Midair Collision Over Hudson River
Piper PA-32R-300, N71MC
and Eurocopter AS350BA, N401LH
Near Hoboken, New Jersey
August 8, 2009

Aircraft Accident Summary Report

NTSB/AAR-10/05
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National
Transportation
Safety Board

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Washington, D.C. 20594

National Transportation Safety Board. 2010. ***Midair Collision Over Hudson River, Piper PA-32R-300, N71MC and Eurocopter AS350BA, N401LH Near Hoboken, New Jersey, August 8, 2009*.** **Aircraft Accident Summary Report NTSB/AAR-10/05. Washington, DC.**

Abstract: This accident summary report discusses the August 8, 2009, accident involving a Piper PA-32R-300 airplane, N71MC, and a Eurocopter AS350BA helicopter, N401LH, operated by Liberty Helicopters, which collided over the Hudson River near Hoboken, New Jersey. The pilot and two passengers aboard the airplane and the pilot and five passengers aboard the helicopter were killed, and both aircraft received substantial damage from the impact. The airplane flight was operating under the provisions of 14 *Code of Federal Regulations* (CFR) Part 91, and the helicopter flight was operating under the provisions of 14 CFR Parts 135 and 136. No flight plans were filed or were required for either flight, and visual meteorological conditions prevailed at the time of the accident. The safety issues discussed in this report address changes within the recently designated special flight rules area (SFRA) surrounding the Hudson River corridor, vertical separation among aircraft operating in the Hudson River SFRA, the see-and-avoid concept, and helicopter electronic traffic advisory systems. Five new safety recommendations to the Federal Aviation Administration are included in the report.

Contents

Figures

Abbreviations

AC	advisory circular
ASR	airport surveillance radar
ATC	air traffic control
ATCT	air traffic control tower
ATIS	automatic terminal information service
CFR	*Code of Federal Regulations*
CTAF	common traffic advisory frequency
ENG	electronic news gathering
EWR	Newark Liberty International Airport
FAA	Federal Aviation Administration
IFR	instrument flight rules
JFK	John F. Kennedy International Airport
JRA	West 30th Street Heliport
JRB	Downtown Manhattan Heliport
LGA	LaGuardia Airport
MSL	mean sea level
nm	nautical mile
NTSB	National Transportation Safety Board
SFRA	special flight rules area
TCAS	traffic collision and avoidance system
TEB	Teterboro Airport
TIS	traffic information service

TRACON	terminal radar and approach control
TSO	technical standard order
VFR	visual flight rules

Executive Summary

On August 8, 2009, at 1153:14 eastern daylight time, a Piper PA-32R-300 airplane, N71MC, and a Eurocopter AS350BA helicopter, N401LH, operated by Liberty Helicopters, collided over the Hudson River near Hoboken, New Jersey. The pilot and two passengers aboard the airplane and the pilot and five passengers aboard the helicopter were killed, and both aircraft received substantial damage from the impact. The airplane flight was operating under the provisions of 14 *Code of Federal Regulations* (CFR) Part 91, and the helicopter flight was operating under the provisions of 14 CFR Parts 135 and 136. No flight plans were filed or were required for either flight, and visual meteorological conditions prevailed at the time of the accident.

The National Transportation Safety Board determines that the probable cause of this accident was (1) the inherent limitations of the see-and-avoid concept, which made it difficult for the airplane pilot to see the helicopter until the final seconds before the collision, and (2) the Teterboro Airport local controller's nonpertinent telephone conversation, which distracted him from his air traffic control (ATC) duties, including correcting the airplane pilot's read back of the Newark Liberty International Airport (EWR) tower frequency and the timely transfer of communications for the accident airplane to the EWR tower. Contributing to this accident were (1) both pilots' ineffective use of available electronic traffic information to maintain awareness of nearby aircraft, (2) inadequate Federal Aviation Administration (FAA) procedures for transfer of communications among ATC facilities near the Hudson River Class B exclusion area, and (3) FAA regulations that did not provide adequate vertical separation for aircraft operating in the Hudson River Class B exclusion area.

Previous safety recommendations issued to the FAA addressed standard operating procedures for the Hudson River Class B exclusion area, ATC performance deficiencies, the designation of a special flight rules area (SFRA) for the Hudson River Class B exclusion area and surrounding areas, and standard operating procedures within and training for SFRAs. The safety issues discussed in this report address changes within the recently designated SFRA surrounding the Hudson River corridor, vertical separation among aircraft operating in the Hudson River SFRA, the see-and-avoid concept, and helicopter electronic traffic advisory systems. Five new safety recommendations to the FAA are included in the report.

1. The Accident

1.1 History of the Flight

On August 8, 2009, at 1153:14 eastern daylight time,[1] a Piper PA-32R-300 airplane, N71MC, and a Eurocopter AS350BA helicopter, N401LH, operated by Liberty Helicopters, collided over the Hudson River near Hoboken, New Jersey. The pilot and two passengers aboard the airplane and the pilot and five passengers aboard the helicopter were killed, and both aircraft received substantial damage from the impact. The airplane flight was operating under the provisions of 14 *Code of Federal Regulations* (CFR) Part 91, and the helicopter flight was operating under the provisions of 14 CFR Parts 135 and 136.[2] No flight plans were filed or were required for either flight, and visual meteorological conditions prevailed at the time of the accident.

The pilot of the accident airplane was conducting a personal flight from Wings Field Airport, Philadelphia, Pennsylvania, to Ocean City Municipal Airport, Ocean City, New Jersey, with a stopover at Teterboro Airport (TEB), Teterboro, New Jersey,[3] to pick up a passenger. The pilot of the accident helicopter was conducting a local sightseeing flight from the West 30th Street Heliport (JRA), New York, New York.

1.1.1 The Airplane

According to the air traffic control (ATC) transcript, the accident airplane pilot contacted the clearance delivery controller at the TEB air traffic control tower (ATCT) at 1140:01. The pilot advised the controller of the airplane's route of flight and intended en route altitude (3,500 feet)[4] and requested departure clearance and traffic advisories (also known as flight-following services). The pilot then contacted the TEB local controller at 1141:50, indicating that he was ready to taxi the airplane for departure, and the controller provided the pilot with taxi instructions.[5] At 1142:21, while the airplane was taxiing, the local controller asked the pilot whether he was "gonna be requesting…v f r [visual flight rules] down the river to Ocean City or just…southwest bound." The pilot replied that he would take whichever route was the most direct to his destination. The local controller stated, "okay just…let me know so I know who [to] coordinate [the] handoff with," to which the pilot responded, "I'll take down the river [that would] be fine."

Because the pilot requested routing over the Hudson River and planned an en route altitude of 3,500 feet, he was required to contact controllers at Newark Liberty International

[1] All times in this report are eastern daylight time based on a 24-hour clock.

[2] Part 136 applies to commercial air tours and national parks air tour management.

[3] The recorded weather at TEB, which is about 8 miles from the accident site, indicated the following: wind variable at 3 knots, visibility 10 statute miles, sky clear, temperature 24° C (75° F), dew point 7° C, and altimeter 30.23 inches of Mercury.

[4] All altitudes in this report are expressed as mean sea level.

[5] The controller's taxi instructions are discussed further in section 2.3.2.

Airport (EWR), Newark, New Jersey, for authorization to climb into Class B airspace[6] after the flight was transferred from TEB to EWR. The Hudson River Class B exclusion area, which comprises Class E and Class G airspace,[7] provides passage below the Class B airspace. (ATC clearance directly into Class B airspace allows aircraft to climb above the exclusion area.) At the time of the accident, the Class B exclusion area extended from the surface of the Hudson River up to, and including, 1,100 feet.[8]

At 1148:15, the pilot indicated that the airplane was ready for departure, and the TEB local controller then cleared the airplane for takeoff and instructed the pilot to make a left turn to the southeast (to avoid entering EWR airspace and the final approach course for EWR runway 22) and maintain 1,100 feet or below. Afterward, the controller contacted the pilot of an inbound Bell 407 helicopter to advise him of the departing traffic.

At 1150:02, the TEB local controller contacted the airplane pilot to determine the airplane's altitude. The local controller then identified the airplane on his radar display and executed an electronic radar handoff of the airplane to the EWR Class B airspace controller but did not transfer radio communications.[9] Afterward, the controller advised the pilot of nearby traffic (the inbound Bell 407 helicopter).[10] The controller then advised the pilot that the Bell 407 pilot had the airplane in sight and would maintain visual separation. The controller provided no further advisories of known or observed traffic to the airplane pilot.

At 1150:32, the TEB controller initiated a telephone call (via a recorded landline) to airport operations that was unrelated to his work.[11] During the call, at 1151:17, the controller instructed the airplane pilot to start a left turn to join the Hudson River, which the pilot acknowledged. The pilot was not advised to self-announce the airplane's position on the

[6] Class B airspace is intended to provide positive control of flight operations near the busiest U.S. airports and separate aircraft operating under VFR from aircraft operating in an airport terminal area. The Federal Aviation Administration (FAA) has designated as Class B airspace the area surrounding EWR; John F. Kennedy International Airport (JFK), Jamaica, New York; and LaGuardia Airport, Flushing, New York. The Class B airspace overlying TEB begins at an altitude of 1,800 feet. According to 14 CFR 91.131, "Operations in Class B Airspace," all aircraft operating within Class B airspace are required to obtain ATC clearance before entry and comply with ATC instructions while operating within the airspace.

[7] Class E and Class G airspace allow pilots to operate under VFR without ATC services. The main difference between Class E and Class G airspace is the minimum ceiling and visibility requirements for flight under VFR. At the time of the accident, the Hudson River Class B exclusion area was Class E airspace from 700 to 1,100 feet and Class G airspace from the surface to 700 feet.

[8] After the accident, the FAA revised the New York airspace (as discussed further in section 3.1.3), and the Class B exclusion area now extends from the surface of the Hudson River up to, but not including, 1,300 feet. Similarly, class E airspace now extends from 700 feet up to, but not including, 1,300 feet.

[9] An electronic radar handoff transfers a radar data block from one controller to another. A controller initiates this process by "flashing" the radar data block to the receiving controller. Once the receiving controller accepts the electronic radar handoff, the radar data block no longer flashes and is modified so that both controllers know that the handoff is complete. Afterward, the controller that initiated the electronic radar handoff directs the pilot to contact the receiving controller so that radio communications can also be transferred.

[10] At that time, the airplane was climbing through an altitude of 400 feet, and the Bell 407 helicopter was at an altitude of 1,000 feet.

[11] According to the ATC recordings, the TEB controller had initiated a previous personal telephone call to airport operations that began at 1135:01 and ended at 1136:40. During that time, a Learjet 40 pilot contacted the tower three times between 1135:04 and 1135:27 to receive authorization to taxi. The controller provided the pilot with taxi instructions between 1135:30 and 1136:00.

common traffic advisory frequency (CTAF)[12] while operating along the Hudson River corridor; such instructions were not required to be provided by ATC and would not have been expected in this case because of the anticipated handoff to the next ATC facility along the airplane's route of flight.

Also during the telephone call, at 1152:19, the TEB controller instructed the airplane pilot to contact the EWR ATCT on a frequency of 127.85 megahertz. The pilot responded to the TEB controller's instruction at 1152:20 and stated, "one two seven point eight."[13] (This transmission was the last communication between the pilot and ATC.) Also at 1152:20, the EWR Class B airspace controller contacted the TEB controller, asking him to transfer communications for the flight (which the TEB controller had already done) and put the airplane on a heading of 220° so that the airplane could stay away from other traffic over the Hudson River and remain clear of the final approach course for runway 22 at EWR. (At that time, the accident helicopter was not yet visible on radar.) At 1152:28, the TEB controller asked the EWR controller to repeat the instruction, which he did, and then the TEB controller attempted to contact the airplane's pilot at 1152:37 and 1152:48 but received no response.

The TEB controller's telephone conversation with airport operations ended at 1153:10. About 7 seconds later, the TEB controller asked the EWR controller about the status of the airplane and was told that the pilot had not made contact.

1.1.2 The Helicopter

The accident helicopter departed from JRA at 1152:00 for a planned 12-minute tour that included a climb westbound across the Hudson River to an altitude of 1,000 feet and a turn southbound to follow the west bank of the river toward the Statue of Liberty. Such tours were narrated by the pilot of the flight.[14] The heliport and most of the tour route were in the Hudson River Class B exclusion area; thus, the helicopter pilot was not required to contact ATC and did not do so.[15] The first radar target for the accident helicopter was detected at 1152:28; at that time, the helicopter was located west of the heliport and near the midpoint of the river and was climbing through 400 feet.[16] The radar data also showed that the helicopter flew to the west side

[12] The CTAF (123.05 megahertz for the Hudson River corridor) allows pilots to exchange traffic information while operating in that airspace.

[13] The FAA-certified ATC transcript showed the pilot's transmission as "one two seven point (unintelligible)." The TEB ATCT's local and ground control frequencies are also recorded by airport operations at TEB. Although these recordings were not transcribed or certified, a comparison of the recorded local control frequency with the ATC transcript showed that the pilot's transmission was "one two seven point eight."

[14] Liberty Helicopters had implemented an FAA-approved air tour safety plan that established procedures, routes of flight, and requirements for air tour operations along the Hudson River corridor. The plan was developed along with three other air tour operators in the corridor and included a letter of agreement, dated April 1, 2007, with the LaGuardia Airport (LGA) and EWR ATCTs for the operation and control of VFR helicopters within the Class B airspace below 2,000 feet.

[15] The Hudson River Class B exclusion area permitted aircraft to fly north and south along the Hudson River, approximately between the George Washington Bridge to the north and the Verrazano Narrows Bridge to the south, without authorization from ATC. The helicopter pilot would have been required to contact the LGA ATCT toward the end of the tour route when the helicopter would have flown northbound over the eastern shore of the river and would have climbed up to 1,500 feet into Class B airspace.

[16] Radar data are accurate to within ± 50 feet.

of the river, turned to the south to follow the river, and continued to climb to an altitude of 1,100 feet.

During a postaccident interview, a Liberty Helicopters pilot, who was waiting to depart from JRA, stated that the accident helicopter pilot made a position report on the CTAF when the helicopter was over Stevens Institute of Technology in Hoboken,[17] which, according to the pilot, is a common reporting point for traffic flying southbound along the Hudson River. The pilot also stated that, at the time of the position report (a few seconds before the accident), he saw the airplane approaching the helicopter from behind and to the right. The pilot further stated that he transmitted a traffic advisory to the accident helicopter pilot on the CTAF to alert him about the airplane's location, but, before transmitting this advisory, the pilot had to wait until after the accident helicopter pilot completed his position report (because only one transmission at a time is possible on a single frequency). The accident helicopter pilot did not respond to the advisory.

1.1.3 The Collision

According to radar data, the collision occurred at 1153:14 at an altitude of 1,100 feet and a groundspeed of about 150 knots for the airplane and about 93 knots for the helicopter. The accident airplane and helicopter then fell into the Hudson River.[18] Radar data also showed that, between 1152:33 and 1153:24, a conflict alert[19] for the accident airplane and an aircraft with a transponder beacon code of 1200 (which the helicopter was using)[20] was generated 11 times to the TEB local controller and the EWR Class B airspace controller, but neither controller recalled seeing or hearing a conflict alert on his radar display during that time.[21]

The collision was witnessed by numerous people in the area and was reported to local emergency personnel, who arrived on scene after receiving the reports. During postaccident interviews, witnesses to the accident indicated that neither aircraft was maneuvered to avoid the other aircraft. A video obtained during the investigation (which was recorded by a ferry boat passenger on the Hudson River) showed that the airplane appeared to roll to the right just before the collision.

The National Transportation Safety Board (NTSB) performed an aircraft performance radar and cockpit visibility study using EWR Airport Surveillance Radar (ASR)-9 data to

[17] Transmissions on the CTAF are not recorded; thus, the content of the helicopter pilot's transmission is not known. Page 3-17 of Liberty Helicopters' *Operations Manual*, dated August 2002, stated, "all helicopters monitor 123.05 in the Hudson River Corridor" and "pilots entering the NY VFR exclusion [area] will announce their ID, location, route, destination, and altitude."

[18] The airplane's wings and the helicopter's main rotor and transmission were not recovered at the accident site.

[19] Certain ATC automated systems generate conflict alerts, which are aural and visual warnings to radar controllers of existing or pending situations among tracked targets (that is, aircraft operating under either instrument flight rules or VFR). Conflict alerts require a controller's immediate attention and action. Three other conflict alerts were generated during that time for the accident airplane and another aircraft.

[20] This transponder code indicates VFR flight. The accident airplane (and all other aircraft shown on the controllers' radar displays during the time of the conflict alerts) had discrete transponder codes assigned by ATC.

[21] On July 12, 2006, the National Transportation Safety Board issued Safety Recommendation A-06-44 to the FAA to improve systems used to direct a controller's attention to potentially hazardous situations. Safety Recommendation A-06-44 is further discussed in section 2.2.

calculate the position and orientation of each aircraft in the minutes preceding the accident.[22] Figure 1 shows the ground tracks of the accident aircraft and the collision location over a Google Earth™ image of the Hudson River Class B exclusion area along with each aircraft's mode C-reported altitudes at each data point. This information was used to estimate the approximate location of each aircraft during the same time as viewed from the other aircraft's windscreen and the traffic information that could have been presented on the navigation display in each aircraft, as discussed in section 2.2. Figure 2 shows the Class B exclusion area in relation to the surrounding Class B airspace. The accident aircraft ground tracks just before the collision are also depicted.

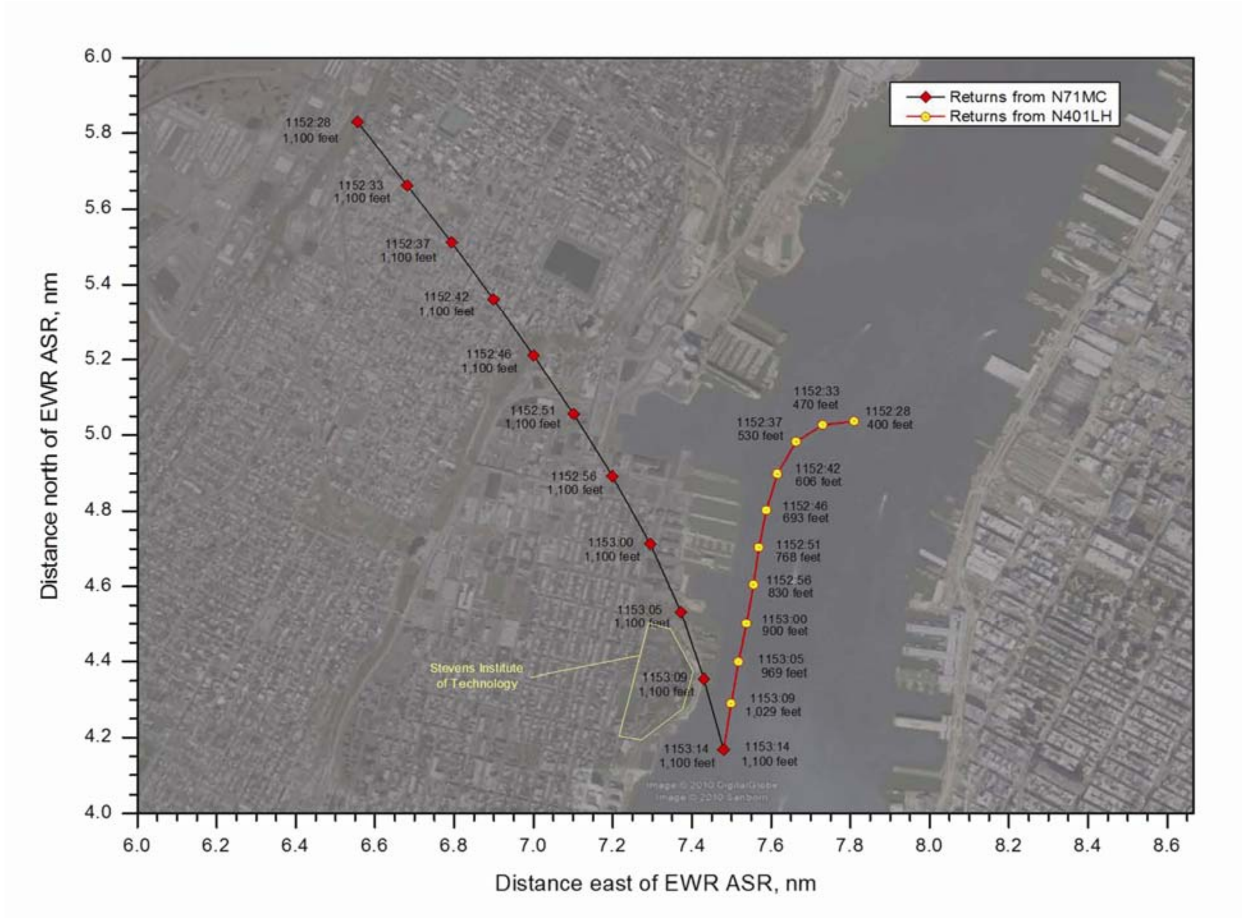
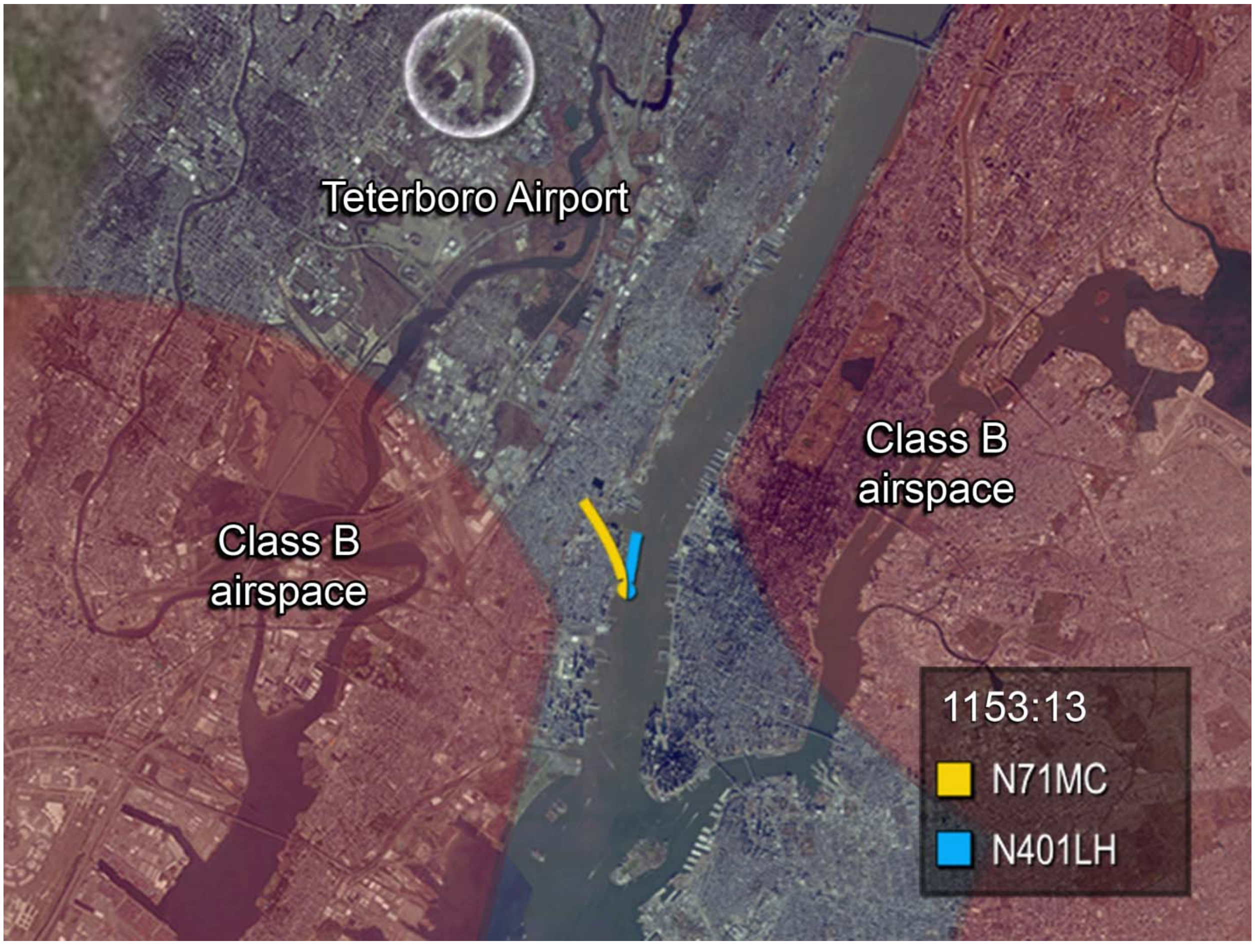


Figure 1. Accident aircraft ground tracks.

[22] ASRs are short-range radars (60 nautical miles [nm]) used to provide ATC services in terminal areas. ASR antennas rotate at a speed of about 13 rpm, resulting in a radar return about every 4.6 seconds. The ASR-9 radar at JFK also received returns from both aircraft, but the EWR ASR-9 radar was used for the study because the radar was closer to the accident site than the JFK ASR-9 radar and detected the accident helicopter at a lower altitude. All of the radar data associated with the accident aircraft were based on secondary returns (signals from the aircraft transponders) because no primary returns (signals reflected from the aircraft) were identified.



Note: The Class B airspace over EWR, shown on the left, extends from 500 to 7,000 feet. The Class B airspace over LaGuardia Airport, shown on the right, extends from the surface to 7,000 feet.

Figure 2. Hudson River Class B exclusion area.

1.2 Pilot Information

1.2.1 The Airplane Pilot

The airplane pilot, age 60, received a Federal Aviation Administration (FAA) private pilot certificate (airplane single- and multiengine land-instrument airplane) on August 20, 2001, and his most recent certificate was dated December 5, 2008. The pilot's third-class FAA medical certificate was issued on May 14, 2009, with the limitation that the certificate holder must have available glasses for near vision. (The NTSB could not determine whether the airplane pilot was wearing corrective lenses at the time of the accident.)

The airplane pilot's most recent biennial flight review was completed on November 12, 2008, and his last instrument proficiency check occurred on May 17, 2009. According to his logbook, the pilot had accumulated 1,121 hours total flight time, with 834 hours in the Piper

PA-32, and had flown 18 hours in the 90 days preceding the accident and about 1 hour in the 30 days before the accident. FAA records indicated no accidents, incidents, violations, or pending investigations.

During a postaccident interview, the pilot's wife stated that he would normally go to bed between 2200 and 2300 and wake up between 0600 and 0630. She characterized the pilot as a "morning person" who normally needed 7 hours of sleep to feel rested and stated that he had no difficulty sleeping and never complained about being tired during the day. She reported that his activities during the 72 hours that preceded the accident were unremarkable and that he maintained his normal schedule except on the morning of the accident when he woke between 0630 and 0700. On the day of the accident, an employee of a fixed-base operator at Wings Field Airport saw the accident airplane taxi for departure about 1000.

1.2.2 The Helicopter Pilot

The helicopter pilot, age 32, received an FAA commercial pilot certificate (rotorcraft-helicopter) on June 11, 2005, and his commercial pilot certificate (rotorcraft-helicopter-instrument helicopter) on May 16, 2008. The pilot's second-class FAA medical certificate was issued on June 16, 2009, with the limitation that the certificate holder must wear corrective lenses. (The NTSB could not determine whether the helicopter pilot was wearing corrective lenses at the time of the accident.) He had worked for Liberty Helicopters since February 2008.

Liberty Helicopters' records showed that the helicopter pilot had accumulated 2,741 hours total flight time, with 781 hours in the AS350. The records also showed that the pilot's last recurrent ground training occurred on January 28, 2009; his last recurrent flight training occurred on February 1, 2009; and his last proficiency check occurred on March 24, 2009. The records further showed that the pilot had flown 182 hours, 74 hours, and 23 hours, in the 90, 30, and 7 days, respectively, preceding the accident. FAA records indicated no accidents, incidents, violations, or pending investigations.

During a postaccident interview, the helicopter pilot's fiancée stated that he would normally go to sleep between 2200 to 2230 and that his awakening time varied according to his schedule. She indicated that, on August 5, 2009, he woke about 0730. (She did not know his awakening time on August 6 through 8.) She described the pilot as a "morning person" and indicated that he did not have any problems sleeping. She also reported that his activities in the 72 hours that preceded the accident were "normal" and "routine." Telephone records showed that his last recorded activity on August 5 was a 6-minute outbound call at 2122. On August 6, the pilot made a 3-minute call at 0737, and his last recorded activity was a 9-minute outbound call at 2128. On August 7, the pilot made a 1-minute call at 0722, and his last recorded activity was a text message sent at 2213.[23] On August 8, the pilot sent a text message at 0730.

Liberty Helicopters' records showed that, even though the pilot was not scheduled to work on August 5, 2009, the company called and asked him to work. He was on duty from 1300

[23] The helicopter pilot's roommate reported that, on the night before the accident, he and the pilot watched a baseball game on television. Although the pilot's actual bedtime is unknown, his roommate stated that they both went to sleep before the baseball game ended (0040 on the day of the accident).

to 1955 (with 2 hours of flight time). The records also showed that the pilot worked from 0815 to 1915 on August 6 (with 4.4 hours of flight time) and 1000 to 2205 on August 7 (with 6.1 hours of flight time). On August 8 (the day of the accident), the pilot reported to work at 0830 and conducted one repositioning flight (from Linden Airport, Linden, New Jersey, to JRA) and four air tour flights (the last of which ended about 1035) before the accident flight.

1.2.3 Toxicological Testing

Postaccident toxicological testing was performed on tissue specimens from both pilots by the FAA's Civil Aerospace Medical Institute. The specimens from both pilots tested negative for a wide range of drugs, including major drugs of abuse. Although specimens from the airplane pilot tested positive for ethanol, the levels of ethanol were consistent with postmortem ethanol production. Specimens from the helicopter pilot tested negative for ethanol.

1.3 Aircraft Information

The Piper PA-32 is a high-performance, single-engine, low-wing airplane with a conventional tail. The Eurocopter AS350 is a small, single-engine, light helicopter with a tailboom. The helicopter was equipped with high-visibility rotor blades, strobe anticollision lights, and pulsing landing and taxi lights.[24] The accident aircraft were current on all required maintenance and inspections.

The accident aircraft were capable of receiving data from the FAA's traffic information service (TIS), which provides pilots of appropriately equipped aircraft[25] with an automatic display of radar-derived traffic information in the cockpit to assist them in visually acquiring nearby aircraft that pose a collision threat. TIS data are uplinked during each radar scan, which occurs about every 5 seconds. The aircraft receiving TIS traffic alerts are referred to as "client" aircraft, and the aircraft triggering the alerts are referred to as "intruder" aircraft.

TIS uses an enhanced capability of mode S radar systems installed near select U.S. major airports, including EWR and John F. Kennedy International Airport (JFK), Jamaica, New York.[26] TIS provides pilots with the estimated position, relative altitude, altitude trend, and ground track information for a maximum of eight intruder aircraft located within 7 nautical

[24] In January 1996, Liberty Helicopters and other helicopter air tour operators established a voluntary safety program for air tour operations. The February 2007 document describing this program, the Tour Operators Program of Safety (also known as TOPS), recognized that aircraft conspicuity was essential in helping to avoid collisions during helicopter air tour operations. The document indicated that high-visibility rotor blades and at least one anticollision light were required to be used at all times (except when the pilot deems it inappropriate for safety reasons).

[25] To receive TIS data, aircraft must be equipped with an altitude-encoding mode S transponder, a processor with TIS software that is capable of receiving the datalink, and a display for the traffic information. Both accident aircraft were equipped with a Garmin GTX 330 mode S transponder. In the airplane, the transponder was connected to a Garmin GNS 530 navigation and communication system; in the helicopter, the transponder was connected to a Garmin GNS 430 navigation and communication system.

[26] The coverage area of a mode S radar site is typically up to 55 nm. The mode S radar at EWR is located about 8.5 nm from the accident site and about 12 nm from TEB. The mode S radar at JFK is located about 13 nm from the accident site and about 18 nm from TEB.

miles (nm) horizontally and +3,500 feet/-3,000 feet vertically.[27] Also, TIS provides an aural and a visual alert to pilots when intruder aircraft are projected to come within a 0.5-nm radius and ± 500 feet of the client aircraft within 34 seconds. One limitation of TIS (and other traffic advisory systems that rely on data from radar systems)[28] is that radar systems cannot resolve distances that are less than 1/8 nm between the client and the intruder aircraft.

TIS operates automatically without pilot intervention. The unit switches automatically from standby to operating mode once the aircraft is airborne and switches back to standby mode once the aircraft has landed. TIS has no volume control, but the system can be manually configured, using a sequence of input commands, to standby mode to inhibit the presentation of traffic information. Additional information about TIS is discussed in section 2.2.2.

[27] Intruder aircraft must have an operating mode A, C, or S transponder; aircraft without an operating transponder cannot be detected by TIS.

[28] The term "traffic advisory system" is used generally rather than specifically throughout this report.

2. Investigation and Analysis

2.1 General

Both pilots were properly certificated and qualified in accordance with applicable federal regulations. Available evidence suggested that the airplane pilot was not likely affected by fatigue at the time of the accident. The helicopter pilot had an opportunity to obtain sufficient sleep before the day of the accident, but it is unknown if he did so; as a result, no assessment about fatigue could be made for the helicopter pilot. Both aircraft were properly certified, equipped, and maintained in accordance with federal regulations, and the recovered components showed no evidence of any preimpact structural, engine, or system failures.

The reported weather near the accident location indicated 10-mile visibility with clear skies. A prevalent factor in many midair collisions during visual meteorological conditions is sun glare, which prevents a pilot from detecting another aircraft when it is close to the position of the sun in the sky. At the time of the accident, the sun's angle was about 61° above the horizon at an azimuth of about 144°. For the airplane pilot, the sun would have been horizontally aligned in the general direction from which the helicopter was visible, but the sun's angle above the horizon would have placed the sun near the top of the airplane's windscreen. Also, any glare caused by the sun's reflection from the Hudson River would have emanated from a point below the airplane that would have been obscured by the airplane's structure. For the helicopter pilot, the sun's position would have been to his left and not in the direction from which the airplane could have been visible. Thus, weather was not a factor in this accident, and sun glare would not have interfered with the pilots' ability to detect and track the other aircraft.

The Office of the Chief Medical Examiner, City of New York, determined that the cause of death for all of the airplane and helicopter occupants was "blunt impact injuries." The accident was not survivable.

2.2 Accident Sequence

Both aircraft were being operated in a high-density traffic area under the see-and-avoid concept. (The airplane had a discrete transponder code, and the pilot was expecting traffic advisories from ATC, as discussed further in the next paragraph.) Pilots operating under VFR are responsible for maintaining separation from other aircraft. To mitigate the risk of collision, pilots need to visually identify aircraft operating in the vicinity and maneuver to stay clear of the aircraft. The *Federal Aviation Regulations* emphasize the importance of these tasks. For example, 14 CFR 91.111(a), "Operating Near Other Aircraft," states, "no person may operate an aircraft so close to another aircraft as to create a collision hazard." Also, 14 CFR 91.113(b), "Right-of-Way Rules," states, "when weather conditions permit, regardless of whether an operation is conducted under instrument flight rules [IFR] or visual flight rules, vigilance shall be maintained by each person operating an aircraft so as to see and avoid other aircraft." In addition, Advisory Circular (AC) 90-48C, "Pilots' Role in Collision Avoidance," states that the see-and-avoid concept requires vigilance at all times by each person operating an aircraft regardless of whether the flight is conducted under IFR or VFR.

Before the accident airplane departed from TEB, the pilot contacted the clearance delivery controller to request an en route altitude of 3,500 feet and traffic advisories throughout the flight. Afterward, the local controller provided the pilot with two departure options: over the Hudson River or to the southwest. At first, the pilot indicated that he wanted the most direct route to his destination and could accept either departure option. The controller stated, “okay just…let me know so I know who [to] coordinate [the] handoff with.” The pilot then requested routing “down the river.” On the basis of these exchanges and the airplane’s discrete transponder code, the pilot most likely expected that he would be provided with continual traffic advisories until the handoff to the next controller along the airplane’s route of flight. Also, it would have been reasonable for the pilot to have expected that the airplane would be cleared into Class B airspace well before the boundaries of the Class B exclusion area. The pilot most likely did not recognize that, by accepting routing “down the river,” he might be entering the Class B exclusion area and would need to monitor the CTAF and heighten his surveillance of other traffic.

At 1148:22, the TEB local controller instructed the airplane pilot to remain at or below 1,100 feet and cleared the airplane for takeoff. After radar identifying the airplane, the local controller executed an electronic radar handoff of the accident airplane to the EWR Class B airspace controller but did not transfer radio communications for the flight at that point. At 1150:08, the local controller advised the pilot of nearby traffic (an inbound Bell 407 helicopter), and the pilot responded by indicating that he was looking for the helicopter. At 1150:17, the controller advised the airplane pilot that the Bell 407 helicopter pilot had the airplane in sight. These advisories would most likely have reinforced the pilot’s expectation that he would be receiving traffic advisories from the TEB controller until a transfer of radio communications had occurred.

At this point, with the potential conflict resolved, the controller should have transferred radio communications for the flight to the EWR Class B airspace controller instead of waiting until later in the flight. FAA Order 7110.65, “Air Traffic Control,” paragraph 5-4-5, “Transferring Controller,” states that controllers are to complete a radar handoff, which includes an electronic radar handoff and a transfer of communications, by the transfer-of-control point. (At the time of the accident, the transfer-of-control point was the Lincoln Tunnel.) Paragraph 5-4-5 also states, “to the extent possible, transfer communications when the transfer of radar identification has been accepted.” For the accident airplane, the transfer of radar identification was accomplished immediately after departure with the electronic radar handoff.

The EWR ATCT was the appropriate facility to provide advisory services for the flight because EWR was responsible for managing the traffic transiting the area within the Class B airspace, whereas TEB was responsible for managing the traffic within the airspace surrounding that airport. Also, ATC procedures did not require TEB controllers to coordinate Class B airspace clearances for pilots. In addition, the electronic radar handoff of the accident airplane to EWR had already occurred, and the controller’s workload would have allowed a transfer of communications for the flight at that point. The NTSB concludes that the TEB local controller unnecessarily delayed transferring communications for the accident airplane from TEB to EWR, which prevented the EWR controller from turning the airplane away from Hudson River traffic and having the airplane climb directly into Class B airspace. Because the TEB local controller had not yet transferred communications for the flight, he was responsible for providing further traffic advisories to the pilot.

Radar data showed that the airplane had leveled off at an altitude of about 1,100 feet at 1151:09. The controller instructed the airplane pilot at 1151:17 to start a left turn to join the Hudson River, which the pilot acknowledged. At that time, the controller could have instructed the pilot to contact the EWR controller, thereby completing the handoff. Also, when the airplane turned to the left toward the Hudson River at 1151:22, no apparent traffic conflicts would have precluded the airplane from climbing into the Class B airspace to the pilot's requested altitude of 3,500 feet. However, because ATC procedures did not require TEB controllers to coordinate Class B airspace clearances for pilots,[29] the airplane could not expeditiously enter the Class B airspace and thus continued toward the Hudson River Class B exclusion area.

At 1152:19, the airplane was about 2 miles west of the western shore of the Hudson River and about 2 miles away from the accident location. At that time, the TEB local controller instructed the pilot to contact the EWR ATCT on a frequency of 127.85. The airplane pilot, however, read back the newly assigned EWR ATCT frequency as 127.8 rather than 127.85.

Also at 1152:19, the accident helicopter had just departed from JRA (which is on the eastern shore of the Hudson River) and was not yet visible on radar. Thus, at the time of the frequency change instruction, the TEB local controller could not have detected the impending conflict between the accident airplane and the accident helicopter or issued a warning to the airplane pilot about the helicopter. However, the TEB controller's radar display did show, as potential conflicts, three radar targets representing other aircraft in the Hudson River Class B exclusion area. Specifically, one radar target was southbound over the river at an altitude of 1,000 feet and was located at the airplane's 2:00 position about 3 miles away. The second radar target was northbound over the river at an altitude of 1,900 feet and was located at the airplane's 1:00 position about 2.5 miles away. The third radar target was northbound over the river at an altitude of 1,500 feet and was located at the airplane's 12:00 position about 2 miles away. The TEB local controller did not advise the accident airplane pilot of this traffic, even though the pilot had requested that traffic advisories be provided. The ATC transcript showed that the controller was engaged in a nonpertinent telephone conversation at this time, as discussed further in section 2.3.1, and his conversation resulted in a 2-minute 17-second delay between the times of the electronic radar handoff and the transfer of communications for the accident airplane.

According to FAA Order 7110.65, paragraph 2-1-2, controllers are expected to "give first priority to separating aircraft and issuing safety alerts." The order also states, in paragraph 2-1-1, that providing traffic advisories to VFR aircraft is an additional service that is "required when the work situation permits." The TEB local controller's workload was light at the time of the frequency change instruction; in addition to the accident airplane, he was working another outbound aircraft, an inbound aircraft, and one aircraft preparing to taxi. Even though the accident helicopter was not yet visible on radar at the time of the frequency change, radar data showed that other traffic was visible. As a result, the NTSB concludes that the TEB local controller did not provide continual traffic advisories to the airplane pilot, as required; such advisories would have heightened the pilot's awareness of traffic over the Hudson River. The NTSB further concludes that the airplane pilot may have believed that no other potential traffic conflicts existed because he had not received additional traffic advisories, but the pilot was still responsible for seeing and avoiding other traffic.

[29] This issue is further discussed in section 3.1.1.

In addition, the NTSB concludes that the TEB local controller did not correct the airplane pilot's read back of the EWR tower frequency because of the controller's nonpertinent telephone conversation and other transmissions that were occurring. Because the airplane pilot had likely entered an incorrect frequency, he would not have been able to receive traffic advisories until he returned to the TEB ATCT frequency or established contact on the correct EWR ATCT frequency.[30] (The correct EWR ATCT frequency appeared on the New York VFR Terminal Area Chart that was in effect at the time of the accident.)

The EWR Class B airspace controller observed the existing traffic in the Hudson River Class B exclusion area and, at 1152:20, called the TEB local controller to ask that he switch over communications and put the airplane on a 220° heading (a turn to the southwest) to avoid traffic over the Hudson River and remain clear of the final approach course for runway 22 at EWR. This communication indicated that the EWR controller had radar contact with the airplane and wanted to provide the pilot with traffic advisories. Also, the requested heading indicated that the controller wanted to provide a clearance into Class B airspace, which would have kept the airplane out of the Class B exclusion area. The call, however, overlapped the pilot's incorrect acknowledgment of the radio frequency change instruction, so the TEB controller requested that the EWR controller repeat his instruction. The TEB controller then attempted to contact the airplane pilot, but the pilot did not respond because he was most likely no longer monitoring the TEB tower frequency. The NTSB concludes that the airplane pilot's incorrect frequency selection, along with the TEB controller's failure to correct the read back, prevented the EWR controller from issuing instructions to the airplane pilot to climb and turn away from traffic.

The first radar target for the accident helicopter was detected at 1152:28, which was about 9 seconds after the TEB local controller issued the frequency change to the accident airplane pilot. At that time, the helicopter had entered a left climbing turn and was at an altitude of 400 feet, and the helicopter and the airplane were located 1.5 miles apart. Each aircraft would likely have appeared as a relatively small and stationary object in the windscreen of the other aircraft. The helicopter would have appeared against a complex background of buildings across the Manhattan skyline and would likely have been difficult for the airplane pilot to detect. The airplane would likely have appeared to the helicopter pilot above the horizon and against the background of the sky, which could have facilitated detection. However, if the pilots had seen the other aircraft at this point, they might not have perceived it to be a threat because of the separation, direction of travel, and altitude at that time.

Traffic awareness procedures established for flights in the Hudson River Class B exclusion area are published on the FAA's New York VFR Terminal Area Chart and New York Helicopter Route Chart.[31] The procedures at the time of the accident recommended (but did not

[30] The airplane was equipped with Garmin GNS 530 and UPS SL-30 navigation and communication systems. The Garmin GNS 530 unit is equipped with a switch referred to as the "COM Flip-Flop Key," which would have allowed the accident airplane pilot to easily return to the previous frequency. Pilots typically use the Garmin GNS as the primary navigation and communications system and the UPS SL-30 as the secondary navigation and communication system. No data could be recovered from the Garmin GNS 530 unit. The frequencies recovered on the SL-30 unit were the TEB clearance delivery frequency and the TEB automatic terminal information service frequency.

[31] The FAA's *Aeronautical Information Manual*, chapter 9, section 1, states that terminal area charts should be used by pilots intending to operate "to or from airfields within or near Class B or Class C airspace." The manual also states that helicopter route charts provide useful information to helicopter pilots navigating in areas with "high

require) that pilots of all aircraft operating in the Hudson River corridor self-announce their aircraft's position on frequency 123.05 (the CTAF).[32] Also, the FAA's *Aeronautical Information Manual* states that pilots using the CTAF are expected to transmit position reports and intentions.

The helicopter pilot operated in the Hudson River Class B exclusion area on a regular basis and was familiar with the high-density traffic environment and the recommended communications procedures.[33] The airplane pilot's logbooks indicated that he had flown to airports near the Hudson River area (including two trips to TEB, the more recent of which was in 2004), but the logbooks contained no information regarding the route of flight or the pilot's familiarity with the area's airspace environment or communication procedures. Aeronautical charts were not recovered in the airplane's wreckage.[34] However, during postaccident interviews, the airplane pilot's family indicated that he was always well prepared, and a pilot who shared the airplane with the accident pilot (and flew occasionally with him) stated that the accident pilot subscribed to a charting service that provided him with aeronautical charts.

The TEB local controller did not advise the airplane pilot to self-announce on the CTAF, and no procedure required controllers to provide this instruction to pilots. However, in this case, this instruction would not have been expected because both the TEB controller and the pilot expected that the airplane would have been handed off to the EWR ATCT and then cleared directly into Class B airspace, which would have allowed the airplane to climb above the exclusion area. Also, the NTSB notes that making and monitoring CTAF reports while maintaining contact with ATC would have required the airplane pilot to be actively transmitting and receiving information on two different radios at the same time, which can be difficult in a busy ATC environment such as the New York area. The airplane pilot was likely attempting to contact EWR using the No. 1 radio, and the airplane's No. 2 radio was tuned to TEB frequencies.

A witness to the accident reported that the helicopter pilot had made a position report on the CTAF over Stevens Institute of Technology (shown in figure 1). Aircraft operating in the Hudson River Class B exclusion area depend on CTAF reports to maintain traffic awareness. However, the NTSB concludes that, because the airplane pilot had requested traffic advisories, was attempting to contact the EWR ATCT, and did not anticipate operating in the Hudson River Class B exclusion area, the pilot was not expected or required to monitor CTAF position reports, including those made by the helicopter pilot. Even if the airplane pilot had been listening to the CTAF, the helicopter pilot's position report might not have helped the airplane pilot because he might not have known the location of Stevens Institute of Technology.

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concentrations of helicopter activity." The New York VFR Terminal Area Chart in effect at the time of the accident was dated May 7 to November 19, 2009; the New York Helicopter Route Chart was dated May 8, 2008. Revisions to the charts issued after the accident are discussed in section 3.1.3.

[32] The New York VFR Terminal Area Chart in effect from November 19, 2009, to May 6, 2010, and the chart in effect from May 6 to November 18, 2010, stated the requirement that no person could operate in the Hudson River Class B exclusion area "unless that person continuously monitors and communicates, as appropriate, on the designated common traffic advisory frequency."

[33] The helicopter was equipped with Garmin GNS 430 and UPS SL-30 navigation and communication systems. No data could be recovered from the primary Garmin GNS 430 unit. The frequency recovered from the secondary SL-30 unit was Liberty Helicopters' company frequency.

[34] Aeronautical charts were recovered immediately after the accident in the Hudson River. Some of the charts were conclusively identified as being from the helicopter, whereas other charts could not be conclusively identified as being from a particular aircraft.

The aircraft performance radar study found that, shortly before the collision, (1) the airplane was flying level on a true heading of about 165° at 1,100 feet (± 50 feet) while in a shallow right turn to follow the Hudson River to the southeast and (2) the helicopter was in, or had just completed, a climb at an average rate of 900 feet per minute to an altitude of 1,100 feet (± 50 feet) on a true heading of about 190°.[35] According to Liberty Helicopters procedures and its FAA-approved air tour safety plan, the altitude at which its helicopters normally operate when proceeding southbound on the west side of the Hudson River was 1,000 feet. The NTSB could not determine why the helicopter was operating above 1,000 feet during this part of the flight. Possible reasons include that the pilot overshot his planned level-off altitude, the pilot exceeded 1,000 feet intentionally, or the altimeter was in error.[36] Regardless of the reason for the altitude deviation, the NTSB notes that, if the helicopter had been operating at an altitude of 1,000 feet, the vertical separation between the aircraft would likely have been greater, thus reducing the probability of a collision. The NTSB concludes that the helicopter's climb above 1,000 feet was not consistent with company procedures and decreased the vertical separation between the aircraft. Further, no federal regulations mandated that air tour helicopters or other local traffic operate at a lower altitude than that for transiting aircraft.

The collision occurred at 1153:14, which was 55 seconds after the TEB controller's frequency change instruction and 26 seconds after his last attempt to contact the airplane pilot. At the time of the accident, the groundspeeds of the airplane and the helicopter were about 150 knots and about 93 knots, respectively; the closure rate (the speed at which the aircraft converged) was about 70 knots; and the collision angle (the smallest angle between the longitudinal axes of the aircraft) was about 25°.

In addition, the aircraft were in different segments of flight and were conducting different types of operations: the airplane was in level cruise flight and was transiting the Class B exclusion area, whereas the helicopter was climbing past its intended cruise altitude and was expected to remain in the exclusion area. These differences demonstrate the need to vertically separate local and transiting aircraft over the Hudson River,[37] as discussed further in section 3.1.3.

Between 1152:33 and 1153:24, 11 conflict alerts for the accident airplane were generated to the TEB local controller and the EWR Class B airspace controller. However, neither controller recalled seeing or hearing a conflict alert on his radar display during that time. On July 12, 2006,

[35] The altitude data recorded by the radar have an uncertainty of ± 50 feet, and a radar return is received every 4.6 seconds. Because of this uncertainty and relatively low sample rate, the instantaneous rate of climb of the helicopter at the time of the collision cannot be determined, and the altitude of the airplane and the helicopter at that time could have ranged from 1,050 to 1,150 feet. In addition, the NTSB could not determine from the radar data whether, if the collision had not occurred, the helicopter would have (1) continued to climb above 1,100 feet and into the Class B airspace, (2) leveled off at 1,100 feet at the base of the Class B airspace, or (3) descended and leveled off at 1,000 feet, per Liberty Helicopters' procedures, after briefly exceeding the 1,000-foot altitude by at least 50 feet.

[36] During the collision, the altimeter had separated from the helicopter's instrument panel. The face of the altimeter was recovered, but it did not yield any usable information.

[37] The inset of the current New York VFR Terminal Area Chart (dated May 6 to November 18, 2010) depicts northbound and southbound routes to provide lateral separation from opposite-direction traffic. The chart also provides written instructions for "persons operating aircraft" in the area to "fly along the west shoreline of the Hudson River when southbound, and along the east shoreline of the Hudson River when northbound." However, vertical separation of traffic is not addressed.

the NTSB issued Safety Recommendation A-06-44, which asked the FAA to (1) redesign the minimum safe altitude warning and conflict alert systems and alerting methods so that they reliably capture, and direct a controller's attention to, potentially hazardous situations detected by the systems and (2) implement software changes at all ATC facilities providing minimum safe altitude warning and conflict alert services.

On October 6, 2006, the FAA responded that it had initiated several actions to refine alert parameters for the minimum safe altitude warning and conflict alert systems, which would help increase the reliability of the systems by reducing false alarms. On September 4, 2007, the NTSB classified the recommendation "Open—Acceptable Response" based on the FAA's response and further information from the FAA indicating that its Human Factors and Engineering Group had initiated a study of the human factors issues associated with the minimum safe altitude warning and conflict alert systems. The study plan objectives were to (1) identify any human factors issues with the existing safety alert systems, procedures, and implementations and (2) recommend improvements to the current alerts based on human factors research and best practices.

2.2.1 Cockpit Visibility

The cockpit visibility study determined that the helicopter would have remained a relatively small and stationary object in the airplane's windscreen until about 5 seconds before the collision, as shown in figures 3 and 4, respectively.[38] The study also determined that the helicopter would have appeared below the horizon and against a complex background of buildings until the last second, as shown in figure 5. These factors could have made it more difficult for the airplane's pilot to see the helicopter until a few seconds before the collision (when the size of the helicopter, as viewed from the airplane, rapidly increased), even with the helicopter's high-visibility rotor blades and strobe anticollision lights, which promote conspicuity.[39]

Figures 3 through 5 show the view from the airplane pilot's seat; the study determined that, from the copilot's seat, where one of the two passengers was likely seated, the helicopter might have been obscured by the airplane's windscreen center post and/or the top of the instrument panel. Figures 3 through 5 also show, in the lower right, the traffic information that might have been displayed in the cockpit. The yellow dot labeled "-01" is the symbol for the accident helicopter; the label indicates that the helicopter was 100 feet below the airplane at that time, and the upward-pointing yellow arrow indicates that the helicopter was climbing at a rate that was at least 500 feet per minute.[40] At the time of the collision, the dot would have been

[38] For the cockpit visibility study, the relative positions of both aircraft were calculated at the points corresponding to the radar returns from the helicopter up to the penultimate radar return (1153:09) and then at 1-second intervals until the collision, the time of which was assumed to have coincided with the last radar return. Cockpit photographs of the airplane were used to determine how the helicopter would have appeared in the airplane's windscreen at these points. The view of the background scenery from the airplane's cockpit was simulated using the X-Plane flight simulation program and the Google Earth computer program. Also, a three-dimensional helicopter model was placed in the X-Plane and Google Earth scenes at the proper location and scale to simulate the view of the helicopter from the airplane's cockpit.

[39] The helicopter's pulsing landing lights would have been oriented away from the accident airplane.

[40] Altitudes shown with a plus sign indicate traffic above the airplane. A downward-facing arrow (not shown in the figures) indicates an aircraft that is descending at a rate of 500 feet per minute or more.

labeled “00,” indicating no vertical separation. The displayed traffic information is further discussed in section 2.2.2.

Figure 3. View of helicopter from airplane cockpit about 9 seconds before collision.

Figure 4. View of helicopter from airplane cockpit about 5 seconds before collision.

Figure 5. View of helicopter from airplane cockpit about 1 second before collision.

The NTSB concludes that the helicopter would not have been obscured from the airplane pilot's view but would likely have been difficult for him to detect until the final seconds before the collision because, before that time, the helicopter would have appeared as a relatively small and stationary object against a complex background of buildings. Also, the relatively high closure rate (70 knots) between the aircraft may have reduced the time available for the airplane pilot to visually acquire the helicopter and avoid the collision. A video of the collision that was obtained during the investigation showed that the airplane rolled suddenly to the right in the last second before the collision. On the basis of this evidence, the NTSB concludes that the airplane pilot appeared to have started an evasive maneuver immediately before the collision to avoid the helicopter.

During the helicopter's southbound climb to 1,100 feet (from 1152:42 onward), the helicopter pilot would not have been able to see the airplane because it was above and behind the helicopter. Specifically, at the time of the helicopter's southbound turn, the airplane would have moved from the helicopter's 1:00 to 4:00 position, which would not have been in the helicopter pilot's field of view. As a result, the NTSB's study did not determine how the airplane would have appeared from the helicopter's windscreen before the collision. The NTSB concludes that the airplane would likely have been in the helicopter pilot's field of view until 32 seconds before the collision, after which time the airplane was above and behind the helicopter and was outside of the pilot's field of view. However, the NTSB notes that the helicopter was also equipped with a cockpit traffic display, which, if operating as designed, should have provided the helicopter pilot with information about the airplane's location.[41]

The accident aircraft were not required to have a cockpit voice recorder or a flight data recorder installed, but the helicopter would have been subject to the requirements for a crash-resistant flight recorder system if the FAA had implemented Safety Recommendation A-09-10.[42] (The airplane would not have been subject to these requirements because it was not turbine powered.) A crash-resistant flight recorder system would have helped the NTSB determine additional information about the accident scenario, including the helicopter's precise locations, altitudes, headings, and airspeeds and the traffic information displayed in the cockpit.

Evidence was not available to determine each pilot's specific activities just before the collision. It is possible that the airplane pilot was focusing on establishing communications with EWR,[43] the helicopter pilot was providing narration for the sightseeing tour,[44] or either pilot was performing other tasks. However, both pilots were responsible for maintaining awareness of and visual contact with nearby aircraft to reduce the likelihood of a collision regardless of their workload at the time. The see-and-avoid concept is further discussed in section 3.3.

2.2.2 Cockpit Display of Traffic Information

TIS intruder aircraft are displayed on Garmin GNS 430 and 530 units with either a solid yellow circle (known as a traffic alert) to denote high-priority traffic or a hollow white diamond (known as a proximity alert) to denote lower-priority traffic, as shown previously in figures 3 through 5. The client aircraft is depicted at the center of the display as a blue or white airplane symbol (depending on the display settings).

An aural alert ("traffic") is generated when the number of traffic alerts (yellow circles) displayed on the Garmin GNS units increases between scans (which occur about every 5 seconds). This feature helps reduce the number of nuisance alerts resulting from nearby aircraft. However, it is possible for an aural alert not to sound when an intruder aircraft's status is

[41] FAA data showed that TIS data were being transmitted to both aircraft, but the status and function of the cockpit displays associated with TIS could not be determined. However, as discussed in section 2.2.2, the cockpit visibility study reconstructed the TIS messages that were likely provided to each aircraft.

[42] Safety Recommendation A-09-10 asked the FAA to "require all existing turbine-powered, nonexperimental, nonrestricted-category aircraft that are not equipped with a cockpit voice recorder and are operating under 14 *Code of Federal Regulations* Parts 91, 121, or 135 to be retrofitted with a crash-resistant flight recorder system. The crash-resistant flight recorder system should record cockpit audio, a view of the cockpit environment to include as much of the outside view as possible, and parametric data per aircraft and system installation, all to be specified in European Organization for Civil Aviation Equipment document ED-155, "Minimum Operational Performance Specification for Lightweight Flight Recorder Systems," when the document is finalized and issued." Safety Recommendation A-09-10, which superseded Safety Recommendation A-03-64, was classified "Open—Acceptable Response" on August 27, 2009. Also, the installation of cockpit image recorders has been on the NTSB's Most Wanted List of Transportation Safety Improvements since 2004.

[43] Bradley International Airport in Windsor Locks, Connecticut, was the closest ATC facility that used the 127.8 frequency. However, no transmissions from the accident airplane were recorded on this frequency most likely because of the airport's distance from the area (about 90 miles) and the airplane's altitude.

[44] A cockpit image recorder would have helped determine the helicopter pilot's workload at the time of the collision.

elevated from a proximity alert to a traffic alert or when a new intruder with traffic alert status appears for the first time if, at the same time, an existing traffic alert is downgraded to a proximity alert or an intruder aircraft disappears from the display. For these scenarios, an aural alert would not be generated because the total number of traffic alerts (yellow circles) would remain the same. According to Garmin's *GNS 430* and *GNS 530 Pilots Guide and Reference Manual* (dated August and September 2008, respectively), TIS is not intended to be a collision avoidance system,[45] and avoidance maneuvers are not recommended or authorized as a direct result of a TIS intruder display or alert.

Interviews with pilots who operate regularly within the Hudson River Class B exclusion area indicated that the high-density traffic in the area resulted in numerous traffic alerts. These pilots also stated that they would prefer to look outside for traffic in the area rather than look at a relatively small display screen in the cockpit. (The Garmin GNS 430 has a screen that measures about 1.8 inches high and 3.3 inches wide; the Garmin GNS 530's screen measures about 3 inches high and 4 inches wide.)[46] In its report on the July 2007 midair collision involving two electronic news gathering (ENG) helicopters over Phoenix, Arizona, the NTSB found that one of the two helicopters was equipped with SkyWatch (a traffic advisory system) and that the system's aural alert would frequently sound over the pilot's headset when an aircraft entered a cylinder of airspace that had a 0.2-nm horizontal radius surrounding the pilot's aircraft, resulting in nuisance alerts. The NTSB also found that pilots using the SkyWatch system would turn down the aural alert during close-in operations because of nuisance alerts, which obscured the communications frequency.[47]

The NTSB's cockpit visibility study for this accident used TIS processing algorithms provided by the Massachusetts Institute of Technology's Lincoln Laboratories to reconstruct TIS messages based on the recorded EWR ASR-9 radar returns.[48] The reconstructed TIS messages indicated that the airplane should have received a traffic alert associated with the helicopter beginning at 1152:42 (32 seconds before the collision), when the helicopter was at an altitude of

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[45] Two fundamental differences between TIS and a traffic collision and avoidance system (TCAS) are (1) TIS does not provide pilots with calculated and coordinated maneuvering guidance to avoid conflicting aircraft, whereas the TCAS version with resolution advisories (TCAS II) provides such guidance, and (2) TIS uses a terminal mode S ground interrogator and data link to provide a 5-second update rate, whereas TCAS uses an airborne interrogator with either a 1-second (TCAS I) or 0.5-second (TCAS II) update rate. Although the range accuracy of TIS and TCAS are similar, the slower update rate with TIS may cause position errors as a result of limitations in the predictive algorithm for maneuvering aircraft.

[46] Also, intruder aircraft can be difficult to distinguish if the map range is not reduced. With large map ranges, intruder aircraft near the client aircraft appear almost on top of one another and the client aircraft symbol, making it harder for pilots to distinguish individual intruder aircraft and their position in relation to the client aircraft. The actual map range settings of the Garmin GNS 430 and 530 displays in the accident aircraft during the accident flight are unknown.

[47] For more information, see *Midair Collision of Electronic News Gathering Helicopters, KTVK-TV, Eurocopter AS350B2, N613TV, and U.S. Helicopters, Inc., Eurocopter AS350B2, N215TV, Phoenix, Arizona, July 27, 2007,* Aircraft Accident Report NTSB/AAR-09/02 (Washington, DC: National Transportation Safety Board, 2009).

[48] The TIS messages provided to both aircraft were likely based on radar returns received by the EWR ASR-9, but these messages were not recorded. (TIS messages are not normally recorded.) TIS messages to both aircraft generated from radar returns received by the JFK ASR-9 were recorded on the day of the accident because tests of the system were being conducted at that time. However, the EWR radar was closer to the aircraft than the JFK radar, and the reconstructed TIS messages showed that the EWR radar might have provided both aircraft a more timely indication of the other's presence compared with the TIS messages based on the JFK radar.

600 feet. (The airplane had leveled off at an altitude of 1,100 feet about 1.5 minutes earlier.) Until 1153:05, when the helicopter was at an altitude of 970 feet, the traffic alert associated with the helicopter would likely have appeared on the airplane's TIS display as a yellow circle indicating that the helicopter was at the airplane's 11:00 to 12:00 position with a relative altitude about 200 feet below the airplane.[49] From 1153:05 to 1153:14 (the time of the collision), the helicopter symbol would likely have been shown coincident with the airplane position because the distance between the aircraft would have been less than 1/8 nm and the radar would not have been able to resolve this separation distance.

In addition, the reconstructed TIS messages provided to the airplane indicated the possibility that an aural alert associated with the appearance of the helicopter as a traffic alert might not have been triggered because another intruder aircraft's status might have been downgraded from a traffic alert to a proximity alert at the same time. Thus, the total number of traffic alerts might have remained the same.

The cockpit visibility study also reconstructed the TIS messages that might have been provided to the helicopter. According to the study, the helicopter should have received a traffic alert associated with the airplane beginning at 1152:37 (37 seconds before the collision). At that time, the helicopter was at an altitude of 530 feet and was heading southwest in a left turn toward the south, and the traffic alert associated with the airplane would likely have appeared on the helicopter's TIS display as a yellow circle in the 12:00 to 1:00 position with a relative altitude about 600 feet above the helicopter. As the turn progressed, the airplane symbol would have moved toward the 3:00 to 4:00 position on the helicopter's TIS display with a relative altitude of 500 feet above the helicopter. From 1153:05 to the time of the collision, the airplane symbol would have been shown coincident with the helicopter's position. It is likely that the TIS messages provided to the helicopter triggered an aural alert associated with the airplane once the helicopter started receiving TIS messages from the EWR radar (at 1152:37).

The NTSB could not determine from the available evidence whether either pilot was aware of the TIS alerts, but FAA data showed that TIS data were being transmitted to both aircraft. The NTSB recognizes that the airplane pilot's ability to strategically use TIS data was limited because the helicopter had likely first appeared as a climbing target below the airplane in a traffic alert status at close range. However, the airplane pilot was presented with information that he could have used to help maintain separation from the helicopter while working to visually acquire the aircraft. For example, the target associated with the helicopter was indicated on the TIS display in front of the airplane, moving in a similar direction, and the helicopter's track intersected the airplane's track at a low angle. Thus, the airplane pilot would only have had to make a slight track change to the right to maintain separation from the accident helicopter.[50]

Although the airplane pilot's efforts to visually acquire the accident helicopter in response to the traffic alert are unknown, his efforts could have been complicated by the traffic

[49] The actual proximity of the intruder aircraft symbol to the client aircraft symbol on the TIS display depends on the map scale in use at the time. (As previously stated, the map scales used in the accident aircraft are unknown.) At larger map scales, the intruder aircraft symbol might have appeared extremely close or even coincident with the client aircraft symbol.

[50] The airplane pilot had been instructed by ATC to maintain an altitude of 1,100 feet or below, which would have reduced the likelihood for the airplane to climb in response to the presence of this target.

alerts associated with multiple targets. Also, the airplane pilot may not have recognized that the ascending target associated with the helicopter represented the most significant threat among the alerts. Further, the pilot's efforts to locate this target could have been hindered by the difficulty of visually acquiring an unknown aircraft type with little apparent movement against a complex background.

For the helicopter pilot, the TIS data displayed in the cockpit would have provided the pilot with information that he could have strategically used to minimize the potential for conflict, even without the TIS aural alert that was likely triggered about 37 seconds before the accident. For example, the appearance of a target converging on the Hudson River, with altitude indications showing level flight and a relative altitude about 100 feet above the helicopter's normal route altitude, should have been an important cue for the helicopter pilot to monitor vertical position relative to the target and visually acquire the aircraft to ensure that vertical separation would be maintained. The helicopter pilot's climb above the normal route altitude of 1,000 feet as the target neared is not consistent with effective use of TIS data. The NTSB concludes that neither pilot effectively used available electronic traffic information to assist in maintaining awareness of nearby aircraft.

2.3 Air Traffic Controller Performance

The local controller had worked at the TEB ATCT from May 2000 to January 2004 and since November 2004. The front line manager (the operations supervisor for the shift) had worked at the TEB ATCT since July 1999 and had been in his current position since April 2008. As a result, they should have been familiar with the provisions of FAA Orders 7110.65 and 7210.3, "Facility Operation and Administration," and TEB Order 7110.10, "Air Traffic Control Tower Standard Operating Procedures." However, both the local controller and the front line manager demonstrated noncompliance with established ATC procedures and a lack of good judgment during the time surrounding the accident, as discussed in sections 2.3.1 and 2.3.2.

2.3.1 Nonpertinent Telephone Conversation

The ATC transcript showed that the TEB local controller initiated two separate telephone calls (via a recorded landline) that were unrelated to his ATC duties. One of these calls, to airport operations, began at 1135:01. While the controller was conversing, the pilot of a Learjet 40 had to contact the tower three times for taxi authorization. The controller ended his personal telephone call at 1136:40.

Although controllers are ultimately responsible for exercising good judgment while on duty,[51] FAA Order 7210.3, paragraph 2-6-1, states that watch supervision (performed by a manager, supervisor, or controller-in-charge) includes managing the operational environment with a goal of eliminating distractions. Thus, the front line manager should not have permitted the local controller's nonpertinent telephone conversation. The paragraph also notes that

[51] As previously stated, FAA Order 7110.65, paragraph 2-1-2, directs controllers to "give first priority to separating aircraft and issuing safety alerts." The paragraph then states, "good judgment shall be used in prioritizing all other provisions of this order based on the requirements of the situation at hand."

on-the-spot corrections are a required part of controller-in-charge duties.[52] However, the front line manager, who was also the controller-in-charge at the time, did not correct the local controller's performance or emphasize to him that personal telephone calls should not interfere with ATC duties.[53]

The local controller initiated another telephone conversation unrelated to his work at 1150:32 (about 2 minutes after he cleared the accident airplane for takeoff), which continued until 1153:10. During this time, the controller was again dividing attention between his telephone conversation and his ATC tasks, which included instructing the accident pilot to start a left turn to join the Hudson River (at 1151:17) and contact the EWR tower (at 1152:19). However, the controller was not fully engaged in his duties and was thus not in compliance with FAA Order 7110.65, paragraphs 2-1-1 and 2-1-2. Specifically, as stated in section 2.2, the controller should have been providing the accident airplane pilot with additional traffic advisories before and at the time of the transfer of communications to EWR, and he should have transferred the flight sooner than he did. The NTSB concludes that the local controller's nonpertinent telephone conversations distracted him from his ATC duties.

The front line manager had signed off position about 1144 for a break and then left the ATCT to run a personal errand. As a result, he was not present in the tower cab at the time of the controller's second nonpertinent telephone conversation. The NTSB concludes that the local controller's nonpertinent telephone conversation during the time of the accident flight might not have occurred if the front line manager had corrected the controller's performance deficiency involving an earlier nonpertinent telephone conversation. The ATC performance deficiencies detailed in this section resulted in the issuance of Safety Recommendation A-09-83, which is discussed in section 3.1.2.

2.3.2 Other Air Traffic Control Performance Deficiencies

In addition to the local controller's failure to prioritize his ATC duties because of his nonpertinent telephone conversation and the front line manager's failure to issue an on-the-spot correction, several other controller performance deficiencies occurred during the time surrounding the accident.

First, the TEB clearance delivery controller wrote "SW" on the flight progress strip[54] for the airplane (to indicate a southwesterly direction of flight from TEB) and provided the pilot with a departure control frequency of 119.2 for the New York Terminal Radar and Approach

[52] TEB Order 7110.10 also states that the operational supervisor/controller-in-charge is to "initiate on-the-spot corrections when appropriate."

[53] During a postaccident interview, the front line manager stated that he had listened to the ATC audio recordings surrounding the time of the accident and had spoken with the local controller about his nonpertinent conversations shortly after he was relieved from the local control position (which, according to facility position logs, occurred about 1217).

[54] A flight progress strip is used by controllers to record aircraft contacts, ATC clearances, and other operationally significant items.

Control (TRACON) facility.[55] However, after his discussion with the pilot about the flight's departure routing over the Hudson River, the local controller should have updated the flight progress strip for the airplane to reflect its revised direction of flight from TEB, and he should have provided the pilot with a modified departure control frequency for the EWR ATCT.

Second, at 1143:38, the pilot of the accident airplane asked the TEB local controller to provide progressive taxi instructions. The controller then told the pilot to "turn left on [taxiway] papa join … [taxiway] papa to [taxiway] lima to [runway] one nine at [taxiway] bravo," and the pilot acknowledged this instruction. The controller provided no additional taxi instructions to the pilot. However, FAA Order 7110.65, paragraph 3-7-2, states that progressive taxi instructions, when requested by a pilot, are to include step-by-step routing directions. Thus, to comply with this provision, the controller should have provided the pilot with each step of the taxi route as it occurred (for example, "turn left at the next intersection").[56]

Third, ATCT staffing on the day of the accident was adequate, but the front line manager, who was responsible for the overall performance of the controllers on duty at the time, did not manage the ATCT's resources appropriately. Before the accident, the TEB ATCT was staffed with five controllers, but only two controllers were in the ATCT at the time of the accident. At that time, the local controller was also working the ground control (which had been previously combined with the local control position), arrival control, and controller-in-charge positions, and the other on-duty controller was working the clearance delivery and flight data positions. Two controllers were on a scheduled break, and, as previously discussed, the front line manager had left the ATCT about 1144 while on break to run a personal errand.

The local controller signed on as controller-in-charge about 1145. However, one of the two controllers on break at that time was qualified as a controller-in-charge and could have assumed the position so that the local controller would not have been responsible for watch supervision in addition to traffic duties.

The front line manager did not advise the controllers that he was leaving the ATCT. Also, the front line manager did not advise the controllers where he would be, how long he would be away from the tower, and how he could be reached during his absence from the tower. The front line manager stated, during a postaccident interview, that he was away from the facility for about 5 or 10 minutes and that he was not aware of a particular policy that prohibited him from being away from the facility or one that required him to notify staff when he was leaving the premises. Because no such policies existed, it was an accepted practice for operational supervisors or controllers-in-charge to leave the premises as long as they delegated controller-in-charge responsibilities to a specialist before leaving (in compliance with TEB Order 7110.10, paragraph 1-1-9). The front line manager signed back into the ATCT about 1220, which meant that he was absent from the tower for 35 minutes.

[55] During a postaccident interview, the clearance delivery controller stated that he had not discussed the airplane's route of flight with the pilot but assumed that the airplane would depart to the southwest and then receive radar advisories from the New York TRACON.

[56] In addition, the controller did not provide a specific taxi route to the pilot of an Embraer ERJ-135, who requested taxi authorization at 1138:35. The controller stated simply, "taxi to runway one nine," which the Embraer pilot acknowledged. FAA Order 7110.65, paragraph 3-7-2, states that taxi clearances are to include the specific route to follow.

FAA Orders 7210.3 and 7210.56, "Air Traffic Quality Assurance," require active supervision and oversight, which cannot be effectively accomplished if a supervisor is not present in the tower facility. The NTSB concludes that the TEB front line manager, who was not present in the ATCT at the time of the accident, exercised poor judgment by not letting staff know how he could be reached while he was away from the tower and by not using an available staffing asset to provide an additional layer of oversight at the tower during his absence.

After the accident, the local controller tried to locate the front line manager by telephone but received no response. (The local controller then tried to page, via the facility's interphone system, the other controller-in-charge assigned to the shift but also received no response.) As a result, the local controller was responsible for making required emergency notifications of the accident but did not because he, along with the other controller on duty at the time, were conducting regular ATC duties and responsibilities. If the front line manager had been available or had assigned the other controller-in-charge to that position, then the local controller's workload would have been reduced, and the notifications could have been made in a timely manner.[57]

Last, during the time that the local controller was also the controller-in-charge, he instructed the pilot of an Embraer ERJ-135 to taxi into position and hold. The pilot acknowledged this instruction, and the controller then cleared the airplane for takeoff. However, FAA Order 7210.3, paragraph 10-3-8, states that, for taxi into position and hold procedures, the local control position must not be consolidated or combined with any non-local control position, including the front line manager/controller-in-charge position. Similarly, TEB Order 7110.10, paragraph 8-10-1, states that, for taxi into position and hold procedures, the local control position must not be combined or consolidated with any other non-local control position and that the front line manager/controller-in-charge position should not be combined with any other position. Thus, because the local controller was also the controller-in-charge at the time, he was not authorized to use taxi into position and hold procedures.

One of the primary purposes of the ATC system is to prevent a collision between aircraft operating in the National Airspace System. As a result, adherence to established ATC procedures is critical. The local controller's noncompliance with existing procedures and his failure to be fully engaged in his duties demonstrated a lack of air traffic controller professionalism, which was addressed at the NTSB's May 2010 safety forum on professionalism in aviation.[58] The NTSB concludes that the local controller's and the front line manager's noncompliance with existing procedures and best practices demonstrated a lack of professionalism, which increased the opportunity for errors.

[57] During a postaccident interview, the TEB front line manager stated that he did not make emergency notifications after returning to the tower because he believed that EWR was responsible for the notifications. (According to FAA Order 8020.11B, "Aircraft Accident and Incident Notification, Investigation, and Reporting," both TEB and EWR controllers were responsible for emergency notifications; EWR controllers made their notifications.)

[58] National Transportation Safety Board, "Professionalism in Aviation: Ensuring Excellence in Pilot and Air Traffic Controller Performance," Washington, DC, May 18-20, 2010. For information from the forum, see http://www.ntsb.gov/events/symp-professionalism-aviation/symp-professionalism-aviation.htm

3. Safety Issues

3.1 Previous Safety Recommendations Issued as a Result of This Accident

On August 27, 2009, the NTSB issued Safety Recommendations A-09-82 through -86 to the FAA as a result of its preliminary findings for this investigation. The sections that follow discuss these recommendations; the FAA's November 30, 2009, letter describing the agency's actions in response to these recommendations; and the NTSB's June 23, 2010, letter analyzing these actions.

3.1.1 Air Traffic Control Procedures

The NTSB found no procedures or instructions that directed controllers to (1) ensure, traffic permitting, that aircraft requesting Class B clearances receive approval to climb before entering the Hudson River Class B exclusion area or (2) prevent, when possible, aircraft from entering the Hudson River Class B exclusion area without first being directed to switch from the ATC frequency to the CTAF. As a result, the NTSB issued Safety Recommendation A-09-82, which asked the FAA to do the following:

> Revise standard operating procedures for all air traffic control (ATC) facilities, including those at Teterboro airport, LaGuardia airport, and Newark Liberty International airport, adjoining the Hudson River Class B exclusion area in the following ways:
>
> a) establish procedures for coordination among ATC facilities so that aircraft operating under visual flight rules and requesting a route that would require entry into Class B airspace receive ATC clearance to enter the airspace as soon as traffic permits,
>
> b) require controllers to instruct pilots with whom they are communicating and whose flight will operate in the Hudson River Class B exclusion area to switch from ATC communications to the common traffic advisory frequency (CTAF) and to self-announce before entering the area,
>
> c) add an advisory to the Automatic Terminal Information Service broadcast, reminding pilots of the need to use the CTAF while operating in the Hudson River Class B exclusion area and to self-announce before entering the area, and
>
> d) in any situation where, despite the above procedures, controllers are in contact with an aircraft operating within or approaching the Hudson River Class B exclusion area, ensure that the pilot is provided with traffic advisories and safety alerts at least until exiting the area.

The FAA stated that, on November 19, 2009, it implemented the following actions in response to the recommendation:

Regarding part (a) of the recommendation, the FAA stated that new coordination procedures were developed between TEB and EWR to ensure that a Class B clearance could be issued to a pilot before departure from TEB. The FAA also stated that TEB would request approval from EWR before takeoff for aircraft requesting a Class B clearance and that the aircraft would be authorized to climb to 1,500 feet. Further, the FAA indicated that it changed the common transfer point identified in a letter of agreement between TEB and EWR so that the receiving controller at EWR could issue appropriate instructions in a timely manner. In addition, the FAA noted that no changes were needed for LaGuardia Airport (LGA) procedures concerning Class B clearances because transiting flights already received Class B clearance from the airport.

Regarding part (b) of the recommendation, the FAA stated that it modified TEB standard operating procedures to incorporate a standard VFR route for departure aircraft that are not requesting entry into Class B airspace. According to the FAA, this route would specify that all fixed-wing aircraft could proceed directly to the George Washington Bridge for entry into the Hudson River exclusion area. The FAA also stated that the mandatory requirement for aircraft to self-announce on the CTAF was added to VFR charts and that pilots were expected to broadcast on the CTAF at mandatory reporting points in the exclusion area. However, the NTSB concludes that the ATC transfer-of-communications procedures applied to the accident airplane might have inadvertently caused the pilot not to follow the traffic awareness procedures established for flights through the area, thereby increasing the chance for a collision.

Regarding part (c) of the recommendation, the FAA stated that it did not expect ATC facilities near the Hudson River Class B exclusion area to amend automatic terminal information service (ATIS) broadcasts to include an advisory about the CTAF. The FAA explained that adding the frequency requirement to the charts would address the pilot notification procedures and that including another advisory on ATIS broadcasts could add confusion to an “already limited” ATIS system. The FAA also stated that the CTAF and pilot notification procedures would be included in pilot training.

Regarding part (d) of the recommendation, the FAA stated that it developed the Class B VFR transition route to encourage pilots to request Class B services for flight over the Hudson River and that these services included traffic advisories and safety alerts. According to the FAA, this route is expected to expedite aircraft handling, enhance safety, improve communication between controllers and pilots, increase the number of aircraft under positive control, reduce cockpit workload, increase pilot situational awareness, and reduce traffic in the Class B exclusion airspace. In addition, the FAA stated that this route was depicted on the New York VFR Terminal Area Chart inset with a note indicating that ATC clearance is required.

The NTSB responded that the revisions to the New York airspace addressed parts (a), (c), and (d) of the recommendation. However, the NTSB stated that the FAA’s planned actions in response to part (b) of the recommendation do not satisfy its intent. The NTSB also stated that, even though tower frequencies are included on VFR charts and pilots are required to contact the tower before landing, departing, and transiting the airport, controllers remind pilots when to switch to the tower frequency and provide the radio frequency at that time. The NTSB indicated that a similar requirement should be implemented for the Hudson River Class B exclusion area. As a result, the NTSB classified Safety Recommendation A-09-82 "Open—Acceptable Response" pending a requirement for controllers to instruct pilots operating in the Class B exclusion area to switch from ATC communications to the CTAF and self-announce before entering the area.

3.1.2 Air Traffic Controller Professionalism

As a result of the actions of the TEB local controller and front line manager during the events surrounding this accident (see section 2.3.1), the NTSB issued Safety Recommendation A-09-83, which asked the FAA to do the following:

> Brief all air traffic controllers and supervisors on the air traffic control (ATC) performance deficiencies evident in the circumstances of this accident and emphasize the requirement to be attentive and conscientious when performing ATC duties.

The FAA stated that it issued an August 14, 2009, memorandum from the vice president of terminal operations, indicating that all tower and radar controllers needed to be briefed on the importance of being diligent in their positions. The FAA indicated that this mandatory briefing item was completed on September 15, 2009. The FAA further stated that it issued a quality assurance alert bulletin describing the events that occurred during this accident and that the bulletin would be included in all controller and supervisor monthly training. In addition, the FAA stated that it expected to provide a similar briefing to en route controllers and system operations personnel by December 2009.

The NTSB responded by acknowledging that, during August and September 2009, all tower and radar controllers had been briefed about the importance of being diligent in their positions and that similar briefings had been provided to all relevant systems operations personnel by early March 2010. The NTSB also stated that, even though the FAA expected to provide these briefings to all en route controllers by the end of December 2009, the briefings have still not been completed. Accordingly, the NTSB classified Safety Recommendation A-09-83 "Open—Acceptable Response" pending such briefings to all en route controllers.

3.1.3 Special Flight Rules Areas

After the accident, the NTSB was concerned that the recommended procedures on the New York VFR Terminal Area Chart and the New York Helicopter Route Chart might not be sufficient for informing pilots about safe operations within the Hudson River Class B exclusion area. The NTSB believed that the implementation of a special flight rules area (SFRA)[59] for the Hudson River Class B exclusion area and nearby areas, including the East River, the Statue of

[59] An SFRA comprises airspace with defined vertical and lateral dimensions for which the FAA has established special operational rules and restrictions under 14 CFR Part 93. SFRAs have been established for the area surrounding Los Angeles International Airport, Los Angeles, California, and the Washington, D.C., security zone.

Liberty,[60] and Ellis Island, would help improve flight safety in these areas and that an additional margin of safety for aircraft operating in these areas would be provided by vertical separation between airplanes and helicopters. The NTSB was also concerned about the potential for similar concentrations of air traffic within other published VFR corridors near Class B airspace. As a result, the NTSB issued Safety Recommendations A-09-84 through -86, which asked the FAA to do the following:

> Amend 14 *Code of Federal Regulations* Part 93 to establish [a] special flight rules area (SFRA) including the Hudson River Class B exclusion area, the East River Class B exclusion area, and the area surrounding Ellis Island and the Statue of Liberty; define operational procedures for use within the SFRA; and require that pilots complete specific training on the SFRA requirements before flight within the area. (A-09-84)
>
> As part of the special flight rules area procedures requested in Safety Recommendation A-09-84, require vertical separation between helicopters and airplanes by requiring that helicopters operate at a lower altitude than airplanes do, thus minimizing the effect of performance differences between helicopters and airplanes on the ability of pilots to see and avoid other traffic. (A-09-85)
>
> Conduct a review of all Class B airspace to identify any other airspace configurations where specific pilot training and familiarization would improve safety, and, as appropriate, develop special flight rules areas and associated training for pilots operating within those areas. (A-09-86)

Regarding Safety Recommendation A-09-84, the FAA stated that, on November 19, 2009, it published a final rule, "Modification of the New York, NY, Class B Airspace Area; and Establishment of the New York Class B Airspace Hudson River and East River Exclusion Special Flight Rules Area." The final rule modified the Class B airspace area by adjusting the floor of the airspace above the Hudson River up to, but not including, 1,300 feet. The final rule also established an SFRA over the Hudson and East Rivers and mandated certain pilot operating practices for flight within the Hudson River and East River Class B exclusion areas. Further, the final rule required pilots to comply with mandatory charted reporting points to be established for position reporting in the Hudson River Class B exclusion area. According to the FAA, these reporting points would be mutually used by the helicopter and fixed-wing communities and would be printed on both the New York VFR Terminal Area Chart and the New York Helicopter Route Chart. (The NTSB's review of the charts showed six mandatory reporting points.)

In addition, the FAA stated that the SFRA incorporated restrictions for fixed-wing aircraft operations in the East River exclusion area and that these restrictions are currently published in the Flight Data Center Notices to Airmen database. (The restrictions were imposed after the October 11, 2006, accident involving a fixed-wing airplane that was attempting a

[60] The National Aeronautics and Space Administration's Aviation Safety Reporting System database included at least four reports of near midair collisions involving aircraft en route to or operating near the Statue of Liberty.

180° turn in the East River exclusion area but crashed into an apartment building.)[61] The FAA noted that the following specific rules and procedures applied to operations in the SFRA:

For Hudson River Class B exclusion area operations:

- Pilots must self-announce, at the charted mandatory reporting points, the aircraft's type, current position, direction of flight, and altitude.
- Aircraft must fly along the west shoreline of the Hudson River when southbound and along the east shoreline of the river when northbound.
- Aircraft overflying the area within the Hudson River exclusion (but not landing at or departing from any of the Manhattan heliports or landing facilities or conducting any local area operations) must transit the Hudson River exclusion at or above an altitude of 1,000 feet up to, but not including, the floor of the overlying Class B airspace.

For operations in both the Hudson and East River Class B exclusion areas:

- Pilots must have a current New York VFR Terminal Area Chart and/or New York Helicopter Route Chart in the aircraft and must be familiar with the information included in the chart.[62]

For East River Class B exclusion area operations:

- VFR flight operations by fixed-wing aircraft (excluding amphibious fixed-wing aircraft landing at or departing from the New York Skyports Seaplane Base) in the East River Class B exclusion area (from the southwestern tip of Governors Island to the northern tip of Roosevelt Island) are prohibited unless authorized by and under control of ATC.
- To obtain authorization for operations in this area, pilots must contact the LGA ATCT before Governors Island.

Finally, the FAA stated that it developed, along with industry, a training program describing the hazards of flying in congested airspace and the rules and requirements for flight in the New York Class B airspace. According to the FAA, the training describes the changes to the operating practices around the Statue of Liberty for the fixed-wing and helicopter communities.

The NTSB responded by acknowledging that the FAA's final rule established an SFRA that included the Hudson River and East River Class B airspace exclusion areas and defined operational procedures for use in the SFRA. The NTSB also recognized the FAA's training program describing the rules and requirements for flight in the New York Class B airspace. The

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61 For more information, see *Crash During Turn Maneuver, Cirrus SR-20, N929CD, Manhattan, New York City, October 11, 2006,* Aircraft Accident Brief NTSB/AAB-07/02 (Washington, DC: National Transportation Safety Board, 2007).

62 The current New York VFR Terminal Area Chart, dated May 6 to November 18, 2010, replaces the helicopter route inset on previous charts with two separate insets titled, "New York Special Flight Rules Area for Flight Below Class B Airspace" and "Skyline Route for Transition Through Class B Airspace." As with the helicopter route inset, both of the new insets have arrows indicating the direction of flight along the Hudson River.

NTSB believed that pilots flying in the SFRA would seek out this training to ensure that they are prepared to meet the required operational procedures; thus, the NTSB believed that the availability of the training was an acceptable alternative to a requirement. Thus, the NTSB classified Safety Recommendation A-09-84 “Closed—Acceptable Alternate Action.”

Regarding Safety Recommendation A-09-85, the FAA stated that it determined that stratification of aircraft based on the type of operation, rather than the type of aircraft, allowed a natural separation of aircraft traversing the Hudson River corridor. The FAA also stated that speed restrictions would minimize the performance differences between helicopters and fixed-wing airplanes. The FAA further stated that aircraft landing at or departing from any of the Manhattan heliports or landing facilities or conducting any local area operations must remain below an altitude of 1,000 feet.[63] (As stated in the FAA’s response to Safety Recommendation A-09-84, aircraft overflying the area within the Hudson River exclusion, but not landing at or departing from any of the Manhattan heliports or landing facilities or conducting any local area operations, must transit the Hudson River exclusion at or above an altitude of 1,000 feet up to, but not including, the floor of the overlying Class B airspace.)[64]

The NTSB responded that the FAA’s final rule revising the New York airspace would allow a flight transiting the area to operate at an altitude of 1,000 feet and a local flight in the same area to operate at 999 feet. However, the NTSB pointed out that pilots do not always maintain their assigned altitude, as demonstrated by the operation of the accident helicopter at 1,100 feet rather than the company-prescribed altitude of 1,000 feet. The NTSB stated that altitudes used in the Hudson River corridor needed to incorporate a sufficient safety margin to prevent a midair collision and that the revised New York airspace does not provide adequate vertical separation between transiting aircraft and local aircraft. As a result, the NTSB classified Safety Recommendation A-09-85 “Open—Unacceptable Response.” (This issue is further discussed in section 3.2.)

Regarding Safety Recommendation A-09-86, the FAA stated that it would conduct an analysis of all Class B airspace, including VFR flyways and containment within the airspace. The FAA also stated that it would provide an update on its actions in response to this recommendation by April 2010. (This update has not occurred.)

The NTSB stated that the FAA’s plan to conduct an analysis of all Class B airspace met the intent of this recommendation. Thus, the NTSB classified Safety Recommendation A-09-86 “Open—Acceptable Response” pending the completion of the analysis and the implementation of appropriate actions based on the analysis results.

[63] Although the FAA’s response to this recommendation indicated that local traffic would operate below 1,000 feet, the current New York VFR Terminal Area Chart and the New York Helicopter Route Chart (as well as the charts that were in effect for the previous 6-month period) showed no restriction for local traffic to operate below this altitude. As a result, it is possible for local traffic to use the same airspace as transiting traffic (1,000 feet up to, but not including, 1,300 feet).

[64] In addition, the FAA stated that the final rule revising the New York airspace required pilots operating in the Hudson River and East River exclusion areas to maintain an indicated airspeed of 140 knots or less and turn on anticollision lights and aircraft positional navigation lights. (The use of landing lights was recommended.) The procedures at the time of the accident recommended that aircraft in the exclusion areas operate at an airspeed of 140 knots or less and have anticollision/navigation and/or landing lights turned on.

3.2 Proposed Changes to Hudson River Special Flight Rules Area

As stated in section 3.1.3, the FAA's November 30, 2009, response to Safety Recommendation A-09-85 indicated that the agency's final rule, "Modification of the New York, NY, Class B Airspace Area; and Establishment of the New York Class B Airspace Hudson River and East River Exclusion Special Flight Rules Area," established, among other things, the following: aircraft overflying the area within the Hudson River exclusion (but not landing at or departing from any of the Manhattan heliports or landing facilities or conducting any local area operations) must transit the Hudson River exclusion at or above an altitude of 1,000 feet up to, but not including, the floor of the overlying Class B airspace (1,300 feet).

The final rule does not mandate that aircraft landing at or departing from any of the Manhattan heliports or landing facilities or conducting any local area operations must remain below an altitude of 1,000 feet. As previously stated, the current VFR charts for the area showed no restriction for local traffic to operate below this altitude.

Since that time, five helicopter tour operators in the New York City area, including Liberty Helicopters, began operating new air tour routes in response to concerns of the local community to mitigate the noise heard from helicopter sightseeing flights. According to information provided by Liberty Helicopters, all air tour helicopters depart from the Downtown Manhattan Heliport (JRB) and operate over the Hudson River at altitudes from 300 to 2,000 feet rather than altitudes from 500 to 1,500 feet.

According to Liberty Helicopters' website, the company began operating its helicopter sightseeing flights from JRB in January 2010 because of an agreement to end all air tour flights at JRA in April 2010. (The company's website also indicated that, after April 2010, JRA would only be used for other commercial or government purposes or for emergency takeoffs and landings.) Although the new air tour routes and altitudes were to be reflected in a revised letter of agreement with the LGA and EWR ATCTs, Liberty Helicopters' chief pilot stated that the company began flying the new routes and altitudes using the procedures established in the letter of agreement with LGA and EWR dated April 2007. (The revised letter of agreement became effective on August 16, 2010.)

Most of the traffic at JRB will be air tour helicopters operating in the Hudson River Class B exclusion area. However, as indicated on the VFR charts for the area, these air tour helicopters are now required to use the CTAF for the East River exclusion area (123.075) rather than the CTAF for the Hudson River exclusion area (123.05). As a result, pilots of these air tour helicopters will not be monitoring and communicating position reports with other aircraft operating in the Hudson River Class B exclusion area while transmitting on the East River CTAF. Figure 6 shows the location of JRA and JRB and the boundary between the Hudson River and East River CTAFs.

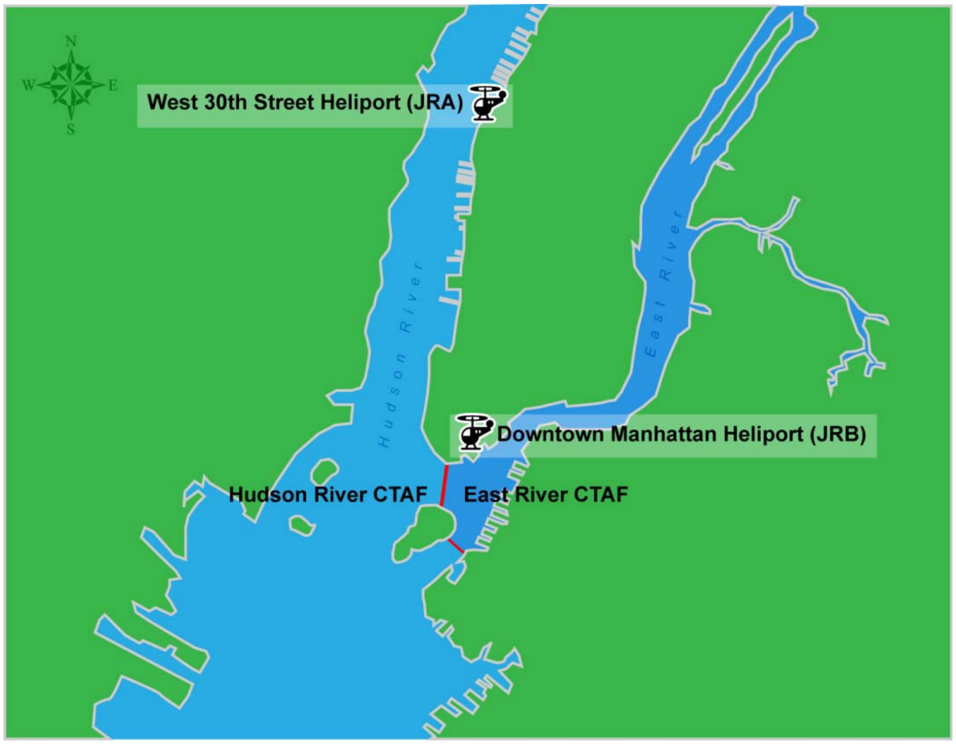

Figure 6. Location of West 30th Street and Downtown Manhattan Heliports and Boundary Between Hudson River and East River common traffic advisory frequencies.

The NTSB concludes that pilots operating air tour helicopters to and from JRB may not be fully aware of other aircraft operating over the Hudson River because the CTAF used for such flights is for the adjacent East River area. Therefore, the NTSB recommends that the FAA redefine the boundaries of the East River CTAF so that JRB will be located in the area that uses the Hudson River CTAF.

The NTSB is also concerned that local flights, including those flown according to the new air tour routes, are allowed to operate in the block of airspace from 1,000 to 1,299 feet, which is designated for transiting flights. According to the NTSB's discussions with air tour operators and ATC personnel in the Hudson River area, air tour helicopters will not climb above 900 feet without ATC clearance (as part of a clearance into the overlying Class B airspace); however, there is no published regulatory definition of the airspace structure for local operators or any mandated restriction for local operations to remain below the airspace designated for transiting aircraft.

Further, the vertical separation provision for local operations noted in the FAA's response to Safety Recommendation A-09-85 is not reflected in 14 CFR Part 93, Subpart W, "New York Class B Airspace Hudson River and East River Exclusion Special Flight Rules Area." Subpart W defines local operation in 14 CFR 93.350(a) as follows: "any aircraft within the Hudson River Exclusion [area] that is conducting an operation other than as described in paragraph (b) of this section. Local operations include but are not limited to operations for sightseeing, electronic news gathering, and law enforcement." Paragraph (b) defines transient operation as an aircraft transiting the entire length of the Hudson River Class B exclusion area from one end to the other. However, 14 CFR 93.352, "Hudson River Exclusion Specific Operating Procedures," mandates the altitudes to be used by aircraft transiting the Hudson River Class B exclusion area (1,000 feet up to, but not including, the floor of the Class B airspace) but does not specify altitudes of operation for aircraft conducting local operations. Thus, according to current regulations, aircraft conducting local operations would not be precluded from operating in the airspace specified for transiting aircraft.

Although 14 CFR Part 93, Subpart W, contains no regulations regarding operating altitudes for local aircraft over the Hudson River, an FAA online training program for the New York SFRA provided this information.[65] The training program described local operations as "flights conducted between the surface and up to, but not including, one thousand feet MSL [mean sea level]." Also, module 3 of the training program, Pilot Operational Procedures, indicated the following: "to ensure your safety and the safety of other aircraft in the area…conduct your entire flight while in the exclusion [area] below 1000 feet MSL."

The NTSB concludes that current FAA regulations do not provide adequate vertical separation for aircraft operating in the Hudson River SFRA because the regulations do not include specific operating altitudes for local aircraft. Therefore, the NTSB recommends that the FAA (1) revise 14 CFR 93.352 to specify altitudes of use for aircraft conducting local operations in the Hudson River SFRA so that the regulation includes required operating altitudes for both local and transiting aircraft and (2) incorporate the altitude information for local operations onto published VFR aeronautical charts for the area.

3.3 Guidance on See-and-Avoid Concept

AC 90-48C, "Pilots' Role in Collision Avoidance," was issued in March 1983. As mentioned previously, the AC states that the see-and-avoid concept requires vigilance at all times by each person operating an aircraft regardless of whether the flight is conducted under IFR or VFR. The AC also notes that most midair collisions and reported near midair collisions occur during good VFR weather conditions and daylight hours. The AC further states that pilots should (1) remain constantly alert to all traffic movement within their field of vision and (2) scan the entire visual field outside of their aircraft to ensure that conflicting traffic can be detected.

Although the guidance in AC 90-48C alerts pilots to the potential hazards of midair and near midair collisions, some of the AC's content is outdated or does not reflect current-day operations. For example, the AC includes guidance on operating within terminal radar service areas, terminal control areas, and airport traffic areas. However, some of these areas were rendered obsolete in 1994 after a reclassification of North American airspace. Also, AC 90-48C describes operational environments in which pilots may find a high volume of traffic, but air tour operational areas are not included in this discussion. In addition, although the AC mentions that pilots should request traffic advisories from ATC to assist with seeing and avoiding other traffic, the AC contains no guidance about technological advances to aircraft equipment that aids in traffic awareness.

[65] This information was obtained from the "New York City Special Flight Rules Area (SFRA)" course on the FAA website http://www.faasafety.gov (accessed July 30, 2010).

The NTSB concludes that the guidance in AC 90-48C could better assist pilots' efforts to establish effective see-and-avoid skills if the AC were to recognize current challenges that pilots encounter in managing their see-and-avoid responsibilities, including complex, high-density airspace and the increasing presence of technology in the cockpit. Therefore, the NTSB recommends that the FAA update AC 90-48C to reflect current-day operations, including (1) a description of the current National Airspace System and airspace classifications, (2) references to air tour operational areas as high-volume traffic environments, and (3) guidance on the use of electronic traffic advisory systems for pilots operating under the see-and-avoid concept.

3.4 Electronic Traffic Advisory Systems

There are inherent limitations associated with the see-and-avoid concept as the primary method for aircraft separation. These limitations include a pilot's ability to perform systematic scans,[66] competing operational task demands, environmental factors, and blind spots associated with an aircraft's structure. Traffic advisory systems can provide pilots with additional information to facilitate pilot efforts to maintain awareness of and visual contact with nearby aircraft to reduce the likelihood of a collision.

Most traffic advisory systems, including TIS, have visual displays of nearby traffic that show an aircraft's position or distance, direction of travel, and relative altitude and indicate whether the aircraft is climbing or descending. The NTSB recognizes that incorporating a visual traffic display into a pilot's scan could increase workload, but any increase in workload would be offset by the safety benefits resulting from the augmented awareness of other aircraft operating in the area, as displayed by the traffic system. However, these safety benefits are not a substitute for the see-and-avoid concept. In fact, Garmin guidance stated that TIS does not relieve pilots of their responsibility to see and avoid other aircraft. Thus, pilots are responsible for paying attention to the position of other aircraft for collision avoidance and not relying solely on a traffic advisory system for aircraft position information.

In its report on the July 2007 midair collision involving two ENG helicopters over Phoenix, the NTSB found that the SkyWatch traffic advisory system installed on one of the helicopters was developed for business and general aviation aircraft, including helicopters, but was not specifically designed according to helicopter flight characteristics.[67] The NTSB's report stated that helicopter flight characteristics require closer range dimensions and closer altitude discrimination because helicopters are more maneuverable and operate at slower speeds than fixed-wing airplanes and that the NTSB was not aware of any traffic advisory systems at the time that met those criteria.[68] The NTSB's report concluded that a traffic advisory system designed

[66] Although reliably detecting conflicting traffic requires pilots to systematically scan the area around their aircraft while dividing their visual attention among other flight tasks, maintaining a systematic scan while maneuvering can be difficult because of the tendency to look predominantly in the direction of travel.

[67] The NTSB notes that TIS was not specifically designed for helicopters and that a traffic advisory system designed for helicopter operations in congested airspace might have provided better information to the helicopter pilot.

[68] Unlike fixed-wing airplanes, helicopters can hover and fly slowly. Also, they are highly maneuverable when operating in a confined airspace and thus can change direction of flight in a short time. As a result, electronic traffic advisory systems designed specifically for fixed-wing airplanes are not necessarily optimal for helicopters operating in a flight regime unique to helicopters.

specifically for helicopters could help eliminate the nuisance warnings that ENG pilots can receive when other aircraft are operating near the system's alerting envelope and that such systems would enhance an ENG pilot's capability to detect other aircraft operating in the same area. As a result, on February 9, 2009, the NTSB issued Safety Recommendations A-09-04 and -05, which asked the FAA to do the following:

> Develop standards for helicopter cockpit electronic traffic advisory systems so that pilots can be alerted to the presence of other aircraft operating in the same area regardless of their position. (A-09-04)
>
> Once standards for helicopter cockpit electronic traffic advisory systems are developed, as requested in Safety Recommendation A-09-04, require electronic news gathering operators to install this equipment on their aircraft. (A-09-05)

On April 17, 2009, the FAA stated that it would review existing certification standards for electronic traffic advisory systems and determine if additional standards for electronic traffic advisory systems installed on helicopters needed to be developed. The FAA also stated that, if additional standards were needed, they would be developed, and the agency would recommend that all ENG operators install electronic traffic advisory systems on their helicopters.

On August 27, 2009, the NTSB stated that the FAA's plan was responsive to Safety Recommendation A-09-04 but that, to meet the intent of Safety Recommendation A-09-05, the FAA must require electronic traffic advisory systems for ENG helicopters. Safety Recommendations A-09-04 and -05 were classified "Open—Acceptable Response" pending the development of standards that address helicopter electronic traffic advisory systems and the establishment of a requirement for all ENG operators to install this equipment on their aircraft.

On May 20, 2010, the FAA responded to Safety Recommendation A-09-04 and stated that it reviewed the current certification standards for electronic traffic advisory systems and determined that technical standard orders (TSO) already existed for these systems.[69] The FAA also stated that the TSOs referenced several RTCA (formerly Radio Technical Commission for Aeronautics) documents that provided minimum operational performance standards and guidance for implementing various traffic advisory systems and displaying traffic information in the cockpit. The FAA further stated that the existing certification standards adequately addressed the issues identified in Safety Recommendation A-09-04 and that no further actions regarding the recommendation were planned.

The NTSB's review of the TSOs found that they described only the minimum standards that all electronic traffic advisory systems must meet to be certified. The TSOs do not address specific standards for helicopter traffic advisory systems, as requested in Safety Recommendation A-09-04, or consider the different types of operations conducted by helicopters. Also, the current standards do not consider the limitations of those helicopter traffic advisory systems that depend on radar systems (such as TIS) to resolve distances that are less than 1/8 nm between aircraft.

[69] According to the FAA, these TSOs are for traffic advisory systems (TSO-CI47), TCAS (TSO-C118), TCAS II (TSO-C119c), and automatic dependent surveillance-broadcast systems (TSO-CI54b and -CI66a).

In addition, the current certification standards for electronic traffic advisory systems do not consider the potential for nuisance alerts during close-in operations, which can desensitize pilots to system warnings and thus decrease the effectiveness of the systems. When pilots fly closely enough to other aircraft to trigger the traffic alerting function of current traffic advisory systems, the traffic alerts may be disregarded by a pilot if such alerts occur frequently and the pilot is already aware of other aircraft operating in the area. Traffic alerts are triggered based on the assumption that certain parameters (ground track, ground speed, and rate of climb) would be maintained long enough for a traffic advisory system to estimate future positions of the aircraft. This assumption works well for those aircraft that are in stable flight with minimal maneuvering (for example, during en route flight). However, this assumption may not be appropriate when numerous aircraft are maneuvering in a congested VFR corridor (such as the Hudson River Class B exclusion area)[70] or ENG aircraft are maneuvering within a relatively small area.

The NTSB concludes that, because the FAA's current TSOs for electronic traffic advisory systems do not distinguish between the different flight characteristics of helicopters and fixed-wing airplanes, the effectiveness of these systems aboard helicopters is limited. The NTSB further concludes that the traffic alerting function of helicopter electronic traffic advisory systems is limited because the parameters used to trigger alerts do not consider frequent maneuvering in congested areas, resulting in nuisance alerts. Therefore, the NTSB recommends that the FAA develop standards for helicopter cockpit electronic traffic advisory systems that (1) address, among other flight characteristics, the capability of helicopters to hover and to fly near other aircraft at lower altitudes, slower airspeeds, and different attitudes than fixed-wing airplanes; (2) reduce nuisance alerts when nearby aircraft enter the systems' alerting envelope; and (3) consider the different types of operations conducted by helicopters, including those in congested airspace. Further, Safety Recommendation A-09-04 is reclassified "Closed—Unacceptable Action/Superseded," and Safety Recommendation A-10-127 is classified "Open—Unacceptable Response."

In addition, Safety Recommendation A-09-05 focuses solely on helicopter ENG operations, but the use of helicopter electronic traffic advisory systems should be expanded beyond ENG operators to provide passenger revenue operations with the same safety benefit.[71] The NTSB concludes that electronic traffic advisory systems installed on helicopters operated for passenger revenue flight would enhance a pilot's capability to detect other aircraft operating in the same area by providing aural annunciations and visual displays of the traffic. Therefore, the NTSB recommends that, once standards for helicopter electronic traffic advisory systems are developed, as requested in Safety Recommendation A-10-127, the FAA require ENG operators, air tour operators, and other operators of helicopters used for passenger revenue flight to install this equipment on their aircraft. As a result of this new recommendation, Safety Recommendation A-09-05 is reclassified "Closed—Acceptable Action/Superseded."

[70] During a postaccident interview, Liberty Helicopters' director of operations stated that TIS was a useful tool during charter flights along the Hudson River corridor but that it could be distracting during air tour flights while operating in the congested areas of the corridor.

[71] This report does not address electronic traffic advisory systems for airplanes operated under 14 CFR Part 91 because most of these airplanes are privately owned and many may not have an electrical system that can support the operation of a traffic advisory system. Also, Part 91 airplanes may be operated under VFR throughout most of the United States without a transponder. (The accident airplane, however, was capable of receiving TIS data and was equipped with a mode S transponder.)

4. Conclusions

4.1 Findings

1. Both pilots were properly certificated and qualified in accordance with applicable federal regulations.

2. Available evidence suggested that the airplane pilot was not likely affected by fatigue at the time of the accident. The helicopter pilot had an opportunity to obtain sufficient sleep before the day of the accident, but it is unknown if he did so; as a result, no assessment about fatigue could be made for the helicopter pilot.

3. Both aircraft were properly certified, equipped, and maintained in accordance with federal regulations, and the recovered components showed no evidence of any preimpact structural, engine, or system failures.

4. Weather was not a factor in this accident, and sun glare would not have interfered with the pilots' ability to detect and track the other aircraft.

5. The accident was not survivable.

6. The Teterboro Airport local controller unnecessarily delayed transferring communications for the accident airplane from Teterboro to Newark Liberty International Airport (EWR), which prevented the EWR controller from turning the airplane away from Hudson River traffic and having the airplane climb directly into Class B airspace.

7. The Teterboro Airport local controller did not provide continual traffic advisories to the airplane pilot, as required; such advisories would have heightened the pilot's awareness of traffic over the Hudson River.

8. The airplane pilot may have believed that no other potential traffic conflicts existed because he had not received additional traffic advisories, but the pilot was still responsible for seeing and avoiding other traffic.

9. The Teterboro Airport local controller did not correct the airplane pilot's read back of the Newark Liberty International Airport tower frequency because of the controller's nonpertinent telephone conversation and other transmissions that were occurring.

10. The airplane pilot's incorrect frequency selection, along with the Teterboro Airport controller's failure to correct the read back, prevented the Newark Liberty International Airport controller from issuing instructions to the airplane pilot to climb and turn away from traffic.

11. Because the airplane pilot had requested traffic advisories, was attempting to contact the Newark Liberty International Airport air traffic control tower, and did not anticipate operating in the Hudson River Class B exclusion area, the pilot was not expected or required

to monitor common traffic advisory frequency position reports, including those made by the helicopter pilot.

12. The helicopter's climb above 1,000 feet was not consistent with company procedures and decreased the vertical separation between the aircraft.

13. The helicopter would not have been obscured from the airplane pilot's view but would likely have been difficult for him to detect until the final seconds before the collision because, before that time, the helicopter would have appeared as a relatively small and stationary object against a complex background of buildings.

14. The airplane pilot appeared to have started an evasive maneuver immediately before the collision to avoid the helicopter.

15. The airplane would likely have been in the helicopter pilot's field of view until 32 seconds before the collision, after which time the airplane was above and behind the helicopter and was outside the pilot's field of view.

16. Neither pilot effectively used available electronic traffic information to assist in maintaining awareness of nearby aircraft.

17. The local controller's nonpertinent telephone conversations distracted him from his air traffic control duties.

18. The local controller's nonpertinent telephone conversation during the time of the accident flight might not have occurred if the front line manager had corrected the controller's performance deficiency involving an earlier nonpertinent telephone conversation.

19. The Teterboro Airport front line manager, who was not present in the air traffic control tower at the time of the accident, exercised poor judgment by not letting staff know how he could be reached while he was away from the tower and by not using an available staffing asset to provide an additional layer of oversight at the tower during his absence.

20. The local controller's and the front line manager's noncompliance with existing procedures and best practices demonstrated a lack of professionalism, which increased the opportunity for errors.

21. The air traffic control transfer-of-communications procedures applied to the accident airplane might have inadvertently caused the pilot not to follow the traffic awareness procedures established for flights through the area, thereby increasing the chance for a collision.

22. Pilots operating air tour helicopters to and from the Downtown Manhattan Heliport may not be fully aware of other aircraft operating over the Hudson River because the common traffic advisory frequency used for such flights is for the adjacent East River area.

23. Current Federal Aviation Administration regulations do not provide adequate vertical separation for aircraft operating in the Hudson River special flight rules area because the regulations do not include specific operating altitudes for local aircraft.

24. The guidance in Advisory Circular (AC) 90-48C, "Pilots' Role in Collision Avoidance," could better assist pilots' efforts to establish effective see-and-avoid skills if the AC were to recognize current challenges that pilots encounter in managing their see-and-avoid responsibilities, including complex, high-density airspace and the increasing presence of technology in the cockpit.

25. Because the Federal Aviation Administration's current technical standard orders for electronic traffic advisory systems do not distinguish between the different flight characteristics of helicopters and fixed-wing airplanes, the effectiveness of these systems aboard helicopters is limited.

26. The traffic alerting function of helicopter electronic traffic advisory systems is limited because the parameters used to trigger alerts do not consider frequent maneuvering in congested areas, resulting in nuisance alerts.

27. Electronic traffic advisory systems installed on helicopters operated for passenger revenue flight would enhance a pilot's capability to detect other aircraft operating in the same area by providing aural annunciations and visual displays of the traffic.

4.2 Probable Cause

The National Transportation Safety Board determines that the probable cause of this accident was (1) the inherent limitations of the see-and-avoid concept, which made it difficult for the airplane pilot to see the helicopter until the final seconds before the collision, and (2) the Teterboro Airport local controller's nonpertinent telephone conversation, which distracted him from his air traffic control (ATC) duties, including correcting the airplane pilot's read back of the Newark Liberty International Airport (EWR) tower frequency and the timely transfer of communications for the accident airplane to the EWR tower. Contributing to this accident were (1) both pilots' ineffective use of available electronic traffic information to maintain awareness of nearby aircraft, (2) inadequate Federal Aviation Administration (FAA) procedures for transfer of communications among ATC facilities near the Hudson River Class B exclusion area; and (3) FAA regulations that did not provide adequate vertical separation for aircraft operating in the Hudson River Class B exclusion area.

5. Recommendations

5.1 New Recommendations

The National Transportation Safety Board recommends the following to the Federal Aviation Administration:

> Redefine the boundaries of the East River common traffic advisory frequency (CTAF) so that the Downtown Manhattan Heliport will be located in the area that uses the Hudson River CTAF. (A-10-124)
>
> Revise 14 *Code of Federal Regulations* 93.352 to specify altitudes of use for aircraft conducting local operations in the Hudson River special flight rules area so that the regulation includes required operating altitudes for both local and transiting aircraft, and incorporate the altitude information for local operations onto published visual flight rules aeronautical charts for the area. (A-10-125)
>
> Update Advisory Circular 90-48C to reflect current-day operations, including (1) a description of the current National Airspace System and airspace classifications, (2) references to air tour operational areas as high-volume traffic environments, and (3) guidance on the use of electronic traffic advisory systems for pilots operating under the see-and-avoid concept. (A-10-126)
>
> Develop standards for helicopter cockpit electronic traffic advisory systems that (1) address, among other flight characteristics, the capability of helicopters to hover and to fly near other aircraft at lower altitudes, slower airspeeds, and different attitudes than fixed-wing airplanes; (2) reduce nuisance alerts when nearby aircraft enter the systems' alerting envelope; and (3) consider the different types of operations conducted by helicopters, including those in congested airspace. (A-10-127) (Supersedes Safety Recommendation A-09-04 and is classified "Open—Unacceptable Response")
>
> Once standards for helicopter electronic traffic advisory systems are developed, as requested in Safety Recommendation A-10-127, require electronic news gathering operators, air tour operators, and other operators of helicopters used for passenger revenue flight to install this equipment on their aircraft. (A-10-128) (Supersedes Safety Recommendation A-09-05)

5.2 Previously Issued Recommendations Resulting From This Accident Investigation

The National Transportation Safety Board issued the following recommendations to the Federal Aviation Administration on August 27, 2009:

Revise standard operating procedures for all air traffic control (ATC) facilities, including those at Teterboro airport, LaGuardia airport, and Newark Liberty International airport, adjoining the Hudson River Class B exclusion area in the following ways:

a) establish procedures for coordination among ATC facilities so that aircraft operating under visual flight rules and requesting a route that would require entry into Class B airspace receive ATC clearance to enter the airspace as soon as traffic permits,

b) require controllers to instruct pilots with whom they are communicating and whose flight will operate in the Hudson River Class B exclusion area to switch from ATC communications to the common traffic advisory frequency (CTAF) and to self-announce before entering the area,

c) add an advisory to the Automatic Terminal Information Service broadcast, reminding pilots of the need to use the CTAF while operating in the Hudson River Class B exclusion area and to self-announce before entering the area, and

d) in any situation where, despite the above procedures, controllers are in contact with an aircraft operating within or approaching the Hudson River Class B exclusion area, ensure that the pilot is provided with traffic advisories and safety alerts at least until exiting the area. (A-09-82)

Brief all air traffic controllers and supervisors on the air traffic control (ATC) performance deficiencies evident in the circumstances of this accident and emphasize the requirement to be attentive and conscientious when performing ATC duties. (A-09-83)

Amend 14 *Code of Federal Regulations* Part 93 to establish [a] special flight rules area (SFRA) including the Hudson River Class B exclusion area, the East River Class B exclusion area, and the area surrounding Ellis Island and the Statue of Liberty; define operational procedures for use within the SFRA; and require that pilots complete specific training on the SFRA requirements before flight within the area. (A-09-84)

As part of the special flight rules area procedures requested in Safety Recommendation A-09-84, require vertical separation between helicopters and airplanes by requiring that helicopters operate at a lower altitude than airplanes do, thus minimizing the effect of performance differences between helicopters and airplanes on the ability of pilots to see and avoid other traffic. (A-09-85)

Conduct a review of all Class B airspace to identify any other airspace configurations where specific pilot training and familiarization would improve safety, and, as appropriate, develop special flight rules areas and associated training for pilots operating within those areas. (A-09-86)

5.3 Previously Issued Recommendations Reclassified in This Report

Safety Recommendation A-09-04, which was issued to the Federal Aviation Administration (FAA) on February 9, 2009, is reclassified “Closed—Unacceptable Action/Superseded” in section 3.4 of this report. The recommendation is superseded by Safety Recommendation A-10-127.

> Develop standards for helicopter cockpit electronic traffic advisory systems so that pilots can be alerted to the presence of other aircraft operating in the same area regardless of their position. (A-09-04)

Safety Recommendation A-09-05, which was issued to the FAA on February 9, 2009, is reclassified “Closed—Acceptable Action/Superseded” in section 3.4 of this report. The recommendation is superseded by Safety Recommendation A-10-128.

> Once standards for helicopter cockpit electronic traffic advisory systems are developed, as requested in Safety Recommendation A-09-04, require electronic news gathering operators to install this equipment on their aircraft. (A-09-05)

BY THE NATIONAL TRANSPORTATION SAFETY BOARD

DEBORAH A.P. HERSMAN
Chairman

ROBERT L. SUMWALT
Member

CHRISTOPHER A. HART
Vice Chairman

MARK R. ROSEKIND
Member

EARL F. WEENER
Member

Adopted: September 14, 2010

Vice Chairman Christopher A. Hart filed the following statement in which he concurred in part and dissented in part with the probable cause of this accident.

Board Member Statement

Vice Chairman Christopher A Hart, Concur In Part and Dissent In Part

I concur in part and I dissent in part regarding the probable cause.

One of the primary reasons for our probable cause statement is to identify a problem that we can recommend measures to resolve in order to prevent the problem from happening again. Thus, I concur with the probable cause to the extent that it is based upon the controller's inadequate attention to his duties because he was on the phone when he should have been doing his job. This is a problem for which there is a very direct remedy -- prohibiting controllers from inappropriately using the phone while on duty.

On the other hand, I dissent from the probable cause to the extent that it is based upon the limitations of "see and avoid." I do not believe that it is useful to specify, as a probable cause, a macro systemic characteristic over which we have little control and for which we can recommend only indirect remedies. Similarly, we do not specify "fog" as part of probable cause because we have no control or direct remedy for fog. Instead, the aviation system has created ground and airplane infrastructure to enable pilots to fly in fog, and our probable cause might note that the pilot failed to use and follow his instruments properly.