Inadvertent Activation of the Fuel Shutoff Lever and Subsequent Ditching
Liberty Helicopters Inc., Operating a FlyNYON Doors-Off Flight
Airbus Helicopters AS350 B2, N350LH
New York, New York
March 11, 2018

Accident Report

NTSB/AAR-19/04
PB2020-100100

National
Transportation
Safety Board

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Aircraft Accident Report

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Abstract: This report discusses the March 11, 2018, accident involving an Airbus Helicopters AS350 B2, N350LH, which lost engine power during cruise flight; the pilot performed an autorotative descent and ditching on the East River in New York, New York. The pilot sustained minor injuries, the five passengers drowned, and the helicopter was substantially damaged. The FlyNYON-branded flight was operated by Liberty Helicopters Inc. (Liberty), per a contractual agreement with NYONair; both companies considered the flight to be an aerial photography flight operated under the provisions of Title 14 *Code of Federal Regulations* (*CFR*) Part 91. Safety issues identified in this report include the effect of the harness/tether system on the ability of each passenger to rapidly egress from the capsizing helicopter; emergency flotation system design, maintenance, and certification issues; ineffective safety management at both Liberty and NYONair; Liberty and NYONair's exploitation of the aerial work/aerial photography exception at 14 *CFR* 119.1(e) to operate FlyNYON flights under Part 91 with limited Federal Aviation Administration (FAA) oversight; lack of policy and guidance for FAA inspectors to perform a comprehensive inspection of Part 91 operations conducted under any of the 14 *CFR* 119.1(e) exceptions; lack of protection from inadvertent activation of the helicopter's fuel shutoff lever; the need for guidance and procedures for operators to assess and address passenger intoxication; and inadequacy of the review and approval process for supplemental passenger restraint systems that the FAA implemented after the accident. As a result of this investigation, the National Transportation Safety Board makes 10 new safety recommendations to the FAA, 1 new recommendation each to Airbus Helicopters and the European Aviation Safety Agency, and 2 new recommendations each to Liberty and NYONair.

For more detailed background information on this report, visit the NTSB investigations website and search for NTSB accident ID ERA18MA099. Recent publications are available in their entirety on the NTSB website. Other information about available publications also may be obtained from the website or by contacting—
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Abbreviations

65NJ	Helo Kearny Heliport
AC	advisory circular
ACO	Aircraft Certification Office
agl	above ground level
ARS	Air Rescue Systems
ATC	air traffic control
ATT	airframe total time
BEA	Bureau d’Enquêtes et d’Analyses pour la Sécurité de l’Aviation Civile
CEO	chief executive officer
CFR	*Code of Federal Regulations*
COO	chief operating officer
CX	customer experience
DO	director of operations
FAA	Federal Aviation Administration
FDNY	Fire Department of the City of New York
FFCL	fuel flow control lever
FOM	flight operations manual
fpm	feet per minute
FOV	field of view
FSDO	flight standards district office
FSOL	fuel shutoff lever
ICA	instructions for continued airworthiness
ICAO	International Civil Aviation Organization

JRB	Downtown Manhattan/Wall Street Heliport
kts	knots
LGA	LaGuardia Airport
LOA	letter of authorization
MG	miscellaneous guidance
msl	mean sea level
nm	nautical miles
NTSB	National Transportation Safety Board
NYC	New York City
NYPD	New York City Police Department
OIG	Office of Inspector General
OpSpec	operations specification
PAI	principal avionics inspector
PCDS	personnel carrying device system
PFD	personal flotation device
PIC	pilot-in-command
PMI	principal maintenance inspector
POI	principal operations inspector
psi	lbs per square inch
RFM	rotorcraft flight manual
RFMS	rotorcraft flight manual supplement
SB	service bulletin
SD	secure digital
SMS	safety management system
SOP	standard operating procedure

SPRS	supplemental passenger restraint system
STC	supplemental type certificate
TCDS	type certificate data sheet
TOPS	Tour Operators Program of Safety
TSB	Transportation Safety Board of Canada
TSO	technical standard order
VFR	visual flight rules

Executive Summary

On March 11, 2018, about 1908 eastern daylight time, an Airbus Helicopters AS350 B2, N350LH, lost engine power during cruise flight, and the pilot performed an autorotative descent and ditching on the East River in New York, New York. The pilot sustained minor injuries, the five passengers drowned, and the helicopter was substantially damaged. The FlyNYON-branded flight was operated by Liberty Helicopters Inc. (Liberty), per a contractual agreement with NYONair; both companies considered the flight to be an aerial photography flight operated under the provisions of Title 14 *Code of Federal Regulations* (*CFR*) Part 91. Visual flight rules (VFR) weather conditions prevailed, and no flight plan was filed for the intended 30-minute local flight, which departed from Helo Kearny Heliport, Kearny, New Jersey, about 1850.

Liberty operated the accident flight as a FlyNYON-branded, doors-off helicopter flight that allowed the five passengers (one in the front seat, four in the rear seats) to take photographs of various landmarks while extending their legs outside the helicopter during portions of the flight. For the accident flight (and other FlyNYON flights that Liberty operated), Liberty configured its Airbus AS350 B2 helicopter with the two right and the front left doors removed and the left sliding door locked open. Before departure, each passenger was fitted with a NYONair-provided harness/tether system that NYONair developed with the intent to prevent passengers from falling out of the helicopter. The harness/tether system used on the accident flight consisted of a full-body, workplace fall-protection harness that was secured (with a locking carabiner) to a tether, the other end of which was secured (with another locking carabiner) to an anchor point in the cabin. Each passenger also wore the helicopter's installed, Federal Aviation Administration (FAA)-approved restraints. The pilot (who was seated in the front right seat) wore only an installed, FAA-approved restraint.

After the flight departed, it traveled past various scenic landmarks. Consistent with the standard operating procedures (SOPs) used for FlyNYON flights, the passengers were allowed (when instructed by the pilot) to position themselves to extend their legs outside the helicopter. The two passengers who had been seated in the rear inboard seats removed their installed, FAA-approved restraints and sat on the cabin floor, wearing their harness/tether systems. The passengers seated in the outboard seats were allowed to rotate outboard in their seats. To enable such freedom of movement, the SOPs allowed the passengers to wear their installed, FAA-approved restraint with the lap belt adjusted loosely and the shoulder harness routed under the arm.

A review of radar data and onboard video showed that, when the flight was proceeding northwest over Manhattan toward Central Park at an altitude of 1,900 ft mean sea level, the front passenger, who was facing outboard in his seat with his legs outside the helicopter, leaned back several times to take photographs using a smartphone. The onboard video showed that, each time he leaned back, the tail of the tether attached to the back of his harness hung down loosely near the helicopter's floor-mounted controls. At one point, when he pulled himself up to adjust his seating position, the tail of his tether remained taut but appeared to pop upward. Two seconds later, the helicopter's engine sounds decreased, and the helicopter began to descend.

As the pilot performed the emergency procedures to perform an autorotation and address the apparent loss of engine power, he noticed that the fuel shutoff lever (FSOL) was in the shutoff position and that it had been inadvertently moved to that position by the tail of the front passenger's tether, which had become caught on it.

Although the pilot pushed the FSOL down to restore fuel flow to the engine and attempted to relight the engine, the helicopter was too low to allow engine power to be restored in time to prevent the emergency landing. The pilot pulled the activation handle to deploy the helicopter's emergency flotation system, and he ditched the helicopter on the East River. However, the helicopter's floats did not fully inflate, and the helicopter rolled right in the water and became fully inverted and submerged about 11 seconds after it touched down.

The pilot was able to release his installed, FAA-approved restraint after he was under water and successfully egress from the helicopter; however, none of the passengers were able to egress, and they all drowned.

Probable Cause

The NTSB determines the probable cause of this accident was Liberty Helicopters Inc.'s use of a NYONair-provided passenger harness/tether system, which caught on and activated the floor-mounted engine fuel shutoff lever and resulted in the in-flight loss of engine power and the subsequent ditching. Contributing to this accident were (1) Liberty's and NYONair's deficient safety management, which did not adequately mitigate foreseeable risks associated with the harness/tether system interfering with the floor-mounted controls and hindering passenger egress; (2) Liberty allowing NYONair to influence the operational control of Liberty's FlyNYON flights; and (3) the Federal Aviation Administration's inadequate oversight of Title 14 *Code of Federal Regulations* Part 91 revenue passenger-carrying operations. Contributing to the severity of the accident were (1) the rapid capsizing of the helicopter due to partial inflation of the emergency flotation system and (2) Liberty and NYONair's use of the harness/tether system that hindered passenger egress.

Safety Issues

The investigation evaluated the following safety issues:

- **Effect of the harness/tether system on the ability of each passenger to rapidly egress from the capsizing helicopter.** The investigation found that minimally trained passengers would have great difficulty extricating themselves from the harness/tether system, each of which was equipped with locking carabiners and an ineffective cutting tool, during an emergency requiring a rapid egress.
- **Emergency flotation system design, maintenance, and certification issues.** The manufacturer of the helicopter's emergency flotation system did not provide information to help operators recognize the presence of unacceptably high pull forces when activating the system; the high pull forces on the accident helicopter's activation system (which resulted from an installation anomaly) contributed to the pilot's mistaken belief that he had taken the necessary action to fully inflate the floats. The

FAA's certification review of the emergency flotation system design installed on the accident helicopter did not identify the manufacturer's omission of an activation handle pull-force limitation.

- **Ineffective safety management at both Liberty and NYONair.** Liberty's managers repeatedly lacked involvement in key decisions related to Liberty-operated FlyNYON flights and allowed NYONair to influence core aspects of the operational control of those flights. Ineffective safety management at both companies allowed foreseeable safety risks to remain unmitigated; these included the potential for passenger interference with the helicopter's floor-mounted controls, partial inflation of the emergency float system, and difficulties passengers would have with the locking carabiners and cutting tools as a means to rapidly release from the harness/tether system.

- **Liberty and NYONair's exploitation of the aerial work/aerial photography exception at 14 *CFR* 119.1(e) to operate FlyNYON flights under Part 91 with limited FAA oversight.** Federal regulations do not define the terms "aerial work" and "aerial photography" to include only business-like, work-related aerial operations. Both Liberty and NYONair demonstrated deliberate efforts to operate the FlyNYON revenue passenger-carrying flights under Part 91 as aerial photography flights and to avoid any indication that the flights may be commercial air tours, which would be subject to additional FAA requirements and oversight that did not apply to aerial photography flights.

- **Lack of policy and guidance for FAA inspectors to perform a comprehensive inspection of Part 91 operations conducted under any of the 14 *CFR* 119.1(e) exceptions.** During the investigation, the FAA determined that the accident flight was a nonstop commercial air tour operated under Part 91 per the 14 *CFR* 119.1(e)(2) exception. Although an air tour operated under Part 91 is subject to FAA requirements and oversight that exceed what applies to aerial photography flights, the FAA lacks policy and guidance for FAA inspectors to support a comprehensive inspection of Part 91 operations conducted under any of the exceptions in 14 *CFR* 119.1(e) to ensure that operators are appropriately managing any associated risks.

- **Lack of FSOL protection from inadvertent activation.** The certification basis for the accident helicopter's FSOL did not require protection from inadvertent activation due to external influences, such as interference from a passenger. However, a design modification that includes protection from external influences could enhance safety.

- **Need for guidance and procedures for operators to assess and address passenger intoxication.** Although the passenger in the front seat on the accident flight was intoxicated, it was not possible to determine whether alcohol played a role in his inadvertent activation of the FSOL. Despite the existence of an FAA regulation prohibiting the carriage of any passenger who appears to be intoxicated or impaired, neither Liberty nor NYONair had any documented policy or guidance materials, including training, for their employees to identify impaired passengers or for denying boarding of such individuals. While FAA guidance does exist on identifying intoxicated or impaired passengers, operators that conduct revenue passenger-carrying flights under Part 91 or 135 in small aircraft could benefit from guidance specific to their operations, particularly if they have passengers seated in close proximity to the aircraft controls.

- **Inadequacy of the review and approval process for supplemental passenger restraint systems (SPRSs) that the FAA implemented after the accident.** The FAA's SPRS approval process that it implemented after the accident appears to focus primarily on the SPRS release mechanism without consideration of the expected operational environment or whether the use of an SPRS is warranted. The NTSB is concerned that, without an assessment of the specific need for and use of an SPRS, the addition of an SPRS may unnecessarily complicate the emergency egress of passengers. Further, without a comprehensive hazard analysis for the use of an SPRS in the operational environment (including aircraft-specific installations), factors that could impede passenger egress, such as the potential for entanglement with headset cords, other equipment, or the SPRS itself; or adversely affect flight safety, such as the potential for the SPRS to interfere with any equipment or controls in a specific aircraft, may be present but go unidentified.

Findings

- None of the following were factors in this accident: (1) the pilot's qualifications, which were in accordance with federal regulations and company requirements; (2) pilot fatigue or medical conditions; and (3) the airworthiness of the helicopter.
- The tail of the front passenger's tether caught on the fuel shutoff lever (FSOL) during the flight, which resulted in the inadvertent activation of the FSOL, interruption of fuel flow to the engine, and loss of engine power.
- The pilot autorotated the helicopter successfully and pulled the emergency flotation system activation handle to deploy the floats at an appropriate time; however, the floats inflated partially and asymmetrically.
- Liberty Helicopters Inc.'s and NYONair's decision to use locking carabiners and ineffective cutting tools as the primary means for passengers to rapidly release from the harness/tether system was inappropriate and unsafe.
- The helicopter's landing was survivable; however, the NYONair-provided harness/tether system contributed to the passenger fatalities because it did not allow the passengers to quickly escape from the helicopter.
- The Federal Aviation Administration's (FAA) approval process for supplemental passenger restraint systems (SPRS) that was implemented after the accident is inadequate because it does not provide guidance to inspectors to evaluate any aircraft-specific installations or the potential for entanglement that passengers may encounter during emergency egress.
- Although the crossover hose in the accident helicopter's emergency flotation system design did not perform its intended function to alleviate asymmetric inflation of the floats during a single-reservoir discharge event, buoyancy stability testing showed that even symmetric distribution of the gas from only one reservoir would not enable the helicopter to remain upright in water.

- In the absence of information from Dart Aerospace specifying pull-force limitations for the emergency flotation system's activation handle, Liberty and other operators lack a means to inspect for and correct high pull forces that may result from an installation anomaly or other issues.
- Although the accident pilot was aware that each gas reservoir may not discharge simultaneously, the high forces required to pull the activation handle, along with the aural and visual cues following a single-reservoir discharge, led the pilot to mistakenly believe that he had successfully pulled the handle fully aft to fully inflate the floats.
- The Federal Aviation Administration's certification review of the emergency flotation system design installed on the accident helicopter did not identify Dart Aerospace's omission of an activation handle pull-force limitation; thus, the FAA's reviews of other approved emergency flotation system designs may not have identified similar omissions.
- Improved guidance for aircraft certification offices for assessing design features, usability, and inspection methods that ensure successful deployment of an emergency flotation system could help ensure that these important aspects are considered during the certification review process for such systems.
- Through their repeated lack of involvement in key decisions related to Liberty Helicopters Inc.-operated FlyNYON flights, Liberty's managers allowed NYONair personnel, particularly NYONair's chief executive officer, to influence core aspects of the operational control of those flights.
- Ineffective safety management at both Liberty Helicopters Inc. and NYONair resulted in a lack of prioritization and mitigation of foreseeable risks.
- Liberty Helicopters Inc. and NYONair exploited the exception at Title 14 *Code of Federal Regulations* 119.1(e)(4)(iii) allowing aerial photography flights to be operated under Part 91, thereby avoiding the additional Federal Aviation Administration requirements and oversight that apply to commercial air tours conducted under either Part 135 or Part 91 with an air tour letter of authorization.
- Without regulatory language that defines the terms "aerial work" and "aerial photography" to include only business-like, work-related aerial operations, operators may attempt to take advantage of the exception at Title 14 *Code of Federal Regulations* 119.1(e)(4)(iii) to carry revenue passengers for personal, entertainment, or leisure purposes without the additional Federal Aviation Administration requirements and oversight that apply to other commercial, revenue passenger-carrying operations.
- The Federal Aviation Administration principal operations inspector assigned to oversee Liberty Helicopters Inc. did not conduct additional surveillance of Liberty's operations after being made aware of its FlyNYON flights and failed to ensure that Liberty was appropriately managing the risks associated with the significant change in operations.
- Because the Federal Aviation Administration (FAA) continues to allow passenger revenue operations to be conducted under Title 14 *Code of Federal Regulations* Part 91—some of which, like the FlyNYON flight operations, transport thousands of passengers annually—the FAA must provide inspectors with sufficient guidance to

pursue more comprehensive oversight with regard to potential hazards they observe and to ensure that operators sufficiently mitigate risks.

- Although the certification basis for the accident helicopter's fuel shutoff lever did not require protection from inadvertent activation due to external influences, a design modification that includes such protection could enhance safety more effectively than continued reliance on operational measures.
- The risk of the NYONair-provided harness/tether system tether tail becoming entangled with the floor-mounted fuel shutoff lever existed independently from passenger intoxication and most likely depended primarily on the passenger's positioning in the cabin.
- When passengers are seated in close proximity to an aircraft's controls, it is critical that they not be impaired to reduce the likelihood of interference with the pilot's ability to safely fly the aircraft.

Recommendations

To the Federal Aviation Administration

- Modify the supplemental passenger restraint system (SPRS) approval process to (1) require letter of authorization (LOA) applicants to specify a need for and the intended use of an SPRS for each aircraft; (2) require the Federal Aviation Administration to evaluate and review, for each specified aircraft, the need for the SPRS on that aircraft for all intended uses; all SPRS design, manufacture, installation, and operational considerations, including, at a minimum, the potential for passengers to become entangled during emergency egress; the adequacy of passenger emergency egress briefings; and the potential for the SPRS to interfere with aircraft controls; and (3) ensure that each LOA lists the specific aircraft on which the holder is authorized to use an SPRS. (A-19-24)
- Until you implement the supplemental passenger restraint system (SPRS) approval process as recommended in Safety Recommendation A-19-24, prohibit the use of SPRS for passenger-carrying doors-off operations. (A-19-25)
- Review the activation system designs of Federal Aviation Administration-approved rotorcraft emergency flotation systems for deficiencies that may preclude their proper deployment, such as a lack of a means to identify high pull forces on manual activation handles or inadequate guidance on the intended use of the activation system, and require corrective actions based on the review findings. (A-19-26)
- Revise Miscellaneous Guidance 10 in Advisory Circular (AC) 27 and AC 29 to include design objectives for emergency flotation systems that consider human factors design objectives, such as activation handle pull-force characteristics; provisions for clear, unambiguous, and positive feedback to pilots to indicate that the float system was successfully deployed; and inspections to ensure that an installation of a manual activation system does not preclude a pilot's ability to deploy the floats, as designed, after it has been fielded. (A-19-27)

- Require all commercial air tour operators, regardless of their operating rule, to implement a safety management system. (A-19-28)
- Revise Title 14 *Code of Federal Regulations* 1.1, "General Definitions," to include definitions for the terms "aerial work" and "aerial photography" that specify only business-like, work-related aerial operations, as originally intended. (A-19-29)
- Revise Order 8900.1, *Flight Standards Information Management System*, to include guidance for inspectors who oversee Title 14 *Code of Federal Regulations* (*CFR*) Part 91 operations conducted under any of the 14 *CFR* 119.1(e) exceptions to identify potential hazards and ensure that operators are appropriately managing the associated risks. (A-19-30)
- Develop and implement national standards within Title 14 *Code of Federal Regulations* (*CFR*) Part 135, or equivalent regulations, for all air tour operations with powered airplanes and rotorcraft to bring them under one set of standards with operations specifications, and eliminate the exception currently contained in 14 *CFR* 135.1. (A 19-31)
- After the actions requested in Safety Recommendation A-19-32 are completed, require owners and operators of existing AS350-series helicopters to incorporate the changes. (A-19-33)
- Develop guidance on how to identify intoxicated or impaired passengers, and distribute it to operators who carry passengers for hire under Title 14 *Code of Federal Regulations* Part 91 and Part 135. (A-19-34)

To Airbus Helicopters

- Modify the floor-mounted fuel shutoff lever in AS350-series helicopters to protect it from inadvertent activation due to external influences. (A-19-32)

To the European Union Aviation Safety Agency

- After the actions requested in Safety Recommendation A-19-32 are completed, require owners and operators of existing AS350-series helicopters to incorporate the changes. (A-19-35)

To Liberty Helicopters Inc.

- Establish a safety management system. (A-19-36)
- Train your employees to identify signs of impairment and intoxication in passengers and to deny those passengers boarding, when appropriate. (A-19-37)

To NYONair

- Establish a safety management system. (A-19-38)

- Train your employees to identify signs of impairment and intoxication in passengers and to deny those passengers boarding, when appropriate. (A-19-39)

1. Factual Information

1.1 History of Flight

On March 11, 2018, about 1908 eastern daylight time, an Airbus Helicopters AS350 B2, N350LH, lost engine power during cruise flight, and the pilot performed an autorotative descent and ditching on the East River in New York, New York.[1] The pilot sustained minor injuries, the five passengers drowned, and the helicopter was substantially damaged. The FlyNYON-branded flight was operated by Liberty Helicopters Inc. (Liberty), per a contractual agreement with NYONair; both companies considered the flight to be an aerial photography flight operated under the provisions of Title 14 *Code of Federal Regulations* (*CFR*) Part 91.[2] Visual flight rules (VFR) weather conditions prevailed, and no flight plan was filed for the intended 30-minute local flight, which departed from Helo Kearny Heliport (65NJ), Kearny, New Jersey, about 1850.[3]

1.1.1 Background Information

The accident flight (like other FlyNYON doors-off flights) was marketed by NYONair as an aerial photography flight in which passengers were allowed to take photographs while extending their feet outside of the helicopter's open doorways during portions of the flight. For the accident flight (and other FlyNYON flights Liberty operated per contract with NYONair), Liberty removed the helicopter's two right doors and front left door and locked the left sliding door in the open position (see figure 1).

[1] (a) An autorotation is a state of helicopter flight during which, in the event of a loss of engine power, the main rotor system is turned by the action of the relative wind as the helicopter descends. It is a means by which a pilot can maintain sufficient rotor rpm to enable a safe flare and touchdown (FAA 2000, 3-8). (b) Ditching is an emergency landing that is deliberately executed on water with the intent of abandoning the helicopter as soon as practical. The helicopter is assumed to be intact with all controls and essential systems (except engine power) functioning properly (FAA 2018a).

[2] Liberty and NYONair considered the accident flight to be an aerial photography flight per the exception in 14 *CFR* 119.1(e)(4)(iii) (see section 1.10.7.1 in this report for more information). During this accident investigation, the Federal Aviation Administration determined that Liberty operated the flight as a nonstop commercial air tour under Part 91. NYONair used the FlyNYON brand for the helicopter doors-off flights it marketed as aerial photography flights, whether operated by NYONair or any other operator under contract.

[3] (a) Flight visibility and distance from clouds exceeded the applicable basic VFR weather minimums specified in 14 *CFR* 91.155. (b) Supporting documentation for information referenced in this report can be found in the public docket for this accident, which can be accessed from the National Transportation Safety Board's (NTSB) Accident Dockets web page by searching ERA18MA099. Other NTSB documents referenced in this report, including reports and summarized safety recommendation correspondence, can be accessed from the NTSB's Aviation Information Resources web page, www.ntsb.gov/air.

Source: Eric Adams (Photograph cropped and faces redacted by NTSB)

Figure 1. Accident helicopter configured for FlyNYON doors-off operations.

Before departure, each passenger on board the accident flight was fitted with a NYONair-provided body harness that was secured via a NYONair-provided tether (harness/tether system) to an anchor point in the cabin.[4] Each passenger was also secured into his/her respective seat using the helicopter's installed, Federal Aviation Administration (FAA)-approved lap belt and shoulder harness (installed, FAA-approved restraint).[5] The pilot (who wore only an installed, FAA-approved restraint) was seated in the front right seat, one passenger occupied the front left dual-position bench (seated in the outboard seat), and four passengers were seated on the two rear dual-position benches. Each passenger wore a headset that enabled them to hear instructions from the pilot.[6]

The standard operating procedures (SOPs) used by Liberty (and NYONair) pilots specified that, to extend their feet outside the helicopter, the passengers seated in the rear inboard seats were allowed to remove their installed, FAA-approved restraints (when directed by the pilot), move to

[4] In this report, the term "harness/tether system" refers to the body harness and tether system that NYONair provided for each passenger to use on board FlyNYON doors-off flights. NYONair developed the harness/tether system to prevent passengers from falling out of the helicopter (see section 1.3.4 for more information).

[5] In this report, the term "installed, FAA-approved restraint" refers to the FAA-approved safety belt (lap belt) and shoulder harness installed at each occupant position (pilot and passenger) in the accident helicopter as required by the applicable rotorcraft airworthiness standards. (See section 1.3.3 for information about the FAA-approved restraints installed on the accident helicopter.)

[6] Unlike the pilot's headset, the passengers' headsets were not equipped with microphones. The pilot said the passengers' headsets enabled them to hear his instructions and the radio communications.

the cabin floor, and sit on the door sills (see section 1.10.5.2). Per the SOPs, passengers in the front and rear outboard seats were allowed to rotate outboard in their seats (see figure 2).[7]

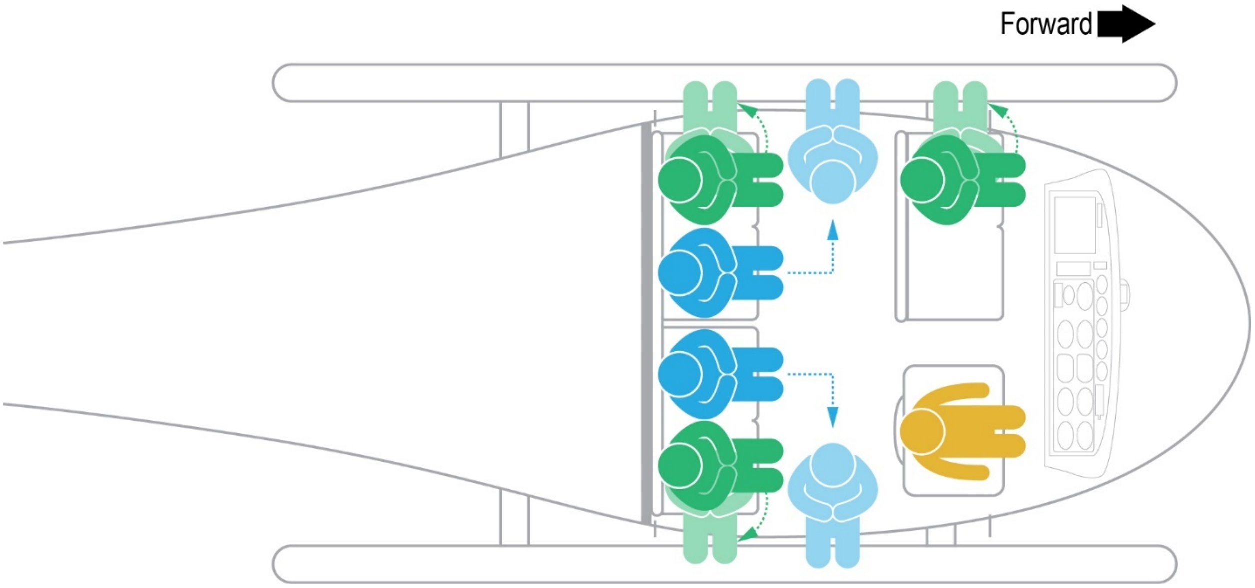

Figure 2. Diagram showing relative locations for helicopter occupants.

Note: The pilot's location is indicated in yellow, the locations of the outboard seat passengers are indicated in green, and the locations of the inboard seat passengers are indicated in blue. Dashed arrows indicate the outboard-facing (feet-out) positions to which passengers could move during the flight.

Note: Not to scale.

1.1.2 Flightpath and Event Sequence

According to the pilot, after the flight departed, it traveled south toward the Statue of Liberty at altitudes between 300 and 500 ft above ground level (agl), then flew near the statue to allow the passengers to take photographs. A National Transportation Safety Board (NTSB) review of videos and photographs captured by onboard image recorders, including a ceiling-mounted camera (see section 1.5.2), found that, by the time the helicopter flew near the statue (about 1859:08), the two passengers who had been seated in the rear inboard seats had removed their installed, FAA-approved restraints (after being told by the pilot to do so) and were seated on the cabin floor (wearing their harness/tether systems).

The flight proceeded past other landmarks, then began to travel north up the East River. A transcript of air traffic control (ATC) communications showed that, at 1903:46, the pilot contacted the ATC tower controller at LaGuardia Airport (LGA), New York, New York, and requested a

[7] According to the pilot, the passengers' installed, FAA-approved restraints were "kept loose to provide freedom of movement" in the cockpit. In addition, a "Ready to Fly" checklist in the SOPs specified that the shoulder harnesses of the installed, FAA-approved restraints were to be routed under the arms (see section 1.10.5.2).

route up the East River to the north end of Central Park. The controller provided a clearance for the pilot to proceed and for the flight to remain at or below 2,000 ft above mean sea level (msl).

ATC radar data showed that the helicopter then proceeded north along the East River and climbed to an altitude of 1,900 ft msl. At 1905:44, the flight track turned left then proceeded northwest over Manhattan (see figure 3).

Figure 3. Accident flightpath over the East River.

Onboard video showed that, between 1900:15 and 1905:40, the front passenger leaned back several times to take photographs using a smartphone. At one time, the front passenger leaned back such that his head was above the helicopter's center pedestal. Two other times, he was lying back in a recumbent position with his body angled horizontally such that his right shoulder contacted the helicopter's glareshield and his feet pointed diagonally aft out the open doorway. Each time the front passenger leaned back, the tail of the tether attached to the back of his harness hung down loosely near the helicopter's floor-mounted controls.

At 1905:51, the front passenger resumed a more upright seated position, and his tether tail appeared taut and was extended toward the helicopter's floor-mounted controls. At 1906:08, when the front passenger pulled on the hand grip (mounted on the helicopter's left door frame) to adjust his seating position, his tether tail remained taut but appeared to pop upward. Audio from the onboard video captured a reduction in ambient engine sounds about 2 seconds later.

ATC radar data showed that, while the helicopter was tracking northwest toward Central Park, it began to descend at 1906:11 (from an altitude of 1,900 ft msl). The pilot said he heard a low rotor rpm alert and saw the cockpit warning lights for engine oil pressure and fuel pressure illuminate. In response to the apparent loss of engine power, he lowered the collective to maintain rotor rpm and initiated an autorotative descent. He briefly considered landing in Central Park, but there were too many people, so he turned the helicopter toward the East River. He yelled for the passengers to get back into their seats.

The pilot said the helicopter had a slow airspeed, and he was not sure if it could make it to the river, so he reduced the rotor rpm so it could glide farther. ATC radar data showed the helicopter began a right turn toward the East River at 1906:30 at 1,200 ft msl. The pilot said that, during the established glide in the autorotative descent, he engaged the engine starter, but the engine did not relight. He also checked the fuel flow control lever (FFCL, one of three floor-mounted control levers [see section 1.3.1]) and found it secure in its detent.

The pilot said that, when the helicopter was about 600 ft above the river, he was "committed to impact" and reached down to activate the fuel shutoff lever (FSOL, another floor-mounted control) but "could tell something was wrong because it was [already] in the up position."[8] He noticed the tail of the front passenger's tether had caught on the FSOL and pulled it up. The pilot "slammed" down the FSOL, engaged the engine starter, and saw an immediate rise in engine temperature, but the helicopter was too low over the water to allow sufficient time to restart the engine. At 1906:58, the pilot made a "mayday, mayday, mayday" call to ATC.[9]

The pilot said that, once he felt sure that the helicopter could reach the river, he activated the emergency float system. According to the onboard video, a "click" sound followed by noise associated with float deployment occurred at 1907:02. An NTSB aircraft performance study (see section 1.9.2) determined that the helicopter was about 100 ft agl at that time. The pilot said that, when he activated the system, he took his left hand off of the collective and placed it on top of the cyclic control (to brace it), gripped the activation handle with his right hand, and "pulled it back fully and completely." He heard a "pop" sound, which to him indicated that the float system had deployed; he also saw parts of the left and right front floats and noticed extra drag.

The pilot stated that, when the helicopter was descending through 100 ft to 50 ft agl, he began the cyclic flare in an extended glide configuration but "did not get a lot of rpm back." He performed a flare reduction, and the helicopter touched down on the water. The aircraft performance study determined that the helicopter was flared at 1907:11 and touched down on the water at 1907:15.

Shore witnesses' videos showed that the helicopter touched down upright in a slightly shallow flare attitude. The helicopter then immediately began to roll to the right, and, within about 5 seconds of touchdown, the rotor blades began striking the water. The right roll continued such that, within about 11 seconds of touchdown, the helicopter was completely inverted and submerged with only the floats visible above the surface.

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[8] Moving the FSOL to the up position closes the fuel shutoff valve to stop fuel flow to the engine (see section 1.3.1).

[9] About 17 seconds earlier, the accident pilot transmitted "LaGuardia may—uh zero lima hotel," but his radio call occurred at the same time as communications from another pilot.

The pilot said the landing was “not a giant jolt,” but water quickly flooded the cabin floor. He started to try to release the front passenger’s tether, but the helicopter rolled to the right such that the pilot was fully under water before he released the buckle on his own installed, FAA-approved restraint to egress (see section 1.8.1 for egress information).

Crewmembers from a tugboat (which was the first boat to arrive) retrieved the pilot, who was in the water and clinging to the inverted helicopter. Emergency response resources, including a helicopter and a boat from the New York City Police Department (NYPD) and a boat from the Fire Department of the City of New York (FDNY), responded and deployed divers. Divers first entered the water about 1925 to recover the passengers.

After the emergency response activities were completed (see section 1.8.2), the wreckage was moved and secured to a pier. The day after the accident (before the wreckage was recovered from the water), the helicopter’s six floats (three mounted on each skid) were visible on the surface. The three right floats appeared to be less inflated than the three left floats (see figure 4).

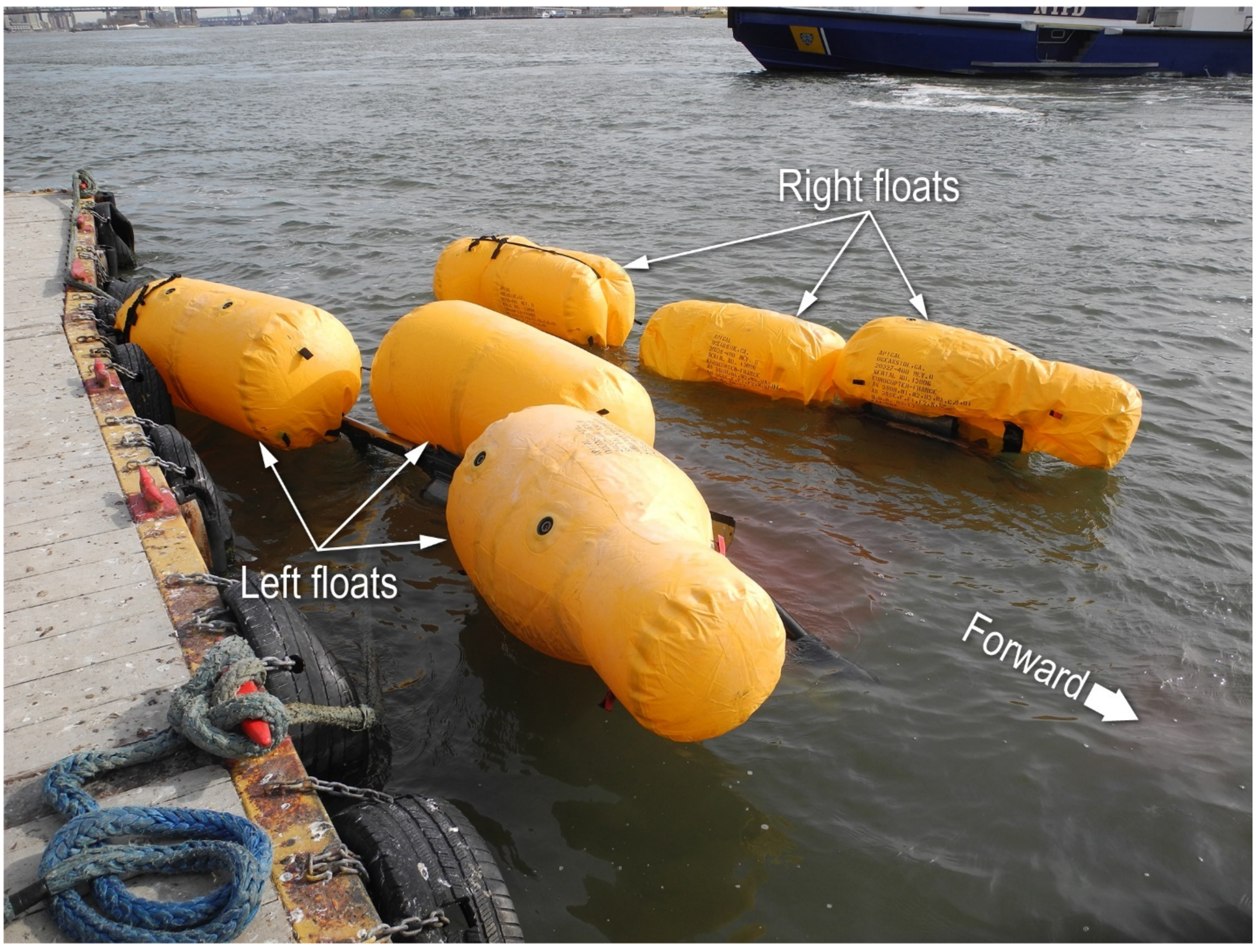

Figure 4. Emergency floats visible above inverted, submerged wreckage.

1.2. Personnel Information

The pilot, age 33, held commercial pilot and flight instructor certificates for rotorcraft-helicopter and instrument helicopter and an advanced ground instructor certificate. He held a second-class airman medical certificate issued July 27, 2017, with no limitations.

According to Liberty's records, the pilot completed his initial new hire training curriculum on March 11, 2016, and he completed his AS350 checkride with Liberty's chief pilot on April 12, 2016. The pilot's most recent proficiency training, emergency procedures training, proficiency check in the AS350, and pilot-in-command (PIC) line check in the AS350 were completed on February 21, 2018. The proficiency check included an evaluation of autorotations with satisfactory results.

The pilot's total flight experience was about 3,100 hours, with about 3,020 hours as PIC and 1,430 hours as PIC in the AS350. The pilot accumulated 57 hours in the 30 days before the accident, with 2 hours flown in the 24 hours before the accident.

The pilot's work schedule was 4 days on, 4 days off. He said that he normally awoke at 0600 on weekdays and 0700 on weekends and typically went to bed around 2300. He said his workdays normally began between 0940 and 0945. He recalled no disruptions to his sleep in the days before the accident.

Company duty logs for March 8 (the beginning of the pilot's work week) showed that he worked from 0700 to 1945. The pilot said he went to bed about 2300. Duty logs for March 9 showed that he worked from 0745 to 1900. Duty logs for March 10 showed that he worked from 0945 to 1815.

The pilot said he awoke about 0700 on March 11 (the day of the accident). Company records showed that he went on duty at 0930 and operated flights in the accident helicopter at 1100, 1200, 1500, and 1700; the pilot said he ate lunch between 1400 and 1500. The accident flight was a 30-minute sunset flight and his fifth flight of the day.

1.3 Helicopter Information

The accident helicopter was an Airbus AS350 B2 manufactured in 2013 under Type Certificate Data Sheet (TCDS) H9EU. It was equipped with a Safran HE Arriel 1D1 turbine engine and configured to transport a pilot and up to six passengers.

The helicopter had a single set of flight controls to be accessed by a pilot in the front right seat. Its original front left seat (single-place) had been removed and replaced with a dual (two-place) high-back seat in accordance with Dart Aerospace (Dart) Supplemental Type Certificate (STC) SR01620NY. The dual high-back seat installation included a tubular armrest installed on the inboard end of the seat.[10]

[10] Dart installation instructions for the armrest kit (part number D350-689-031) stated that it would prevent passengers "from sliding off the seat into the [helicopter's] controls" and reduce the amount of flex in the seat back.

An estimated weight and balance for the accident flight performed by investigators based on available information determined that the helicopter was loaded within limits.

The helicopter was maintained under the aircraft manufacturer's recommended inspection program. Airframe maintenance log entries showed that, at the time of the accident, the airframe had accumulated 5,510 hours airframe total time (ATT).[11] According to the helicopter logbook, the last airframe 100-hour inspection was performed on March 6, 2018, at 5,496 hours ATT, and the most recent airframe 1-month inspection was completed on February 28, 2018, at 5,481 hours ATT. No defects were noted in either inspection.

Engine maintenance log entries showed that, at the time of the accident, the engine had accumulated 1,437 hours since overhaul, which was completed on September 22, 2016, at 3,599 hours since new. The most recent engine 100-hour inspection was completed on March 6, 2018, at 5,024 hours since new, and the last compressor wash was performed on March 8, 2018.

1.3.1 Fuel Shutoff Lever

The helicopter's FSOL was one of three floor-mounted control levers located near the base of the pilot's collective control, along with the FFCL and the rotor brake.[12] Each floor-mounted control had a different lever length and head shape; also, the FSOL and rotor brake lever were both red, and the FFCL was yellow (see figure 5).

By design, the FSOL provided a means to close the fuel shutoff valve on the fuel line between the fuel tank and the engine. The rotorcraft flight manual (RFM) for the helicopter specified closing the FSOL (by pulling it up and aft) in the event of an emergency landing. The FSOL was equipped with a breakable snap wire routed through a hole in the fuel control plate to keep the FSOL positioned down and forward unless force was applied to the lever to change its position.

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[11] All aircraft times in section 1.3 and its subsections are rounded to the nearest hour.

[12] Some later variants and models of helicopters added to TCDS H9EU (specifically, the AS350 B3, EC130 B4, and EC130 T2) were equipped with a ceiling-mounted FSOL; collective control-mounted, twist-grip engine control (instead of a floor-mounted FFCL); and ceiling-mounted rotor brake lever. For those helicopters, the ceiling-mounted FSOL included a breakaway plate to prevent inadvertent operation, and the ceiling-mounted rotor brake lever incorporated a button to release its locking mechanism. The accident helicopter's FFCL included modifications 07-3283 and 07-4685 (in accordance with service bulletin [SB] AS350-76.90.20), which incorporated locking detents. The accident helicopter's rotor brake lever included modification 07-4337, which changed its shape to avoid interference with the collective control.

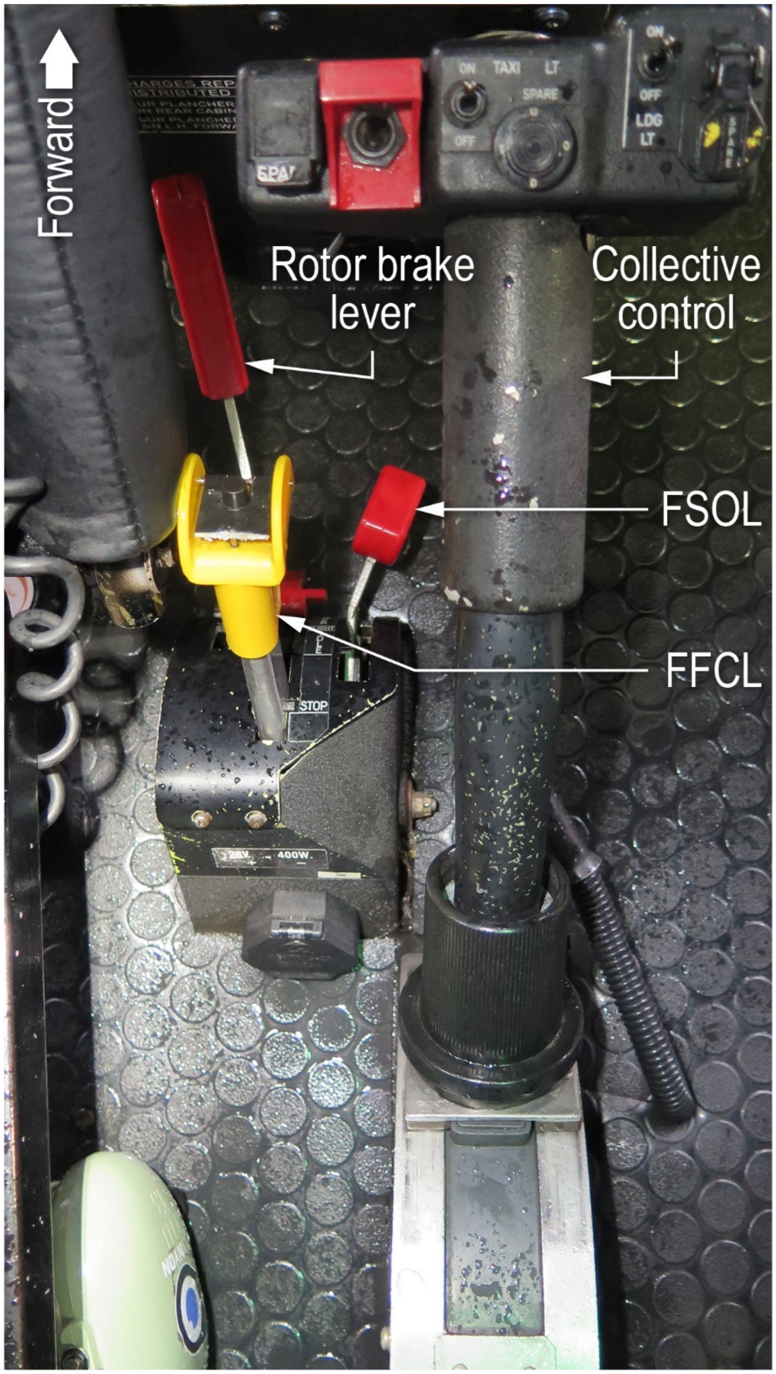

Figure 5. FSOL and other floor-mounted controls in the accident helicopter.

According to the FAA Rotorcraft Standards Office, the accident helicopter's FSOL design met the 14 *CFR* 27.1189(b) requirement to guard against "inadvertent operation," that is, the possibility that a pilot may mistakenly operate the incorrect lever. FAA personnel stated that the visual and tactile differences between the FSOL and the adjacent floor-mounted controls (different color and/or head shape) help pilots correctly identify each control lever.

According to the FAA and Airbus, no previous events involving either inadvertent operation of an FSOL (by a pilot) or inadvertent activation of an FSOL (due to an external influence, like a passenger or unsecured object) have been reported.[13]

A review of the accident helicopter's maintenance records revealed that inspections of the FSOL occurred during airframe 600-hour and 24-month inspections in August and September 2017, respectively. Neither inspection, which included a test of the FSOL and its ball valve to check for excessive friction and force, noted any defects.

During postaccident examination, the FSOL was found positioned forward and down with the snap wire broken adjacent to the fuel control plate hole. Examination of a fractured segment of the wire using a scanning electron microscope revealed elongation deformation and other features consistent with ductile overstress.

1.3.2 Emergency Flotation System

1.3.2.1 Design and Certification Basis

Airbus AS350 B2 helicopters were not certified (or required to be certified) for ditching.[14] The accident helicopter (which Liberty used in both Part 135 and Part 91 flight operations) was equipped with an emergency flotation system in accordance with Dart STC SR00470LA.[15] The system was designed to inflate the six floats (each containing two chambers separated by bulkheads) when the pilot pulled the float activation handle mounted on the cyclic control in the cockpit. According to Dart, the system design intended that a pilot could pull the handle to fully deploy the floats using only the right hand (the hand operating the cyclic control) without letting go of the cyclic grip (similar to how a bicycle brake lever is operated without letting go of the handlebar). A review of the RFM supplement (RFMS) for the emergency float system (FMS-350[2], revision E, was current at the time of the accident) and Dart's installation, maintenance, and inspection instructions found that none described or illustrated the intended single-handed activation technique.

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[13] There was no documentation that the FSOL design certification process required consideration of scenarios in which an external influence could result in an unintended change in the FSOL position.

[14] Ditching certification includes provisions for structural strength, emergency exits, flotation, and ditching equipment. Airbus AS350 B2 helicopters can be equipped with an emergency flotation system, which provides a means for flotation when ditching.

[15] (a) The application for STC SR00470LA, held by Apical Industries Inc. doing business as Dart Aerospace, was dated July 1, 1996. The FAA Los Angeles Aircraft Certification Office, which had reviewed the STC application, issued STC SR00470LA on November 17, 1997, after determining that the design satisfied the applicable sections of Part 27. (b) Title 14 *CFR* 135.183(d) stated that land helicopters that are used to carry passengers over water must be equipped with flotation devices.

The activation handle was equipped with a shear pin (designed to break under about 12 lbs of force) to help prevent inadvertent activation. According to the FAA Los Angeles Aircraft Certification Office (ACO) project manager for the review and approval of STC SR00470LA, the applicant (Apical) had proposed (and the ACO had accepted) a 30-lb pull-force limit for the activation handle (that is, the maximum allowable force needed to pull the handle to successfully deploy the floats). A review of the STC and related documents found that none specified a pull-force limit for the activation handle.[16] On the accident helicopter, the activation handle alignment was offset from the cyclic grip about 32° to the right (as specified in the installation instructions) to prevent interference with the cyclic grip (see figure 6).

Figure 6. Float activation handle (red) installed on the accident helicopter's cyclic control.

The activation handle was connected to a mechanical pull-cable system designed to activate the valves of two reservoirs (one mounted on each side of the airframe) containing compressed nitrogen gas. A single pull cable extended from the activation handle to a junction box

[16] Subsequent internal testing performed by Dart for design iterations used a 25-lb pull force in the test failure criteria.

mounted on the helicopter's left frame rail. The junction box contained a dual cable block designed to transmit the motion of the activation handle's single pull cable (attached to the forward end of the block) to the pull cables for each reservoir assembly. The aft-upper and aft-lower pull cables, which extended forward from the left and right reservoir assemblies, respectively, passed through the dual cable block and terminated at jam nuts that abutted the dual cable block's forward surface. By design, pulling the activation handle would move the dual cable block forward (by means of the activation handle pull cable), which would pull the aft-upper and aft-lower pull cables forward by means of the cable block's contact with each cable's jam nut. Thus, when the activation handle is pulled to full travel, the resulting movement of the dual cable block and the aft-upper and aft-lower pull cables would result in activation of the valves to discharge each reservoir assembly (see figure 7).

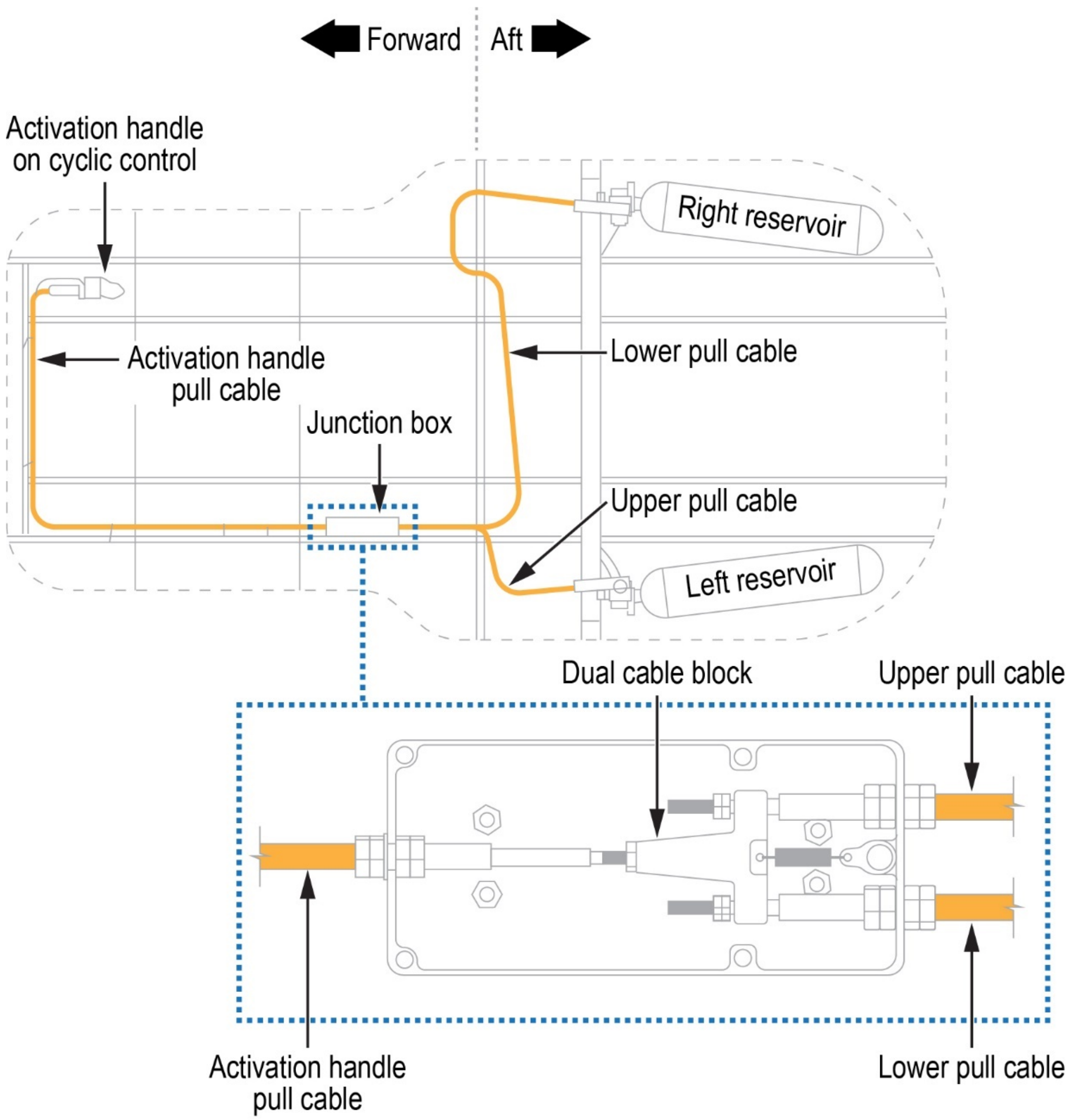

Figure 7. Top-down view of helicopter showing basic routing of the pull cables for the emergency flotation system and inset showing side view of components inside the junction box.

Note: Not to scale and adapted from a Dart Aerospace diagram.

The left reservoir assembly was equipped with a manifold that was connected by hoses to the left three floats, and the right reservoir assembly was similarly configured for the right three floats. A crossover hose between the left and right manifolds allowed gas to move between the left and right sides.[17]

1.3.2.2 Installation and Maintenance

The emergency flotation system was installed new on the accident helicopter by EuroTec Canada (according to a work order dated December 2, 2013). The investigation found that the junction box for the activation handle's pull cable was installed on the outboard side of the left frame rail about 1.6 inches farther aft and about 0.25 inch higher than the location prescribed by Apical Industries Inc. (Dart) Installation Instruction No. II350-600.[18]

The instructions for continued airworthiness (ICA), document ICA350-21, revision P (current at the time of the accident), prescribed maintenance and inspection criteria. The ICA specified that the 6-month inspection included (among other items) a visual inspection of the pull cables and junction box and a check for ease of pull-cable movement by pulling on the activation handle with a "small amount" of tension applied to the clevis (disconnected before this procedure) for each valve; the ICA did not specify a pull-force limitation for the activation handle. The 18-month inspection required (among other items) inspecting the pull cables for corrosion and proper rigging. The 36-month inspection required (among other items) pulling the activation handle to inflate the floats and measuring the pressure in each float chamber to ensure a minimum of 1.75 lbs per square inch (psi) at 70°F after 10 minutes and with no leaks.

Maintenance logs for the accident helicopter showed that the system's most recent 6-month inspection was performed on October 26, 2017, at 5,204 hours ATT. A 36-month inspection was performed on December 14, 2016, at 4,228 hours ATT, at which time both reservoir assemblies were replaced with overhauled units (section 1.9.3.2 describes the contents of several videos that Liberty provided showing various inflation tests performed as part of the 36-month inspection of its helicopters equipped with the Dart emergency flotation system).

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[17] According to SB 99001, the crossover hose (which was approved on April 18, 2000, as a modification and was later incorporated into the standard installation) was intended to allow some gas to reach all floats in the "remotely possible" event that one gas reservoir assembly (valve/cylinder combination) does not function. Neither the FAA Los Angeles ACO (which approved the crossover hose modification) nor Dart could provide the NTSB with information explaining what prompted the addition of the crossover hose to the design or documenting that any testing was performed to substantiate the design change. A July 26, 1999, memorandum from Dart described a crossover hose design for STC SR00470LA as similar to the installation used on a different model of Dart floats; an FAA flight test report for that different float model described that, using only one cylinder, partial but symmetrical inflation of all floats occurred.

[18] A EuroTec Canada representative said the modified location had been discussed with a Dart engineer before the junction box was installed. EuroTec provided a letter dated October 30, 2013, from a Dart engineer that referenced installing the junction box on the outboard (rather than inboard) side of the left frame rail. The letter did not reference any other location variables. At the time of the accident, Installation Instruction No. II350-600 (revision J, which was current at the time) contained a provision to allow the junction box to be installed on either the inboard or outboard side of the left frame rail.

1.3.2.3 Postaccident Examination

Examination of the floats after the helicopter was recovered from the water revealed that all six floats (forward, mid, and aft for the left and right sides) contained residual gas. Each float remained attached (at least partially) to its respective float cover, and the float covers remained attached to the helicopter's skids. The left-aft float's forward chamber and right-mid float's aft chamber were torn; the other chamber of each of these two floats held residual gas when compressed. Both chambers of all other floats held residual gas when compressed.

Examination of the system's crossover hose revealed no anomaly. Application of pressurized air to the crossover hose and all other hoses of the emergency float system revealed no substantial debris.

Examination of the pressure gauges for the left and right reservoir assemblies indicated about 0 psi and 4,000 psi, respectively; the left valve had activated, and the right valve had not. Computed tomography imaging of the right valve assembly showed no anomalous damage or abnormal positioning of internal components (the pull cable and ball). Subsequent pull tests performed on the right valve assembly revealed that, each time, it activated at a pull force below the prescribed limit (15 lbs) for valve activation.[19]

The pull-cable routing from the activation handle to the dual cable block in the junction box was continuous, and the handle shear pin was not present. The aft-upper and aft-lower cables were attached to the dual cable block in the junction box, and their routing was continuous to the left and right reservoir assemblies, respectively. The exterior cover (sheathing) of the cables exhibited no anomalous damage. The pull-cable rigging met the specified 0.625-inch minimum travel requirement for the pull-cable clevis at each valve assembly.

As described previously, pulling the activation handle in the cockpit (to activate the floats) would pull the dual cable block forward (by means of the activation handle pull cable). The dual cable block was equipped with a spring intended to return the block to its original position after the activation handle was released (following float activation) in the cockpit.[20]

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[19] After the first pull test, external visual examination of the right valve revealed that anti-seize compound was present on the ball and grommet and that the grommet was installed backward.

[20] Following a normal activation sequence, a gap between the forward face of the dual cable block and each jam nut would be evident, indicative of the cables having been pulled forward by the dual cable block (and remaining there after the block returned to its original position). See section 1.9.3.1 for a description of cable movements and gaps evident on the accident helicopter following test activation sequences (activation handle pull-force tests).

The accident helicopter's aft-upper cable exited the junction box aligned about horizontal, and the aft-lower cable showed a downward bend about 30° from horizontal. Inside the junction box, the aft-upper cable showed a gap of about 0.25 inch between its jam nut and the dual cable block surface, and the aft-lower cable showed no gap between its jam nut and the cable block (see figure 8).

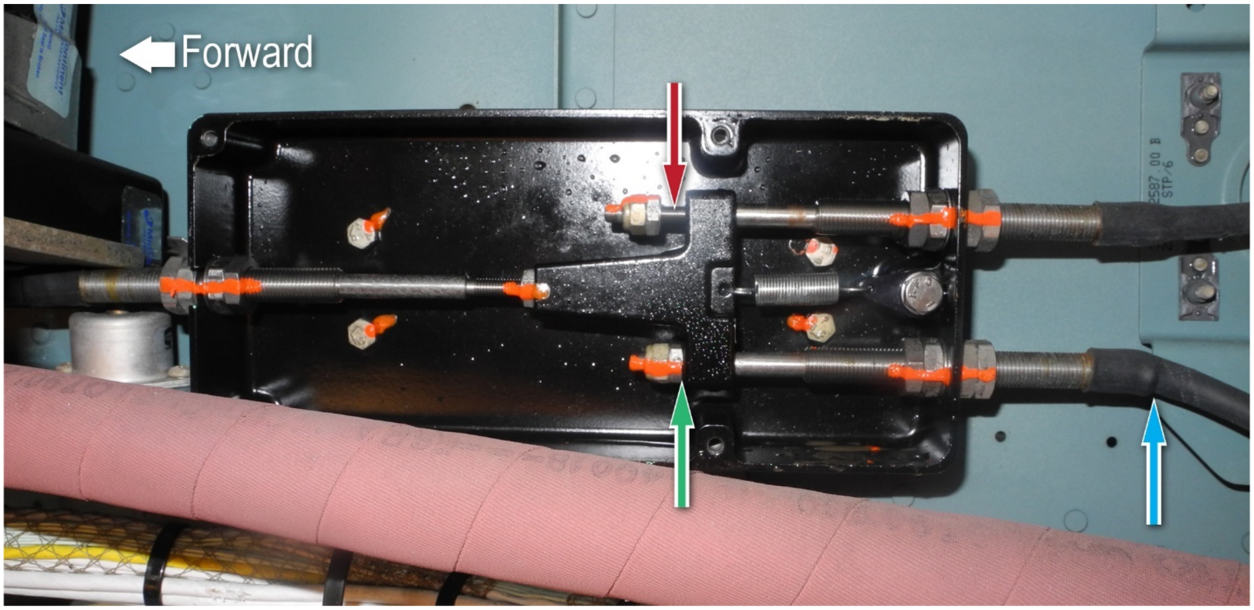

Figure 8. View inside the junction box for the accident helicopter's emergency flotation system.

Note: A gap between the dual cable block surface and the jam nut of the aft-upper cable (for the left reservoir assembly) is indicated by the red arrow, the lack of a gap between the block surface and jam nut of the aft-lower cable (for the right reservoir assembly) is indicated by the green arrow, and the blue arrow indicates the downward bend of the aft-lower cable.

1.3.3 Installed, FAA-Approved Restraints

As required by 14 *CFR* 27.2 (the rotorcraft airworthiness standards applicable to the accident helicopter), each occupant seat (pilot and passenger) had an installed lap belt and shoulder harness that was equipped with a single-point release.[21] Each of these installed, FAA-approved restraints was designed and manufactured to conform to Technical Standard Order (TSO)-C114 for torso restraint systems.[22] Each shoulder harness included an inertia reel.

[21] Title 14 *CFR* 27.2 applied to the accident helicopter based on its date of manufacture, as defined in 14 *CFR* 27.2(a)(4). The requirements for installed, FAA-approved restraints specified in 14 *CFR* 27.2(1) were identical to those specified in 14 *CFR* 27.785(c), which applied to helicopters receiving a new type certificate after December 6, 1984 (the effective date of Amendment 27-21).

[22] A TSO is a minimum performance standard for specified materials, parts, and appliances that may be installed on a civil aircraft. Manufacturers must receive authorization (which includes design and production approvals) to manufacture a component to a TSO standard. A separate FAA approval is required to install the component on an aircraft.

The pilot's seat had a four-point system that consisted of an adjustable-length lap belt and two-strap shoulder harness (one strap over each shoulder) that fastened into a single rotary buckle. By design, rotating the buckle would release the lap belt and both shoulder harness straps (see figure 9).

Figure 9. Exemplar four-point system with a rotary buckle.

Note: Arrows show direction to release.

Each seat on the front left dual-position bench had a four-point system that consisted of an adjustable-length lap belt and two-strap shoulder harness (one strap over each shoulder) that fastened into a single lift-latch buckle.[23] By design, lifting the buckle latch would release the lap belt and both shoulder harness straps.

Each seat on each rear dual-position bench had a three-point system that consisted of an adjustable-length lap belt and single-strap shoulder harness (over one shoulder) that fastened using a single lift-latch buckle. (The lap belt fastened into the buckle, and the shoulder harness strap fastened onto a standoff button on one side of the buckle.) By design, lifting the buckle latch would release the lap belt and free the wearer from the shoulder harness (even if the shoulder harness remained attached to the standoff button).

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[23] The end fittings of the shoulder harness straps were secured by the insert tab of the lap belt when the lap belt was fastened.

At the time that the accident flight departed, each passenger's installed, FAA-approved restraint was fastened over their harness/tether system and personal flotation device (PFD), which consisted of a waist belt with a pouch that contained an inflatable vest. Onboard video showed that, at the time of departure, the shoulder harness of the installed, FAA-approved restraints for the front passenger and the rear-left outboard passenger were routed under the arm (rather than over the shoulder), and the lap belt for the front passenger was adjusted very loosely.[24] (Configurations for other passengers were not clearly visible, and the rear-right outboard passenger never entered the camera's field of view [FOV].)

The onboard video also provided evidence that at least some passengers did not have their installed, FAA-approved restraints fully and/or tightly fastened at the time of landing. About 5 minutes before the loss of engine power, the front passenger's installed restraint came unfastened. The video showed he manipulated the lap buckle (and the lap belt later appeared to be fastened loosely), but he did not refasten the shoulder harness. The rear-left inboard passenger returned to his seat (from the floor) about 15 seconds before the emergency landing but did not appear to secure himself with the installed, FAA-approved restraint. There was no indication that the rear-right inboard passenger returned to his seat.[25]

The video showed that, after the landing (and before the camera's lens became obscured by submersion), the front passenger and the rear-left outboard passenger made no efforts to unlatch the single-point release buckle of their installed, FAA-approved restraints. (See section 1.8.1 for more information about the passengers' egress activities.)

It is unknown to what extent first responders may have manipulated the installed, FAA-approved restraints and buckles when recovering the passengers from the cabin. Postaccident testing of the installed, FAA-approved restraints found that the pilot's rotary buckle, the passengers' lift-latch buckles, and the inertia reels for all shoulder harnesses functioned as designed. The examination found that the lap belts for the installed, FAA-approved restraints for the rear passengers were attached to floor anchors adjacent to the rear bulkhead.[26]

1.3.4 Harness/Tether System

1.3.4.1 Design

The harness/tether system provided by NYONair for the accident flight (and other FlyNYON doors-off flights) was not part of the helicopter's installed equipment required by rotorcraft airworthiness standards. According to NYONair's chief executive officer (CEO), the

[24] For the front passenger (whose installed, FAA-approved restraint had two shoulder straps), the right shoulder strap was routed under his right arm and the left shoulder strap over his left shoulder at the time of takeoff.

[25] The camera's FOV captured part of the rear-right inboard seat. After the passenger moved from this seat to the floor, he was outside of the camera's FOV and was not described again in the NTSB's prepared transcript regarding certain video/audio events and the times captured (see section 1.5.2 and appendix C).

[26] The *AS350 B2 Maintenance Manual* contained a diagram (in section 25-22-00, chapter 4-4) that depicted one side of one lap belt attached to an anchor on the aft bench bar (not the floor); the anchor location for the other side of the lap belt was not shown. The manual did not contain a diagram showing all anchors for all four lap belts.

components used to make up the harness/tether system were suggested by company pilots and other personnel who had extensive experience with film production work.

NYONair's intent was to protect passengers on FlyNYON doors off-flights from falling out of the helicopter when their installed, FAA-approved restraints were either deliberately removed (as was allowed by FlyNYON operators for the rear inboard passengers) or were to become unfastened inadvertently.

Harnesses

The harness that NYONair provided for each passenger on the accident flight (referred to as the "yellow" harness by Liberty and NYONair personnel due to their color) was designed to protect users from workplace fall hazards.[27] The harness included interconnected shoulder straps and leg straps, a chest strap that spanned the two front shoulder straps, and a dorsal D-ring (used on the accident flight for attaching a tether) between the wearer's upper shoulder blades. NYONair attached a pouch containing an emergency cutting tool on either the right or left upper shoulder strap of each harness (see figure 10).[28]

Figure 10. Front and rear views of a person wearing an exemplar yellow fall-protection harness with a pouch containing a cutting tool attached to the upper left shoulder strap.

Note: In this example, a blue lanyard secures a personal item, a locking carabiner is attached between the upper rear shoulder straps, and two spare locking carabiners (one on the back right and one on the front left) are attached (see section 1.10.6.1 for information related to various attachment configurations).

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[27] Product-specific applications listed in the manufacturer's manual for the harness included protecting workers from falls from structures, enabling workers to work while suspended from a structure, and rescuing workers from confined spaces (Guardian 2019, 2).

[28] The pouches and cutting tools for four of the five passengers were visible in the onboard video; one was attached to the upper right shoulder, and three were attached to the upper left shoulder.

Cutting Tools

NYONair provided cutting tools to FlyNYON passengers for use in freeing themselves from the harness/tether system in the event of an emergency (see section 1.10.5.1). The cutting tools provided to the accident flight passengers included models made by two manufacturers; one model was marketed as a seatbelt cutting blade and window punch for emergency escape from a vehicle, and the other was marketed as an emergency safety cutter (StatGear 2019; Benchmade 2019). Each model featured a hook-shaped, fixed blade and coated handles (see figure 11).

Figure 11. Two types of cutting tools recovered from the accident flight.

Tethers and Locking Carabiners

For the accident flight (and other FlyNYON doors-off flights), the dorsal D-ring on each passenger's harness was secured with a locking carabiner to a tether, which consisted of several loops of 11 mm webbing of varying lengths (manufactured by a climbing gear supplier). The other end of each tether was secured to a cabin anchor point with a second locking carabiner.

Three different models of locking carabiners were used on the accident helicopter, each of which featured a similar type of gate and locking mechanism. The gate could be opened by pushing it inward when not locked. The locking mechanism featured a screw-type, threaded locking sleeve that was operated by manually rotating multiple turns to lock or unlock the gate (depending on the direction of rotation) (see figure 12).

Figure 12. An exemplar locking carabiner used on a tether on the accident helicopter.

1.3.4.2 Use During Accident Flight

As described previously, before departure, each passenger was fitted with a harness and secured by a tether to the helicopter. Also, each passenger's headset was secured to his or her harness with a nonlocking carabiner and zip tie, per the SOPs for FlyNYON doors-off flights.[29]

The onboard video showed that the front passenger's tether was routed under the armrest of his seat and to a floor anchor located aft of the helicopter's floor-mounted controls. According to Liberty personnel, each rear seat passenger's tether was routed such that it was secured to an anchor point located behind a different passenger. That is, the right outboard passenger's tether was secured to an anchor point (on the aft bench bar) behind the left outboard passenger (and vice versa), and the right inboard passenger's tether was secured to an anchor point behind the left inboard passenger (and vice versa). (See figure 13.)

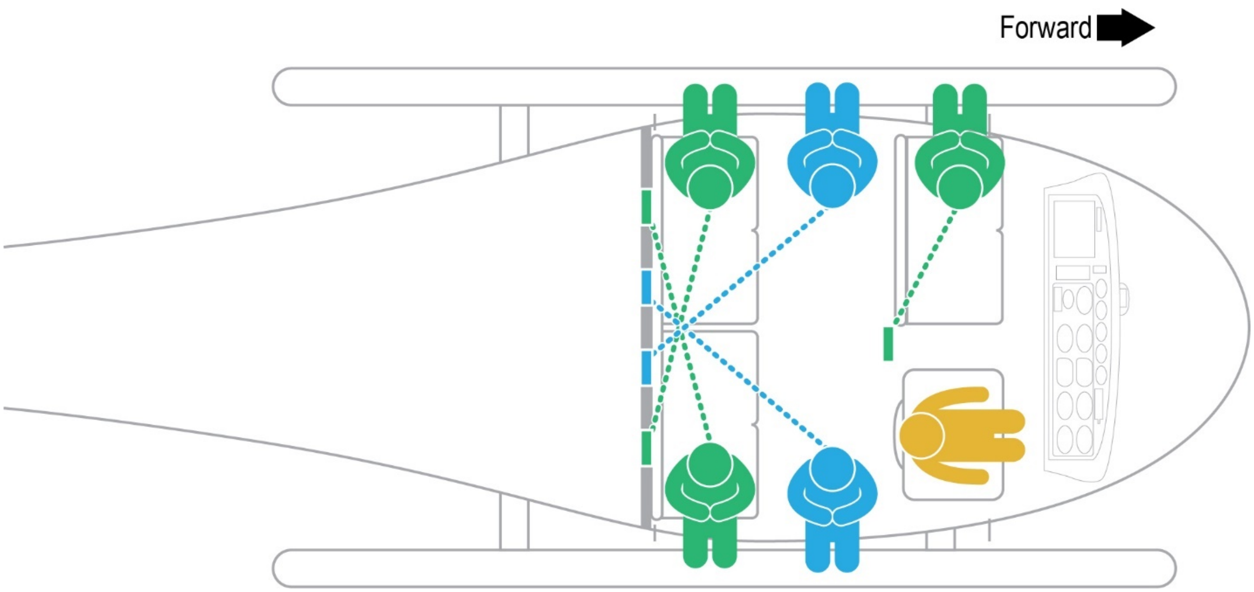

Figure 13. Diagram showing the tether routing for each passenger to the respective anchor point in the cabin.

Note: Not to scale.

All three passengers who were in the FOV of the onboard camera after landing (the front passenger, the rear-right outboard passenger, and the rear-right inboard passenger) were still wearing their harnesses and were connected to their tethers at the time that the camera's lens became obscured by submersion (see 1.8.1 for more information about their egress activities).

[29] According to NYONair personnel, the passengers' headset cords were secured to the harnesses to prevent the possibility of a headset falling out of the helicopter. For the accident helicopter, the headset cord for the front passenger plugged into an audio jack on the helicopter's front panel, and the headset cords for the rear passengers routed through a rack on the ceiling and plugged into audio jacks above the rear bench seats.

1.3.4.3 Postaccident Examination

First responders reported that they found the passengers strapped in the cabin, and they had to cut various straps to free them (see section 1.8.2). It is unknown to what extent response personnel may have also manipulated any locking carabiners. Portions of four harnesses worn by passengers were recovered for examination. The fifth harness was not located. One cutting tool was found loose (that is, not contained in a harness pouch) inside the helicopter.

Part of the front passenger's harness was found in the helicopter with the D-ring secured to the tether (and the tether secured to the cabin floor fitting) with locking carabiners. The shoulder strap and chest strap sections (including the strap that would include a pouch and cutting tool) were missing. Portions of two harnesses were obtained from the NYPD. One had a pouch attached that contained a cutting tool; the other had a pouch attached, but no cutting tool was present.

The medical examiner's office provided a harness that it had removed from the passenger who had occupied the rear-left outboard seat. A locking carabiner was attached between the upper rear shoulder straps. A lanyard was attached at the right chest, and a nonlocking carabiner and zip tie secured a portion of a headset cord (from the plug to a frayed end) to the left shoulder strap. A pouch attached to the front of the left shoulder strap contained a cutting tool.

Postaccident examination found locking carabiners attached to both ends of the front passenger's tether. The tether consisted of six webbing loops: one 15-inch loop and five 5-inch loops. The bottom locking carabiner (attached to the floor fitting) was inserted through the 15-inch loop.[30] The top locking carabiner (attached to the harness D-ring) was inserted through the tether's third loop from the floor, leaving a tail of three 5-inch loops (see figure 14).

The tethers for the four rear passengers each consisted of multiple loops of webbing secured to an anchor point with a locking carabiner.[31] The anchor end of each tether was secured through a terminating loop. When examined by investigators (after passenger recovery), the top (occupant end) of each rear tether had a locking carabiner inserted through a loop such that excess tether loops hung from the carabiner as a tail. Each tether (from the anchor point to the D-ring attachment) was between 39 and 41 inches long (see figure 15).

[30] Liberty used a floor anchor located inboard of the front left bench (and aft of the floor-mounted controls) to secure the front passenger's tether.

[31] Liberty used four stationary anchors on the aft bench bar of the rear benches to secure the rear seat passengers' tethers. According to communications from Airbus during the investigation, these anchors were to be used only for lap belt installations, and there was no documentation for other approved uses. Airbus also stated that two of the four stationary anchors in the accident helicopter were in locations that differed from their approved installed locations.

Figure 14. Front passenger's tether from the accident flight with top locking carabiner inserted through third webbing loop (from floor) with three excess loops hanging as a tail.

Note: The tether tail's terminating loop (yellow) is partially obscured in this photograph.

Figure 15. Rear passengers' tethers from the accident flight secured to anchor points on the aft bench bar with locking carabiners.

1.3.4.4 Postaccident Evaluation of Tether Routing and Access Scenarios

Tether for Front Passenger

To evaluate operational scenarios related to the front passenger's tether tail and floor-mounted controls, investigators observed an exemplar occupant move through a range of positions on the front bench while secured by a harness and the accident flight tether, which was routed under the seat armrest (consistent with the routing shown in the onboard video). Figure 16 shows this tether routing with the exemplar occupant seated upright on the bench facing outboard.

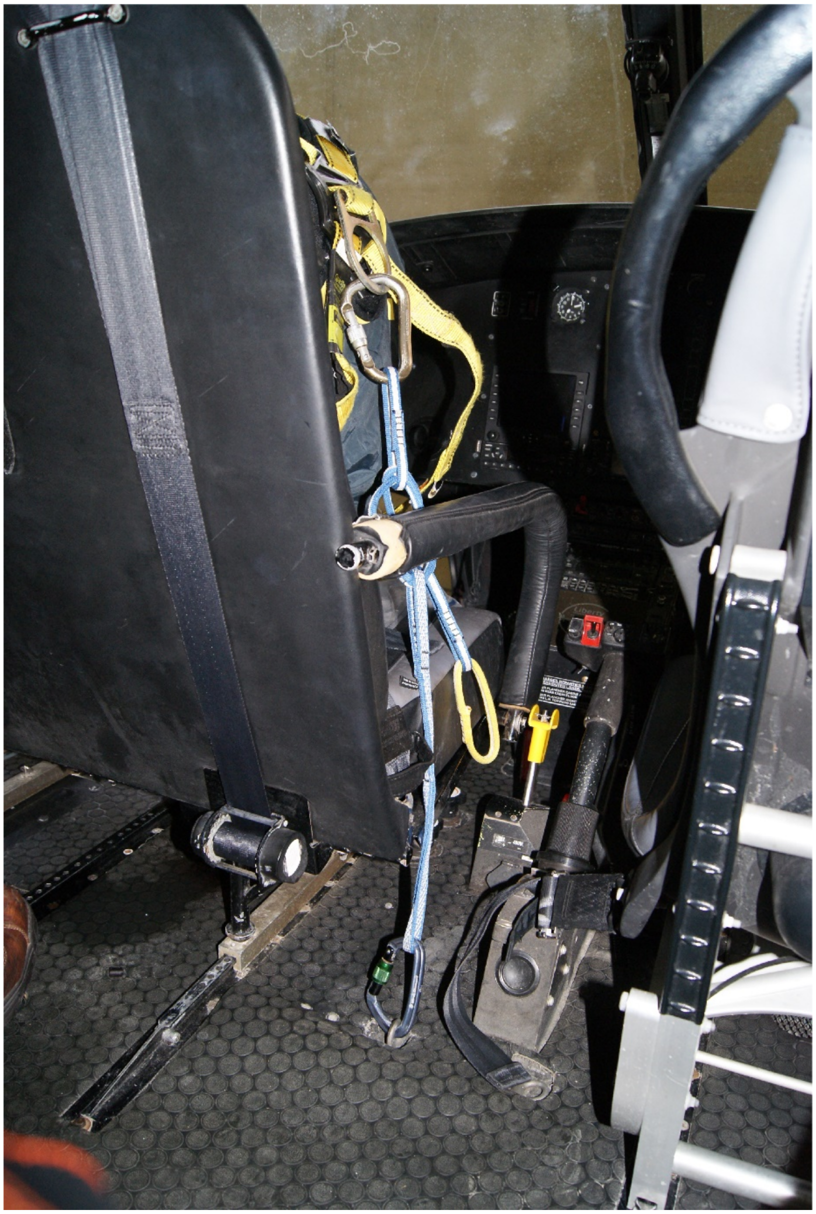

Figure 16. Front passenger's tether (attached to exemplar occupant) routed under the armrest.

When the exemplar occupant leaned back while facing outboard to assume body positions similar to those of the front passenger (as captured by the onboard video), the loops of the tether tail dangled into the floor-mounted controls.[32]

[32] The tether tail loops also dangled into the floor-mounted controls during test scenarios with the tether routed over—rather than under—the armrest.

Tethers for Rear Passengers

To evaluate the rear passengers' access to their own tethers, investigators observed an exemplar occupant seated in the rear-right outboard seat and secured by the tether from the accident flight. When another exemplar occupant was added to occupy the rear-right inboard seat, this occupant's body obstructed the outboard passenger's access to his own tether. To enable the outboard passenger to access his own tether, the inboard occupant needed to lean forward. Investigators also observed that, when the outboard passenger rotated his upper body inboard to reach his tether, the movement resulted in tension in the tether that restricted his rotation.

1.4 Meteorological Information

The closest weather observation to the accident site was at LGA, about 3 nautical miles (nm) east of the accident location. At 1851 (about 17 minutes before the accident), conditions at LGA included wind from 300° at 5 knots (kts), visibility 10 miles or more, scattered clouds at 25,000 ft agl, temperature 44°F, dew point 21°F, and an altimeter setting of 30.05 inches of mercury.

The closest water temperature observation was from the Battery Park, New York, National Weather Service buoy located 5 miles south-southwest of the accident site at the entrance of the East River. It reported a water temperature of 39.7°F.

1.5 Flight Recorders

1.5.1 Appareo Vision 1000

The helicopter's original equipment included an Appareo Vision 1000 image recorder system that recorded imagery and data parameters simultaneously to both a secure digital (SD) card and an internal memory.[33] The system was designed to capture imagery of the cockpit instrument panel, the caution and warning panel, the pilot actions on the flight controls, and the near environment (such as obstacles and weather conditions) and to detect and record helicopter position, altitude, roll, pitch, yaw, heading, and angular velocities and acceleration in the three axes.

Postaccident readout of the SD card revealed that the most recently recorded file contained image, audio, and parametric data from July 1, 2014. Readout of the recorder's internal memory revealed contents that appeared consistent with the data recovered from the SD card. The examination found that the recorder contained an older firmware version that had a known fault condition that could result in the unit ceasing to function properly. Updated firmware intended to correct the condition was available before the accident but had not been installed.

[33] The SD card could retain up to 4 hours of video and 200 hours of data, and the internal memory could retain up to 2 hours of video and 200 hours of data.

The helicopter's maintenance manual contained a requirement for a 12-month inspection of the Appareo system (including a camera functional test), and the RFM contained a system description with a figure depicting the camera's location in the cockpit. Maintenance records for the accident helicopter showed that, during the most recent airframe 12-month inspection completed on October 27, 2017, maintenance for the Appareo system was labeled "N/A" (not applicable). Liberty's director of maintenance said he did not know the function of the camera installed on the helicopter (as part of the Appareo system) until investigators identified it after the accident.

1.5.2 Other Sources of Onboard Video and Images

A digital camera (GoPro HERO 5) and an Apple iPhone X smartphone used during the accident flight were recovered. Video and audio were extracted from both devices (as well as still images from the smartphone).

The digital camera was mounted on the helicopter's ceiling just aft of the front seats and faced to the left. It was enclosed in a ruggedized housing and included a wide-angle glass lens. The camera's FOV included (for much of the flight) the helicopter's center pedestal area, left windscreen, left open doorway, front left bench, and rear left bench (see figure 17).[34]

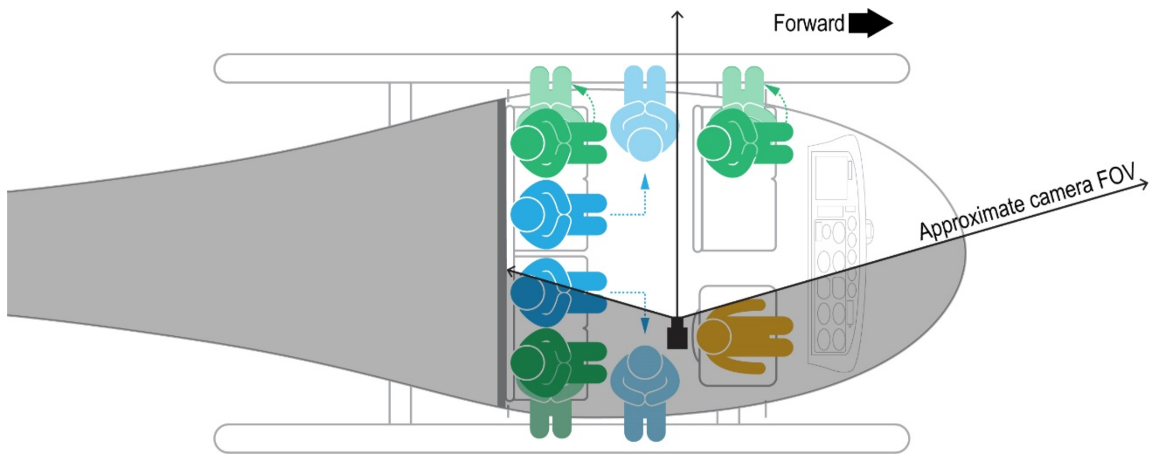

Figure 17. Diagram showing ceiling-mounted camera's approximate FOV.

Note: Diagram not to scale.

The digital camera captured video and audio information beginning at 1843:57 (during preflight preparations). The camera's lens became submerged at 1907:26 (about 11 seconds after the helicopter touched down), but the camera continued to record video (which became and remained mostly black for the remainder of the recording) and audio until about an hour after the accident.

[34] The NTSB's video transcript documented two instances in which the camera's FOV changed slightly, once after a sound similar to wind hitting the camera microphone and once after the helicopter touched down.

The smartphone, which had been held by the passenger in the rear-right outboard seat, captured various views from that position.

Times for onboard events referenced in this report have been rounded to the nearest second from the times referenced in the NTSB's transcript (which documented time to hundredths of a second) (see appendix C).

1.6 Wreckage and Impact Information

The helicopter was in the water and inverted for about 18 hours before it was recovered and relocated to a hangar for examination.

Examination of the airframe revealed that it remained generally intact with no evidence of major fractures, and the skids and crosstubes showed no evidence of major deformation. The tail boom remained attached with wrinkles in the metal skin observed immediately forward of the horizontal stabilizer. All three main rotor blades were attached to their respective sleeve assemblies, and the two tail rotor blades remained attached to the tail rotor hub. Continuity for the cyclic and collective controls and pedal controls was established.

Examination of the engine modules and accessories; fluids, filters, and chip detectors; and fuel control unit revealed no anomalies that would have precluded normal operation.

One PFD was recovered from inside the cabin, and two PFDs (recovered from the front passenger and rear-left outboard passenger) were obtained from the medical examiner's office. The inflatable vest for each PFD was found in the pouch (unopened) and in good condition.[35]

1.7 Medical and Pathological Information

1.7.1 Pilot

The pilot stated that he sustained bruises inside his right palm from pulling hard on the float activation handle and received superficial cuts to his left knuckles from pushing down the FSOL. The FAA Forensic Sciences Laboratory performed toxicology testing on blood and urine specimens from the pilot. The results were negative for ethanol and all tested-for substances.[36]

The pilot reported no use of medications or significant medical concerns on his most recent FAA airman medical certificate application, and the aviation medical examiner identified no significant conditions during the associated physical examination of the pilot.

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[35] Before the flight departed, each passenger was provided and wore a PFD that consisted of an inflatable vest stowed in a pouch on a waist belt.

[36] The FAA Forensic Sciences Laboratory has the capability to test for more than 1,300 substances including toxins, common prescription and over-the-counter medications, and illicit drugs (FAA 2019a).

1.7.2 Passengers

Autopsies were performed on each of the five passengers by the State of New York, Office of the Chief Medical Examiner. The cause of death for each passenger was listed as “drowning.” Each passenger also sustained abrasions and contusions.

Toxicology testing was performed on specimens from the passengers at the request of the medical examiner. The results indicated the presence of ethanol in blood samples for the front passenger (0.18 gm/dl) and the rear-left inboard passenger (0.03 gm/dl).

1.8 Survival Aspects

1.8.1 Emergency Egress Sequence

As described in section 1.1.2, after the helicopter touched down, it immediately rolled to the right, and the right roll continued such that the helicopter was completely inverted and submerged in about 11 seconds. According to the pilot, he was still wearing his installed, FAA-approved restraint when he reached down to try to open the locking carabiner on the tether of the front passenger, but, as he turned the locking sleeve, the helicopter was “listing past a 45° roll.” The pilot said he was fully under water by the time he released his own restraint (which he described as easy to remove) to evacuate. Once free, he used two hands to grab the door frame and pull himself out. He said the helicopter was rolling on top of him, and, when he tried to swim to the surface, he did not go up as fast as he thought he would. He was wearing multiple layers of winter clothing, which became heavy when wet.

The ceiling-mounted camera in the helicopter captured video and audio information of emergency egress-related events in the cabin; only three passengers (the front passenger and the rear-left inboard and outboard passengers) were within the camera’s FOV. The recorded events included the following (rounded to the nearest second):

- 5 seconds before touchdown (1907:11): The pilot told the passengers, “prepare yourself for exiting the helicopter.”
- From 0 to 5 seconds after touchdown (1907:15 to 20):
    - A float was visible and appeared cylindrical in shape with wrinkles on its surface.
    - All three passengers who were in the camera’s FOV were conscious and without any obvious signs of blunt force trauma.
    - Water entered the cabin at the left door and flooded the floor.
    - The rear-left inboard passenger asked, “how do I cut this…?”
    - The pilot stated, “everybody” (spoken in an excited tone.)
- From 5 to 9 seconds after touchdown (1907:20 to 24).
    - Sounds similar to rotor blades striking water occurred.

  - The helicopter was pitched forward and slightly to the right in the water.
  - The front passenger began using both hands to manipulate the shoulder straps of his harness/tether system. He continued this action and was still performing it at the time the camera's lens became obscured.
  - The rear-left inboard passenger brought his left arm across his body toward the area of his right chest toward the cutting tool pouch on his harness, then looked down toward his right chest.
  - The rear-left outboard passenger looked downward toward her chest.
- From 9 to 11 seconds after touchdown (1907:24 to 26):
  - The rear-left inboard passenger pivoted his body toward the hard point where his tether was secured.
  - The helicopter had rolled significantly to the right such that primarily sky was visible out the left open doorway.
  - The rear-left inboard passenger grabbed the outboard edge of the front left seat and made an upward motion toward the left open door of the helicopter (the right roll of which had placed the door above him). The cord for his headset (which had come off during the landing but was secured to the back of his harness) became taut.
  - The rear-left outboard passenger was seated with her installed, FAA-approved restraint fastened. Her headset was moved forward on her head and rotated forward over part of her eyes.
  - The lens of the ceiling-mounted camera became completely submerged.
- From 0 to 64 seconds after camera submersion (1907:26 to 1908:30): sounds attributed to occupant movement occurred.

1.8.2 Emergency Response

According to NYPD records, NYPD Aviation Unit resources were notified of the accident by LGA personnel about 1908 and responded about 1910 with two units. Divers deployed from an NYPD helicopter and entered the water about 1925.

According to two other NYPD divers who arrived by boat about 1935 to 1940, an NYPD helicopter was already on scene, an FDNY boat was nearby, and the inverted and submerged helicopter was tethered to the tugboat (the crew of which had retrieved the pilot). They saw that FDNY had deployed two tethered rescue swimmers wearing cold-water immersion suits. The two NYPD divers subsequently entered the water; one said the underwater visibility was about 1 ft, and both said they found the passengers strapped in the cabin. They used knives to cut various straps when extricating the passengers.

1.9 Tests and Research

1.9.1 Video Study (Shore Witness Sources)

To estimate the accident helicopter's touchdown location, ground track, ground speed, and descent rate, the NTSB performed a study using two videos (captured by smartphones) provided by ground witnesses. The study used video image frames from each camera that showed the helicopter about the time of touchdown to estimate the touchdown location. Analysis of the helicopter's ground track, ground speed, and descent rate required the use of a mathematical model of camera optics for which the input parameters (camera location, orientation angles, and FOV) were estimated for select video frames using land reference points for calibration.

The study estimated that the helicopter's ground speed was about 22 kts (+/- 2 kts) during the final 63 ft of its ground track (estimated to be oriented 186°), and its descent rate was about 780 feet per minute (fpm) (+/- 80 fpm). The estimated magnitude of the velocity vector at the time of landing was 23 kts (+/- 2.5 kts).

1.9.2 Aircraft Performance Study

The NTSB used the results of the video study, airport surveillance radar (from John F. Kennedy International Airport), information from the onboard video, and weather information from LGA to perform an aircraft performance study of the helicopter's autorotation.

According to the RFM, the helicopter's glide distance in autorotation is 0.54 nm per 1,000 ft of altitude at an indicated airspeed of 65 kts and a rotor speed of 410 rpm. The study determined that, during its descent from 1,900 ft, the accident helicopter traveled more than 1 nm (including the distance between the final radar point and the touchdown location).

1.9.3 Emergency Flotation System

1.9.3.1 Activation Handle Pull-Force Tests

Investigators performed a series of test activations of the accident helicopter's emergency flotation system to obtain information about the tactile (and other) characteristics associated with float deployment. To facilitate the testing, a digital force gauge was applied to the accident helicopter's activation handle, and the reservoir assemblies were equipped with exemplar valves.[37] For each test (unless otherwise specified), an investigator braced the cyclic control (to prevent its movement) with one hand and pulled the activation handle with the other hand (by pulling the attached force gauge).

During one test, an investigator pulled the activation handle aft until a "pop" sound was heard. (The investigator stopped pulling as soon as the "pop" occurred.) The left valve had activated, and the right valve had not. The force gauge indicated a peak load of 45.1 lbs, and the

[37] The accident helicopter's valves were tested separately (with the pull force applied at the valve clevis), and each activated within the force limits specified for valve movement (between 6 and 15 lbs). As described in section 1.3.2.1, the STC did not specify a pull-force limit for the float activation handle to fully inflate the floats.

activation handle had not been pulled fully aft. Examination of the junction box showed that, during the test, releasing the activation handle enabled the dual cable block to return to its resting position. The aft-upper cable (for the left reservoir assembly) displayed a larger gap between its jam nut and the cable block surface than the gap displayed by the aft-lower cable (for the right reservoir assembly) between its jam nut and the cable block.

Without resetting the pull-cable system, the investigator again pulled the activation handle aft. The force gauge indicated a peak load of 58.4 lbs before the investigator stopped pulling. No “pop” was heard, the right valve still had not activated, and the activation handle still had not been pulled fully aft. Without resetting the system, the investigator next used two hands to pull the activation handle aft (without using the force gauge) until a “pop” was heard. The right valve had activated.

1.9.3.2 Liberty and Other Operators’ Experience with Float Activation

Previous Inflation Tests at Liberty

During the investigation of this accident, Liberty provided several videos of inflation tests performed as part of the 36-month float inspections of its helicopters equipped with the Dart emergency flotation system.[38] In every video, a participant seated in the right seat braced the cyclic control with the left hand and pulled the activation handle with the right hand (see an example in figure 18).

Source: Liberty Helicopters

Figure 18. Screen capture from a Liberty-provided video of a test activation of the Dart emergency flotation system.

Note: The participant is shown bracing the cyclic control with the left hand and pulling the float activation handle with the right hand.

[38] The accident pilot participated in one such test and saw videos of others (see section 1.10.4.3).

One video was dated December 14, 2016, which was the same date that a test had been logged for the accident helicopter. When the participant pulled the activation handle, a muted "bang" followed by hissing sounds occurred. The inflation status (partial or full) of the floats was not shown.

Three videos (two with views from the cockpit and one with an external view) dated May 2, 2016, showed another test activation. In one cockpit video, when the participant pulled the activation handle, a "pop" followed by hissing sounds occurred, and the participant stopped pulling the handle. The participant then pulled the handle again, the handle rotated outboard relative to the cyclic grip, and the video ended. The second cockpit video showed a participant pulling the activation handle to what appeared to be farther aft than it was pulled in the first video, and a hissing sound occurred before the video ended. In the third video, which showed an exterior view of the floats, the floats partially inflated.

Two videos of an inflation test performed on March 1, 2017, showed multiple attempts to pull the activation handle (one of which was followed by a loud "bang" then a hissing sound) but did not show the inflation status of the floats.

Other Operators' Experiences

Investigators interviewed personnel from two other operators who had the same model of float system installed on their AS350-series helicopters.

The maintenance manager for an operator in Alaska said that his personnel generally experienced no difficulty in pulling the activation handle during the 36-month inflation tests and that the activation handle could be pulled with "two fingers." He recalled one instance of high pull forces on the activation handle and said it was due to a "bad cable" that likely had binding within it.

The director of maintenance for an operator in Canada said that, during a 36-month inflation test, a partial and asymmetric inflation occurred when only one of the two reservoirs activated. He said it was "common knowledge" among the pilots that the activation handle was difficult to pull and required taking the left hand off the collective and placing it on the cyclic control (to brace it). He provided videos of inflation tests performed on two different helicopters. In the video for one test, a "bang" was heard, and the floats partially inflated (with the right floats appearing less inflated than the left). About 19 seconds later, a second "bang" was heard, and the floats inflated more fully.[39] In the video for the other test, a "bang" was heard, and the floats partially inflated, with the right floats appearing less inflated than the left.

1.9.3.3 Postaccident Partial-Inflation Tests

Investigators performed a series of partial-inflation tests at Dart Aerospace facilities in Vista, California, using an exemplar emergency float system mounted as part of a test rig. Each of

[39] The left three floats appeared to inflate fully, and the forward end of the right-forward float appeared to inflate more (wrinkles on its surface smoothed out).

the tests described below used only one compressed gas (nitrogen) reservoir to accomplish partial inflation of the floats. Different crossover hose configurations were tested to observe the potential effect on symmetry during partial inflation of the left and right floats. Additional tests were performed to observe the buoyancy stability characteristics provided by partially inflated floats.

Crossover Hose Configurations

One test used a crossover hose installation consistent with the accident helicopter's equipment (that is, STC SR0047LA, as modified in accordance with Service Bulletin [SB] 99001). Discharging a single gas reservoir resulted in the left three floats becoming more inflated than the right three floats in a pattern that appeared visually similar to the condition of the accident helicopter's floats. Measuring the pressure within each chamber of each float confirmed that each left float chamber contained more gas (ranging from 0.061 to 1.195 psi) than any right float chamber (ranging from 0.020 to 0.055 psi). (As described in section 1.3.2.2, full inflation using both gas reservoirs should result in at least 1.75 psi in each float chamber.)

Another test used a modified (conceptual) crossover hose design that distributed the gas from a central point. Discharging a single gas reservoir resulted in partial inflation of all floats in a pattern that appeared visually symmetrical between the right and left sides. Measuring the pressure within each chamber of each float confirmed that the inflation levels between the left and right sides differed less than those of the other test configurations. (Left-side values ranged between 0.029 and 0.057 psi, and right-side values ranged between 0.038 and 0.062 psi.)

Buoyancy Stability

For the tests described below, the test rig weighed about 5,220 lbs (the maximum gross weight for the AS350 B2) and was suspended from a crane above a pool. Investigators used one gas reservoir to partially and symmetrically inflate the floats, then slowly lowered the rig into the pool to observe its buoyancy stability (see figure 19).

For one test, all floats were partially inflated with generally symmetrical levels between the left and right sides.[40] Once the rig was lowered into the pool, it floated for at least 26 seconds (but less than 1 minute) before it began a roll to the right; the roll was arrested by straps that suspended the test rig from a crane. A repeat test using the same test rig configuration but with less tension in the suspension straps resulted in the test rig rolling quickly to the right, with the right skid hitting the bottom of the pool.

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[40] Measuring the pressure within each chamber of each float showed that the left-side values ranged between 0.023 and 0.053 psi, and the right-side values ranged between 0.018 and 0.065 psi.

For another test, air from a shop compressor was added to increase the partial inflation pressure in each float chamber to about 1 psi (the designed minimum operating pressure of the floats). Once the test rig was lowered into the pool, it floated with no evidence of listing after several minutes. None of the six floats became completely submerged.

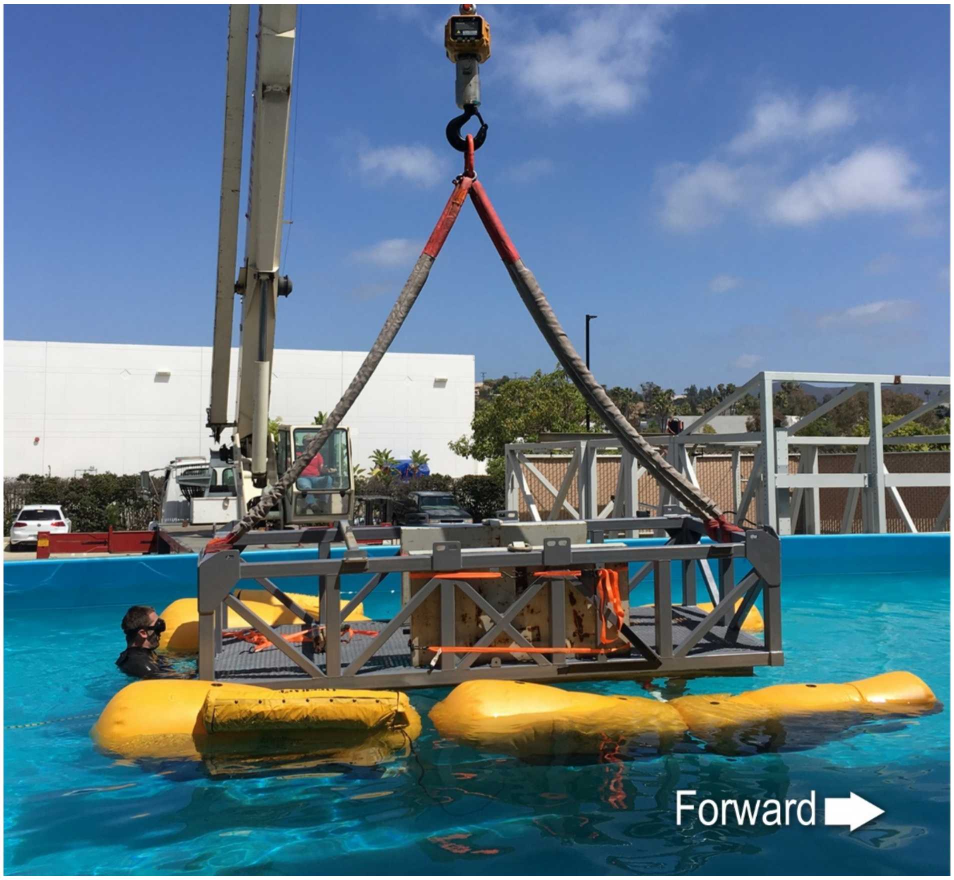

Figure 19. A test rig with partially, symmetrically inflated floats is shown suspended by a crane and lowered into a pool.

1.10 Organizational and Management Information

1.10.1 General

At the time of the accident, Liberty was a Part 135 air carrier authorized by the FAA to conduct rotorcraft on-demand passenger and cargo flights in both day and night VFR conditions.[41] Liberty's FAA Operations Specification (OpSpec) D085 listed one AS355 F1 and seven AS350 B2 helicopters. Liberty also held an air tour letter of authorization (LOA) (as specified in 14 *CFR* 91.147) to operate nonstop commercial air tours (sightseeing flights) under Part 91 per the

[41] Liberty was founded in 1986 (by the director of operations at the time of the accident) and became a subsidiary of Sightseeing Tours of America, a company founded in 1996 (by the CEO at the time of the accident and another individual).

14 *CFR* 119.1(e)(2) exception.[42] According to Liberty's flight operations manual (FOM), all of Liberty's commercial air tours were conducted in accordance with 14 *CFR* Part 136, as well as OpSpec B057, which contained other limitations for Liberty's air tours, including a requirement to maintain a 1,000-ft horizontal radius from the Statue of Liberty National Park Boundary and Ellis Island.[43] (See appendix B for more information about the regulations that can apply to commercial air tour flights.)

A company organizational chart included in the FOM showed the president (a position that was vacant) as the head of the company with the chief operating officer (COO) reporting to the president. The director of operations (DO), director of maintenance, and director of safety (a position that became vacant about 6 months before the accident) reported to the COO.[44] Liberty also had a director of training and a safety officer, positions that were not listed on the organizational chart. (See section 1.10.3 for more information about Liberty's safety program.) Per the FOM, pilots reported to the chief pilot, who reported to the DO. The DO said that, at the time of the accident, Liberty employed seven pilots.

Liberty's website listed NYONair's CEO, who was the son of Liberty's DO, as Liberty's director of marketing.[45] Liberty's COO said NYONair's CEO left Liberty at the beginning of 2018 but maintained a consulting arrangement with Liberty's CEO for developing new business opportunities for Liberty, perhaps in markets outside of New York City (NYC). Liberty's DO was also the DO of East West Helicopter, LLC (East West), a Part 135 certificate acquired by NYONair in January 2017.[46] Liberty's director of training and its chief pilot were contract instructors and check airmen on the East West certificate.

Liberty operated its sightseeing flights from the Downtown Manhattan/Wall Street Heliport (JRB), New York, New York, and its charter flights and FlyNYON flights from 65NJ, which was a private heliport shared by Liberty and NYONair. Liberty's COO said that, in 2017, about 75% of Liberty's revenue was generated from its sightseeing flights operating out of JRB. According to Liberty's CEO, Liberty's financial condition was hurt by citywide measures to reduce helicopter sightseeing tours in NYC by 50% by January 2017; the chief pilot described the

[42] The air tour LOA required that the operator provide to the FAA its name and any other names under which it was doing business; its business address, mailing address, and principal place of business; the names of persons responsible for managing the business and for aircraft maintenance; the aircraft type, make, model, and registration number(s); and an antidrug and alcohol misuse prevention program registration.

[43] Part 136 specifies, in part, additional requirements for commercial air tour operations that address such areas as passenger briefing items, PFDs, helicopter emergency flotation systems, helicopter performance plans and operations, and operations over or near national parks and tribal lands.

[44] The former director of safety had been a line pilot while also serving as the director of safety from 2013 to September 2017. He left Liberty to accept a job located closer to his home.

[45] Liberty's DO said his son (NYONair's CEO) had just transitioned from Liberty's charter marketing department to a lesser role as consultant because NYONair was a flourishing business that was taking up his son's time. NYONair's CEO said he did not hold a position at Liberty and had not been Liberty's director of marketing since 2012.

[46] (a) East West was based in Harrison, Ohio, and its certificate was overseen by inspectors in the FAA flight standards district office in Cincinnati, Ohio. Liberty's DO said he did not consider it a challenge occupying the position of DO at two separate Part 135 operators because he had been doing it for a long time, and safety was a priority at both companies. (b) NYONair's CEO said that, at the time of the accident, about 30% of NYONair's flights were operated under Part 135.

reduction as a "devastating blow."[47] The CEO said the company tried to offset resulting financial losses by increasing its number of charter flights, but the company had to lay off about 1/3 of its workforce. The COO said he had no doubts about the company's survival but said the reduction in sightseeing tours forced the company to look for ways to save money.

According to Liberty's CEO and COO, NYONair's CEO approached them in 2017 about having Liberty provide helicopters and pilots for FlyNYON flights. Liberty's CEO agreed, and, by September 2017, Liberty was operating FlyNYON doors-off flights out of 65NJ.[48] According to Liberty's DO, the FlyNYON flights were not subject to the citywide reduction in sightseeing flights because they were "aerial photography" flights, and they were not operated out of JRB. He said they could fly aerial photography flights anywhere.

Liberty's COO said NYONair was just another charter customer, and the FlyNYON flights had a thin profit margin that added only about 5% to 15% to Liberty's bottom line. Liberty's DO said the growth of the FlyNYON flights had been "explosive," and that, at the time of the accident, Liberty was operating about 10 to 20 FlyNYON flights per day. Liberty's chief pilot said NYONair was Liberty's biggest customer.

According to NYONair's CEO, about 80% of the 11,000 to 12,000 customers who flew on FlyNYON flights in the year before the accident did so NYC.[49] At the time of the accident, most of the FlyNYON passengers in NYC were carried on flights operated by Liberty out of 65NJ.

1.10.2 Operation of FlyNYON Doors-Off Flights

1.10.2.1 Agreement with NYONair

NYONair (which was formed as "New York on Air" in 2012) had been operating FlyNYON flights under Part 91 since November 2014.[50] NYONair's CEO said that the initial focus of FlyNYON was promoting doors-off aerial photography flights on social media sites to build a following of potential customers. NYONair operated two Airbus AS 355 helicopters to cover its FlyNYON flights initially, but, in 2016 due to an increase in demand, NYONair contracted with another operator to provide an additional helicopter and pilot. By July 2017, a continued increase in demand for FlyNYON flights prompted NYONair's CEO to approach

[47] The agreement between the New York City Economic Development Corporation and the Helicopter Tourism and Jobs Council sought to eliminate about 30,000 flights per year by January 2017. The agreement included the prohibition of Sunday tour flight operations from JRB, beginning on April 1, 2016; other reduction measures were scheduled to take effect in June and October 2016. For more information, see https://www.nycedc.com/press-release/nycedc-and-helicopter-tourism-jobs-council-announce-new-measures-reduce-helicopter (accessed March 12, 2019).

[48] According to the chief pilot, Liberty had operated very few doors-off flights before 2017, and those flights were news-gathering or movie production flights in which the passengers wore only the installed, FAA-approved restraints.

[49] NYONair also had operations bases in Las Vegas, Nevada; Miami, Florida; and Los Angeles, California.

[50] New York on Air was formed by NYONair's CEO and involved primarily production photography and filming, including work for the Screen Actors Guild.

Liberty. NYONair's CEO said Liberty was chosen because its fleet and pilot training were similar to NYONair's, and it was located in the same hangar (and, thus, would not incur helicopter ferry costs).

On November 1, 2017, Liberty's COO signed what he described as a business contract with NYONair's chief financial officer for Liberty to provide helicopters (and pilots). A review of the contract showed it was a "charter customer agreement" between the two companies that specified the two companies were independent contractors and listed the hourly "charter rates" that NYONair would pay Liberty for all "Part 135 flights."

Liberty's FOM specified that a member of management or a designee must authorize the initiation of any flight under Part 91 or Part 135. The FOM also specified that Liberty maintained operational control and safety responsibility for Part 135 flights it operated under agreement or contract with another entity. The FOM stated that "Liberty's responsibility for operational control supersedes any contractor agreement" and that "no direction from sources outside Liberty is allowed to influence or direct the operation in any manner."[51] Liberty's DO said Liberty had operational control of the accident flight (and the other FlyNYON flights it operated).

Liberty's operation of FlyNYON flights involved daily coordination with NYONair customer experience (CX) personnel and regular communications with NYONair pilots and managers. FlyNYON passengers (including the accident flight passengers) checked in for their flights at the NYON Terminal, a 10,000 sq ft operational, office, and retail space that NYONair opened in October 2017 in Kearny, New Jersey (near 65NJ). The NYON Terminal was staffed primarily by NYONair employees, including CX personnel.

The NYON Terminal also contained an operations center used for monitoring weather and active flights. At the time of the accident, one Liberty-employed flight follower worked in the operations center.[52] The NYONair flight operations manager said FlyNYON flights were scheduled by taking passenger information from the FlyNYON booking source and assigning passengers to a specific flight (specific pilot/helicopter). For Liberty-operated FlyNYON flights, NYONair coordinated with Liberty for pilot and helicopter availability. Liberty was responsible for assigning its pilots and helicopters to support the schedule. A Liberty scheduler said he would involve NYONair's CEO in the decision to cancel a FlyNYON flight.

1.10.2.2 Use of the Aerial Photography Exception

According to Liberty and NYONair personnel, the FlyNYON flights met the exception criteria in 14 *CFR* 119.1(e)(4) for "[a]erial work operations, including…(iii) [a]erial photography or survey" flights. The regulatory exception enables aerial work/aerial photography flights to be

[51] Per 14 *CFR* 1.1, operational control refers to exercising the authority over initiating, conducting, or terminating a flight. Liberty maintained documentation that described (as required by the FAA for a certificated operator) its system for exercising operational control, both in its OpSpecs and FOM.

[52] Liberty flight followers assisted Liberty pilots with analyzing weather, assigned aircraft and pilots to flights (including Liberty-operated FlyNYON flights), and communicated with Liberty pilots and maintenance personnel. Liberty used satellite tracking equipment, automatic dependent surveillance-broadcast, and direct radio communications to follow its flights.

operated without an operator certificate (required for Part 135 and Part 121 operations) and under Part 91 with no additional requirements (such as an air tour LOA, which is required for air tours operated under the 14 *CFR* 119.1[e][2] exception). (See appendix B for more information about these regulations.)

According to Liberty's safety officer, the aerial photography flights were much more variable than an air tour flight, and there were places they could see on an aerial photography flight that they would be unable to see during a regular tour. He said the air tours in NYC involved prescribed routes, altitudes, and turns that were coordinated with ATC.

NYONair's marketing materials for FlyNYON doors-off flights did not include the words "air tour" or "sightseeing," and passengers were asked which landmarks they wanted the pilot to fly past for their photographs. According to NYONair's *CX Training Manual*, CX personnel were to avoid using the words "tour," "route," and "sightseeing" and instead use "custom," "photo flight," and "photography." The manual also described (in bold, red font) "buzz words to look out for—if people are asking too many questions." These buzz words included "tour, owners, management, certificates" and "FAA—anyone with a badge."

1.10.3 Safety Program

Liberty's CEO said the company's "chain of command," including the COO, DO chief pilot, and director of safety, was responsible for safety. He incorrectly identified Liberty's director of training as the director of safety (a position that was vacant).[53] The COO said the DO and the director of maintenance were responsible for managing safety. The DO said the company did not have a formal safety program or use a flight risk assessment tool, but assessments were made by himself and the chief pilot. He said he and the chief pilot provided safety leadership for the pilots, and the chief pilot said safety was one of his responsibilities.

Regarding the operation of FlyNYON doors-off flights and the use of the NYONair-provided harness/tether system, Liberty's DO said Liberty did not perform a formal risk assessment but instead used an informal process of reviewing the operation through meetings and conversations (see section 1.10.6 for more information).

Liberty had a safety officer (a position that was not on the organizational chart) who assumed the safety officer duties (in addition to his line pilot duties) after the previous safety officer left the company about 6 weeks before the accident.[54] The safety officer said that the position was a holdover from when Liberty participated in the Tour Operators Program of Safety

[53] The COO said Liberty's former director of safety used to provide him with quarterly safety meeting summaries to review. The former director of safety said that, while serving in that role, he had reported to the COO, organized quarterly safety meetings for pilots and heliport personnel, received hazard reports, and updated the company's safety manual. The COO said he expected the company to fill the director of safety position within 3 months of the former director's departure. When asked why that timeframe was exceeded, he said he was not aware of the extended delay.

[54] Liberty's former safety officer (who had been a line pilot who also served as safety officer from 2014 to January 2018) said he left Liberty because he disagreed with the company's decision to operate FlyNYON flights. He also stated that he thought the authority of Liberty's chief pilot was being undermined by NYONair's CEO.

(TOPS), which Liberty left in 2017.[55] Liberty's DO said that, when Liberty was a member of TOPS, Liberty personnel had to attend all the TOPS meetings and undergo audits. Liberty's COO said he decided to cease the company's participation in TOPS as a cost-saving measure until Liberty could develop a new business plan for its downtown sightseeing tours.

Liberty's safety officer said that there was no formal description of his safety officer duties and that he had no training for his role other than the former safety officer having discussed with him the things he should be looking into and what the few responsibilities were as related to the PFDs. He said that, even though the position was informal, he could help the pilots get things addressed by being a second set of eyes on procedures and looking for ways for Liberty to improve their operations. He said Liberty had a hazard reporting system but it was not being used.

Liberty had a *Safety Manual* that (according to the manual) served as a "guide for all company personnel in complying with the corporate policy for safety management and mishap prevention." It was not part of Liberty's FAA-approved or -accepted manuals.

Liberty's former director of safety said that he had been responsible for revising the *Safety Manual* and holding quarterly safety meetings. The manual specified that minutes from the quarterly safety meetings were to be reported to the COO within 3 days. Liberty's safety officer said he had not yet convened a quarterly safety meeting.

The manual did not describe duties for a "director of safety" position but described a position called the "company safety officer," who reported to the COO and was vested with the authority to prohibit the use of unsafe equipment and suspend unsafe operations. This person was responsible for maintaining the *Safety Manual*, developing the safety program, evaluating program results, and guiding its implementation through activities that included specifying requirements for internal safety reporting. The specified duties included preparing progress reports of safety activities, safety reports, and safety studies; assisting in providing safety evaluations of new equipment and procedures; and arranging for safety reviews by outside experts, when appropriate.

Per the *Safety Manual*, the COO was responsible for implementing and establishing support for the safety program and for "integrat[ing] safety systems into all areas of operations" through activities that included, in part, the following:

- Delegating specific aviation safety assurance and safety responsibilities, authority, and accountability to the [safety officer] and applicable first-line supervisors.

[55] According to its website, TOPS is an independent, nonprofit organization incorporated in 1996 that promotes collaboration among helicopter air tour operators on the development of voluntary safety standards that exceed regulatory requirements. While a member of TOPS, Liberty was subject to semi-annual audits to verify compliance with TOPS standards. These standards included the requirement to have a safety management program that included top management commitment to safety, a trained safety manager reporting to top management, and procedures (including safety reporting) for identifying hazards. A 2016 TOPS audit of Liberty's safety program determined that it was in compliance with these standards. At that time, Liberty had a safety program, a safety manual, a director of safety who convened quarterly safety meetings and reported to top management, and a safety officer who assisted and reported to him.

- Promptly implementing approved recommendations resulting from incident reports, investigations, and other safety improvement projects.

The manual specified that the DO was responsible for the following, in part:

- Supervising, coordinating, and directing flight operations without compromising safety under any circumstance.

- Using measurement and control tools, such as reports and inspections, to enhance safety performance.

- Suspending any operation for safety reasons.

The COO said he did not participate in pilot safety meetings or communicate with the safety officer about operational matters. He said the safety culture at Liberty was such that, if there was any question or concern about the safety of doing something, it was not done.

Liberty's DO said any concerns that any pilots had would be discussed in an intelligent way, and the company would make adjustments, if needed. He said it was a small company, so pilots had the open ability to talk to leadership. The last issue he recalled occurred within the 2 months before the accident and involved the pilots developing a temperature threshold for cold-weather operations.

The chief pilot said Liberty had a "good safety culture." He said he was a big proponent of safety and believed that the pilots understood that. He said he believed that a good safety culture started at the top and worked its way down and that, for his pilots, he was the face of the company and drove the safety culture at Liberty.

Liberty's safety officer said that, when pilots expressed safety concerns to management, they were addressed. He said that nothing that had been brought to his attention required looking into further or required him to bring it to anyone else's attention, but he would escalate concerns up the chain of command, if needed. He said his biggest safety concerns were that a passenger on a FlyNYON doors-off flight could fall out of the helicopter or that a headset could blow off, break free, and hit the tail rotor.

1.10.4 Pilot Training and Procedures

Liberty's FAA-approved training program was outlined in its *Training Program Manual*. Initial new hire PIC training included both a ground and a flight curriculum. The ground curriculum included a basic introduction and segments that included emergency situation training, general ground operations, and aircraft systems, among other topics. The flight curriculum applicable to pilots of the AS350 B2 helicopter included initial and transition/difference segments. The manual also contained qualification segments, PIC line checks, instructor/check airmen, record-keeping, and tour training, among other topics. Procedures related to ground and flight operations were contained in Liberty's FOM and its *Training Program Manual*, which did not address the use of the NYONair-provided harness/tether system or other equipment specific to FlyNYON doors-off flight operations.

Liberty (and NYONair) pilots received training on ground and flight procedures for FlyNYON flights from a slide presentation, “FlyNYON New Pilot Onboarding,” created by the NYONair NYC lead pilot. The slide presentation referenced a review of the “NYON SOP” document (referred to as “the SOPs” in this report) that specified various procedures for FlyNYON doors-off flights, including preflight preparation of the helicopter, preflight safety briefings on the ramp, loading and securing the passengers, inflight instructions for passengers, and after-landing tasks. The NYONair NYC lead pilot stated that the training covered the entire process for handling FlyNYON doors-off flight passengers from the time they arrived to the time they exited the helicopter at the end of the flight and included hands-on training on the use of the harness/tether system. The training and SOPs were not part of Liberty’s (or NYONair’s) FAA-reviewed or -approved manuals.

According to Liberty’s chief pilot, before Liberty’s agreement with NYONair, NYONair had been using its own procedures for conducting FlyNYON flights, but Liberty wanted standardized procedures that both companies could use. As a result, soon after Liberty began operating FlyNYON flights, Liberty and NYONair personnel worked together to develop the SOPs. Liberty’s safety officer said all pilots (from Liberty and NYONair) and CX personnel who handled FlyNYON doors-off flights were trained on the SOPs. The most recent SOP revisions were completed in November 2017. According to minutes from a pilot safety meeting (attended by both Liberty and NYONair personnel, see section 1.10.6), the SOP document was continually updated as new best practices were discovered.

According to a Liberty loader who assisted with the accident flight, he received on-the-job training for his FlyNYON doors-off flight duties from a NYONair CX manager. He said that the training included a video on the harness/tether system and hands-on training on how to operate the system and double- and triple-check items. He also received instruction on removing (and reinstalling) the helicopter’s doors, helping passengers with their PFDs, and making sure that there were no loose items in the cabin. He stated that guidance for the loading procedures was provided in a manual and the SOPs.

1.10.4.1 Engine Failure and Autorotation

The AS350 B2 RFM contained procedures in Section 3.1, “Emergency Procedures,” for performing an autorotation landing after a loss of engine power. The procedures included, in part, the following:[56]

- Set low collective pitch.
- Monitor and control rotor rpm.
- Establish approximately 65 kts…airspeed.
- Move the [FFCL] to the shutdown position.

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[56] For the purposes of this report, quoted excerpts from manuals, checklists, and other sources may have minor editorial revisions (such as punctuation, capitalization, abbreviations, or spelling variations) applied for style consistency. The unrevised source documents are contained in the public docket for this accident.

- According to the cause of loss of the engine:
    - Relight the engine…
    - Otherwise:
        - Close the [FSOL]
        - Switch off:
            - The booster pumps
            - Generator
            - Alternator (if installed)
            - Electrical power master “ALL-OFF” switch…
- Maneuver to head the helicopter into the wind on final approach.
- At a height of 20-25 ft…and at constant attitude, gradually apply collective to reduce the sink rate.
- Resume level attitude before touchdown. …
- Gently reduce collective pitch after touchdown.

The “AS350 Emergency Maneuvers” section in Liberty’s *Training Program Manual* also specified, in part, that the pilot should maintain 65 kts as the optimum autorotative airspeed, attempt to relight the engine (and continue attempts if time and situation permit), and close the FSOL before landing if relighting the engine is not possible.

1.10.4.2 Ditching

Liberty’s FOM contained procedures to address an emergency water landing. The FOM specified that, after the helicopter is landed on water, all occupants should remove their installed, FAA-approved restraints, put on their PFDs, and “stay in the aircraft unless it is in danger of turning over ([PIC] should make this determination). If the aircraft is in danger of turning over, personnel should exit the aircraft and inflate their [PFDs].”

Liberty’s *Training Program Manual* included, in part, the following additional information:

- Touchdown speed must be below 10 kts.
- If aircraft is afloat, evacuate when emergency help arrives.
- If aircraft is sinking, release the seatbelts when the cabin is submerged. Evacuate the aircraft and then inflate the life vests.

According to Liberty’s director of training, the training program discussed ditching scenarios, and water was considered the appropriate landing zone in the event of an emergency.

He said training during new-hire and recurrent cycles included a slide presentation and a classroom discussion guide with specific talking points.

Liberty's DO said that, during an autorotation with passengers on board, he expected the pilot to give as much of a briefing as possible but noted that a loss of engine power at 1,000 ft agl meant that touchdown would occur in about 1 minute. He said Liberty pilots understood (from their training) how much time they had.

1.10.4.3 Deployment of Emergency Flotation System

The emergency procedures in the RFMS for the emergency float system stated, in part, that the maximum airspeed for float inflation was 75 kts, the "recommend[ed] maximum speed for water contact" was 10 kts or less, and the time for complete inflation was about 5 to 6 seconds.

The RFMS stated that pilots should inflate the floats by actuating the float activation handle on the cyclic control and specified that the shear pin on the activation handle required about 12 lbs of force to shear. The RFMS did not specify the maximum pull force required on the activation handle to fully deploy the floats or indicate that the design intended that the pilot could use the same hand operating the cyclic control to pull the activation handle without letting go of the cyclic grip.

Liberty's director of training said pilots received ground instruction and video training that included instruction on how to operate the activation handle. The training program's description of ditching for the AS350 included guidance that the maximum firing speed is 80 kts, and the touchdown speed must be below 10 kts. He said the training discussed the possibility of incomplete inflation of the floats and the possibility of a rollover once the helicopter was in the water. He said the floats were designed to keep the helicopter upright but, in rough water, it might tip over. He recalled no maintenance issues with the float system.

Liberty's chief pilot said company pilots were trained that, in the event of a loss of engine power, they should activate the floats as soon as practical and land the helicopter on the water. He said the director of training would show pilots the system and have them watch the activation of the floats when it was performed during maintenance inspections. Pilots who were present during the recurrent 36-month inspection of the float system were provided an opportunity to observe the deployment of the float system while one pilot operated the activation handle.

The accident pilot said he deployed the float system on the accident helicopter during maintenance in December 2016. He said the hand positioning to activate the floats was not ideal, but he had pulled the float activation handle, and the system functioned normally. He had seen videos of two other instances of the float system on Liberty AS350 B2 helicopters having been activated during ground maintenance. He said no malfunctions occurred in either instance, but, in one instance, the floats had "only partially deployed at first because the [activation] handle was only partially pulled." When the handle was then pulled the rest of the way, the floats fully deployed. He said that, as a result, Liberty "routinely enforced in its training the importance and necessity of pulling the float [activation] handle fully and to completion."

1.10.5 Operation of the Accident Flight

1.10.5.1 Preflight Passenger Safety Video and Harness Fitting

NYONair CX personnel assisted the accident flight passengers with preflight preparations, which included showing the passengers NYONair's 3-minute 22-second passenger safety video. The video addressed general safety topics (such as harness fitting, use of the headset to hear instructions from the pilot, and securing loose items) and emergency safety procedures (such as harness release, cutting tool use, egress, and location and use of the PFDs and fire extinguisher).

The video narrative for releasing from the harness/tether system in the event of an emergency stated that "the harness can be released by opening the quick release clip in the back of the harness"; the visual that accompanied this narrative showed one person releasing another person's carabiner.[57]

The video also instructed passengers that "a cutter [cutting tool] is also secured to one of your chest straps and will allow you to quickly cut through the harness if you are unable to reach the quick release clip." The visual that accompanied this narrative showed a tether made of a different webbing than the tethers provided to the accident passengers. It showed a person (seated alone in the back of a helicopter) grasping the tether with one hand and applying the cutting tool with the other, successfully cutting through the tether with one pull of the tool (see figure 20).[58]

Figure 20. Screen capture from the safety video shown to the passengers before the accident flight showing a person using a cutting tool on a type of tether.

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[57] It showed a person on the ground releasing the locking carabiner from the dorsal D-ring of the harness of another person seated in the helicopter.

[58] The tether was also attached to an anchor point between the rear bench seats and had enough slack to enable the person to extend the tether outward from the body.

According to the video, passengers were to exit the helicopter only in an emergency and when instructed by the pilot. The video showed PFDs stowed inside the helicopter and instructed passengers to unfasten their installed, FAA-approved restraints before retrieving, opening, and putting on the PFDs.

According to NYONair's *CX Training Manual*, after showing passengers the safety video, the CX representative was to ask the passengers if they had any questions. One CX representative (of two who were present for the briefing provided to the accident flight passengers) said none of the passengers had any questions or concerns. She said one passenger from the accident flight (the passenger who was later seated in the rear-left outboard seat) spoke very little English, so she translated safety information into Spanish for that passenger.

According to the SOPs, harness fit (for the yellow harnesses) could be adjusted tighter for smaller passengers by adding a locking carabiner between the shoulder blades (across the two rear shoulder straps, either above or below the dorsal D-ring) and/or across the torso above the navel. (For the rear-left outboard passenger on the accident flight, a locking carabiner was used between the upper-rear shoulder straps.)

The SOPs specified that smartphone holders and cameras were to be secured to the harnesses using carabiners, lanyards, parachute cords, and/or key rings. Zip ties were to be used as a redundant means of securing items.

For the accident flight, once the passengers were harnessed and their loose items secured, CX personnel transported them by van from the NYON Terminal to 65NJ and assisted with the passengers at the helicopter. Liberty also used a Liberty-employed loader to assist with loading its FlyNYON passengers.

1.10.5.2 Passenger Loading and Safety Briefing

The SOPs for FlyNYON doors-off flights specified various passenger loading tasks to be performed by the pilot and the CX representative. The SOPs specified guidelines for verifying that all clothing, shoes, and personal items (like smartphones and cameras) were secure. The SOPs specified that both the pilot and the CX representative were to check each passenger's harness to ensure it was not sagging or falling off the passenger's shoulders. For the accident flight, a loader employed by Liberty performed some of the tasks specified for CX personnel.

The SOPs specified that the NYONair CX representative was to secure the passengers' installed, FAA-approved restraints with the shoulder harnesses routed under the arms and provide a basic safety briefing to include, in part, instructions on the following (paraphrased):[59]

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[59] According to interviews with multiple personnel (including the accident pilot), routing the shoulder harnesses under the arms enabled passengers to more easily rotate outboard to take photographs. The Liberty loader who assisted with the accident flight said the routing avoided uncomfortable contact between the shoulder harness and the passenger's neck and was safer because the shoulder harness could be secured tighter.

- Outboard seat passengers are not to remove their installed, FAA-approved restraints.

- Rear inboard seat passengers can, when instructed by the pilot, remove their installed, FAA-approved restraints, secure the restraints behind them, and move to the floor.

- After landing, passengers should not attempt to "unhook" themselves but wait for assistance from the pilot and CX representative.

According to the SOPs, the pilot was to brief the passengers on items that included, in part, the following (paraphrased):

- Instructions for rear inboard seat passengers about when they can remove their installed, FAA-approved restraints to move to the floor and about refastening their restraints before landing.

- Instructions for the outboard seat passengers to "twist" in the seat, never remove their installed, FAA-approved restraint, and pay attention for inadvertent release of the restraints.

The accident pilot said that, when the passengers arrived at the helicopter for the accident flight, he checked the tightness of their harnesses and put their PFDs on them. He said he explained how to use the cutting tool and told them it was to be used to cut the tether, not the harness.

The pilot said that, as part of his preflight briefing before the accident flight, he explained to the passengers that, in the event of an emergency, he would tell them to get back up into their seats (if seated on the floor). He said he also performed a communications check through the headsets. The CX representative who had assisted the passengers at the terminal said she repeated the pilot's briefing in Spanish for the Spanish-speaking passenger.

The onboard video recorder captured part of the pilot's preflight briefing provided after the passengers were seated in the helicopter. The pilot told the outboard passengers to keep their installed, FAA-approved restraints fastened for the entire flight. He told the rear inboard passengers he would let them know when they could move from their seats to the floor, and he told the outboard passengers they could also put their feet out. He advised them the wind would be strong and reminded them that, after landing, they should not remove any gear themselves but wait for assistance.

The accident pilot said there was nothing unusual about the passengers. He said they were attentive and compliant during his safety briefing, and they paid attention to the safety information they had received.

1.10.5.3 Securing and Routing the Tethers

According to the SOPs, the pilot was to secure the tethers for the passengers. The Liberty loader who assisted with the accident flight said that only he or the pilot could secure the tethers.

The SOPs specified that the tether for the front passenger must be secured to an airframe anchor (not the seat) but did not prescribe specific routing for any tethers or address securing any excess tether length (tether tail). NYONair's *CX Training Manual* specified that CX personnel were to work with a teammate to tether-in the passengers and confirm with each passenger that they are "locked in." The manual also did not prescribe specific routing for tethers or address securing tether tails. According to Liberty's safety officer, routing the tethers for the rear outboard passengers to anchor points on the opposite side of the cabin (as was done for the accident flight) kept those passengers inside the helicopter better than attaching the tethers to the closest anchor point.

The accident pilot and the Liberty loader who assisted with the flight both said that they tethered the accident flight passengers to the helicopter. The pilot said he seated the passengers and adjusted the passengers' tether length by moving the locking carabiner up (or down) the tether loops, as needed.[60] The pilot said the front passenger was the last to be tethered.

The Liberty loader said the tether for the front passenger was routed under the armrest to keep it away from the controls. He said he secured the last loop of the tether tail through the top carabiner (which would shorten the tail). He said the locking carabiners were spun tight to secure and lock, and they required force to loosen.

1.10.5.4 Denying Boarding for Potentially Intoxicated Customers

According to 14 *CFR* 91.17(b), no pilot may transport "a person who appears to be intoxicated or who demonstrates by manner or physical indications that the individual is under the influence of drugs" (unless during an emergency or medical patient transport). Liberty's FOM specified that "no passenger that appears intoxicated will be allowed entry into the helicopter." Liberty did not provide any training or guidance to its pilots for assessing passengers for potential intoxication.

During preflight preparations at the terminal (where NYONair CX personnel worked), a witness (from a different FlyNYON flight) who observed the front passenger said he had a "very pronounced whiff of alcohol on his breath." Based on his observations of staff interaction with the passenger, the witness believed that the staff were aware of the alcohol odor. The witness said that the front passenger did not seem inebriated but had a very exuberant personality.

The SOPs stated that, when greeting the passengers, the pilot should "get a feel for the passengers" to determine if they are "excited, nervous, or scared." The SOPs did not contain any information for assessing passengers for potential intoxication.

According to NYONair's CEO, any customer that arrived intoxicated at the terminal would be dismissed from the facility. NYONair's director of business operations said that CX personnel could refuse to allow an obviously inebriated customer to fly or bring it to his attention, if needed, and he would handle the situation delicately. He said that, in the event that a compliant but

[60] The pilot said that, before adjusting the passengers' tether lengths, he had the passengers seated in the outboard seats sit facing outboard and the passengers from the rear inboard seats sit on the floor facing outboard.

intoxicated customer was not completely functional but wanted to fly, the CX representative would notify the pilot about such a customer and the pilot would have final say on the ramp. He said NYONair did not provide training to its personnel on how to handle potentially intoxicated customers.

1.10.6 Communications with NYONair Regarding Safety

NYONair's CEO said NYONair did not have a formal safety structure but he had informally designated NYONair's NYC lead pilot and its chief pilot (who joined the company in January 2016 and June 2017, respectively) as the company's safety officers. NYONair's NYC lead pilot said she was not aware of any formal safety program at NYONair, and NYONair did not have a safety officer. She said that she and the chief pilot were responsible for managing safety.

NYONair's CEO said that, about the time his company began working with Liberty to operate FlyNYON flights, he started regular pilot meetings (attended by both NYONair and Liberty personnel, including Liberty's safety officer) as a means to facilitate communications and address any problems that might arise. He said he ran the first few meetings then tasked NYONair's NYC lead pilot to run them. NYONair's NYC lead pilot said she was responsible for interfacing with the Liberty and NYONair pilots and holding the pilot meetings by phone every other week.[61] She said the meetings discussed matters involving operations, safety, training, and customer experience, and she compiled and distributed minutes from each meeting (via e-mail) to all participants, NYONair's CEO, and NYONair's chief pilot. She also updated the CEO and chief pilot with any follow-up actions.

Minutes from 17 of the meetings that were held between August 9, 2017, and March 7, 2018, were provided to investigators. These minutes referenced a range of topics, including, in part, the following:

- Passenger use of installed, FAA-approved restraints
- Reporting of safety issues
- Operational control
- Tethering of passengers and their belongings
- Passenger harness use and harness inventory
- Passenger safety briefings
- SOPs and related training

[61] NYONair's NYC lead pilot said that, at first, all Liberty and NYONair pilots and various other personnel were invited to attend, and up to 25 or 30 people participated in the meetings.

When asked if any safety issues were identified in these meetings, NYONair's CEO said he would not call them issues, but there would be recommendations and an array of opinions. He said he was not directly involved in follow-up actions because NYONair's NYC lead pilot and chief pilot were in better positions to address them. He said if they wanted something and it improved the safety of the passengers, his stance was to spend the money and get it.

Liberty's safety officer said that the pilot safety meetings were initially used as a forum to try to voice any concerns and that the minutes would include agreed-upon conclusions about solving problems. Liberty's director of training said that, when he or Liberty's safety officer identified a safety issue that they thought they could improve, NYONair personnel would say they would work on the suggestions but, in terms of taking action, it was a "stalemate." Liberty's safety officer said that, when Liberty pilots expressed safety concerns to NYONair, they were "shut down." Liberty's director of training said that, after a January 11 pilot meeting in which Liberty pilots had raised various concerns, NYONair's CEO plainly smited the Liberty pilots (see section 1.10.6.1); according to Liberty's safety officer, Liberty pilots were told they were no longer allowed to participate in the meetings.

According to NYONair's NYC lead pilot, NYONair's CEO asked her to limit the meeting participants (which took effect after January 21, 2018) because he believed the meetings had become an open forum and were being run inefficiently.[62] Liberty's director of training said it was his impression that NYONair felt there was too much complaining and too much talking on the calls. Liberty's safety officer said that NYONair's NYC lead pilot subsequently asked him to rejoin the meetings because it was decided that pilots should be represented.

Liberty's safety officer was unaware if Liberty's DO or other managers pushed back on the decision to exclude the other Liberty pilots from the meetings. According to Liberty's safety officer, after the other Liberty pilots were excluded from the meetings, the focus shifted more toward discussing what was going on with FlyNYON. About a week before the accident, Liberty's safety officer was barred from participating in the meetings after a personal conflict with NYONair's CEO. (He was also barred from flying FlyNYON flights; see section 1.10.6.4.).

1.10.6.1 Pilot Concerns about Harness/Tether Systems

NYONair provided the harness/tether system equipment Liberty (and NYONair) used on its FlyNYON doors-off flights, and, according to NYONair's director of business operations, NYONair's CEO and chief of staff made the purchasing decisions related to harnesses.

NYONair's CX manager said that, at the time of the accident, NYONair had about 30 to 40 of the yellow fall-protection harnesses (like those used on the accident flight). NYONair also had available for use five Air Rescue Systems (ARS) harnesses (of 15 that it owned), which were

[62] According to a January 21, 2018, e-mail, NYONair's NYC lead pilot stated that future meeting participation would be limited to herself, NYONair's chief pilot, Liberty's safety officer, and one representative from each of the following: NYONair management, NYONair operations/flight-following, NYONair CX, and each of NYONair's four operating locations (NYC; Miami, Florida; Las Vegas, Nevada; and Los Angeles, California).

manufactured in accordance with TSO-C167.[63] The ARS harnesses (referred to as the "blue" harnesses by Liberty and NYONair personnel due to their color) had attachment points on the passenger's chest, upper back, and lower back.

Liberty and NYONair pilots said the blue harnesses fit smaller passengers better than the yellow ones. Liberty's safety officer said the blue harnesses were superior for egress because passengers could reach a carabiner attached at the lower back attachment point; however, not all passengers chose to use the lower attachment point. (He said he let passengers choose whichever attachment point was most comfortable.)

Liberty's director of training said that Liberty pilots preferred to use the blue harnesses (over the yellow ones) because of the better fit for smaller passengers and the lower attachment point option. He said Liberty experienced delays of several months receiving the new harnesses from NYONair.

Meeting minutes dated October 1, 2017, stated that new, FAA-approved passenger harnesses (blue harnesses) had been purchased. Minutes dated November 5, 2017, referenced that NYONair would order 20 more blue harnesses and start phasing out the old-style (yellow) harnesses.[64] Minutes dated November 26, 2017, stated that NYONair had received "a batch of new harnesses" and would be updating the passenger safety video to reflect their use.

According to meeting minutes dated January 11, 2018, the use of the blue harnesses should take priority over the use of the yellow fall-protection harnesses such that, if the blue harnesses were not being used (for example, if some were available but the passengers arrived at the helicopter wearing yellow harnesses instead), the pilots could ask about the blue harnesses. The minutes also stated that the use of the blue harnesses should be encouraged for smaller passengers (such as those weighing less than 120 lbs).

Liberty's director of training said that, after the January 11, 2018, pilot meeting, NYONair's NYC lead pilot checked on the status of NYONair's blue harness order.[65] He said NYONair's NYC lead pilot subsequently told the Liberty pilots that NYONair had decided to cancel the order for more blue harnesses because the yellow harnesses were legal and good enough,

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[63] (a) NYONair's CX manager said that 10 of NYONair's ARS (blue) harnesses were waiting to be equipped with cutting tools before the company would make them available for use. (b) TSO-C167, "Personnel Carrying Device Systems (PCDS), also known as Human Harnesses," applied to human harnesses that were required for personnel transported in human external cargo operations under Part 133; such harnesses were intended for long-term, work-related activities in which the user was required to wear the harness for an extended period of time. TSO-C167 specified, in part, that the human harness "shall be capable of snug adjustment by the occupant by a means easily within reach of that person and easily operable" and that "[a]ny adjusting release hardware…must release when a force of not more than…30 lbs is applied to a pull or lift release mechanism. Release mechanisms requiring a twisting or torsional motion must release with a force equal to…30 lbs applied" (FAA 2004, A1-4). According to the TSO, the minimum performance standards for human harnesses were based, in part, on the Society of Automotive Engineers Aerospace Standard 8043, revision A, "Restraint Systems for Civil Aircraft," issued in March 2000.

[64] Correspondence from ARS to NYONair dated October 30, 2017, provided a cost estimate for 50 harnesses. Invoices from ARS showed that NYONair ordered two harnesses on October 30, 2017; three harnesses on November 6, 2017; and 10 harnesses on January 25, 2018.

[65] According to Liberty's director of training, NYONair's CEO had said he had spent $30,000 for the new harnesses.

and there was no need to do anything extra. NYONair's director of business operations said he did not think the order had been canceled.

In a January 17, 2018, e-mail to the participants of the January 11 meeting, NYONair's CEO stated the following:

> Pilots: 1. Let me be clear, this isn't a safety issue with the harnesses, the pilot may not query about the harness. If they have an issue as with all issues that aren't safety-related, they can take it to their chief pilot, who can address it with me.

The accident pilot e-mailed a response that asked, "Just to be clear, as pilots, we shouldn't ask about the blue harnesses, or we can't ask about the blue harnesses?"

NYONair's CEO replied to the accident pilot on January 18, 2018, stating, in part, the following:

> [T]he FAA requirement for doors-off flights is passengers to only wear their seat belts. [Other] doors-off operators…only require seat belts for their passengers. NYON believes in going above and beyond as we continue to scale. …The blue harnesses are FAA-approved, but that isn't a requirement for a doors-off flight. The yellow harnesses are just as legal/safe as the blue. Let me know if you need further understanding.
>
> NYONair's NYC lead pilot replied, in part, the following:
>
> The logic for using the blue harnesses first is that they are FAA-approved, far superior to the yellow harnesses in terms of comfort and fit, and NYON invested in them so why not?
>
> NYONair's CX manager responded, in part, the following:
>
> I don't agree with delaying [passengers] on the ramp at sunset just because CX didn't bring out the blue harnesses. … Rules can't be made on the ramp. … Rules can be proposed in the pilots' meeting but must be approved by [the NYONair CEO].
>
> Liberty's safety officer replied, in part, the following:
>
> A rule wasn't made on the ramp, a judgement/safety call was. The flight…was delayed because the yellow harness couldn't be adjusted any further, and it was falling off of [the passenger's] body.

NYONair's CX manager said he agreed with NYONair's CEO because he (the CX manager) did not see a safety concern, there was no regulation on the harnesses, and he trusted the NYONair CEO's judgment. The CX manager said the yellow harnesses worked fine.

Liberty's director of training said that he was disappointed by the NYONair CEO's response to Liberty pilots' concerns about the yellow harnesses and that responses left him with the impression that "the man [had] spoken." Liberty's director of training said the NYONair CEO's response was status quo and a reinforcement of the attitude and safety culture at NYONair, which Liberty's director of training said were negative.

Liberty's chief pilot said he made sure Liberty's DO was aware of the e-mail from NYONair's CEO telling Liberty pilots not to ask about the blue harnesses, but he did not know if the DO took any action. Liberty's chief pilot said that he explained to his pilots that NYONair's CEO could not dictate whether they could ask questions and that, as PICs, they could question anything. Liberty's safety officer said Liberty's management supported the pilots' authority to have a passenger fitted with a blue harness instead of a yellow one, but NYONair's CEO did not want them to delay flights based on the harness.

Liberty's DO said concerns were raised related to passengers' ability to egress in an emergency, but the general discussion focused on ensuring that passengers would not fall out of the helicopter and questioning whether the egress method was sufficient. When asked how they evaluated or decided that the egress method was adequate, Liberty's DO said they discussed some changes about harnessing but he was not sure if those changes were ever put in place. He said the discussion occurred during the 6 months before the accident. Liberty's COO said he had not personally inspected the NYONair-provided equipment used on Liberty's FlyNYON flights and was unaware of any concerns with it.

1.10.6.2 Pilot Concerns about Effectiveness of Cutting Tools

The accident pilot said that, during Liberty's initial involvement with FlyNYON flights, he was concerned about whether the cutting tools could cut the tethers. He said the concern was also expressed by pilots "talking amongst themselves" and that the personnel who worked to develop the SOPs were "trying to get a better option." He said he believed an SOP had been developed to address it. Liberty's chief pilot said pilots had asked how tethered passengers could get out if a helicopter goes into the water. He said the answer was that the passengers have knives to cut themselves out, but they should not need them because the helicopter is equipped with floats. He said he had never had a conversation about what to do if the helicopter rolls over because the floats were not working; he said that, in that case, occupants would get the knife and cut themselves out.

Liberty's director of training said that, during a joint training exercise in November 2017, Liberty and NYONair pilots and other personnel had the opportunity to cut the tethers with the cutting tools. He said various participants took between 3 and 10 seconds to cut through the tether, which they held in front of them while the other end was tied to a stationary object. He said the most successful technique involved making an elliptical pattern with the cutting tool and working it back and forth a few times.

Liberty's safety officer said that he felt he could cut through the tether in about 5 seconds but was concerned about how a typical passenger could cut it, particularly if they were not taking it seriously or had never used the cutting tool before. In a February 8, 2018, e-mail, Liberty's safety officer told Liberty's chief pilot that he was researching new cutting tools and tethers.

The NYONair NYC lead pilot said that she was surprised about the pilots' concerns with the existing cutting tools and tether and that, as soon as the Liberty safety officer brought it to her attention, she added the issue to the agenda for a pilot meeting. She said that, when she tried cutting the tether (using the same type of tether and cutting tool as on the accident flight), she found it difficult, and it took her more than 30 seconds to cut through it.

Pilot meeting minutes dated February 21, 2018, noted that the Liberty safety officer was "researching and procuring" new cutting tools and tethers that "we will be testing shortly." The proposed equipment was discussed again at a pilot meeting on March 7, 2018, that was attended by NYONair's CEO. The minutes from that meeting said, "we are going forward with a bulk inventory purchase which includes the new style tether and [cutting tools] which are much easier to use."[66] NYONair's NYC lead pilot said the reception to the proposal had been enthusiastic and management was accepting of the change. The NYONair chief of staff said that NYONair had decided to purchase the new equipment but had not ordered it before the accident occurred.

1.10.6.3 Potential for Interference with Floor-Mounted Controls

The accident pilot said he was aware that passengers or loose items in the cabin could interfere with the helicopter's floor-mounted controls. He said that he had moved tethers and other items away from the controls before and that FlyNYON flight passengers can get close to the controls when they move onto the cabin floor. The accident pilot described the force that would be required to pull the FSOL up and aft (to close the fuel shutoff valve) as "not difficult." He said closing the valve even a little would starve the engine of fuel.

Another Liberty pilot said he could think of two or three times he had to pull a tether away from the floor-mounted controls, as well as other instances in which items or passengers had gotten near the controls during other types of operations. According to Liberty's director of training, it was general knowledge among pilots of this type of helicopter to watch for things that could interfere with the floor-mounted controls and that it was an issue with any operation, not just FlyNYON flights. He said that this control vulnerability was covered in pilot training and that he emphasized it during new-hire training. The accident pilot said he was unsure if anybody had ever relayed any concerns to management about the potential for a passenger or unsecured object to interfere with the floor-mounted controls.

NYONair's chief pilot said the potential for a conflict between the tethers and the floor-mounted controls in Liberty's helicopters was known. (NYONair did not operate any helicopter with floor-mounted controls [other than the collective control] for its FlyNYON flights.) NYONair's CEO said, in his experience as a pilot with tours since the 1970s, there was always a concern about putting a guard over exposed floor-mounted controls.

[66] Liberty's safety officer said that he and Liberty's chief pilot bought different tethers, knives, and cutting tools in an attempt to find a foolproof system. He said, about 1 month before the accident, they found a thinner tether and a new cutting tool that cut the thinner tether easily.

The SOPs for FlyNYON doors-off flights contained no passenger briefing items or procedures that specifically addressed preventing passenger interference with the helicopter's floor-mounted controls.

1.10.6.4 Discussions about Other Operational Topics

Inadvertent Release of Installed, FAA-Approved Restraints

Pilot meeting minutes dated September 6, 2017, indicated that NYONair was exploring solutions for keeping installed, FAA-approved restraints from falling outside the helicopter if they are "inadvertently unbuckled." The topic appeared again in the November 5, 2017, minutes, which reminded pilots to remain vigilant about the security of passengers' installed, FAA-approved restraints and stated, "winter clothing can be cumbersome, and it's easy to bump the seatbelt off." Minutes from a November 12, 2017, meeting said that Liberty's director of training was researching other restraint types that cannot be easily bumped off in flight.

Cold-Weather Operations

The October 1, 2017, minutes indicated discussion of a cold-weather operations policy. The minutes stated, in part, that flights could be operated with the doors open for the entire flight if the temperature was above 45°F and that sliding doors could be used for colder temperatures. Minutes dated November 12 and 19, 2017, reported other strategies that were being planned to facilitate cold-weather operations, including gloves, heated clothing, and increased breaks for pilots.

January 2018 text messages between NYONair's director of business operations, NYONair's CEO, Liberty's director of training, and Liberty's chief pilot discussed that a Liberty pilot declined to operate a flight that, according to a text from Liberty's director of training, would have been operated in a temperature of 30°F. NYONair's CEO responded with text messages that berated Liberty for hurting his brand.

Liberty's safety officer said that NYONair's CEO "threw a fit" over the cancellation and pressured the pilots to not turn down flights due to cold weather, which included telling the pilots that Liberty needed the money. Liberty's safety officer and Liberty's director of training said that Liberty's DO stood by the pilot's decision to cancel the flight.

Removal of Liberty's Safety Officer from Flying FlyNYON Flights

A March 7, 2018, pilot meeting resulted in conflict between NYONair's CEO and Liberty's safety officer when he disagreed with a statement by the CEO. Liberty's safety officer said that, after the disagreement, NYONair's CEO included him on a text to Liberty's chief pilot stating that his (the safety officer's) services were no longer required for FlyNYON flights. Liberty's safety officer said that Liberty operations personnel were informed that he would be flying only tours and charters rather than FlyNYON flights. He said that there was no indication that Liberty's DO either approved of or intervened in this decision and that he supposed it was made solely by NYONair. According to interviews with the Liberty safety officer, NYONair's CEO, and others, the removal was due to a personal conflict, not a safety issue.

1.10.7 FAA Oversight

Oversight for Liberty's Part 135 operating certificate was provided by a principal operations inspector (POI), a principal maintenance inspector (PMI), and a principal avionics inspector (PAI) from the FAA Flight Standards District Office (FSDO) in Teterboro, New Jersey. Guidance for FAA inspectors concerning their oversight of Part 135 (and other certificated) operators is contained in Order 8900.1, *Flight Standards Information Management System*, including provisions for assessing hazards and ensuring operator's mitigation of risks. Volume 6, chapter 2, section 18 (change 450) stated, in part, the following:

> Certificate holders continually seek a critical balance between markets, resources, and operations in order to remain viable. … During transition periods, the certificate holders may knowingly or unknowingly accept, or even generate, an undesirable level of safety risk. These transition periods place additional responsibility on Flight Standards Service…personnel. Principal inspectors…must anticipate potential hazards and evaluate the likelihood and severity of risks, to ensure that the operator is appropriately managing these risks consistently with the changing conditions.

Liberty's POI said that Liberty's chief pilot had informed him in fall or early winter 2017 that Liberty planned to begin operating FlyNYON flights. He said he had never before heard of FlyNYON or seen any FlyNYON flight operations and that he did not know when Liberty began operating the flights.

Liberty's PMI and PAI said that they had been unaware that Liberty was operating FlyNYON flights until October 31, 2017. On that day, as part of their oversight of Liberty's Part 135 certificate, they were performing a scheduled routine surveillance visit at Liberty when they saw passengers wearing harnesses and walking to a Liberty helicopter.

Liberty's PMI said that when he first saw Liberty's FlyNYON operation on October 31, 2017, he asked to see the harness/tether system, asked about load rating, and took photographs of the tether attach points on the helicopter. The PMI said the helicopter manuals contained information about the attach point limitations, but no manual addressed the use of the harness/tether system. He said that, in his opinion, "it seemed like a very unorthodox situation" and that he was concerned about the operation. He said he expressed his opinions to Liberty personnel, the POI, and FSDO management.

According to Liberty's DO, the FAA came in and looked at Liberty's FlyNYON operation, and he believed the PMI observed a loading and left with no comments. He said the POI did not observe the operation. The DO said that he (the DO) did not usually interact with the POI and that doing so was typically the function of the chief pilot.

1.10.7.1 Review of Aerial Photography Exception Used for FlyNYON Flights

According to the POI, after seeing Liberty's FlyNYON operation, the PMI and PAI conferred with him and the FSDO management. The POI said they reviewed the regulations, and all agreed that the flights were aerial photography flights that could be operated under Part 91 per the 14 *CFR* 119.1(e)(4) exception. The POI stated that they did not seek any counsel from FAA legal sources outside the FSDO when making this determination.

As part of this investigation, on March 21, 2018, the NTSB requested that the FAA provide a legal interpretation of the accident flight's operating requirements. In its April 30, 2018, response, the FAA stated that it would need more information to determine the rules that applied to the accident flight; however, the response included the following:

> The term "aerial work" is not defined in 14 CFR, and the FAA has construed it to reflect the common import of its language. Thus, it means work done from the air. These flights are restricted in that (i) they must depart and arrive at the same point, (ii) no property of another may be carried on the aircraft, and (iii) only essential persons to the operation may be carried onboard… Aerial work operations include: (i) crop dusting, seeding, spraying, and bird chasing; (ii) banner towing; (iii) aerial photography or survey; (iv) fire-fighting; (v) helicopter operations in construction or repair work (except for transportation to and from the site of operations); and (vi) powerline or pipeline patrol.
>
> Akin to the term "aerial work," the term "aerial photography" is not defined in FAA regulations. The FAA has opined that the term "connotes a condition where taking pictures or filming is done from the air."… The exception is meant for business-like, work-related operations such as newsgathering, aerial mapping, surveying, commercial photography, or commercial filming; not for personal, entertainment, or leisure purposes. If work-related aerial photography is the sole purpose of the flight, then the operator may operate under part 91…. This exception does not extend to operations in which the primary purpose is sightseeing.

The NTSB notes that historic FAA legal interpretations about aerial work and the aerial photography subset contain similar language.[67] On March 5, 2019, the NTSB requested an update from the FAA regarding the rules that applied to the accident flight. On April 11, 2019, the FAA stated that the FSDO determined that Liberty held an air tour LOA issued under 14 *CFR* 91.147 and operated the accident flight as a nonstop commercial air tour under Part 91 per the exception specified in 14 *CFR* 119.1(e)(2). The FAA provided no additional explanation of how it made this determination.

[67] FAA legal interpretations can be accessed from the FAA's legal interpretations web page at https://www.faa.gov/about/office_org/headquarters_offices/agc/practice_areas/regulations/Interpretations/. Several FAA historic legal interpretations state that "aerial work" operations carry on board only persons essential to the operation and that "aerial photography" operations include work-related aerial photography as the sole purpose and not operations for which the primary purpose is sightseeing. For more information, see Legal Interpretation to Samuel T. Ragland from Lorelei Peter, FAA Deputy Assistant Chief Counsel for Regulations (May 5, 2015); Legal Interpretation to Steven Saint Amour from Mark W. Bury, FAA Assistant Chief Counsel for International Law, Legislation, and Regulations (September 8, 2014); Legal Interpretation to Gregory Winton from Mark W. Bury, FAA Acting Assistant Chief Counsel for International Law, Legislation and Regulations (February 14, 2013); Legal Interpretation to Jeffrey Hill from Rebecca B. MacPherson, FAA Assistant Chief Counsel for Regulations (March 10, 2011); and Legal Interpretation to Pritchard H. White from Leland S. Edwards, Jr., FAA Attorney (May 11, 1995).

1.10.7.2 Guidance for Ramp Inspection of a Part 91 Operation

FAA guidance for conducting a ramp inspection of a Part 91 operation is contained in volume 6, chapter 1, section 4 of Order 8900.1, *Flight Standards Information Management System* (change 262), and its related job aid. The order specifies numerous inspection items (including documents and aircraft equipment, such as installed, FAA-approved restraints) for determining an operation's compliance with the applicable regulations.

The POI said that, because Liberty's FlyNYON flights were a Part 91 operation, he did not feel "compelled" to observe for himself the operation or the harness/tether system (and did not do so). He said the other inspectors had looked at the harness/tether system but that there was no rule, policy, or standard that inspectors could refer to during surveillance to determine whether the harness/tether system was safe or unsafe.

According to Liberty's PMI, after an in-depth discussion with the POI and FSDO management about Liberty's operation of the FlyNYON doors-off flights, they could not identify anything about the operation that was contrary to the applicable (Part 91) regulations. According to the POI, Liberty's inspectors and their manager determined that the only aspect of the operation for which they had surveillance authority related to the Part 91 passenger safety belt requirements for takeoff and landing (which included ensuring that passengers are briefed on how to fasten and unfasten the installed, FAA-approved restraints).[68] The POI said that he asked Liberty's chief pilot for assurance that Liberty would comply with that rule.

The POI said that, had Liberty's FlyNYON flights been conducted under Part 135, the picture would change quite dramatically as to how an inspector might surveil a task. He said that, for a harness used in a Part 135 operation, the operator's manuals would contain information that an inspector could refer to, such as an approval request process and authorization process. The POI also stated that the structure of the FAA safety assurance system places an inspector's primary focus on air carrier (Part 121) and Part 135 operations and the focus on Part 91 operations is nearly nonexistent as far as being a prioritized mandate to surveil or inspect.

1.11 Additional Information

1.11.1 Preaccident Standards and Guidance for Harnesses Used in Aircraft Applications

At the time of the accident, standards for additional occupant restraints (other than installed, FAA-approved restraints) used in US civil aircraft existed for equipment used by

[68] Title 14 *CFR* 91.107, "Use of safety [lap] belts, shoulder harnesses, and child restraint systems," stated, in part, that the pilot must ensure that each person on board the aircraft is briefed on how to fasten and unfasten his or her installed, FAA-approved restraint. It also stated that, before any aircraft movement on the surface, takeoff, and landing, the pilot must ensure that each person has been notified to fasten his or her installed restraint and is seated in an approved seat with his or her installed restraint properly secured.

personnel transported in human external cargo operations under Part 133. Such harnesses were required to comply with TSO C-167 (previously described in section 1.10.6.1).

Also, guidance and requirements for secondary harness systems used during doors-off or -open operations performed by the US Forest Service, National Park Service, US Fish and Wildlife Service, National Association of State Foresters, and US Fire Administration was contained in the *Interagency Helicopter Operations Guide*. The guide stated personnel who perform special activities and need to be in a location other than seated with a normal restraint system may require a secondary harness, which must be attached to an approved tether and helicopter anchor point.

Guidance provided in the US Department of the Interior and US Forest Interagency Aviation Life Support Equipment handbook suggested that crewmembers use a secondary restraint system (in addition to the installed, FAA-approved restraint) when performing certain duties when the aircraft doors are open or removed.

1.11.2 Previously Issued Safety Recommendation

As a result of preliminary information discovered during the investigation of this accident, on March 19, 2018, the NTSB issued Urgent Safety Recommendation A-18-12, which recommended that the FAA "prohibit all open-door commercial passenger-carrying aircraft flights that use passenger harness systems, unless the harness system allows passengers to rapidly release the harness with minimal difficulty and without having to cut or forcefully remove the harness" (NTSB 2018).

To mitigate the hazard associated with the use of any occupant restraint that prevents quick egress from an aircraft, on March 22, 2018, the FAA issued an emergency prohibition, effective immediately, to all operators of doors-off flights (to include flights with the doors open or removed) for compensation or hire.[69] FAA Order FAA-2018-0243, "'Doors-off' and 'Open-door' Flight Prohibition: Emergency Restriction Prohibition Order," prohibited the use of supplemental passenger restraint systems (SPRSs) that cannot be released quickly in an emergency. The emergency order defined SPRS (a term that was undefined before the order's issuance) as "any passenger restraint that is not installed on the aircraft pursuant to an FAA approval" (FAA 2018b, 12856).

The emergency order contained provisions for allowing the use of an SPRS if the FAA determined (by means of an application and demonstration process) the following:

> [The SPRS] can be quickly released by a passenger with minimal difficulty and without impeding egress from the aircraft in an emergency. … [The SPRS] must not require the use of a knife to cut the restraint, the use of any other additional tool, or the assistance of another person. [The SPRS] also must not require passenger

[69] The FAA had previously announced, on March 16, 2018 (via Twitter), its intent to prohibit doors-off operations that involve restraints that cannot be released quickly in an emergency.

training beyond what would be provided in a preflight briefing. [FAA 2018b, 12856]

The FAA also issued guidance for inspectors related to enforcing the emergency prohibition, with the most current guidance (as of the date of this report) contained in Order 8900.4, effective July 8, 2019.[70] The guidance specified that operators of doors-off flight operations for compensation or hire (excluding parachuting, public aircraft, and Part 133 external-load operations) must obtain an LOA to use an SPRS. It also stated that the FAA would consider the design, manufacture, installation, and operation of the SPRS when reviewing an application for an LOA. The guidance outlined the procedures that operators must follow when applying to obtain an LOA, which included submitting at least one video that shows an occupant demonstrating the method of release from the SPRS (FAA 2019b, 2-3).

As a result of the FAA's actions, the NTSB classified Urgent Safety Recommendation A-18-12 "Closed—Acceptable Action" on July 26, 2018.

On July 16, 2019, the Department of Transportation, Office of Inspector General (OIG), announced that it was initiating an audit to assess the FAA's processes for reviewing and approving SPRSs for doors-off helicopter operations and overseeing operators' use of SPRSs. The OIG stated that its audit activities would include working with personnel at the FAA (both at FAA headquarters and in offices that oversee helicopter operations), interviewing personnel at companies that use SPRSs, and coordinating with the NTSB, industry associations, and other helicopter tour industry stakeholders.

1.11.3 Other Postaccident Safety Actions

1.11.3.1 Dart Revisions to Operational, Installation, and Maintenance Procedures for Emergency Flotation System

Clarification of Operational Characteristics

On July 2, 2018, Dart released SB2018-03 to provide clarification, to be communicated to pilots within 1 month, on the activation method for its emergency flotation systems (STC SR00470LA and SR00645LA). The SB stated that the activation handle must be pulled fully aft to ensure that both reservoirs are discharged. It stated that, even after initial float inflation is observed, further travel of the activation handle may be required, especially if the floats on one side appear to be fluttering.

On October 12, 2018, the FAA approved Dart's revision to the RFMS (revision F for FMS-350[2]), which incorporated the clarification (as specified in the SB) that "full activation of

[70] The FAA first issued guidance on March 23, 2018, in Notice N 8900.456, which was superseded by Notice N 8900.457, effective April 10, 2018, through April 10, 2019. Notice N 8900.506, effective April 10, 2019, was superseded by Order 8900.4.

the floats will result in both sides appearing firm and fully rounded in less than 5 seconds. If one side appears to be fluttering, further travel of the handle may be required."

Revisions to Installation and Maintenance Instructions

In November 2018, Dart issued revisions to its installation and maintenance instructions (II350-600 and ICA350-21, respectively) to specify the use of a pull-cable test tool kit (newly developed by Dart and available for purchase) to enable maintenance personnel to verify the pull-cable routing and activation handle pull forces, for which a 30-lb limit was established.[71] The ICA revision specified that the test tool kit should be used to verify the pull-cable routing and activation handle pull forces during every 6-, 18-, and 36-month inspection and after any pull-cable replacement. Both documents also specified the gap between each pull cable's jam nut and the dual cable block should be 0 to 1/16 inch.

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In October 2019, Dart released SB2018-07, revision B (categorized as "mandatory" with a compliance deadline of March 31, 2020), for operators to verify that the pull cable installation results in the simultaneous activation of the valves for both reservoir assemblies and to use the pull cable test tool kit to ensure that pull force is below the 30-lb limit. The SB also recommended using the test tool kit for pilot training in deploying the floats.

1.11.3.2 FlyNYON Doors-Off Flight Equipment and Operational Changes

Authorization to Use FAA-Approved SPRS

After the accident, Liberty ceased to operate FlyNYON doors-off flights. NYONair suspended operations until April 8, 2018, when it resumed FlyNYON doors-off flights without the use of the harness/tether systems. Passengers wore only the installed, FAA-approved restraints, and a NYONair employee remained on board the helicopter to ensure that passengers kept their restraints fastened.

FlyNYON doors-off flights began using an FAA-approved SPRS after the then-DO of East West (not the same person who was the East West DO at the time of Liberty's accident) applied for and then received, on June 18, 2018, an LOA, which the FAA authorized him to use for "any doors-off flight operation for compensation or hire."[72] The approved SPRS equipment that the LOA authorized consisted of the ARS 338 Heli-Ops Harness, ARS Personal Retention Lanyard

[71] Specifically, Dart released revision K of II350-600 on November 12, 2018, and revision R of ICA350-21 on November 26, 2018 (followed by revision T on May 28, 2019).

[72] Specifically, the SPRS LOA stated that, "if issued to a pilot or operator, this [LOA] must be carried on the aircraft whenever the SPRS is used on any doors-off flight operation for compensation or hire. If issued to an individual, this [LOA] may be used by you, at the discretion of the pilot/operator, on any doors-off flight operation for compensation or hire."

with Quick Release Device, and ARS 16-in Primary Anchor.[73] According to the LOA, the FAA reviewed the application and determined that the SPRS met its criteria and could "be quickly released by a passenger with minimal difficulty and without impeding egress from the aircraft in an emergency."[74]

Changes in Standard Operating Procedures

On October 18, 2018, NYONair issued revised SOPs for FlyNYON doors-off flights that addressed the use of the SPRS. The revised procedures included a requirement that passengers verbally confirm and demonstrate (using a practice tether) that they can release from the SPRS when given an "egress" command. The revised SOPs also specified that nothing could be attached to the SPRS. NYONair also updated the preflight passenger safety video for FlyNYON doors-off flights to reflect the use of the SPRS.

The revised SOPs also stated that the shoulder harness of the installed, FAA-approved restraints should not be routed under the arm. The SOPs specified passenger safety briefing items for the pilot, which included information about water landing egress, among other topics.

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[73] The certification standards for each of these components were listed respectively as ISO 9001 "Advanced Helicopter Operations Equipment Certificate," NFPA [National Fire Protection Association] 1983, and ANSI [American National Standards Institute]/ASSE [the former American Society of Safety Engineers] 2359.12 (09)-1992 specifications for personnel restraints.

[74] At the time that the SPRS LOA was issued, FAA Notice N 8900.457 was in effect, which stated that the FAA "will consider the design, manufacture, installation, and operation of the SPRS when reviewing all applications for an LOA" (FAA 2018c, 2).

2. Analysis

2.1 Introduction

Liberty operated the accident flight per agreement with NYONair as a FlyNYON-branded, doors-off helicopter flight that allowed the five passengers (one in the front seat, four in the rear seats) to take photographs of various landmarks while extending their legs outside the helicopter during portions of the flight. For the accident flight (and other FlyNYON flights that Liberty operated), Liberty configured its Airbus AS350 B2 helicopter with the two right and the front left doors removed and the left sliding door locked open. Before departure, each passenger was fitted with a NYONair-provided harness/tether system that NYONair developed with the intent to prevent passengers from falling out of the helicopter. The harness/tether system used on the accident flight consisted of a full-body, workplace fall-protection harness that was secured (with a locking carabiner) to a tether, the other end of which was secured (with another locking carabiner) to an anchor point in the cabin.[75] Each passenger also wore the helicopter's installed, FAA-approved restraints. The pilot (who was seated in the front right seat) wore only an installed, FAA-approved restraint.

After the flight departed, it traveled past various scenic landmarks. Consistent with the SOPs used for FlyNYON flights, the passengers were allowed (when instructed by the pilot) to position themselves to extend their legs outside the helicopter. The two passengers who had been seated in the rear inboard seats removed their installed, FAA-approved restraints and sat on the cabin floor, wearing their harness/tether systems. The passengers seated in the outboard seats were allowed to rotate outboard in their seats. To enable such freedom of movement, the SOPs allowed the passengers to wear their installed, FAA-approved restraint with the lap belt adjusted loosely and the shoulder harness routed under the arm.

A review of radar data and onboard video showed that, when the flight was proceeding northwest over Manhattan toward Central Park at an altitude of 1,900 ft msl, the front passenger, who was facing outboard in his seat with his legs outside the helicopter, leaned back several times to take photographs using a smartphone. The onboard video showed that, each time he leaned back, the tail of the tether attached to the back of his harness hung down loosely near the helicopter's floor-mounted controls. At one point, when the front passenger resumed a more upright position, the tail of his tether appeared taut and was extended toward the floor-mounted controls.

Seventeen seconds later, he pulled himself up to adjust his seating position and the tail of his tether remained taut but appeared to pop upward. Two seconds later, the helicopter's engine sounds decreased, and the helicopter began to descend. As the pilot performed the emergency procedures to address the apparent loss of engine power (described further in the next section), he noticed that the FSOL was in the shutoff position and that it had been moved there by the tail of the front passenger's tether being caught on it. Thus, the NTSB concludes that the tail of the front

[75] The tether for the front passenger was secured to an anchor point aft of the helicopter's floor-mounted controls. The tethers for the rear passengers were secured to anchor points on the aft bench bar.

passenger's tether caught on the FSOL during the flight, which resulted in the inadvertent activation of the FSOL, interruption of fuel flow to the engine, and loss of engine power.

The following analysis evaluates the following:

- The pilot's performance, including his execution of the autorotation and the timeliness of his action to deploy the emergency flotation system (section 2.2);
- Survival aspects, including the rapid capsizing of the helicopter, the effect of the harness/tether system on the ability of each passenger to rapidly egress, and the NTSB's concerns about the adequacy of the SPRS review and approval process that the FAA implemented after the accident (section 2.3);
- The design, maintenance, and certification of the emergency flotation system, including the lack of buoyancy stability with partial inflation; the lack of pull-force limitation information available to operators to help recognize the presence of unacceptably high pull forces when activating the system, which contributed to the pilot's mistaken belief that he had taken the necessary action to fully inflate the floats; and considerations for the FAA's certification review process (section 2.4);
- Organizational and management issues, including deficiencies in Liberty's safety program; aspects of Liberty's relationship with NYONair by which Liberty allowed NYONair to influence the operational control and safety responsibilities of Liberty-operated FlyNYON flights; and deficiencies in the safety management at both companies that resulted in a lack of timely intervention to address foreseeable safety risks, including the potential for inadvertent passenger interference with the helicopter's floor-mounted controls, partial inflation of the emergency float system, and impediments to passenger egress during an emergency due to the use of the harness/tether system (section 2.5);
- FAA regulations and oversight, including Liberty and NYONair's use of the aerial work/aerial photography exception in 14 *CFR* 119.1(e) to operate FlyNYON flights under Part 91 with limited FAA oversight; the lack of increased FAA surveillance to address Liberty's change in operations when it began operating FlyNYON flights; and the lack of policy and guidance available to FAA inspectors to support a comprehensive inspection of Part 91 operations conducted under any of the exceptions in 14 *CFR* 119.1(e) to ensure that operators are appropriately managing any associated risks (section 2.6);
- Design considerations for the FSOL on Airbus AS350-series helicopters to include protection from external influences (section 2.7.1); and
- Guidance and procedures for Part 135 and Part 91 operators that conduct revenue passenger-carrying flights to assess and address passenger intoxication (section 2.7.2).

After completing a comprehensive review of the circumstances that led to this accident, the investigation established that the following factors did not contribute to the cause of the accident:

Pilot qualifications and medical conditions. The pilot held a commercial rotorcraft helicopter certificate and met the PIC qualifications specified by regulations and company requirements. A review of the pilot's work schedule and activities before the accident indicated no evidence of fatigue. Toxicological testing performed on specimens from the pilot revealed no evidence of ethanol or drugs. He reported having no chronic medical conditions or short-term illnesses and that he was not taking any medications at the time of the accident.

Helicopter mechanical condition. Damage observed on the helicopter's airframe, flight control systems, and engine was consistent with the impact and submersion that occurred when the helicopter landed on and capsized in the water.

Thus, the NTSB concludes that none of the following were factors in this accident: (1) the pilot's qualifications, which were in accordance with federal regulations and company requirements; (2) pilot fatigue or medical conditions; and (3) the airworthiness of the helicopter.

2.2 Pilot's Performance

About 65 seconds passed between the helicopter's loss of engine power and its ditching into the East River. According to the NTSB aircraft performance study, based on the helicopter's position and altitude about the time of the power loss, Central Park (to the northwest) and the East River (to the east) were within the helicopter's RFM-specified glide distance. The pilot said he chose to head toward the East River because of the number of people on the ground in Central Park. Per Liberty's training and procedures for pilots, the water was appropriate for emergency landings in a float-equipped helicopter.

The onboard video showed that the pilot initiated the autorotative descent about 2 seconds after the helicopter lost engine power. The pilot's initial attempts to relight the engine (per the emergency procedures in the RFM) were unsuccessful because, at the time, he was unaware that the FSOL was in the shutoff position. The RFM procedures specified that, if an engine relight was not possible, the pilot should close the FSOL (to cut off fuel flow to the engine) in preparation for the emergency landing; it was at this point in the procedures that the pilot discovered that the passenger's tether had caught on and moved the FSOL to the shutoff position. Although the pilot pushed the FSOL down to restore fuel flow to the engine and attempted again to relight the engine, he determined that, at that point in the descent, the helicopter was too low to allow engine power to be restored in time to prevent the emergency landing.

The NTSB aircraft performance study determined that the pilot pulled the float activation handle when the helicopter was about 100 ft agl, about 13 seconds before it touched down on the water. According to the RFMS, once the activation handle is pulled, the floats should fully inflate in about 5 to 6 seconds. The NTSB video study estimated that the helicopter touched down at a ground speed between 20 to 24 kts.

The NTSB notes that performing a maximum range autorotation (as described by the pilot) involves maintaining the rotor rpm in the lower portion of its normal range. The lower rotor rpm will reduce the amount of rotor energy available for the autorotative flare and landing. This is consistent with the pilot's description of the helicopter's flare and, in part, explains the slightly shallow flare attitude captured by the shore witnesses' videos of the landing. Although the RFMS for the emergency flotation system recommended a touchdown speed of 10 kts, there was no indication that the accident helicopter's higher velocity resulted in any damage to the floats that would have precluded them from fully inflating. Thus, the NTSB concludes that the pilot autorotated the helicopter successfully and pulled the emergency flotation system activation handle to deploy the floats at an appropriate time; however, the floats inflated partially and asymmetrically.

2.3 Survival Aspects

The pilot attempted to deploy the helicopter's emergency flotation system, but only the left gas reservoir assembly discharged, which resulted in the partial and asymmetric inflation of the floats (with the floats on the right containing less gas than the floats on the left). As a result, after the helicopter touched down upright on the water, it immediately began to list then roll to the right, which continued until it was completely inverted in about 11 seconds. (See section 2.4 for more information about the emergency flotation system.) Although the occupants observed in the onboard video were conscious and free from major traumatic injuries, the helicopter's rapid capsizing reduced the amount of time available for egress before the cabin became submerged. The pilot was able to release his installed, FAA-approved restraint after he was under water and successfully egress from the helicopter; however, none of the passengers were able to egress, and they all drowned.

A review of NTSB accident reports indicated that it is not uncommon for helicopters involved in ditchings to overturn in the water. In addition, research has shown that a capsized helicopter can disorient occupants and hamper egress (Muller et al. 1996). Therefore, in this type of scenario (or others requiring rapid egress, like those involving fire), it is imperative that occupants have a means to rapidly release their restraints to reduce egress time and improve their chance of survival.

Per the applicable rotorcraft airworthiness regulations, the helicopter's installed, FAA-approved restraints (for the pilot and passengers) were each equipped with a single-point release; postaccident examination of these restraints found no anomalies that would have precluded normal release. Two of the passengers (based on evidence from the onboard video) were likely not wearing their installed, FAA-approved restraints at the time that the helicopter touched down and, thus, were likely secured only by their harness/tether systems.[76]

2.3.1 Design and Use of Harness/Tether System

According to the NYONair preflight safety video that was shown to the accident passengers, in the event of an emergency, passengers had two methods by which they could free themselves from the harness/tether system: they could either open a "quick release clip" on the back of their harnesses or use a cutting tool stowed in a pouch on the harness to cut the tether. However, no quick release features existed on the accident passengers' harnesses (locking

[76] These two occupants had been seated on the floor during the flight.

carabiners were used instead), and the effectiveness of the cutting tools was a subject of concern among some Liberty and NYONair pilots.

On the accident flight, each passenger's tether was secured to the back of the harness (at the D-ring on the wearer's upper back between the shoulder blades) with a locking carabiner that required users to manually unscrew a sleeve to open it. According to the Liberty loader who assisted with the accident flight, the locking sleeves were screwed tightly and required force to unlock. The preflight safety video showed a person on the ground opening this carabiner (located at the back of the harness) for a person seated in the helicopter.

Locking carabiners were also used to secure the other end of the passengers' tethers to anchor points in the cabin. (The preflight safety video did not instruct passengers to access these locking carabiners, which were in locations that were difficult to access, particularly for the rear passengers.) Although the accident pilot said he reached for a locking carabiner for the front passenger's tether after the helicopter touched down, he was unable to unlock and open it before he (the pilot) became submerged. Thus, because of the type and location of locking carabiners used on the accident flight, it would have been extremely difficult for a passenger to reach, unlock, and open a carabiner rapidly in the event of an emergency.

The preflight safety video instructed passengers that they could use a cutting tool to free themselves; however, the narrative told passengers to cut the "harness" while the video showed a person cutting the tether, which differed from the type of tethers used on the accident flight. The pilot said he also briefed the passengers about using the cutting tools; however, neither Liberty nor NYONair provided any hands-on training for passengers to actually cut a tether. Further, Liberty and NYONair pilots were aware that the cutting tools were ineffective for quickly severing the tethers. However, even if effective cutting tools had been provided, the cross-routing of the tethers behind passengers in the rear seats would have made it unfeasible for these passengers to access their own tethers during an emergency.

The onboard video from the accident flight showed that at least one passenger who was restrained only by the harness/tether system when the helicopter landed attempted to egress before the cabin became submerged.[77] The passenger who had been seated in the rear-left inboard seat reached toward his cutting tool pouch (it was unclear if he removed the cutting tool); asked, "how do I cut this?"; and pivoted his body toward the location of his tether. However, he did not free himself from the harness or tether as the helicopter's roll angle increased. He then quickly moved toward the left open doorway but was unable to exit; further, his headset cord, which was secured to the back of his harness, became taut (and remained taut at the time that the onboard camera's view was obscured by submersion).

The circumstances of this accident show that minimally trained passengers would have great difficulty extricating themselves from the harness/tether system during an emergency requiring a rapid egress, such as an event involving capsizing in water or a postcrash fire. Thus, the NTSB concludes that Liberty's and NYONair's decision to use locking carabiners and

[77] The video evidence indicated that the two rear inboard passengers were restrained only by their harness/tether systems when the helicopter landed; however, the rear-right inboard passenger (who had left his seat earlier in the flight) never reentered the camera's FOV.

ineffective cutting tools as the primary means for passengers to rapidly release from the harness/tether system was inappropriate and unsafe.

The NTSB notes that all of the occupants experienced cold-water immersion after the cabin became submerged in water that was about 40°F. One known consequence in cold-water immersion is cold shock, an immediate cardiovascular response that can cause involuntary inhalation and drowning in some individuals (Tipton 1989, 581–8). It cannot be definitively known whether cold shock was related to the deaths of any of the passengers; however, the onboard camera's microphone detected the sounds of passenger movement for about 1 minute after the cabin submerged. This indicates that the lack of an adequate means for passengers to rapidly extricate themselves from the helicopter was a critical factor in the passengers' deaths. Thus, the NTSB concludes that the helicopter's landing was survivable; however, the NYONair-provided harness/tether system contributed to the passenger fatalities because it did not allow the passengers to quickly escape from the helicopter.

2.3.2 Concerns about the FAA Postaccident SPRS Approval Process

As described in section 1.11.2, 8 days after the accident, the NTSB issued Urgent Safety Recommendation A-18-12 to recommend that the FAA "prohibit all open-door commercial passenger-carrying aircraft flights that use passenger harness systems, unless the harness system allows passengers to rapidly release the harness with minimal difficulty and without having to cut or forcefully remove the harness." Effective March 22, 2018, the FAA issued Emergency Order FAA-2018-0243, which required operators to obtain an LOA for the use of any SPRS for these types of flights.

The LOA review process required applicants to demonstrate that the SPRS could be quickly released by a passenger with minimal difficulty (and without the use of any knife, tool, or assistance), would not impede egress from the aircraft in an emergency, and would not require passenger training beyond a preflight briefing. The FAA also provided guidance to its inspectors (Order 8900.4), stating that the FAA would consider the design, manufacture, installation, and operation of the SPRS when reviewing an application for an LOA. However, there is no indication that the guidance that the FAA provided to its inspectors addressed evaluating the specific need for an SPRS for a given operation or performing a comprehensive hazard analysis for the use of an SPRS in specific aircraft installations in the expected operational environment.

After the accident, NYONair revised the SOPs for its FlyNYON doors-off flights to require passengers to remain in their seats with their installed, FAA-approved restraints fastened properly (that is, with the lap belts adjusted snugly and the shoulder harnesses routed over the shoulders rather than under the arms). Additionally, NYONair added a crewmember to the cabin to ensure passengers did not inadvertently release their installed, FAA-approved restraints.

After June 2018, FlyNYON doors-off flight operations began using an SPRS authorized under an LOA that was issued to the DO of East West. According to the SPRS LOA, the FAA determined that the SPRS (which included a TSO-C167 compliant harness and a mechanism for a passenger to quickly release the tether) could be quickly released and would not impede egress from the helicopter in an emergency. The NTSB notes, however, that the FAA's SPRS approval process appears to have focused primarily on the SPRS release mechanism without consideration of the expected operational environment or whether the use of an SPRS is warranted; the SPRS LOA did not reference any specific aircraft installations or operator SOPs but rather authorized the holder to use the SPRS on "any doors off flight operation for compensation or hire."

The NTSB is concerned that, without assessing the specific need for and use of an SPRS, the addition of an SPRS may unnecessarily complicate the emergency egress of passengers. Further, without a comprehensive hazard analysis for the use of an SPRS in the operational environment, other factors that can impede a passenger's emergency egress may be present but go unidentified, such as potential entanglement with headset cords, other equipment, or the SPRS itself. Such an analysis should consider whether an SPRS is needed, as well as operators' intended procedures for SPRS use, such as routing of any tethers or the attachment of items, such as headset cords, to the SPRS.[78] Further, as the circumstances of this accident show, use of the harness/tether system in a helicopter equipped with floor-mounted controls presented a risk for control interference that should have been considered but was not; thus, SPRS approvals must be evaluated on an aircraft-specific basis.

The NTSB concludes that the FAA's approval process for SPRSs that was implemented after the accident is inadequate because it does not provide guidance to inspectors to evaluate any aircraft-specific installations or the potential for entanglement that passengers may encounter during emergency egress. Therefore, the NTSB recommends the FAA modify the SPRS approval process to (1) require LOA applicants to specify a need for and the intended use of an SPRS for each aircraft; (2) require the FAA to evaluate and review, for each specified aircraft, the need for the SPRS on that aircraft for all intended uses; all SPRS design, manufacture, installation, and operational considerations, including, at a minimum, the potential for passengers to become entangled during emergency egress; the adequacy of passenger emergency egress briefings; and the potential for the SPRS to interfere with aircraft controls; and (3) ensure that each LOA lists the specific aircraft on which the holder is authorized to use an SPRS.

The NTSB is also concerned that existing FAA-approved SPRS installations that have not been comprehensively evaluated can result in emergency egress complications, leaving passengers vulnerable to being restrained within the helicopter in the event that an emergency egress is necessary. Therefore, the NTSB further recommends that, until the FAA implements the SPRS approval process as recommended in Safety Recommendation A-19-24, the FAA prohibit the use of SPRS for passenger-carrying doors-off operations.

2.4 Emergency Flotation System

As described in section 2.3, the floats for the accident helicopter's emergency flotation system did not fully inflate. Postaccident examination of the pull-cable system from the activation handle to the gas reservoir assemblies found that, inside the junction box, the aft-upper cable (for the left reservoir assembly) showed a gap of about 0.25 inch between its jam nut and the cable

[78] In a September 2017 safety alert, the NTSB noted that the plugs on communications cords (such as headset cords) might not readily release if pulled in a direction that is not aligned with the jack. Although the safety alert specifically addressed flight helmet cords, headset cords have similar plugs (NTSB 2017a).

block surface. This gap is evidence of the cable having moved in response to the pilot's operation of the activation handle, which resulted in the discharge of the left reservoir assembly. The aft-lower cable (for the right reservoir assembly) showed no gap between its jam nut and the cable block, and the right reservoir assembly had not been discharged.

2.4.1 Lack of Buoyancy Stability with Partial Inflation

Although the accident helicopter's emergency flotation system was equipped with a crossover hose that was intended to prevent asymmetric inflation between the right and left floats in the event that only one reservoir assembly discharged, inflation tests conducted on the system by discharging only one gas reservoir resulted in asymmetric distribution of the gas between the floats on the two sides in every test. Buoyancy stability tests performed using a test rig demonstrated that, even when the gas from a single gas reservoir was symmetrically distributed between the right and left floats, the test rig could not remain upright in the water. Thus, the NTSB concludes that, although the crossover hose in the accident helicopter's emergency flotation system design did not perform its intended function to alleviate asymmetric inflation of the floats during a single-reservoir discharge event, buoyancy stability testing showed that even symmetric distribution of the gas from only one reservoir would not enable the helicopter to remain upright in water.

The NTSB notes that, although a redesign of the crossover hose may allow for more even distribution of gas between the left and right floats in the event that only one reservoir discharges, the redesign may not be beneficial unless other elements in the system, such as reservoir capacity, are changed to ensure a single-reservoir discharge allows for the helicopter to remain upright in the water. Thus, changes to the installation, maintenance, and inspection procedures (as described in section 1.11.3.1) that ensure that a pilot can pull the activation handle fully aft without difficulty to discharge both reservoirs would obviate the need for a redesign of the crossover hose.

2.4.2 High Pull Forces on Float Activation Handle

2.4.2.1 Lack of Pull-Force Information for Operators

According to information from Dart and the FAA, the design of the activation system intended that a pilot would pull the activation handle using the same hand that operated the cyclic control without letting go of the cyclic grip (similar to how a bicycle brake lever is operated without letting go of the handlebar), and the intended pull-force limitation for the activation handle was 30 lbs. However, neither the RFMS nor any of Dart's installation, maintenance, or inspection instructions described this intended, single-handed activation technique or contained any information about activation handle pull-force limitations.

Videos of inflation tests Liberty conducted during maintenance on the accident helicopter (and at least one other helicopter equipped with the same type of system) demonstrated that the valve for each reservoir assembly could activate at different points during the activation handle's aft travel when pulled. The videos also showed that the technique used by each person who deployed the floats involved using the left hand to brace the cyclic grip while pulling the activation handle with the right hand.

During a postaccident activation handle pull-force test performed on the accident helicopter's emergency flotation system, the cyclic control was braced, and a force of about 45 lbs on the activation handle was required before the left reservoir assembly activated. Subsequent tests found that a force exceeding 58 lbs was needed to pull the activation handle fully aft to activate the right reservoir assembly.

Postaccident examination of the helicopter found that the junction box for the float activation cables was installed aft of the specified location, which resulted in a tighter bend in the aft-lower cable in its routing toward the right reservoir assembly.[79] This bending increased resistance to the aft-lower cable's movement within its sheathing. Because the activation handle cable pulls both the aft-upper and aft-lower cables simultaneously via the dual cable block, the aft-lower cable's increased resistance to movement resulted in the need for increased forces to pull the activation handle aft.

Although the high pull forces on the accident helicopter resulted from the nonstandard location of the junction box, the NTSB notes that a variety of anomalies can result in high activation handle pull forces, including the introduction of undesirable bends in the activation cables during new system installation (regardless of junction box location) or the development of corrosion or damage over time. However, in the absence of information from Dart to define pull-force limitations or describe its intended single-handed activation technique, operators may not recognize that abnormally high pull forces may be indicative of a system anomaly. Thus, the NTSB concludes that, in the absence of information from Dart specifying pull-force limitations for the emergency flotation system's activation handle, Liberty and other operators lack a means to inspect for and correct high pull forces that may result from an installation anomaly or other issues.

2.4.2.2 Pilot's Perception of Float Activation Status

The accident pilot (who had participated in a test inflation of the emergency flotation system during maintenance on the accident helicopter and had seen videos of others) said that he and other Liberty pilots were aware that each reservoir assembly could discharge at different points during the activation handle's aft travel and were trained on the importance of pulling the activation handle fully aft to fully inflate the floats. He said that, during the accident flight, he braced the cyclic with his left hand and pulled the activation handle aft fully and completely with his right hand. He said he heard a "pop" noise and saw the floats on both sides begin to inflate.

However, contrary to the accident pilot's belief, the investigation found that the handle had not been pulled through its full travel. As a result, the valve on only the left gas reservoir assembly was activated. Thus, the NTSB concludes that, although the accident pilot was aware that each gas reservoir may not discharge simultaneously, the high forces required to pull the activation handle,

[79] Dart's letter to EuroTec regarding the accident helicopter's installation contained no provisions to modify the junction box location other than to the outboard side of the frame rail.

along with the aural and visual cues following a single-reservoir discharge, led the pilot to mistakenly believe that he had successfully pulled the handle fully aft to fully inflate the floats.

2.4.3 Certification Review Process

During the FAA's certification review of the emergency flotation system installed on the accident helicopter (STC SR00470LA) and during subsequent testing performed for design iterations related to the STC, Dart proposed, and the FAA accepted, a maximum pull force for the activation handle. However, Dart did not include this important information in any documents for operators in the initial STC or in subsequent iterations. Thus, the NTSB concludes that the FAA's certification review of the emergency flotation system design installed on the accident helicopter did not identify Dart's omission of an activation handle pull-force limitation; thus, the FAA's reviews of other approved emergency flotation system designs may not have identified similar omissions. Although Dart has revised the RFMS and maintenance documents for STC SR0047LA to address these deficiencies, the NTSB is concerned that similar deficiencies may remain undiscovered and unresolved in other FAA-approved emergency flotation system designs.

Therefore, the NTSB recommends that the FAA review the activation system designs of FAA-approved rotorcraft emergency flotation systems for deficiencies that may preclude their proper deployment, such as a lack of a means to identify high pull forces on manual activation handles or inadequate guidance on the intended use of the activation system, and require corrective actions based on the review findings.

At the time of the FAA's initial certification review of STC SR00470LA (July 1996 through November 1997), formal guidance for the certification review of emergency flotation systems did not exist. Consistent with the typical approval process in place at the time, the FAA Los Angeles ACO had to make its own determination as to which regulations within Part 27 applied to the approval of the STC.

A few years later, the FAA issued Advisory Circular (AC) 27-1B, "Certification of Normal Category Rotorcraft," which introduced Miscellaneous Guidance (MG) 10, "Advisory Material for Substantiation of Emergency Flotation System."[80] Although MG 10 (which is also contained in AC 29, applicable to transport-category rotorcraft) provides basic guidance related to evaluating design objectives, it does not contain specific information related to human factors considerations for the design of manual activation systems, such as activation handle pull-force characteristics or provisions for clear, unambiguous, and positive feedback to pilots to indicate the successful or unsuccessful deployment of the float system. Further, the guidance does not contain provisions that address methods for ensuring that a manual activation system continues to function as intended after it has been fielded, such as initial and recurrent inspections to check activation handle pull forces.

As the circumstances of this accident show, ambiguous control action feedback and high activation handle pull forces can lead to partial inflation of the emergency flotation system in a

[80] AC 27-1B was issued September 30, 1999. AC 27-1B, Change 8, issued June 29, 2018, was current at the time of this report (FAA 2018a).

situation in which no other malfunctions would preclude full inflation. Thus, the NTSB concludes that improved guidance for ACOs for assessing design features, usability, and inspection methods that ensure successful deployment of an emergency flotation system could help ensure that these important aspects are considered during the certification review process for such systems. Therefore, the NTSB recommends that the FAA revise MG 10 in AC 27 and AC 29 to include design objectives for emergency flotation systems that consider human factors design objectives, such as activation handle pull-force characteristics; provisions for clear, unambiguous, and positive feedback to pilots to indicate that the float system was successfully deployed; and inspections to ensure that an installation of a manual activation system does not preclude a pilot's ability to deploy the floats, as designed, after it has been fielded.

2.5 Organizational and Management Issues

2.5.1 Liberty's Safety Program

Before Liberty's development of the cooperative business relationship with NYONair, core aspects of Liberty's safety program, which was not required or approved by the FAA, had begun to deteriorate. For example, Liberty withdrew from participating in TOPS, an air tour industry group, in early 2017. Liberty's director of safety left the company in October 2017, and his position was not backfilled. Liberty's safety officer was new to his position, effective January 2018, after the former safety officer left the company. Liberty's safety officer said his position was informal and that he had no training for his role other than a briefing from the former safety officer. He also reported to Liberty's chief pilot, not the upper management. Although the former director of safety had performed some of the tasks prescribed in the *Safety Manual*, the manual was not part of Liberty's FAA-approved or -accepted manuals, and there was no indication that the safety officer was tasked to perform the safety actions. Thus, Liberty did not have a robust safety management structure in place before it began integrating the FlyNYON flights into its operation.

2.5.2 Liberty's Relationship with NYONair

As Liberty's air tour business declined due to city restrictions on commercial air tour flights operated out of JRB, the FlyNYON-branded aerial photography flights operated out of 65NJ rapidly increased because they were not subject to the city restrictions, and NYONair was able to generate demand for the flights through social media marketing. As demand for FlyNYON flights surpassed NYONair's ability to operate them using its own fleet, NYONair's CEO approached Liberty's top management with a proposal that Liberty operate some of these flights. The establishment of a contract between Liberty and NYONair for FlyNYON flights provided Liberty with a new revenue stream.

During Liberty's initial operation of FlyNYON flights (late 2017 to early 2018), Liberty's chief pilot coordinated closely with NYONair personnel on the execution of these flights, including scheduling helicopters and pilots, developing the SOPs, and handling safety issues. As the volume of Liberty's FlyNYON flight operations increased (and were expected to increase further in the warmer weather months), Liberty's DO, COO, and CEO did not increase any engagement in supervising the day-to-day aspects of Liberty's FlyNYON flight operations. These activities were largely delegated to Liberty's chief pilot, who, along with Liberty's safety officer, worked to address any operational or safety concerns that Liberty's pilots raised.

In contrast, NYONair's CEO and NYONair's director of business operations were closely engaged in the day-to-day operations of FlyNYON flights. A combination of factors, including the NYONair CEO's former employment at Liberty, the close cooperation between personnel from the two companies for Liberty's FlyNYON flights operated out of the NYON Terminal, the "hands-off" approach of Liberty's top management on its day-to-day operations, and the fact that Liberty's DO (who was the father of NYONair's CEO) also served as the DO for East West (NYONair's Part 135 certificate), blurred the roles and responsibilities of personnel from both companies with regard to their ability to influence aspects of Liberty's operation of FlyNYON flights.

2.5.2.1 Operational Control Aspects

Although Liberty's FOM defined operational control responsibilities for only flights conducted under Part 135, Liberty's DO said that Liberty had operational control of the accident flight and other FlyNYON flights it operated under Part 91. The NTSB expects that, in keeping with known operational control concepts outlined in its FOM, Liberty's operational control of its FlyNYON flights would involve, for example, maintaining safety responsibility for the operation and ensuring that no outside source is allowed to influence or direct the operation in any manner. However, the investigation found that Liberty allowed NYONair to have significant influence in multiple aspects of Liberty's operation of FlyNYON flights.

For example, although Liberty was responsible for assigning its pilots and helicopters to support FlyNYON flights, NYONair created the daily flight schedule. Further, a Liberty scheduler said he involved NYONair's CEO in the decision to cancel a FlyNYON flight. Also, NYONair's CEO barred Liberty's safety officer from conducting FlyNYON flights (and from participating in regularly scheduled pilot meetings) due to a personal conflict. There was no evidence that Liberty's DO either approved of or intervened in this decision.

Further, Liberty used the NYONair-provided harness/tether system (including cutting tools) on the FlyNYON flights it operated, but NYONair controlled the inventory of this equipment. Although Liberty pilots (including Liberty's safety officer) voiced their desire for NYONair to purchase and equip more passengers with a type of FAA-approved harness (referred to as the blue harnesses by personnel at both companies) that fit small passengers better than the yellow harnesses and had a more accessible tether attachment option, NYONair's CEO was in control of the purchase and supply decisions. After a Liberty pilot delayed a NYONair flight by requesting that a passenger's yellow harness be replaced with a blue one, NYONair's CEO declared (via e-mail) that the yellow harnesses were just as good as the blue ones and that the pilots were not allowed to ask about the harnesses.

Although Liberty's chief pilot said he made it clear to Liberty's pilots that they could ask about the harnesses and Liberty's safety officer said that Liberty's management supported the pilots' authority, Liberty's chief pilot said he did not know if Liberty's DO took any direct action.

Liberty's COO said he had not personally inspected the NYONair-provided equipment and was unaware of any concerns with it.

Thus, the NTSB concludes that, through their repeated lack of involvement in key decisions related to Liberty-operated FlyNYON flights, Liberty's managers allowed NYONair personnel, particularly NYONair's CEO, to influence core aspects of the operational control of those flights.

2.5.2.2 Safety Management Responsibilities

Since the departure of Liberty's director of safety in October 2017, Liberty had not had any of its own pilot safety meetings (which the former director of safety had convened quarterly and provided minutes to Liberty's COO). Liberty's safety officer was Liberty's representative for the NYONair-led pilot meetings where logistical, customer service, and safety matters for FlyNYON flights were discussed. These meetings were run by the NYONair NYC lead pilot, who was sometimes assisted by NYONair's CEO, and Liberty's safety officer used them as an opportunity to voice any safety concerns about FlyNYON flight operations from the Liberty pilot group. However, the investigation found that, for a variety of reasons, the meetings were not an effective mechanism for Liberty in managing its pilots' safety concerns.

The NYONair personnel (including the NYC lead pilot) who led and participated in these meetings were not trained in safety management, and NYONair itself did not have a formal safety structure. Although NYONair's CEO said he had appointed the NYONair NYC lead pilot as a safety officer, she did not share that understanding. Additionally, the NYONair NYC lead pilot did not have the authority to enforce safety-related operating policies or to authorize the purchase of safety-related equipment. All such decisions were directly made, or heavily influenced, by NYONair's CEO. However, NYONair's CEO had not established clear lines of accountability through top management or systematic processes for identifying hazards, prioritizing interventions (or mitigations), and mitigating the related risks, which are all key components of a strong safety program.

Liberty pilots were aware of some risks associated with FlyNYON flights, including the potential for entanglement of the harness/tether system with the helicopter's floor-mounted controls; the difficulties passengers would have in accessing the carabiners on their harness/tether system in an emergency (particularly for the yellow harnesses); the inadequacy of the passengers' cutting tools to quickly sever their tethers; and the possibility that the emergency flotation system may only partially inflate if the activation handle is not pulled fully aft. Although Liberty pilots took some informal operational measures to address floor-mounted control interference vulnerabilities, and Liberty's training program made pilots aware of the need to pull the float activation handle fully aft, these mitigations were not evaluated at the organizational level, and Liberty did not assess and manage the overall risks in the context of FlyNYON flight operations. In addition, for FlyNYON flights, due to the previously discussed absence of support from Liberty management (specifically Liberty's DO) in operational and safety-related discussions, Liberty pilots had to advocate for safety improvements themselves.

The culture among Liberty pilots emphasized the responsibility of individual pilots to take the initiative to ensure safe flight operations. Thus, Liberty's safety officer and chief pilot informed

NYONair about their concerns about passenger egress, which included their desire for NYONair to provide blue harnesses for Liberty pilots to use on FlyNYON flights. (Some NYONair pilots were also concerned about passenger egress.)

When Liberty's safety officer and chief pilot first approached NYONair stating that they wanted the blue harnesses for safety reasons (due to better fit on smaller passengers and the presence of a more accessible attachment point), NYONair provided assurances that their concerns would be addressed. However, meeting minutes showed that implementing the request became deprioritized over time, and NYONair management and other employees came to regard the Liberty pilots' concerns about the harness/tether system as superfluous and not urgent.

NYONair's CEO eventually decided that there were no safety issues with the old type of harness and told the pilots to stop asking for the replacement harnesses. Although there is no indication that NYONair performed any risk evaluation to support this decision, there is likewise no indication that Liberty management provided any risk evaluation to counter it. Key decisions related to FlyNYON flight operations were being made by NYONair's CEO, whereas Liberty's top management had little involvement, having delegated these responsibilities to Liberty's chief pilot and Liberty's safety officer. Thus, Liberty's pilots had no one at the top management level to advocate for their concerns. This created impediments to change when the Liberty pilots brought up the need for safety improvements.

Interviews with Liberty and NYONair employees, as well as copies of communications, indicated that the organizational culture at NYONair emphasized goals such as customer satisfaction, expanding the business, and reducing costs. With regard to FlyNYON flights, NYONair's safety goals were focused primarily on ensuring that passengers and equipment did not fall out of the helicopter and did not devote sufficient attention to mitigating other possible risks, like equipment issues that could hinder passenger egress.

When Liberty pilots attempted to take what they considered to be safety action (such as canceling a cold-weather flight and delaying a flight until a passengers could be fitted with a blue harness), NYONair's CEO responded by chastising them for hurting his brand, and he deprioritized their concerns by deciding that they were unrelated to safety. This contributed to a polarization of attitudes and reduced cooperation between the Liberty pilots and NYONair management on safety matters.

As a result, known risks remained unresolved due to blurred lines of authority, lack of safety management expertise, and lack of a formal process at both companies for systematically prioritizing and addressing foreseeable risks. Thus, the NTSB concludes that ineffective safety management at both Liberty and NYONair resulted in a lack of prioritization and mitigation of foreseeable risks.

Both Liberty and NYONair lacked a safety management system (SMS). According to the FAA's website, "SMS is the formal, top-down business-like approach to managing safety risk, which includes a systemic approach to managing safety, including the necessary organizational structures, accountabilities, policies, and procedures."[81] The goal of SMS is to identify safety hazards, ensure necessary remedial action is implemented to maintain an acceptable level of safety, provide continuous monitoring and regular assessment of the safety level achieved, and continuously improve a company's overall level of safety. When an SMS is implemented, senior management establishes adequate safety resources, develops a safety policy, establishes safety objectives and standards of safety performance, and leads the development of a positive organizational safety culture. Research indicates that this approach to safety leads to improved organizational outcomes (Smith et al. 1978, 5-15; Shannon, Mayr, and Haines 1997, 201-17). Because of the failures of organizational safety management that played a role in this accident, the NTSB believes that adoption of an SMS would enhance safety at both Liberty and NYONair. Therefore, the NTSB recommends that Liberty and NYONair establish an SMS.

In 2015, the FAA required Part 121 air carriers to develop a functioning SMS by March 9, 2018. After determining that inadequate operational safety oversight had been a contributing factor in several accidents involving Part 135 operators, the NTSB recommended in 2016 that the FAA require all Part 135 operators establish an SMS (NTSB 2016). This recommendation is applicable to Part 135 operators such as Liberty and NYONair's East West Helicopters. However, this requirement (if implemented by the FAA) would not apply to commercial air tour operators that operate under Part 91. (See 2.6.3 for more information about Part 91 air tours.)

Information that the FAA disseminated on the framework of SMS notes that, by design, SMS is scalable to allow the integration of safety management practices into any size operator's unique business model (FAA 2015). The NTSB believes that the safety of commercial air tour operations, regardless of their operating rule, would be enhanced if all air tour operators established an SMS. Therefore, the NTSB recommends that the FAA require all commercial air tour operators, regardless of their operating rule, to implement an SMS.

2.6 FAA Regulations and Oversight

Certification of air carriers and commercial operators enables greater FAA oversight of their operations. For example, the regulatory and oversight requirements that apply to Part 135 operations are more comprehensive than those that apply to Part 91 operations. Part 135 operators are subject to a higher level of aircraft maintenance, crewmember training, and other requirements (beyond those required under Part 91). Further, FAA inspectors are assigned to each Part 135 operator to provide oversight and perform specific surveillance activities per guidance provided in FAA Order 8900.1.

2.6.1 Intent of the Aerial Work and Aerial Photography Exception

The FAA originally created the 14 *CFR* 119.1(e)(4)(iii) exception in regulatory text issued in 1964 to allow for aerial work and aerial photography flights to be operated outside the scope of regulatory and oversight requirements applicable to certificated operators (FAA 1964, 2988). After this accident, the FAA provided a legal interpretation stating that the exception "is meant for

[81] More information can be found at www.faa.gov/about/initiatives/sms/faq.

business-like, work-related operations such as newsgathering, aerial mapping, surveying, commercial photography, or commercial filming; not for personal, entertainment, or leisure purposes." However, the terms "aerial work" and "aerial photography" are not defined in the regulations, and NYONair and Liberty took measures to operate the FlyNYON revenue passenger-carrying flights under Part 91 as aerial photography flights.

For example, NYONair avoided using words like "air tour" and "sightseeing" in marketing materials for FlyNYON flights and trained its CX personnel to be vigilant for people who ask "too many questions," mention the words "tour, owners, management, certificates," or appear to be "FAA" or "anyone with a badge." Liberty (and NYONair) pilots who flew FlyNYON flights asked passengers to choose which landmarks they wanted in their photographs (rather than providing a predefined flight route). Through these actions, both Liberty and NYONair demonstrated deliberate efforts to avoid any indication that the FlyNYON flights may be commercial air tours, which would be subject to additional FAA requirements and oversight (and NYC-imposed restrictions) that did not apply to aerial photography flights. Commercial air tour operators that are either Part 135 certificate holders or holders of an air tour LOA issued under 14 *CFR* 91.147 in accordance with exemptions in 14 *CFR* 119.1(e)(2) are known to the FAA and subject to certain requirements (which may include equipment requirements, route limitations, and/or other restrictions) and oversight by FAA inspectors.

Thus, the NTSB concludes that Liberty and NYONair exploited the exception at 14 *CFR* 119.1(e)(4)(iii) allowing aerial photography flights to be operated under Part 91, thereby avoiding the additional FAA requirements and oversight that apply to commercial air tours conducted under either Part 135 or Part 91 with an air tour LOA.

The NTSB recognizes that, at the time the aerial photography exception under 14 *CFR* 119.1(e)(4)(iii) was created, the FAA could not have envisioned that high-quality cameras (like those found in smartphones) would become common or that operators, like NYONair and Liberty, would use this exception to carry thousands of revenue passengers annually based on their interpretation that those passengers' intent to take photographs during the flight constitutes aerial work.

Thus, the NTSB concludes that, without regulatory language that defines the terms "aerial work" and "aerial photography" to include only business-like, work-related aerial operations, operators may attempt to take advantage of the exception at 14 *CFR* 119.1(e)(4)(iii) to carry revenue passengers for personal, entertainment, or leisure purposes without the additional FAA requirements and oversight that apply to other commercial, revenue passenger-carrying operations. Therefore, the NTSB recommends that the FAA revise 14 *CFR* 1.1, "General Definitions," to include definitions for the terms "aerial work" and "aerial photography" that specify only business-like, work-related aerial operations, as originally intended.

2.6.2 Oversight of Operating Certificate

Before Liberty Helicopters entered into a contractual agreement with NYONair to operate FlyNYON doors-off flights, Liberty's operations consisted of Part 135 charter flights and Part 91 nonstop, sightseeing flights (operated under its own air tour LOA) that were conducted with the helicopter's doors on and with the passengers using only the installed, FAA-approved restraints.

Liberty operated the FlyNYON flights, however, with the helicopter's doors off (sometimes in cold weather, which required the pilots to wear multiple layers of clothing) and while using the NYONair-provided harness/tether systems for the passengers. These flights also required coordination with NYONair personnel and the use of FlyNYON-flight-specific SOPs for securing passengers and items in the cabin and providing customer service-related actions. Thus, incorporating the FlyNYON doors-off flights into its operations represented a significant operational change for Liberty.

Guidance for FAA inspectors concerning their oversight of Part 135 (and other certificated) operators includes provisions for assessing hazards and ensuring the operator's mitigation of risks. For example, volume 6, chapter 2, section 18 of FAA Order 8900.1 (Change 450) stated, in part, the following:

> Certificate holders continually seek a critical balance between markets, resources, and operations in order to remain viable. … During transition periods, the certificate holders may knowingly or unknowingly accept, or even generate, an undesirable level of safety risk. These transition periods place additional responsibility on Flight Standards Service…personnel. Principal inspectors…must anticipate potential hazards and evaluate the likelihood and severity of risks, to ensure that the operator is appropriately managing these risks consistently with the changing conditions.

The POI responsible for oversight of Liberty's certificate recognized that Liberty's operation of the FlyNYON flights constituted a significant change in the way Liberty was operating its helicopters with respect to the use of the harness/tether system. Although the PMI conveyed his concerns to the POI that Liberty's operation of FlyNYON flights "seemed like a very unorthodox situation," the POI said he believed there was no requirement for him to evaluate the harness system because the FlyNYON flights were being conducted under Part 91. Further, he noted that (unlike the manuals and approval processes that would apply to harnesses used in a Part 135 operation) for a Part 91 operation, no rule, policy, or standard existed to which he could refer to determine if the harness/tether systems were safe or unsafe.

The NTSB notes that, under 14 *CFR* 119.51, the FAA can unilaterally amend a certificate holder or operator's OpSpecs when the FAA has determined that safety in air transportation and the public interest necessitates such an amendment.[82] Amendment of a certificate holder or operator's OpSpecs could result in additional FAA scrutiny or oversight of that operation, including oversight of any agreements to incorporate Part 91 flights into its overall operations. However, the POI stated he never considered whether an amendment to Liberty's OpSpecs would be warranted. Thus, the NTSB concludes that the FAA POI assigned to oversee Liberty did not

[82] FAA Order 8900.1, volume 3, chapter 18, section 8 states that "In some cases, the FAA may decide to amend a certificate holder or operator's OpSpecs due to a change in the operator's operational environment… In such cases, the…POI may initiate and amend an operator's OpSpecs due to the change, without the operator having to apply for the change."

conduct additional surveillance of Liberty's operations after being made aware of its FlyNYON flights and failed to ensure that Liberty was appropriately managing the risks associated with the significant change in operations.

2.6.3 Oversight of Part 91 Revenue Passenger-Carrying Operations

As stated in section 1.10.7.1, although the FAA determined that Liberty and NYONair's use of the 14 *CFR* 119.1(e)(4)(iii) exception to conduct the accident flight under Part 91 as an aerial photography flight was inconsistent with the intent of the exception, the FAA determined that the flight was eligible to be operated under Part 91 as a nonstop commercial air tour under the 14 *CFR* 119.1(e)(2) exception. Although an air tour operated under Part 91 with an LOA is subject to FAA requirements and oversight that exceed what applies to aerial photography flights, the NTSB has a long history of concerns about the safety of various passenger-carrying revenue operations (such as air tours, parachute jump operations, and sightseeing flights in hot air balloons) that are allowed to operate under Part 91 per various 14 *CFR* 119.1(e) exceptions (NTSB 1995, 2008, and 2017b).

The NTSB believes that FAA inspectors' statements during the investigation of this accident highlight problems with the level of safety oversight that the FAA applies to revenue passenger-carrying operations conducted under Part 91 per various 14 *CFR* 119.1(e) exceptions. Although Liberty's PMI had concerns after observing a Liberty FlyNYON flight on the ramp and examining the harness/tether systems, the POI pursued no additional safety oversight, noting his perceived limitations on his surveillance authority for a Part 91 operation and the low priority the FAA assigns to oversight of Part 91 operations. Thus, the NTSB concludes that because the FAA continues to allow passenger revenue operations to be conducted under Part 91—some of which, like the FlyNYON flight operations, transport thousands of passengers annually—the FAA must provide inspectors with sufficient guidance to pursue more comprehensive oversight with regard to potential hazards they observe and to ensure that operators sufficiently mitigate risks. Therefore, the NTSB recommends the FAA revise Order 8900.1, *Flight Standards Information Management System*, to include guidance for inspectors who oversee Part 91 operations conducted under any of the 14 *CFR* 119.1(e) exceptions to identify potential hazards and ensure that operators are appropriately managing the associated risks.

However, for air tours in particular—considering that some air tour operators transport thousands of passengers annually under Part 91—the NTSB maintains its longstanding concern that the level of oversight that the FAA applies to Part 91 operations is insufficient to identify and correct safety deficiencies that could expose these revenue passengers to unacceptable safety risks. For example, in 1995, we recommended that the FAA develop and implement national standards for all air tour operations within Part 135 or equivalent regulations.[83] At the time, we expressed our concerns that FAA inspectors have less leverage to control and perform oversight on Part 91

[83] Specifically, on June 19, 1995, we issued Safety Recommendation A-95-58, which asked the FAA to "[d]evelop and implement national standards…within…Part 135, or equivalent regulations, for all air tour operations with powered airplanes and rotorcraft to bring them under one set of standards with operations specifications and eliminate the exception currently contained in 14 *CFR* 135.1." Title 14 *CFR* 135.1 contains an exception in section 135.1(a)(5) for nonstop commercial air tours conducted in accordance with 14 *CFR* 119.1(e)(2).

operations compared to Part 135 operations. The NTSB notes that, in its 2003 notice of proposed rulemaking for air tours, the FAA stated that "there are significant differences in risks between sightseeing flights conducted under Part 91 and air tour flights conducted under air carrier/commercial operator regulations" and acknowledged "the public expectation that all operators offering commercial air tours are regulated and *surveilled* [emphasis added] to a level of safety higher than that applied to the general aviation [Part 91] operator" (FAA 2003, 60584).

In 2007, the FAA issued a final rule for National Air Tour Safety Standards that established the LOA requirement for air tours operated under Part 91 per the 14 *CFR* 119.1(e)(2) exception; however, we considered this action unacceptable because the LOA requirement did not subject Part 91 air tour operators to requirements and oversight similar to those for Part 135 operators, such as limitations and risk mitigations that can be imposed through OpSpecs and operations manuals.[84] Further, the final rule did not subject Part 91 air tour operators to a level of oversight and surveillance equivalent to that which is applied to Part 135 operators. Therefore, the NTSB recommends that the FAA develop and implement national standards within Part 135, or equivalent regulations, for all air tour operations with powered airplanes and rotorcraft to bring them under one set of standards with OpSpecs, and eliminate the exception currently contained in 14 *CFR* 135.1.

2.7 Other Safety Issues

2.7.1 Fuel Shutoff Lever

The certification basis for the FSOL design (as installed in the accident helicopter) for preventing "inadvertent operation" primarily considered scenarios in which a pilot may inadvertently select the wrong lever when operating a floor-mounted control. There was no documentation that the FSOL design certification process required consideration of scenarios in which an external influence, such as an unsecured object or a passenger, could result in an unintended change in the FSOL position. Risks associated with such scenarios in a normal-category rotorcraft are typically controlled through operational measures, such as pilots ensuring that all loose items are secured and that passengers are briefed on avoiding touching the controls.

However, the NTSB notes that other floor-mounted controls in the accident helicopter (and the redesigned controls of some later models and/or variants) included design features that can provide protection from the effects of external influences (such as interference from a passenger or unsecured object), even if they were not specifically designed for that purpose.[85] The NTSB

[84] Specifically, on November 21, 2007, the NTSB classified Safety Recommendation A-95-58 "Closed—Unacceptable Action," citing our disagreement with the final rule's allowance that certain commercial air tour flights can be operated under Part 91.

[85] During the investigation of the April 15, 2008, accident involving a then-Eurocopter AS350 B2 helicopter (equipped with the original FFCL design), the NTSB discovered that the FFCL (which was adjacent to the left front-seat passenger's right foot) could be easily moved with minimal pressure (see NTSB case number

concludes that, although the certification basis for the accident helicopter's FSOL did not require protection from inadvertent activation due to external influences, a design modification that includes such protection could enhance safety more effectively than continued reliance on operational measures. Therefore, the NTSB recommends that Airbus Helicopters modify the floor-mounted FSOL in AS350-series helicopters to protect it from inadvertent activation due to external influences. The NTSB further recommends that, after the actions requested in Safety Recommendation A-19-32 are completed, the FAA and the European Union Aviation Safety Agency require owners and operators of existing AS350-series helicopters to incorporate the changes.

2.7.2 Lack of Training and Guidance Assessing Passenger Intoxication

Toxicology results for the front passenger indicated that he was intoxicated by alcohol, and a witness said the front passenger had an odor that was consistent with alcohol consumption. Based on information from this witness and on statements that the front passenger and another passenger made to the pilot and a CX representative before the flight, there were cues available to Liberty and NYONair personnel to indicate that the passenger had consumed alcohol before the flight. However, the passenger was permitted to board the helicopter.

Research has shown that the relationship between blood alcohol levels and social behaviors is difficult to describe due to differences in personal tolerance levels and underlying personality differences (NHTSA 2001; Chesher and Greeley 1992; and NIH 1995). Although the front passenger was intoxicated, the NTSB notes that his behaviors during the flight—leaning back to take photos; inadvertently releasing his installed, FAA-approved restraint; and inadvertently catching the tail of his tether on the FSOL—are all behaviors that could have been performed by an enthusiastic but sober passenger. Thus, it is not possible to determine whether alcohol played a role in the front passenger's inadvertent activation of the FSOL. The NTSB concludes that the risk of the NYONair-provided harness/tether system tether tail becoming entangled with the floor-mounted FSOL existed independently from passenger intoxication and most likely depended primarily on the passenger's positioning in the cabin.

Despite the existence of an FAA regulation prohibiting the carriage of any passenger who appears to be intoxicated or impaired, neither Liberty nor NYONair had any documented policy or guidance materials, including training, for their employees to identify impaired passengers or

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ANC08FA053). On October 20, 2010, the NTSB issued Safety Recommendations A-10-129 and -131, which asked the FAA and the European Union Aviation Safety Agency, respectively, to "[r]equire Eurocopter to review the design of the…FFCL and/or its detent track on AS350-series helicopters and require modification to ensure that the FFCL is protected to prevent unintentional movement out its detents and that it does not move easily to an unintended position." On the same date, the NTSB issued Safety Recommendation A-10-130, which asked that the FAA "[e]valuate other helicopters with …FFCLs and detent tracks similar in design to those on Eurocopter AS350-series helicopters and require modification, as necessary, to ensure that the FFCL is protected to prevent unintentional movement out of its detents and that it does not move easily to an unintended position." As a result of responsive action from the FAA and the European Union Aviation Safety Agency, the NTSB classified Safety Recommendations A-10-129 and -131 "Closed—Acceptable Alternate Action." On November 14, 2014, the FAA informed the NTSB that its extensive evaluation of other helicopters found that none were equipped with an FFCL and detent track design similar to that of the AS350-series helicopters (and that, therefore, no modifications were required). As a result, the NTSB classified Safety Recommendation A-10-130 "Closed—Acceptable Action."

to deny boarding of such individuals. Evaluating customers for potential impairment and limiting liability related to their behavior is a skill taught throughout the hospitality industry and the Part 121 aviation industry. The evaluation is based primarily on observed behaviors and conversation and does not include a measurement of alcohol, such as a breathalyzer test.[86] The importance of assessing passengers' level of impairment becomes even more critical when they are seated in close proximity to the helicopter controls, as was the case in this accident.

Although the NTSB could not determine whether the front passenger's level of intoxication played a role in this accident, we are concerned that in other situations, a passenger's behavior while intoxicated or impaired could lead to interference with the controls or the pilot's operation of the aircraft. Thus, the NTSB concludes that when passengers are seated in close proximity to an aircraft's controls, it is critical that they not be impaired to reduce the likelihood of interference with the pilot's ability to safely fly the aircraft. While FAA guidance does exist on identifying intoxicated or impaired passengers, it may not specifically address concerns relevant to operations that conduct revenue passenger-carrying flights under Part 91 or Part 135 in aircraft in which a passenger may be seated in close proximity to the controls. Therefore, the NTSB recommends that the FAA develop guidance on how to identify intoxicated or impaired passengers, and distribute it to operators who carry passengers for hire under Part 91 and Part 135. Further, the NTSB recommends that Liberty and NYONair train their employees to identify signs of impairment and intoxication in passengers and to deny those passengers boarding, when appropriate.

[86] See, as an example, Washington Mandatory Alcohol Server training online. Course Details. https://www.washingtonalcoholtraining.com/course-details/ (Accessed August 15, 2019).

3. Conclusions

3.1 Findings

- None of the following were factors in this accident: (1) the pilot's qualifications, which were in accordance with federal regulations and company requirements; (2) pilot fatigue or medical conditions; and (3) the airworthiness of the helicopter.
- The tail of the front passenger's tether caught on the fuel shutoff lever (FSOL) during the flight, which resulted in the inadvertent activation of the FSOL, interruption of fuel flow to the engine, and loss of engine power.
- The pilot autorotated the helicopter successfully and pulled the emergency flotation system activation handle to deploy the floats at an appropriate time; however, the floats inflated partially and asymmetrically.
- Liberty Helicopters Inc.'s and NYONair's decision to use locking carabiners and ineffective cutting tools as the primary means for passengers to rapidly release from the harness/tether system was inappropriate and unsafe.
- The helicopter's landing was survivable; however, the NYONair-provided harness/tether system contributed to the passenger fatalities because it did not allow the passengers to quickly escape from the helicopter.
- The Federal Aviation Administration's (FAA) approval process for supplemental passenger restraint systems (SPRS) that was implemented after the accident is inadequate because it does not provide guidance to inspectors to evaluate any aircraft-specific installations or the potential for entanglement that passengers may encounter during emergency egress.
- Although the crossover hose in the accident helicopter's emergency flotation system design did not perform its intended function to alleviate asymmetric inflation of the floats during a single-reservoir discharge event, buoyancy stability testing showed that even symmetric distribution of the gas from only one reservoir would not enable the helicopter to remain upright in water.
- In the absence of information from Dart Aerospace specifying pull-force limitations for the emergency flotation system's activation handle, Liberty and other operators lack a means to inspect for and correct high pull forces that may result from an installation anomaly or other issues.
- Although the accident pilot was aware that each gas reservoir may not discharge simultaneously, the high forces required to pull the activation handle, along with the aural and visual cues following a single-reservoir discharge, led the pilot to mistakenly believe that he had successfully pulled the handle fully aft to fully inflate the floats.
- The Federal Aviation Administration's certification review of the emergency flotation system design installed on the accident helicopter did not identify Dart Aerospace's omission of an activation handle pull-force limitation; thus, the FAA's reviews of other

approved emergency flotation system designs may not have identified similar omissions.

- Improved guidance for aircraft certification offices for assessing design features, usability, and inspection methods that ensure successful deployment of an emergency flotation system could help ensure that these important aspects are considered during the certification review process for such systems.
- Through their repeated lack of involvement in key decisions related to Liberty Helicopters Inc.-operated FlyNYON flights, Liberty's managers allowed NYONair personnel, particularly NYONair's chief executive officer, to influence core aspects of the operational control of those flights.
- Ineffective safety management at both Liberty Helicopters Inc. and NYONair resulted in a lack of prioritization and mitigation of foreseeable risks.
- Liberty Helicopters Inc. and NYONair exploited the exception at Title 14 *Code of Federal Regulations* 119.1(e)(4)(iii) allowing aerial photography flights to be operated under Part 91, thereby avoiding the additional Federal Aviation Administration requirements and oversight that apply to commercial air tours conducted under either Part 135 or Part 91 with an air tour letter of authorization.
- Without regulatory language that defines the terms "aerial work" and "aerial photography" to include only business-like, work-related aerial operations, operators may attempt to take advantage of the exception at Title 14 *Code of Federal Regulations* 119.1(e)(4)(iii) to carry revenue passengers for personal, entertainment, or leisure purposes without the additional Federal Aviation Administration requirements and oversight that apply to other commercial, revenue passenger-carrying operations.
- The Federal Aviation Administration principal operations inspector assigned to oversee Liberty Helicopters Inc. did not conduct additional surveillance of Liberty's operations after being made aware of its FlyNYON flights and failed to ensure that Liberty was appropriately managing the risks associated with the significant change in operations.
- Because the Federal Aviation Administration (FAA) continues to allow passenger revenue operations to be conducted under Title 14 *Code of Federal Regulations* Part 91—some of which, like the FlyNYON flight operations, transport thousands of passengers annually—the FAA must provide inspectors with sufficient guidance to pursue more comprehensive oversight with regard to potential hazards they observe and to ensure that operators sufficiently mitigate risks.
- Although the certification basis for the accident helicopter's fuel shutoff lever did not require protection from inadvertent activation due to external influences, a design modification that includes such protection could enhance safety more effectively than continued reliance on operational measures.
- The risk of the NYONair-provided harness/tether system tether tail becoming entangled with the floor-mounted fuel shutoff lever existed independently from passenger intoxication and most likely depended primarily on the passenger's positioning in the cabin.

- When passengers are seated in close proximity to an aircraft's controls, it is critical that they not be impaired to reduce the likelihood of interference with the pilot's ability to safely fly the aircraft.

3.2 Probable Cause

The NTSB determines the probable cause of this accident was Liberty Helicopters Inc.'s use of a NYONair-provided passenger harness/tether system, which caught on and activated the floor-mounted engine fuel shutoff lever and resulted in the in-flight loss of engine power and the subsequent ditching. Contributing to this accident were (1) Liberty's and NYONair's deficient safety management, which did not adequately mitigate foreseeable risks associated with the harness/tether system interfering with the floor-mounted controls and hindering passenger egress; (2) Liberty allowing NYONair to influence the operational control of Liberty's FlyNYON flights; and (3) the Federal Aviation Administration's inadequate oversight of Title 14 *Code of Federal Regulations* Part 91 revenue passenger-carrying operations. Contributing to the severity of the accident were (1) the rapid capsizing of the helicopter due to partial inflation of the emergency flotation system and (2) Liberty and NYONair's use of the harness/tether system that hindered passenger egress.

4. Recommendations

To the Federal Aviation Administration

Modify the supplemental passenger restraint system (SPRS) approval process to (1) require letter of authorization (LOA) applicants to specify a need for and the intended use of an SPRS for each aircraft; (2) require the Federal Aviation Administration to evaluate and review, for each specified aircraft, the need for the SPRS on that aircraft for all intended uses; all SPRS design, manufacture, installation, and operational considerations, including, at a minimum, the potential for passengers to become entangled during emergency egress; the adequacy of passenger emergency egress briefings; and the potential for the SPRS to interfere with aircraft controls; and (3) ensure that each LOA lists the specific aircraft on which the holder is authorized to use an SPRS. (A-19-24)

Until you implement the supplemental passenger restraint system (SPRS) approval process as recommended in Safety Recommendation A-19-24, prohibit the use of SPRS for passenger-carrying doors-off operations. (A-19-25)

Review the activation system designs of Federal Aviation Administration-approved rotorcraft emergency flotation systems for deficiencies that may preclude their proper deployment, such as a lack of a means to identify high pull forces on manual activation handles or inadequate guidance on the intended use of the activation system, and require corrective actions based on the review findings. (A-19-26)

Revise Miscellaneous Guidance 10 in Advisory Circular (AC) 27 and AC 29 to include design objectives for emergency flotation systems that consider human factors design objectives, such as activation handle pull-force characteristics; provisions for clear, unambiguous, and positive feedback to pilots to indicate that the float system was successfully deployed; and inspections to ensure that an installation of a manual activation system does not preclude a pilot's ability to deploy the floats, as designed, after it has been fielded. (A-19-27)

Require all commercial air tour operators, regardless of their operating rule, to implement a safety management system. (A-19-28)

Revise Title 14 *Code of Federal Regulations* 1.1, "General Definitions," to include definitions for the terms "aerial work" and "aerial photography" that specify only business-like, work-related aerial operations, as originally intended. (A-19-29)

Revise Order 8900.1, *Flight Standards Information Management System*, to include guidance for inspectors who oversee Title 14 *Code of Federal Regulations* (*CFR*) Part 91 operations conducted under any of the 14 *CFR* 119.1(e) exceptions to identify potential hazards and ensure that operators are appropriately managing the associated risks. (A-19-30)

Develop and implement national standards within Title 14 *Code of Federal Regulations* (*CFR*) Part 135, or equivalent regulations, for all air tour operations with powered airplanes and rotorcraft to bring them under one set of standards with operations specifications, and eliminate the exception currently contained in 14 *CFR* 135.1. (A-19-31)

After the actions requested in Safety Recommendation A-19-32 are completed, require owners and operators of existing AS350-series helicopters to incorporate the changes. (A-19-33)

Develop guidance on how to identify intoxicated or impaired passengers, and distribute it to operators who carry passengers for hire under Title 14 *Code of Federal Regulations* Part 91 and Part 135. (A-19-34)

To Airbus Helicopters

Modify the floor-mounted fuel shutoff lever in AS350-series helicopters to protect it from inadvertent activation due to external influences. (A-19-32)

To the European Union Aviation Safety Agency

After the actions requested in Safety Recommendation A-19-32 are completed, require owners and operators of existing AS350-series helicopters to incorporate the changes. (A-19-35)

To Liberty Helicopters Inc.

Establish a safety management system. (A-19-36)

Train your employees to identify signs of impairment and intoxication in passengers and to deny those passengers boarding, when appropriate. (A-19-37)

To NYONair

Establish a safety management system. (A-19-38)

Train your employees to identify signs of impairment and intoxication in passengers and to deny those passengers boarding, when appropriate. (A-19-39)

BY THE NATIONAL TRANSPORTATION SAFETY BOARD

ROBERT L. SUMWALT
Chairman

JENNIFER HOMENDY
Member

BRUCE LANDSBERG
Vice Chairman

Adopted: December 10, 2019

Board Member Statement

Member Jennifer Homendy filed the following concurring statement on December 17, 2019:

I find it hard to believe that NYONair LLC and FlyNYON LLC (collectively "NYON") are allowed to continue to operate anywhere in the United States given their blatant disregard for safety and their deliberate exploitation of an exemption in federal regulations that was clearly intended for business-like, work-related operations such as newsgathering, aerial mapping, surveying, commercial photography, or commercial filming; not for personal, entertainment, or leisure purposes. NYON's motivation: to avoid federal safety regulation and oversight.

The Federal Aviation Administration (FAA) had the opportunity to step in when its regional inspectors first visited NYON in October 2017. Although one of the inspectors noted that "it seemed like a very unorthodox situation" the FAA took no further action. It didn't even visit NYON again, at least not until five people tragically perished in what was accurately described by Chairman Sumwalt as a death trap.

The actions the FAA did take after the accident didn't go far enough.

First, instead of mandating that NYON operate under the same set of safety standards that apply to many other commercial air tour operators (14 Code of Federal Regulations (CFR) Part 135), the FAA is allowing NYON to operate under parts 91 (which normally applies to general aviation) and 136 with a letter of authorization (LOA).

What does this mean? Unlike other commercial air tour operators, NYON isn't required to have an operating certificate, an FAA-approved training program, or an FAA-approved maintenance program. Nor is it required to have sufficient qualified management and technical personnel show that it can perform the operation "with the highest degree of safety," or have FAA inspectors that are specifically assigned to inspecting their operations.

Frankly, the only real difference in how NYON is operating post-accident is that they had to implement a drug and alcohol program for their pilots, which wasn't even a factor in this accident, and they *could be* subject to further surveillance by federal regulators.

Flight crews and passengers deserve better. The NTSB has long recommended one level of safety for commercial tour operators. Passengers who aren't familiar with federal regulations or aviation operations (nor should they be expected to) should be guaranteed the "highest degree of safety."

Our recommendation goes back to 1995, following a special NTSB investigation of the U.S. air tour industry which, at the time, resulted from 139 air tour accidents and incidents between October 1988 and April 1995[1]. The recommendation was classified by the NTSB as closed

[1] https://www.ntsb.gov/safety/safety-studies/Documents/SIR9501.pdf

unacceptable action, following the FAA issuance of a Final Rule in 2007 that exempted certain air tour flights from 14 CFR Part 135.

Accidents and incidents involving air tour flights operated under this exemption continue to occur. Just this year alone, Board Members launched to several, including one in Hawaii which killed 10 passengers and the pilot. It's time for the FAA to take action and implement one level of safety for commercial air tour operators. That is why I am pleased we issued the following recommendation to the FAA in this report, the same recommendation we issued in 1995 that the FAA failed to act on:

> *Develop and implement national standards within 14 CFR Part 135, or equivalent regulations, for all air tour operations with powered airplanes and rotorcraft to bring them under one set of standards with operations specifications and eliminate the exception currently contained in 14 CFR Part 135.1.*

Now the FAA needs to implement it! The FAA also needs to take action to improve the LOA for Supplemental Passenger Restraint Systems for "Doors-Off" Flight Operations Conducted for Compensation or Hire, issued in an Emergency Order (EO) on March 26, 2018. The EO prohibits the use of SPRSs that cannot be released quickly in an emergency during flight operations for compensation or hire with the doors open or removed, unless operators obtain a LOA from the FAA. Although the EO states that the FAA will consider the design, manufacture, installation, and operation of the SPRS when reviewing all applications for an LOA, the FAA stops short of evaluating (1) the need for an SPRS in the first place (for all intended uses); (2) the potential for passengers to become entangled during emergency egress; (3) the adequacy of passenger emergency egress briefings; and (4) the potential for the SPRS to interfere with aircraft controls.

Shockingly, NYON received a SPRS LOA following the accident after FAA review of a 7 second video and one page of marketing materials. No further evaluation or detailed examination (not even in person) of the SPRS itself, NYON's need for the SPRS, or any of the other commonsense factors listed above was conducted. Until those are incorporated in the approval process, the use of SPRS for all passenger-carrying doors-off operations should be prohibited.

5. Appendixes

Appendix A: Investigation

The National Transportation Safety Board (NTSB) was notified of this accident on March 11, 2018, and members of the investigative team arrived on scene that day. Then-Board member T. Bella Dinh-Zarr accompanied the team.

Investigative groups were formed to evaluate operational factors, survival factors, onboard image recordings, and the helicopter's airworthiness, powerplant, and emergency flotation system. Also, specialists were assigned to evaluate human performance, pilot and passenger medical information, air traffic control data and communications, and data from the onboard image recorder (Appareo) and recovered smartphones, with studies performed on the videos provided by shore witnesses, helicopter performance, and meteorological conditions. The NTSB materials laboratory provided assistance with metallurgical and computed tomography examinations of select components.

The Federal Aviation Administration, Liberty Helicopters Inc., NYONair, and Dart Aerospace were parties to the investigation. In accordance with the provisions of Annex 13 to the Convention on International Civil Aviation (ICAO), the Bureau d'Enquêtes et d'Analyses pour la Sécurité de l'Aviation Civile (BEA) of France (as accredited representative of the state of manufacture of the airframe and engine) and the Transportation Safety Board (TSB) of Canada (as accredited representative with responsibilities for continuing airworthiness as specified in ICAO Annex 8) participated in the investigation. Airbus Helicopters Inc., Safran Engines, and the European Union Aviation Safety Agency participated as technical advisers to the BEA, and EuroTec Canada participated as technical adviser to the TSB.

Appendix B: Summary of Referenced Regulatory Requirements

	General Aviation	Aerial Photography	Commercial Air Tours	
Operating Rules	Part 91	Part 91[1]	Part 91[2] with air tour LOA[3] and Part 136[4]	Part 135 and Part 136
Operating Certificate	Not required	Not required	Not required	Required
Part 119 Management Personnel	Not required	Not required	Not required	Required
Operations Specifications	Not required	Not required	Not required	Required
FAA-approved Training Program	Not required	Not required	Not required	Required
FAA-approved Maintenance Program	Not required	Not required	Not required	Required
Drug/alcohol Program	Not required	Not required	Required	Required
FAA Oversight	Ramp inspection authority	Ramp inspection authority	Ramp inspection authority, record of operator, and responsibility for oversight of LOA and Part 136 compliance	Assigned inspectors responsible for routine and scheduled oversight of the operating certificate, operations specifications, training program, and maintenance program.

[1] Allowed per the 14 *CFR* 119.1(e)(4)(iii) exception for "aerial work" purposes.

[2] Allowed per the 14 *CFR* 119.1(e)(2) exception, which specified, in part, that each nonstop flight must be operated in an aircraft with 30 or fewer passenger seats, operate within a 25-nm radius of the airport from which the flight began and ended, and be conducted in accordance with the air tour LOA.

[3] The air tour LOA required, in part, that the operator provide to the FAA its name and any other names under which it was doing business; its business address, mailing address, and principal place of business; the names of persons responsible for managing the business and for aircraft maintenance; the aircraft type, make, model, and registration number(s); and an antidrug and alcohol misuse prevention program registration.

[4] Part 136 contained, in part, requirements for passenger briefing items, PFDs, helicopter emergency flotation systems, helicopter performance plans and operations, and operations over or near national parks and tribal lands.

Appendix C: Onboard Image Recorder Transcript

The following is an audio transcript of and video comments on recording from the GoPro Hero 5 image recorder, serial number C3161354671380, that was installed on an Airbus Helicopters AS350 B2 helicopter, N350LH, that experienced an inadvertent activation of the fuel shutoff lever and was subsequently ditched into the East River in New York, New York, on March 11, 2018.

LEGEND	
CAM	Cockpit area microphone ambient voice or sound source
Pilot	Voice identified as the pilot
CX	Voice identified as the "Customer Experience Representative"
MPAX	Voices of multiple passengers
PS-2	Voice identified as the front seat passenger (outer portion of bench seat)
PS-3	Voice identified as the rear, left, outer seat passenger
PS-4	Voice identified as the rear, left, inner seat/doorway passenger
PS-5	Voice identified as the rear, right, inner seat/doorway passenger
PS-6	Voice identified as the rear, right, outer seat/doorway passenger
PS-X?/Y?	Voice of either passenger X or passenger Y
RDO	Voice determined to be speaking into a radio.
-?	Voice unidentified
*****	Unintelligible word
#	Expletive
@	Non-pertinent word
( )	Questionable insertion
[ ]	Editorial Insertion

Note 1: Times are expressed in eastern daylight time (EDT).

Note 2: Generally, only radio transmissions to and from the accident aircraft were transcribed.

Note 3: Words shown with excess vowels, letters, or drawn out syllables are a phonetic representation of the words as spoken.

Note 4: A non-pertinent word, where noted, refers to a word not directly related to the operation, control or condition of the aircraft.

| 18:43:56.9
[Start of recording.] | | | |
| 18:43:57.0
CX | smile at the camera guys its lookin at you. | 18:43:57.45 | PS-2 was wearing the supplemental harness and was tethered to a hardpoint on the helicopter's floor near the right rear base of the front passenger seat (bench). The tether from the hardpoint was routed under Seat 1’s right arm rest and was connected to the rear of the passenger's supplemental harness via a twist lock carabiner. Three excess tether loops were hanging from PS-2's carabiner forming a tail of tether loops. PS-2 was wearing a NorthFace style jacket, jeans and sneakers. PS-2 was facing outboard from the helicopter and was having a mostly unintelligible conversation with the pilot who was standing outside the left of the helicopter. At this time, PS-2 was not wearing a headset or the factory installed rotorcraft restraint.

PS-3 was seated in seat number 3. PS-3 was wearing a headset, the supplemental harness, the factory installed rotorcraft restraint and was equipped with both a fanny pack style personal floatation device (PFD) as well as a hook knife on the left upper side of the supplemental harness. PS-3 also had a PED tethered to the supplemental harness using a blue lanyard. Later, it was visible that PS-3's factory installed rotorcraft restraint's shoulder strap was routed under her right arm. PS-3 was wearing winter clothing, including a hat and finger optional gloves.

PS- 4 was seated in seat number 4. PS-4 was wearing a headset around his neck in which the headset cable |

			was tethered to the supplemental harness using a carabiner and zip tie, the supplemental harness, the factory installed rotorcraft restraint and was equipped with both a fanny pack style PFD as well as a hook knife on the right upper side of the supplemental harness. PS-4 also had a PED tethered to the supplemental harness using a blue lanyard. PS-4 was wearing a winter jacket, jeans and sneakers. PS-4 was not wearing gloves. The CX was stepping inside the rotorcraft to activate GoPro cameras.
18:43:57.6 **CAM**	[Mostly unintelligible conversation between the pilot and PS-2 near the left front side of the helicopter, away from the microphone. The conversation related to the geographic differences between rural areas and cities.]		
18:43:59.6 **PS-5?/PS-6?**	yeaaa.		
18:44:01.0 **CX**	sorry - I gotta go right here.		
		18:44:02.43	The CX continued to install and activate GoPro cameras in the helicopter's cabin.
18:44:08.2 **CX**	this is to get the front angle from both sides.		
18:44:10.8 **PS-4**	alright. cool.		
18:44:12.7 **CAM**	[Three quick beeps. The sound of a GoPro powering on.]		

18:44:20.7 **CAM**	[Sound of beep, consistent with GoPro starting a recording.]		
18:44:22.9 **PS-4**	awesome.		
18:44:24.7 **CX-RDO**	zero lima is gunna leave in a little bit.		
18:44:29.5 **PS-4**	hey @PS-2		
18:44:31.2 **CX**	ahh - I'm just putting on your seat belt.		
18:44:32.3 **PS-2**	yeah yeah.		
18:44:33.4 **CX**	(I) mean your headset.		
		18:44:33.48	The CX attached PS-2's headset cable to the back of PS-2's supplemental harness using a zip tie and a carabiner.
18:44:34.9 **PS-2**	yeah.		
18:44:35.8 **PS-4**	I'm ready.		
18:44:36.0 **CX**	this is yours.		
18:44:36.9 **PS-4**	hey @PS-2		
18:44:37.6 **PS-2**	captain captain.		
18:44:38.3 **Pilot**	what's up?		

Audio Transcript		Video Comments	
18:44:39.1 **PS-4**	[to PS-2] just know where the cameras are. [to CX] There's not one up there - right?		
18:44:43.1 **CX**	no. that - this one is (good) with recording you guys right here.		
18:44:47.3 **PS-4**	this one right here [Sounds as if speaking in unison with PS-2.]		
		18:44:47.60	PS-2 leaned back to reveal that he was equipped also with a fanny pack style PFD and a hook knife located on the upper left portion of his supplemental harness.
18:44:48.2 **CX**	and that one too.		
18:44:49.0 **PS-2**	this one too.		
18:44:49.6 **CX**	and this one too.		
18:44:50.0 **PS-4**	that's not one.		
18:44:50.5 **Pilot?**	sup - super wide fish eye lens.		
		18:44:50.93	The CX pointed to cameras throughout the helicopter's cabin.
18:44:51.8 **CX**	this one right here? that was - yeah.		
18:44:53.7 **PS-5?/6?/Pilot?**	good - we're good.		
18:44:54.6 **PS-4**	that one's us - and then that one.		

Audio Transcript		Video Comments
18:44:56.7 **CX**	and that one.	
18:44:57.2 **PS-2**	let's all be safe - again.	
18:44:59.0 **MPAX**	[Sound of laughter, mostly attributed to PS-4.]	
18:44:59.3 **CX**	* * *.	
18:45:01.4 **PS-2**	I'm so (excited/psyched).	
18:45:02.1 **PS-3?**	[Sound of laughter.]	
18:45:02.3 **PS-4**	what's that?	
18:45:02.7 **PS-4**	he had like five bloody marys before we even… [Voice trailed off.]	
18:45:04.6 **PS-2**	yeah yeah - I am - I am - I'm a little twisted.	
18:45:07.2 **PS-6**	had - had some liquid courage.	
18:45:09.5 **PS-?**	[Sound of laughter.]	
18:45:09.5 **CX**	[Sound of laughter.] he's pumped you guys.	
18:45:11.0 **PS-2**	I'm (Rick/redic) twisted. anyone see Rick and Morty?	
18:45:14.3 **MPAX**	[Sound of laughter.]	

18:45:15.2 **PS-2**	get schwiffftyyy.[1]
18:45:16.9 **PS-4**	[Sound of laughter.]
18:45:18.0 **PS-4**	god.
18:45:18.7 **Pilot**	* * * this under your arm.
18:45:19.6 **PS-6**	now that's gunna be stuck in my head. thanks.
18:45:21.3 **CX**	* * *.
18:45:21.4 **PS-4**	yeah.
18:45:22.0 **PS-4**	[Sound of laughter.]
18:45:22.1 **PS-2**	ahhh - get schwifty.
18:45:23.2 **PS-6**	(hey/thanks.)
18:45:25.6 **Pilot**	here we go.
18:45:27.3 **PS-5?**	nice.
18:45:27.4 **Pilot**	* get that.

[1] "Get Schwifty" – A reference to Season 2, Episode 5 of the television show *Rick and Morty*. The reference is to a song, "Get Schwifty." The popculture website UrbanDictionary.com defines "schwifty" as "The ultimate abandonment of inhibition while having a good time."

Time / Speaker	Audio Transcript	Time	Video Comments
18:45:27.8 **PS-6**	I was like * * *. I was like - do I pop into a liquor store and get something? - then I was like "NO" - business meeting - shouldn't do. no shots before a business meeting. [Sound of laughter.]		
		18:45:27.90	The CX, then later, the pilot, assisted PS-2 in securing PS-2's factory installed rotorcraft restraint. PS-2 was now seated properly in his seat and was facing forward, no longer facing outboard from the helicopter. The left shoulder strap was routed over PS-2's left shoulder and down PS-2's chest to the central buckle. The right shoulder strap was routed under PS-2's right arm and to the central buckle.
18:45:28.9 **PS-4**	[to PS-2] (I'm gunna check) into my flight - tonight.		
18:45:32.8 **CX**	* * *. okay?		
18:45:33.3 **PS-5?**	a (flask)?		
18:45:36.3 **CX**	feel good? you guys good? have fun guyyys.		
18:45:39.9 **MPAX**	[Sound of laughter.]		
18:45:40.4 **Pilot**	they tell us we're not supposed to drink before we fly too - but I mean come on. [Spoken in a joking tone.]		
18:45:43.2 **PS-?**	[Sound of laughter.]		
18:45:43.6 **PS-6?**	whatever. [Spoken in a joking tone.]		

Audio Transcript		Video Comments	
18:45:44.2 **PS-2**	ehhh - you know. like come on?		
18:45:45.0 **Pilot**	you want this? [Shouting in another direction, toward CX who was unseen.]		
18:45:46.7 **PS-2**	its twenty eighteen. you know.		
18:45:47.7 **Pilot**	[to PS-2] yeah. right.		
18:45:49.9 **CX-RDO?**	any parking spots? [CX speaking in another direction, or radio, out of view of camera.]		
18:45:50.7 **PS-2**	let's get schwifty guys. [Shouted.]		
18:45:52.7 **MPAX**	[Sound of laughter.]		
		18:45:53.33	Pilot had exited the helicopter and walked toward the CX who was now standing outside the left front of the helicopter and handed her a piece of paper.
18:45:54.6 **PS-5?/ 6?**	* * *.		
18:45:55.7 **PS-4**	[Sound of laughter.]		
18:45:55.9 **Pilot**	get back four more days. [A response to a conversation with CX in which only one side was heard.]		
18:45:57.3 **PS-5?**	ohhh man.		
18:45:59.0 **PS-5?/PS-6?**	ahhh.		

Audio Time / Source	Audio Transcript	Video Time	Video Comments
18:45:59.8 **CAM**	[Sound consistent with door closing and automotive motor starting.]		
18:46:01.1 **PS-6?**	(weee/weirddd)		
18:46:02.5 **Pilot**	ohhh everybody saw that. (that was bad).		
18:46:03.6 **MPAX**	[Sound of laughter.]		
18:46:05.1 **Pilot**	oh that's a good one.		
18:46:06.6 **PS-2**	get (schwifty). that's the way you do it. @Pilot is gettin' (schwifty/jiffy/drifty).		
18:46:09.7 **Pilot**	alright guys. I take it everyone's doin good?		
		18:46:11.92	The pilot entered the helicopter in the pilot's seat and faced backward to address the passengers.
18:46:12.2 **MPAX**	yeah.		
18:46:13.3 **Pilot**	alright. so just a couple things first. just give me a couple minutes for ya. ummm. they probably just told ya. they told you back at the other place probably. just remember so. front seat - two corners from me - leave your seatbelts on the whole flight. you're tethered in - you're not goin' anywhere - just so you we don't beat the crrrap out of the helicopter or each other with the buckles - it will hurt. - ummm - for you guys [points at PAX4 and PS-5] - as soon as we get outta here - I'll let you know when you can get down.		
18:46:36.5 **PS-4**	okay.		

18:46:36.9 **Pilot**	and when I say that - that means corners can spin out - you can spin your legs out. ummm - if it's too cold - too windy while we're enroute and you wanna like - hang out - in the helicopter - that's cool - you don't have to wait for me to tell you AGAIN you can move. Once I say you're free to do your thing - go for it - you know you guys pay to dangle - dangle. umm be advised though - if you do decide to stick your body out - right when I tell you - like I don't waste time - like as soon as we get goin' go ahead get down. If you ever stuck your hand out the car window drivin' - muuultiply that by about three. we're gunna be cookin' so you are gunna feel it.
18:47:13.8 **PS-4**	ohhh (cookin').
18:47:14.6 **Pilot**	ummm - don't let it scare ya - ya know you'll feel it in your waist - legs might go back a little - BUT you'll be okay. alright. I just wanna give you guys a head's up - that will happen.
18:47:23.1 **PS-5?/6?**	okay.
18:47:23.6 **Pilot**	ummm - tryin to think. uh then when we land - when we come back - do me a favor - umm - ya know - dont worry about takin' any gear off yet ya know or tryin' to get untethered. let me shut down we'll get out we'll help you guys. uhh so for the thirty minute - kinda ya know - the little sheet they gave me - just kinda said everything. did you guys have anything specific you wanted - or you want me just kinda give you what I think is kinda the best for ya?

18:47:53.2 **PS-2**	I know that you know what's best. have you seen Billions [Showtime television program] - the openings to Billions where it's like - the - it's like right - right - right at Battery [Battery Park] - na no - it sounds stupid - ya know Battery Park city where its like -
18:48:01.4 **Pilot**	umm hmm.
18:48:02.0 **PS-2**	where its like - boom - World Trade Center -
18:48:03.7 **Pilot**	alright. so --
18:48:04.4 **Pilot**	yeah that. that too.
18:48:06.1 **PS-2**	yeah. straight on - the southern part.
18:48:08.7 **Pilot**	I'll throw this out there - uhhh - we'll get outta here-
18:48:11.7 **PS-5?/6?**	umm hmm.
18:48:12.1 **Pilot**	are you guys interested in the statue at all?
18:48:14.5 **MPAX**	yeah. for sure. for sure.
18:48:15.2 **Pilot**	alright. so what I can do is I uhhh - for the statue - we usually park just south of her.
18:48:19.9 **PS-?**	yea.
18:48:20.1 **Pilot**	ya get the city in the background.

18:48:21.6 **MPAX**	umm hmm. I love it.
18:48:22.2 **Pilot**	umm - move over to the face and like I'm down eye level with her.
18:48:26.5 **PS-2**	yeah.
18:48:27.2 **Pilot**	so it's - it's cool.
18:48:28.5 **PS-2**	that's nice.
18:48:29.1 **Pilot**	from there - Brooklyn Bridge - up the East River - Central Park.
18:48:32.8 **PS-5?/6?**	yup.
18:48:33.2 **Pilot**	down to the Empire State Building.
18:48:35.0 **PS-2**	(yeah/yup)
18:48:35.5 **Pilot**	One World Trade and then that shot from Governors Island northbound.
18:48:36.2 **CAM**	[Sound of turbine engine starting in vicinity of ramp area, not the accident helicopter.]
18:48:38.2 **PS-2**	sure.
18:48:39.6 **MPAX**	sounds good. sounds perfect. yea. sure.
18:48:39.7 **Pilot**	sounds good?
18:48:41.0 **MPAX**	[sound of clapping. general agreement was verbalized.]

Audio Transcript		Video Comments	
18:48:41.9 **Pilot**	alrighhht.		
18:48:42.8 **PS-2**	alright. LET'S DO IT. [Shouted.]		
18:48:43.3 **PS-4**	party.		
18:48:44.2 **PS-2**	HOOO. [Spoken loudly.]		
18:48:45.1 **PS-2?**	(go again)		
18:48:45.7 **PS-2**	we're gettin' schwifty.		
18:48:47.1 **Pilot**	alright. well again - my name is @PilotFN[2] I'll be your pilot for the next thirty minutes.		
18:48:50.8 **PS-5?/6?**	alright @PilotLN sounds good.		
18:48:51.6 **Pilot**	hang tight we'll be outta here.		
18:48:52.9 **PS-2?**	alright		
18:48:54.2 **Pilot**	alright - just so you know - like these up here - (and up here for you/there not here for you) - that's not the heat - the heat is under the seats. so there's vents under there - so if your hands get cold - stick em under the seats.		
		18:49:00.12	The pilot pointed out air vents in the helicopter's cabin.

[2] @PilotFN = Pilot's First name - @PilotLN = Pilot's Last Name

Audio Transcript		Video Comments	
18:49:05.2 **PS-?**	okay.		
18:49:05.7 **Pilot**	I love watching people try to put their hand in front of that.		
18:49:07.8 **MPAX**	[Sound of laughter.]		
18:49:08.3 **Pilot**	naw dude that's not-- turn on the A-C for ya if ya want.		
18:49:11.4 **MPAX**	[Sound of laughter.]		
18:49:12.1 **PS-2**	I thought your name was @PilotLN - I was looking at your jacket.		
18:49:13.5 **Pilot**	ahh that's my last name.		
18:49:14.5 **Pilot**	ahh okay. (thanks).		
18:49:16.2 **PS-2**	like (@PilotLN).		
18:49:19.1 **PS-2**	let's do it @PilotFN.		
18:49:20.2 **PS-2**	like Rick and Morty.		
18:49:21.4 **Pilot**	I get that all the time - yeah.		
18:49:22.8 **PS-2**	I'm (little) @PilotFN man - I'm helicopter - I'm helicopter @PilotFN - bruh [Sounds as if the speaker is impersonating a voice.]		
		18:49:32.25	All PAX visible were wearing their headsets over their ears. PS-3 put on clear protective eyewear.

Time / Speaker	Audio Transcript	Time	Video Comments
18:49:32.7 **MPAX**	* * *. [Unintelligible comments and the sound of laughter.]		
18:49:35.0 **PS-2**	get schwiffftttyyy.		
		18:49:40.39	The pilot was now seated in the pilot's seat facing forward. The pilot put on the factory installed rotorcraft restraint.
18:49:43.5 **MPAX**	[Sound of laughter.]		
18:49:47.1 **PS-2**	*.		
18:49:49.0 **PS-2**	they love me. [Gestures in direction of the other helicopter on the ramp area.]		
18:49:50.9 **PS-4**	doubt it. doubt it. I don't even love you.		
18:49:53.6 **PS-2**	they love me - they all love me.		
18:49:55.2 **PS-4**	[Sound of laughter.]		
18:49:56.6 **PS-?**	*.		
18:49:56.8 **PS-2**	* * * schwifty.		
		18:50:04.02	The pilot reached with his left hand toward the floor controls to check the position of the floor controls (Fuel Shutoff Lever, Fuel Flow Control Lever and Rotorbrake).
18:50:08.0 **Pilot**	clear. [Shouted.]		

Audio Transcript			Video Comments
		18:50:19.05	Although most of the pilot's body was not visible, it was apparent that the pilot was beginning a start sequence of the helicopter.
18:50:22.8 **PS-2**	(how long you) been a pilot?		
18:50:24.7 **PS-?**	(do it).		
18:50:26.1 **PS-2**	turn it on (@PilotFN).		
18:50:28.0 **Pilot**	dude you're in a turbine engine (fire on).		
18:50:31.2 **PS-2**	yeaaah.		
18:50:33.5 **Pilot**	I don't know if you heard it when (he/it) started but there's ignitors that go click click click click click.		
18:50:36.7 **PS-2**	pow.		
18:50:38.4 **Pilot**	alright. * * .		
18:50:40.3 **Pilot**	a lot better than a piston engine - right?		
18:50:42.0 **PS-2**	yeah.		
18:50:42.4 **Pilot**	exactly.		
18:50:44.5 **PS-4**	[to PS-2] can already see our breath.		
18:50:45.9 **PS-2**	[to PS-4] what?		

Audio Transcript		Video Comments	
18:50:45.9 **PS-4**	[to PS-2] you can already see my breath.		
18:50:50.5 **PS-2**	[to PS-4] image it up there in a minute or two.		
		18:50:55.60	The pilot continued to perform a start-up of the rotorcraft and avionics. The pilot performed his preflight and started the helicopter without incident.
18:51:03.5 **PS-4**	woohoo.		
		18:51:03.65	The pilot put on his headset. All visible passengers were still seated in their assigned seats and appeared ready for flight.
18:52:12.2 **PS-?**	like this		
		18:51:14.63	The pilot put on a pair of full finger gloves.
		18:51:26.39	PS-2 pointed outward from the helicopter and waved.
		18:51:44.35	PED screens of the passengers showed that another departing helicopter was situated just to the left of the accident helicopter.
18:52:15.0 **CAM**	[Sound of adjacent helicopters operating and increasing rotor RPM.]		
18:52:41.5 **CAM**	[Sound of increase of rotor RPM and N1 of adjacent helicopter.]		
		18:52:42.50	The pilot reached down with his left hand and put the Fuel Flow Control Lever into the "Flight" gate.
18:52:59.7 **CAM**	[Due to the sound of adjacent helicopters operating, it was unclear exactly when the accident helicopter started.]		

Audio Transcript		Video Comments	
18:53:16.8 **MPAX**	[Sounds of laughter.]		
		18:53:18.02	The pilot began actively manipulating the flight controls and the helicopter began to depart.
		18:53:21.22	The helicopter lifted off from the ground.
18:53:24.5 **PS-?**	ooouuu. [Sound of laughter.]		
18:53:25.7 **PS-?**	ohhh what the hell.		
18:53:27.3 **MPAX**	[General comments about passenger's excitement of departing accident helicopter.]		
		18:53:28.35	The helicopter began transitioning through effective translational lift (ETL) and began forward flight.
		18:53:34.33	The helicopter departed the helipad property.
		18:53:49.43	PS-2 turned to face outboard from the helicopter. PS-2 was still wearing the factory installed rotorcraft restraint.
		18:54:01.18	At a hand motion from the pilot, PS-4 began unbuckling the factory installed rotorcraft restraint.
18:54:04.8 **PS-2**	HEY. [Shouted.]		
		18:54:12.03	PS-4 pivoted off the assigned seat and rebuckled the factory installed rotorcraft restraint. A view was exposed of PS-4's tether to the rear of his supplemental harness.
18:54:27.8 **PS-?**	it's strong bruh.		

Audio Transcript		Video Comments	
		18:54:42.87	PS-2 faced more forward in his seat, similar to how he was seated during takeoff. PS-4 continued to rebuckle the factory installed rotorcraft restraint.
18:55:09.5 **MPAX**	it's strong it's strong we're flyin' we're flyin. [Some words between PS-2 and pilot.]		
		18:55:10.20	PS-4 moved to the left side floor of the helicopter and took a seat at the door area. Part of PS-5's supplemental harness was visible, a hook knife was on the left upper side of the supplemental harness. PS-3 was facing more outboard from the helicopter.
		18:55:56.00	PS-2 turned to face outboard from the helicopter. PS-2 was still wearing the factory installed rotorcraft restraint.
18:56:09.7 **PS-2**	*. [Unintelligible shout.]		
18:56:14.6	oh # yea.		
18:56:19.6 **PS-5?/PS-6?**	* * *.		
18:56:27.4 **PS-2**	Whoooaaa.		
		18:56:32.55	Helicopter crossed over Bayonne Piers, New Jersey.
		18:56:33.73	PS-4's excess tether loops were now visible. Three excess tether loops formed a tail hanging below the carabiner.
18:56:37.5 **CAM**	[Sound of rotor flap consistent with normal operations.]		
18:57:32.7 **CAM**	[Sound of rotor flap consistent with normal operations.]		

Audio Transcript		Video Comments	
		18:57:56.25	Helicopter transitioned into a hover south of the Statue of Liberty. PS-5 began unbuckling his factory installed rotorcraft restraint. PS-5 had a fanny pack style PFD. It appeared that PS-5 rebuckled the factory installed rotorcraft restraint behind his body.
18:58:06.7 **PS-2**	let's go around (we're) * * *.		
		18:58:25.30	PS-5 moved to the floor of the helicopter. Three tether loops were visible hanging from PS-5's rear carabiner forming a tail. PS-5 was no longer in view of the camera.
		18:58:30.43	PS-3, PS-4 and PS-5's tether routing was visible. All tethers connected to a hardpoint on the aft bench of the helicopter.
18:59:00.4 **CAM**	[Sound of rotor flap consistent with normal operations].		
		18:59:07.88	The helicopter transitioned to the east of the Statue of Liberty and hovered in front of the statue's face.
18:59:49.9 **PS-4**	* * *.		
18:59:59.5 **PS-2**	* * *.		
19:00:04.0 **PS-2**	* * *.		
19:00:09.0 **PS-?**	* * *.		
		19:00:15.10	PS-2 leaned back inside the helicopter and the lapbelt portion of the factory installed rotorcraft restraint appeared very loose.

Audio Transcript		Video Comments	
		19:00:37.97	The helicopter passed south of the Staten Island Ferry Terminal and began transiting up (north) the East River.
19:00:50.3 **PS-?**	* * *.		
19:01:01.9 **CAM**	[Sound of rotor flap consistent with normal operations.]		
		19:01:10.42	The helicopter passed east of South Street Sea Port, traveling north up the East River.
19:01:14.2 **CAM**	[Sound of rotor flap consistent with normal operations.]		
		19:01:15.60	PS-2 rotated his upper body and drew his right arm across the front of his body to give a thumbs up. As this motion occurred, the factory installed rotorcraft restraint lapbelt became unbuckled. Moments later, it was apparent that the factory installed rotorcraft restraint shoulder strap had also come unbuckled. The "tang" [male end of seatbelt] of the factory installed rotorcraft restraint was visible out of seatbelt buckle receiver.
		19:01:30.37	The helicopter transitioned into a hover over the east side of the Brooklyn Bridge. The helicopter was over Brooklyn, on the east shore of the East River.
		19:02:20.23	The helicopter passed the Manhattan Bridge traveling north on the eastern shore of the East River.
		19:02:35.00	PS-2 leaned into (leaned backward) the helicopter, his head was over the helicopter's center pedestal. Around the same moment, the pilot reached with his left hand and tapped PS-2's right shoulder, almost in a blocking motion. It appeared the pilot had given instruction to

	PS-2 to refasten PS-2's factory installed rotorcraft restraint.
19:02:37.50	The pilot's left hand moved onto Seat 1, the pilot was either blocking PS-2 from leaning back or reaching for PS-2's factory installed rotorcraft restraint. The pilot's arm stayed on Seat 1 as PS-2 leaned back into the pilot's arm.
19:02:46.78	PS-2 nodded after turning only his face toward the pilot. PS-2 slid backward into the Seat 1 position, the pilot’s arm was no longer there. For the next 20 seconds, PS-2 appeared to be manipulating the lapbelt portion of the factory installed rotorcraft restraint. The pilot gestured once to PS-2 as PS-2 seemed to continue manipulating only the lap-belt portion, however, it was unclear if PS-2 had successfully re-buckled his lap-belt.
19:03:06.25	The pilot gestured to PS-2 and PS-2 gave a thumbs up and returned to shooting pictures/videos with his PED.
19:03:06.57	The helicopter passed the Williamsburg Bridge traveling northbound on the East River.
19:03:11.03	PS-2 was shooting photos/videos with his PED. PS-2 was leaning back again and was in the position of Seat 1.
19:03:15.08	PS-2's tether tail was visible hanging loose in the area of the floor mounted controls. The tether tail continued to hang loose in the area of the floor mounted controls, unless otherwise noted. As PS-2 leaned back to take shoe selfies, he was in the position

Audio Transcript		Video Comments	
			of Seat 1, his carabiner was touching Seat 1's right armrest. The floor mounted controls were in a nominal position for flight.
19:03:30.8 **PS-4**	* * *.		
19:03:43.1 **PS-2?/4?**	* * *.		
		19:03:59.58	PS-2 transitioned back and forth, sliding along Seat 1 and Seat 2 positions as PS-2 took photographs/videos.
		19:04:00.50	PS-2's lap belt of the factory installed rotorcraft restraint was routed over PS-2’s hips but was slack. The lap belt appeared to be fastened loosely.
		19:04:07.90	PS-2's shoulder belt portion of the factory installed rotorcraft restraint system was flapping in the slipstream outside the helicopter.
		19:04:10.15	PS-4 grabbed the loose shoulder belt portion of the factory installed rotorcraft restraint system for PS-2 and flipped it over Seat 1 and Seat 2.
		19:04:36.25	The helicopter passed the United Nations building traveling northbound on the East River.
		19:05:24.87	The helicopter was still traveling northbound on the East River, abeam the south end of Central Park which was in the distance.
		19:05:20.30	PS-2 began leaning back substantially and freely as he sat between Seat 1 and Seat 2. PS-2 continued to take shoe selfies. PS-2’s torso was angled about 45 degrees backward, pointing his feet diagonally aft of the helicopter. PS-2's right shoulder contacted the helicopter's glareshield, his left shoulder was just above Seat 1's armrest. PS-2 was leaning back in a plank-like position. As noted before, PS-2's tether tail

Audio Transcript		Video Comments	
			was still visible hanging in the vicinity of the floor mounted controls.
		19:05:38.28	PS-2 sat back up and the tether tail was visible hanging in the area of the floor mounted controls but at this time, was not contacting the floor mounted controls.
		19:05:40.83	PS-2 leaned back again in the manner described at 19:05:20.30. PS-2 continued to take shoe selfies.
		19:05:51.40	PS-2 leaned back up and the tether tail now was taut. The end of the tether tail was not visible but was leading toward the area of the floor mounted controls.
		19:05:52.70	PS-2 adjusted himself in the area between Seat 1 and Seat 2, the tether tail still appeared taut and continued to take photos.
		19:06:06.77	PS-2 grabbed the helicopter's assist handle which was next to Seat 2 (hand grab, not a flight control) and steadied himself.
		19:06:08.05	PS-2 pulled on the helicopter assist handle to adjust his seating position, PS-2 rotated his body slightly right. The tether tail still appeared taut but had moved upward as a unit. The tether tail unit appeared to pop upward yet remained taut. Contact with the floor mounted controls was not visible, but the tautness of the tether tail led directly to that area. **Figure 2 is a redacted screenshot captured at this time.**
19:06:10.1 **CAM**	[Reduction in sound of ambient engine audio.]		
		19:06:11.17	The helicopter yawed right. The helicopter was abeam and east of the Jacqueline Kennedy Onassis Reservoir, above York Avenue, somewhere over the Upper East Side of New York.

Audio Transcript		Video Comments	
		19:06:12.25	The pilot's left hand and arm motion were consistent with lowering the collective.
		19:06:12.47	The occupants of the helicopter experienced a brief negative G force. The passengers fumbled around a bit. PS-3 removed her hat and her headset slid forward and later near her eyes. PS-4 who was still seated in the doorway grabbed a hold of the seatback for Seat 1 and Seat 2. PS-3 steadied herself on PS-4's shoulder.
19:06:14.0 **CAM**	[Sound to similar to wind hitting camera microphone at an angle.]		
		19:06:14.62	The pilot moved his hand from the area of the collective to the area of the floor mounted controls.
		19:06:18.85	The angle of the GoPro camera changed slightly upward. A view of the pilot's actions diminished because of the new field of view.
19:06:19.6 **PS-4**	I don't want (it) it hit me in the face. [to PS-2.]		
		19:06:20.05	PS-4 handed PS-2's the shoulder harness portion of the factory installed rotorcraft restraint system which PS-4 had previously held at 19:04:10.15.
		19:06:26.38	PS-2’s face displayed an expression of confusion as he handled the shoulder harness portion of the factory installed rotorcraft restraint system.
		19:06:25.98	PS-3 slid back toward Seat 4. PS-4 was still in the doorway but slid backward toward the center of the helicopter.
19:06:27.2 **CAM**	[Sound similar to increase in rotor RPM.]		

Audio Transcript		Video Comments	
		19:06:27.62	The rotorcraft began rolling into a right turn. The helicopter was descending. The helicopter was over 2nd Avenue and 92nd Street, Upper East Side.
19:06:31.1 **CAM**	[Sound similar to rotor RPM management]		
		19:06:41.38	Passengers remained seated as described at 19:06:25.98.
19:06:42.2 **CAM**	[Sound similar to rotor RPM management.]		
		19:06:44.75	Landmarks outside the helicopter and the helicopter's MFD showed the helicopter crossing back over the shore line over the east river. The helicopter was above E. 92nd Street.
		19:06:52.15	PS-2 looked back toward PS-4, said something unintelligible and smiled.
19:06:50.6 **PS-2**	[Spoken at PS-4] * *.		
		19:06:56.25	The helicopter continued in a descent over the East River. The helicopter was just south of Mill Rock Island. PS-3 and PS-4 still had their PEDs out. PS-4 was typing a caption in the social media app Snapchat.
19:06:56.8 **PS-5?/6?/Pilot?**	* * *.		
		19:07:00.10	PS-4 moved off the floor and pulled himself into Seat 4. PS-3 moved back outward toward Seat 3 and rotated forward into a normally seated position. The helicopter continued in the descent and banked right.
		19:07:01.60	The pilot moved his left hand off the collective and toward the cyclic.

Audio Transcript		Video Comments	
19:07:01.8 **CAM**	[Sound of click.]		
19:07:02.0 **CAM**	[Sound similar to faint whooshing noise associated with float deployment.]		
		19:07:02.02	PS-2 grabbed the assist handle on the left doorframe of the helicopter with his right hand. PS-2 was facing about 45 degrees off to the left and seated somewhere between Seats 1 and 2. PS-2's headset was on his head.
		19:07:02.28	The pilot moved his left hand from the area of the cyclic back to the collective.
		19:07:03.25	One of the helicopter's left floats came into view. It was inflating.
		19:07:03.37	Chalk dust from one of the left floats was visible in the aircraft's slipstream outside the left open doorway.
		19:07:03.50	The rotorcraft leveled in the roll axis while still in a descent.
19:07:04.9 **CAM**	[1100 hz beep. The following two beeps came in rapid succession with approximately 75 millisecond spacing.]		
		19:07:04.98	Chalk dust continued to stream from the inflating left float.
19:07:05.1 **CAM**	[1100 hz beep.]		
		19:07:05.22	One of the left floats began to take a cylindrical shape. The float was pointed upward vertically and still inflating.
19:07:05.3 **CAM**	[1100 hz beep.]		
19:07:07.0 **CAM**	[Sound similar to increase of compressed air release, air filling floats.]		

Audio Transcript		Video Comments	
		19:07:07.20	The main body of one of the left floats began taking cylindrical shape.
		19:07:09.45	The left float continued to inflate, it was oriented 45 degrees from vertical, facing forward moving toward the inflated position.
19:07:10.5 **Pilot**	prepare yourself for exiting the helicopter.		
19:07:10.8 **CAM**	[Sound similar to increase in rotor pitch, similar to helicopter in autorotative flare.]		
19:07:14.9 **CAM**	[Sound of impact began and lasted until 19:07:15.3.]		
		19:07:15.37	During impact, the float was cylindrical in shape and beginning to face forward toward it's inflated position. A number of wrinkles were visible in the float's cylindrical surface. At the same time, the water's surface appeared smooth with some light ripples. **Figure 3 is a redacted screenshot captured at this time. The figure shows the condition of the float.**
		19:07:15.43	The left float appeared to make contact with water.
19:07:15.5 **PS-4**	whoa. #.		
		19:07:15.53	The camera's rolling shutter exhibited signs of impact and G force in the Z-axis. PS-4's headset was knocked off in the impact. The camera's position changed slightly after impact. Only PS-2,-3 and -4 were visible. They appeared conscious and free from any obvious signs of blunt force trauma.
		19:07:15.77	Water was splashing around the area around the helicopter.

Audio Transcript		Video Comments	
19:07:15.9 **CAM**	[Sound of intermittent mid frequency horn.]		
		19:07:16.02	Water splashed into the cabin of the helicopter.
		19:07:16.70	The visual signatures of impact lessened, water came into the cabin at the left door near the floorboard level of the helicopter. The floor was flooded near the occupants' feet.
		19:07:17.57]	PS-2 grabbed the assist handle on the left side of the helicopter's cabin, steadying himself.
19:07:18.8 **PS-4**	how do I cut this #?		
		19:07:18.92	PS-2 slid back to Seat 1 position. PS-2 was leaning backward toward the pilot's seat and looked toward PS-4.
		19:07:19.38	PS-4 looked down toward the region of where his factory installed helicopter restraint would have been located.
19:07:19.7 **Pilot**	EVERYBODY-- [Spoken in an excited tone.]		
19:07:20.1 **CAM**	[Sound similar to rotor blade striking water.]		
19:07:20.4 **CAM**	[Sound of water sloshing.]		
19:07:20.4 **CAM**	[Sound similar to rotor blade striking water.]		
19:07:20.7 **CAM**	[Sound similar to rotor blade striking water.]		
19:07:20.9 **PS-5?/6?**	[Sound similar to person panting.]		

19:07:21.2 **CAM** [Sound similar to rotor blade striking water.]

19:07:21.8 **CAM** [Sound similar to rotor blade striking water.]

19:07:22.28 The helicopter was not sitting level in the water. The helicopter was pitched forward and rolled slightly right. Water was coming up into the cabin at the floorboard level on the left side of the helicopter. The water surface condition appeared calm with small ripples, in other areas around the helicopter, the water's condition looked slightly wind blown. **Figure 4 is a redacted screenshot at this time. The figure shows the condition of the float and the surface condition of the water.**

19:07:22.5 **PS-5?/6?** #.

19:07:22.67 PS-2 looked downward toward his chest and used both hands and manipulated the shoulder strap portions of his supplemental restraint. PS-2 performed this action until water later covered the GoPro's lens.

19:07:23.67 PS-4 brought his left arm across his body toward the area of his right chest where the hook knife was previously visible. PS-4 looked down toward his right chest. The hook knife was never visible in his hand. PS-3 looked downward toward her chest.

19:07:24.63 PS-4 pivoted his body and looked toward the hardpoint where PS-4's tether was installed. The helicopter was rolled significantly right.

19:07:25.33 **Figure 5 is a redacted screenshot at this time. The figure shows the condition of the float and the surface condition of the water.**

Audio Transcript		Video Comments	
19:07:25.5 **CAM**	[Sound similar to camera microphone being submerged in water.]		
		19:07:25.82	PS-4 grabbed the outboard edge of Seat-2 on the left side of the helicopter. The helicopter had rolled right significantly and PS-4 was making an upward motion toward the left open door of the helicopter. PS-4's headset was tethered to the rear of his supplemental harness, the headset cable became taut.
		19:07:26.13	PS-3 was still seated and her factory installed helicopter restraint was still fastened as was visible earlier. PS-3's headset was still on and moved forward over her head, rotated forward over part of her eyes.
		19:07:26.27	Water began obscuring the GoPro's lens. PS-4 was still at the left door of the helicopter, his headset cable still taut.
		19:07:26.43	The GoPro's lens became completely covered in water.
19:07:26.9 **CAM**	[Sound of three loud thumps in rapid succession.]		
		19:07:31.08	The GoPro video became mostly black due to the water and remained this way for most of the rest of the recording.
[End of Detailed Transcript] 19:07:31.08			
19:07:31.08 **CAM**	[Until 19:08:30, sounds attributed to occupant movement.]		
19:08:30 **CAM**	[Between 19:08:30 and 19:10:42.9, almost no noise was detected.]		
19:10:42.9			

Audio Transcript		Video Comments
CAM	[Last sound potentially attributed to a passenger. Sound lasted for approximately 14 seconds.]	
19:10:56 **CAM**	[Between 19:10:56 and 19:23:29.9, almost no significant noise was detected.]	
19:23:29.9 **CAM**	[Start of mechanical noise similar to a boat maneuvering. Variations of this noise were heard for the majority of the remainder of the recording.]	
19:38:10.9 **CAM**	[Sound similar to Self-Contained Underwater Breathing Apparatus (SCUBA). Sounds continued intermittently until nearly the end of the recording.]	
[End of Recording] 20:17:38.8	[The recording ended, likely due to camera battery exhaustion.]	

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