investigator
[redacted] .....UAS Operations Coordinator
[redacted] .....UAS Pilot
[redacted] .....Public Affairs

Other Parties to the Investigation (Airworthiness Group):

[redacted] .....FAA, Accident Investigation AVP-100, Fort Worth, TX
[redacted] .....FAA, Rotorcraft Standards Branch, Fort Worth, TX
[redacted] .....FAA, Van Nuys FSDO

[redacted] .....Sikorsky Senior Manager of Fleet Safety
[redacted] .....Sikorsky Senior Manager of Aviation Safety Operations
..... (originally assigned to Operations, reassigned to Airworthiness)

[redacted] .....Pratt & Whitney Canada, Air Safety Investigator

[redacted] .....Honeywell Air Safety Investigator
[redacted] .....Honeywell Air Safety Investigator

[redacted] .....NATCA Air Safety Investigator

[redacted] .....Island Express Helicopter, Inc.
[redacted] .....Mechanic, Rotorcraft Support, Inc.
[Rotorcraft Support and Island Express have a partial shared ownership]

APPENDIX III: Selected Component Serial Numbers

ITEM	PART NUMBER	SERIAL NUMBER	PHYSICAL VERIFICATION	LOG VER
Main Gearbox	76351-09600-044	A231-00226	Physical (beyond central area)	Log Only
Intermediate Gearbox	76357-05600-041	A242-00079 [6]	Physical (remained in pylon)	☑
Tail Rotor Gearbox	76358-05600-042	A239-00060 [7]	Physical (near initial impact site)	☑
Main Rotor Head	76103-08010-050	B027-00408	Physical (on MGB)	☑
Main Rotor Swashplate	76104-08500-041	A238-00086	Physical (on MGB)	☑
Primary Servo (Forward)	76650-09805-110	0174XD	Physical (on MGB)	☑
Primary Servo (Lateral)	76650-09805-110	0565XD	Physical (on MGB)	☑
Primary Servo (Aft)	76650-09805-110	0806	Physical (on MGB)	☑
SAS Actuator Pitch #1	76900-01802-106	96030152	Fire Damaged	Log Only
SAS Actuator Pitch #2	76900-01802-106	81021904	Lightly Charred, Impact Dmg	Log Only
SAS Actuator Roll #1	76900-01802-106	8402494	Not recovered	Log Only
SAS Actuator Roll #2	76900-01802-106	79J9831	Impact Damaged	Log Only
SAS Actuator Yaw #1	76900-01802-106	90020050	Intact (on TRH)	Log Only
SAS Actuator Yaw #2	76900-01802-106	8501956	Intact (on TRH)	Log Only
Pitch Trim Servo	L109BBM	N/A	Impact Damaged, Charred	Not in log [8]
Roll Trim Servo	L109BBM	N/A	Impact Damaged, Charred	Not in log
Collective Trim Servo	L109CDM	N/A	Impact Damaged, Charred	Not in log
Pedal Damper/Trim Act	76900-01810-XXX	N/A	Fire Damaged	Not in log
Hydraulic Module #1	76650-09801-XXX	N/A	Impact Damaged	Not in log
Hydraulic Module #2	76650-09801-XXX	N/A	Impact Damaged	Not in log
Main Rotor Blade Red	76150-09100-053	A086-01833	Physical (at initial impact site)	☑
Main Rotor Blade Blue	76150-09100-053	A086-01831	Physical (at initial impact site)	☑
Main Rotor Blade Yellow	76150-09100-053	A086-02625	Physical (on MRH)	☑
Main Rotor Blade Black	76150-09100-053	A086-01834	Physical	☑
Tail Rotor Servo	76650-05801-114	B346-00684	Physical (on TRH)	☑
Tail Rotor Blade (R/Y)	76101-05501-042	A245-00166	Physical	☑
Tail Rotor Blade (Bl/Bk)	76101-05501-042	A245-00165	Physical	☑
Engine #1 PWC	PT-6B-36A	PCE 36149	Fire Damaged (in central area)	☑
Engine #2 PWC	PT-6B-36A	PCE 36144	Fire Damaged (in central area)	☑
ELT ME406 (Artex)	452-6499	374204-033	Physical (in central area)	Log Only
Data was unreadable on recovered unit, except for the unique hexadecimal code	Unique ELT Code -	Hexadecimal:	ADCC4-084AC-002F1	☑

[6] Originally recorded as -00075 by visual. Corrected based on logbook.
[7] Originally recorded as A230. Corrected typo based on logbook.
[8] These components are replaced *on-condition* and are not life-tracked by serial number in the logbooks.

APPENDIX IV: Meteorological Data

Daily Weather History for Van Nuys, CA (VNY)

METAR Hourly Observations

Source: FAA METAR Observations

Time PST	Temp °C	Dewpt °C	Pressure inHg	Visibility (sm)	Wind Dir	Wind Speed (kt)	Precip	Conditions
0711	11	9	30.14	2.5	n/a	0	None	BR OVC009
0751	11	9	30.15	2.5	230°	3	None	BR OVC009
0821	12	9	30.15	2.5	170°	3	None	HZ OVC011
0851	12	9	30.16	2.5	n/a	0	None	HZ OVC011
0951	12	9	30.16	2.5	n/a	0	None	HZ OVC013
1051	13	9	30.18	2.5	n/a	0	None	HZ OVC014
1107	13	9	30.18	2.5	VRB	3	None	HZ OVC015
1158	14	9	30.15	6	n/a	0	None	HZ BKN015
1207	14	10	30.14	6	VRB	3	None	HZ BKN015