January 27, 2026 Aviation Investigation Report AIR-26-02

Midair Collision over the Potomac River PSA Airlines Flight 5342, Mitsubishi Heavy Industries (MHI) RJ Aviation CL-600-2C10 (CRJ700), and US Army Priority Air Transport Flight 25, Sikorsky UH-60L

Washington, DC
January 29, 2025

Abstract: This report discusses the January 29, 2025, midair collision involving a Sikorsky UH-60L helicopter, operated by the US Army under the callsign PAT25, and a Mitsubishi Heavy Industries RJ Aviation (formerly Bombardier) CL-600-2C10 (CRJ700) airplane, N709PS, operated by PSA Airlines as flight 5342, over the Potomac River in southwest Washington, DC, about 0.5 miles southeast of Ronald Reagan Washington National Airport (DCA), Arlington, Virginia. The 2 pilots, 2 flight attendants, and 60 passengers on board the airplane and all 3 crewmembers on board the helicopter died. Both aircraft were destroyed as a result of the accident. Safety issues discussed in this report include:

- helicopter route design surrounding DCA;
- the extensive use of pilot-applied visual separation and the inherent limitations of see-and-avoid, including when using night vision goggles;
- unclear and inconsistent Federal Aviation Administration (FAA) guidance on helicopter route altitudes and boundaries and operators' misinterpretation of those altitudes;
- limitations and gaps in the traffic awareness, alerting, and collision-avoidance technologies available to both aircraft;
- risks associated with separate helicopter and airplane radio frequencies and blocked transmissions;
- controller workload, position-combining, and communication practices;
- deficiencies in FAA safety culture, facility-level oversight, and postaccident drug- and alcohol-testing procedures; and
- shortcomings in FAA and US Army safety assurance and risk management processes, including lack of proactive data sharing and safety analysis to identify and mitigate midair collision risk in complex terminal environments.

As a result of this investigation, the National Transportation Safety Board makes 33 recommendations to the FAA, 8 recommendations to the US Army, 5 recommendations to the Department of War Policy Board on Federal Aviation, 2 recommendations to the Department of Transportation (DOT), 1 recommendation to the DOT Office of the Inspector General, and 1 recommendation to the RTCA.

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Acronyms and Abbreviations

AAPS	aviation accident prevention survey
AAR	airport arrival rate
AC	advisory circular
ACM	aircrew members
ACAS	airborne collision avoidance system
ACAS X	airborne collision avoidance system, X family
ACAS Xa	airborne collision avoidance system Xa (airplane version)
ACAS Xo	airborne collision avoidance system Xo (optimized for specific operations)
ACAS Xr	airborne collision avoidance system Xr (rotorcraft version)
ADS–B	Automatic Dependent Surveillance–Broadcast
AFMES	Armed Forces Medical Examiner System
agl	above ground level
AJI	ATO Office of Safety and Technical Training, FAA
ALC	assistant local control
ALPA	Air Line Pilots Association
ANVIS	Aviator's Night Vision Imaging System
AOV	Air Traffic Safety Oversight Service, FAA
ARAP	Army Readiness Assessment Program
ARIA	Aviation Risk Identification and Assessment
ARMS	Aviation Resource Management Survey
ASMIS	Army Safety Management Information System
ASOHMS	Army Safety and Occupational Health Management System

ASAP	Aviation Safety Action Program
ASIAS	Aviation Safety Information Analysis and Sharing
ASRS	Aviation Safety Reporting System
ATAS	ADS-B Traffic Advisory System
ATC	air traffic control
ATCT	airport traffic control tower
ATM	air traffic manager
ATO	Air Traffic Organization, FAA
ATP	airline transport pilot
ATSAP	Air Traffic Safety Action Program
AVS	Aviation Safety Organization, FAA
BAR	barrier analysis review
CA	conflict alert
CBA	collective bargaining agreement
CD	clearance delivery
CDTI	cockpit display of traffic information
CFR	*Code of Federal Regulations*
CFT	crash-resistant fuel tanks
CISP	Confidential Information Share Program
CLT	Charlotte-Douglas International Airport
CIC	controller in charge
COO	chief operating officer
CST	central standard time
CRM	crew resource management

CPC	certified professional controller
CTRD	control tower radar display
CVR	cockpit voice recorder
DA PAM	Department of the Army Pamphlet
DAA	Davison Army Airfield
DAB	Daytona Beach International Airport
DCA	Ronald Reagan Washington National Airport
DOD	Department of Defense
DOT	Department of Transportation
DOW	Department of War
ECV	external compliance verification
ESIS	electronic standby instrument system
ESSS	external stores support system
EST	eastern standard time
ERC	event review committee
FAA	Federal Aviation Administration
FD	flight data
FDR	flight data recorder
FO	first officer
FOQA	flight operations quality assurance
FPS	flight path stabilization
FRZ	flight restricted zone
FSDO	flight standards district office
GAO	Government Accountability Office

GC	ground control
HC	helicopter control
HUD	heads-up display
HUMS	health and usage monitoring system
HWG	Helicopter Working Group
IAD	Washington Dulles International Airport
ICAO	International Civil Aviation Organization
ICT	Wichita Dwight D. Eisenhower National Airport
ICV	internal compliance verification
IFR	instrument flight rules
IMC	instrument meteorological conditions
inHG	inches of mercury
IP	instructor pilot
IRT	indicator/receiver-transmitter
ISA	international standard atmosphere model
IVHMS	integrated vehicle health monitoring system
IVHMU	integrated vehicle health monitoring unit
LC	local control
LFT	Lafayette Regional Airport
LIMC	low instrument meteorological conditions
LOA	letter of agreement
LOSA	line operations safety audit
LVMC	low visual meteorological conditions
MFD	multifunction display

MFOQA	military flight operations quality assurance
MGB	main gearbox
MHI	Mitsubishi Heavy Industries
MIT	miles in trail
MIT–LL	Massachusetts Institute of Technology–Lincoln Laboratory
MLAT	multilateration
MOR	mandatory occurrence report
MPFR	multipurpose cockpit voice and flight data recorder
msl	mean sea level
MWAA	Metropolitan Washington Airports Authority
NAS	National Airspace System
NASA	National Aeronautics and Space Administration
NATCA	National Air Traffic Controllers Association
nm	nautical miles
NMAC	near midair collision
NMACS	Near Midair Collision System
NTSB	National Transportation Safety Board
NVG	night vision goggles
OHR	operational hazard report
OM	operations manager
OS	operations supervisor
PAPI	precision approach path indicator
PAT25	Priority Air Transport Flight 25
PAR	preliminary ARIA report

PBFA	Policy Board on Federal Aviation, DOW
PDARS	Performance Data Analysis and Reporting System
PFD	primary flight display
PMI	phase maintenance inspection
RA	resolution advisory
RCM	rated crewmember
RCOP	Risk Common Operating Picture
RCU	remote control unit
RL	readiness level
RTCA	RTCA, formerly Radio Technical Commission for Aeronautics
SAS	stability augmentation system
SFRA	special flight rules area
SM	support manager
SMS	safety management system
SOH	safety and occupational health specialist
SOHAC	Safety and Occupational Health Advisory Council
SPPM	Safety Policies and Procedures Manual
SRM	safety risk management
SRMP	safety risk management panel
SSS	staff support specialist
SRT	services rendered telephone conference
STARS	Standard Terminal Automation Replacement System
SUPSALV	Supervisor of Salvage and Diving, US Navy
SYSIR	systemic issue review

TA	traffic advisory
TAAB	The Army Aviation Brigade
TBFM	time-based flow management
TCAS	traffic alert and collision avoidance system
TEM	threat and error management
TIS–B	Traffic Information Service–Broadcast
TMC	traffic management coordinator
TRACON	terminal radar approach control
TSO	technical standard order
UH-60L	Sikorsky Utility Helicopter 60 Lima model (“Black Hawk”)
USAF	United States Air Force
USCG	United States Coast Guard
VFR	visual flight rules
VHF	very high frequency
VMC	visual meteorological conditions

Executive Summary

What Happened

On January 29, 2025, about 2048 eastern standard time (EST), a Sikorsky UH-60L, operated by the US Army under the callsign PAT25 (Priority Air Transport Flight 25), and an MHI (Mitsubishi Heavy Industries) RJ Aviation (formerly Bombardier) CL-600-2C10 (CRJ700), N709PS, operated by PSA Airlines as American Airlines flight 5342, collided in flight about 0.5 miles southeast of Ronald Reagan Washington National Airport (DCA), Arlington, Virginia, and impacted the Potomac River in southwest Washington, DC. The 2 pilots, 2 flight attendants, and 60 passengers on board the airplane and all 3 crewmembers on board the helicopter died. Both aircraft were destroyed as a result of the accident.

Flight 5342 was operating under the provisions of Title 14 *Code of Federal Regulations* Part 121 as a scheduled domestic passenger flight from Wichita Dwight D. Eisenhower National Airport, Wichita, Kansas, to DCA. PAT25 originated from Davison Army Airfield (DAA), Fort Belvoir, Virginia, for the purpose of the pilot's annual standardization evaluation flight with the use of night vision goggles (NVGs). Night visual meteorological conditions prevailed in the area of DCA at the time of the accident.

PAT25 departed DAA and landed at sites in Virginia and Maryland before the crew turned south toward Washington, DC, and was cleared by the DCA tower controller (who was working combined local control and helicopter control positions) to transition the DCA airspace via helicopter Routes 1 and 4 before proceeding back to DAA. The helicopter joined Route 1 near Cabin John, Maryland, and followed the Potomac River southbound at low altitude, passing the Key Bridge, Memorial Bridge, Tidal Basin, and Hains Point before continuing onto Route 4.

At the same time, flight 5342 was approaching DCA on an instrument flight rules flight that had been uneventful during departure, cruise, and initial descent. The airplane was inbound from the south on a visual approach to runway 1 when the DCA tower controller asked the flight crew if they could accept runway 33 instead. After confirming landing performance, the crew accepted a circling approach to runway 33 and maneuvered the airplane to align with the runway 33 final approach path.

While PAT25 was transitioning from Route 1 to Route 4 and flight 5342 was circling to land, the controller issued a traffic advisory to the helicopter crew about the airplane, which was south of the Woodrow Wilson Bridge. At this time, the airplane was about 6.5 nautical miles (about 7.5 statute miles) south of the helicopter's position, and its exterior lights would have been visible in the dark among those of several other airplanes, which were on approach to runway 1 from the south. The instructor pilot onboard PAT25 stated that they had the traffic in sight and requested visual separation, which the controller approved.

As the aircraft flightpaths converged near the runway 33 approach corridor about 1 1/2 minutes later (20 seconds before impact), the controller asked the helicopter crew whether they had the airplane in sight and instructed PAT25 to pass behind it; however, one of the helicopter pilots pressed the radio push-to-talk switch for 0.8 seconds while the controller was speaking, and this brief radio transmission blocked the helicopter crew from receiving the "pass behind" portion of the controller's instruction. The instructor pilot onboard PAT25 again indicated that they had the airplane in sight and requested visual separation, which the controller approved. PAT25 continued southbound along Route 4 while flight 5342 descended on final approach for runway 33, and the aircraft collided over the Potomac River at an altitude about 278 ft above mean sea level (msl).

What We Found

The National Transportation Safety Board (NTSB) found that the Federal Aviation Administration (FAA) placed Helicopter Route 4 in close proximity to the runway 33 approach path at DCA without procedural mitigations to separate helicopter and fixed-wing traffic, and that the FAA Air Traffic Organization (ATO) did not regularly review or reevaluate the route as required. Although midair collision risk was apparent in multiple data sources and concerns had been repeatedly raised by air traffic control (ATC) personnel, the FAA failed to act on recommendations or available information to mitigate the identified risk.

We also found that the air traffic system relied heavily on pilot-applied visual separation to maintain efficient traffic flow in the DCA terminal area, without adequate consideration of the inherent limitations of see-and-avoid in a complex, high-workload environment. This reliance contributed to a gradual normalization of using pilot-applied visual separation as the primary means of managing mixed helicopter and fixed-wing operations, which increased the likelihood of a midair collision.

Additionally, published information about the Washington, DC, helicopter routes did not provide fixed-wing and rotorcraft operators or controllers with a shared, complete understanding of the route limitations, and aeronautical charts for fixed-wing aircraft did not depict nearby helicopter routes that could intersect with approach and departure paths at DCA. The majority of Army pilots interviewed incorrectly assumed that flying at or below the published route altitudes provided inherent separation from fixed-wing traffic arriving and departing DCA.

We further found that the Army did not ensure that helicopter pilots were adequately informed about the effects of allowable error tolerances in barometric altimeters. As a result, the accident helicopter crew was flying above the published maximum route altitude.

We found that the helicopter crew did not effectively apply visual separation. Due to degraded radio reception, the crew did not receive information about the airplane's circling approach to a different runway, which reinforced an incorrect expectation that the airplane did not pose a conflict. That expectation shaped the crew's visual scan and led the instructor pilot to report "traffic in sight" and request visual separation without positively identifying the airplane.

We found that high workload at the DCA air traffic control tower (ATCT) degraded controller performance and situation awareness. The combination of the helicopter control and local control positions during a period of elevated traffic volume, together with the absence of a structured risk assessment process to support real-time operational decision making, contributed to misprioritization of duties, incomplete traffic advisories, and the lack of safety alerts to both flight crews that could have resulted in flight crew actions to avert the collision.

We found that both flight crews were operating under conditions that made visual acquisition of the other aircraft difficult, including nighttime operations, a complex background of city lights, and limited relative motion between the aircraft. In addition, the limitations of the traffic awareness and collision alerting systems on both aircraft prevented effective alerting of the impending collision. Although advanced collision avoidance technologies could have provided earlier or more informative alerts, neither crew received technological cues sufficient to overcome the limitations of visual scanning in this environment.

The helicopter was not equipped with any integrated traffic awareness or collision avoidance technology that could have alerted its crew to the impending collision. The helicopter crew did have access to tablets running an application that could display Automatic Dependent Surveillance—Broadcast (ADS-B) traffic information and could have provided a visual and aural alert concerning the airplane 48 seconds before the collision. However, Army pilots did not typically monitor the tablets while flying low-level on the DC helicopter routes, and the pilots' helmets did not have the capability to receive aural traffic alerts produced by the tablet. In the absence of this capability, these alerts would not have been audible to the crew over the ambient noise inside the helicopter.

We found that the airplane crew did not detect the helicopter until about 1 second before impact. The combination of a demanding nighttime circling approach, the helicopter's low conspicuity and lack of relative motion against a complex background of city lights, and the lack of a required traffic advisory from the controller all contributed to the airplane crew's lack of timely awareness. The airplane's traffic alert and collision avoidance system (TCAS) operated as designed, but, because the airplane was below existing altitude limitations for higher-level alerts that provide crews with instructions to resolve traffic conflicts, the crew did not receive this type of alert and was, therefore, unaware of the severity of the conflict.

We found that if the airplane had been equipped with airborne collision avoidance system (ACAS) Xa—the next generation of collision avoidance technology that uses enhanced threat modeling and ADS-B information to provide improved traffic alerting to pilots—the crew of flight 5342 would have received an alert regarding the helicopter about 8 seconds earlier than the traffic advisory they received. While TCAS provides pilots with limited information about the location of perceived traffic conflicts, we found that, with the enhanced information provided by ADS-B, ACAS Xa could be modified to provide a visual depiction on the cockpit display of the direction a target is traveling, and could also provide aural alerts that announce the position of a target, giving pilots immediate information about where they should look to visually acquire the traffic. This information would significantly increase pilots' situation awareness.

Additionally, we found that ACAS Xa could be modified to provide alerts to pilots at lower altitudes than those currently provided by TCAS. In simulations using the accident circumstances, we found that reducing the alert altitude would have resulted in the airplane crew receiving instructions to maneuver to avoid the helicopter, decreasing the risk of a midair collision by more than 90%. These simulations also showed a significant decrease in the risk of midair collision if the helicopter had been equipped with ACAS Xr, a variant of ACAS X currently under development and designed specifically for use in helicopters.

The helicopter was equipped with a transponder capable of broadcasting ADS-B information. Although the helicopter was not required to be broadcasting ADS-B due to Department of Defense procedures and FAA exemptions for sensitive missions, the transponder's setting was found in the ON position.[1] Examination of the transponder found that improper settings upon installation prevented the helicopter from broadcasting ADS-B; however, ADS-B Out would not have improved the traffic information the airplane crew received about the helicopter—because the airplane was not equipped with ADS-B In capability—nor would it have improved the information the controller received. As a result of the shortcomings of both the airplane's and helicopter's traffic awareness and collision avoidance equipage,

[1] On September 5, 2025, Executive Order 14347 redesignated the Department of Defense as the Department of War. Consistent with the provisions of this executive order, when discussing events prior to its issuance—such as at the time of the accident—this report refers to the Department of Defense and otherwise refers throughout to the Department of War.

neither crew received technological cues that could have compensated for the limitations of visual scanning at night.

We found that increasing traffic volume, an unsustainable airport arrival rate, a changing fleet mix, and airline scheduling practices at DCA regularly strained tower operations and increased complexity, further degrading safety margins over time.

We also found that, although evidence was available to the Army that indicated the risk of a midair collision in the DCA area, including regular exceedances of the published helicopter route altitudes, the Army's safety management system (SMS) lacked the ability to capture these risk factors because it was not yet fully implemented or integrated into its aviation operations.

Finally, we found that the absence of effective data sharing, integration, and analysis among the FAA, the Army, and industry stakeholders hindered the identification and mitigation of recurring hazards in the DCA terminal area. Fragmented safety data, incomplete implementation of SMS processes, and failure to act on previous NTSB recommendations reduced the likelihood that systemic risks—such as recurring close proximity events between helicopters and airplanes—would be identified and addressed before the accident.

We determined that the probable cause of this accident was the FAA's placement of a helicopter route in close proximity to a runway approach path; their failure to regularly review and evaluate helicopter routes and available data, and their failure to act on recommendations to mitigate the risk of a midair collision near Ronald Reagan Washington National Airport; as well as the air traffic system's overreliance on visual separation in order to promote efficient traffic flow without consideration for the limitations of the see-and-avoid concept. Also causal was the lack of effective pilot-applied visual separation by the helicopter crew, which resulted in a midair collision. Additional causal factors were the tower team's loss of situation awareness and degraded performance due to the high workload of the combined helicopter and local control positions and the absence of a risk assessment process to identify and mitigate real-time operational risk factors, which resulted in misprioritization of duties, inadequate traffic advisories, and the lack of safety alerts to both flight crews. Also causal was the Army's failure to ensure pilots were aware of the effects of error tolerances on barometric altimeters in their helicopters, which resulted in the crew flying above the maximum published helicopter route altitude. Contributing factors included:

- the limitations of the traffic awareness and collision alerting systems on both aircraft, which precluded effective alerting of the impending collision to the flight crews;

- an unsustainable airport arrival rate, increasing traffic volume with a changing fleet mix, and airline scheduling practices at DCA, which regularly strained the DCA ATCT workforce and degraded safety over time;
- the Army's lack of a fully implemented safety management system, which should have identified and addressed hazards associated with altitude exceedances on the Washington, DC, helicopter routes;
- the FAA's failure across multiple organizations to implement previous NTSB recommendations, including ADS-B In, and to follow and fully integrate its established safety management system, which should have led to several organizational and operational changes based on previously identified risks that were known to management; and
- the absence of effective data sharing and analysis among the FAA, aircraft operators, and other relevant organizations.

What We Recommended

On March 11, 2025, about 5 weeks into this investigation, the NTSB issued two urgent safety recommendations to the FAA addressing the potential for midair collisions between helicopters operating on Route 4 and airplanes landing on runway 33 or departing from runway 15 at DCA. These urgent recommendations asked the FAA to prohibit operations on Route 4 between Hains Point and the Wilson Bridge when runways 15 and 33 are being used for departures and arrivals, respectively (Safety Recommendation A-25-1), and to designate an alternative helicopter route that can be used to facilitate travel between Hains Point and the Wilson Bridge when that segment of Route 4 is closed (Safety Recommendation A-25-2).[2]

Beyond these urgent actions, our investigation identified additional systemic vulnerabilities that required a broader set of safety improvements. As a result, we made 33 new recommendations to the FAA, 8 new recommendations to the US Army, 5 new recommendations to the Department of War (DOW) Policy Board on

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[2] Immediately following the accident, the FAA implemented temporary airspace restrictions around DCA. On March 14, 2025, the FAA removed from helicopter route charts the section of Helicopter Route 4 between Hains Point and the Woodrow Wilson Bridge. Additionally, the FAA prohibited use of runways 15/33 and 4/22 at DCA during "specific, limited helicopter operations" in the vicinity of DCA. On May 2, 2025, the NTSB responded that these actions exceeded the intent of Safety Recommendation A-25-1 and classified it Closed—Exceeds Recommended Action.

In correspondence dated March 26, 2025, the FAA stated that it would collaborate with stakeholders to develop a new helicopter route connecting the Wilson Bridge to the Anacostia River and would provide updates on the alternative route designation process as it progresses. On May 2, 2025, the NTSB stated that this planned work was responsive to Safety Recommendation A-25-2 and, pending its completion, the recommendation was classified Open—Acceptable Response.

Federal Aviation (PBFA), 2 new recommendations to the Department of Transportation (DOT), 1 new recommendation to the DOT Office of Inspector General, and 1 new recommendation to the RTCA (formerly known as the Radio Technical Commission for Aeronautics) Program Management Committee.

We recommended that the FAA develop and implement time-on-position limits for ATC supervisors to ensure effective monitoring of safety critical operations and risk assessment tools to assist supervisory personnel in risk identification, mitigation, and decision making; and to require that supervisory ATC personnel document the reason for combining any control position with the local control position, or when the operations supervisor or controller-in-charge is combined with a control position. We recommended the FAA develop new, comprehensive, instructor-led, scenario-based training on the proper use of visual separation, and that all controllers receive this training recurrently.

We also recommended that controllers receive annual instructor-led threat and error management training to better identify and mitigate risks to operational safety. We recommended that the FAA conduct safety risk management activities to determine the risks and benefits to helicopter and fixed-wing flight crews using a common frequency when helicopter and local control positions are combined, and we recommended that the FAA and its technical partners develop a means to alert controllers and flight crews when simultaneous radio transmissions block one another. We also recommended that the agency enhance its conflict alert system so that alerts better reflect the severity of developing conflicts, and that once these improvements are made, to train controllers on its use.

We issued several recommendations regarding traffic management and flow at DCA. These include initiating rulemaking to ensure that air carrier scheduling practices do not exceed airport capacity; that the FAA fully implement the time-based flow management system to assist controllers in managing the flow of air traffic at DCA; and that they evaluate DCA's airport arrival rate with adequate consideration given to the complexity of its operations.

Based on our concern that issues observed at DCA regarding spacing between arriving aircraft may exist elsewhere in the National Airspace System (NAS), we recommended the FAA require all Class B and C ATCT facilities evaluate their existing procedures or agreements to ensure that the spacing provided between arriving aircraft is appropriate for operational safety, and to make the evaluations' results publicly available. We also recommended that the FAA develop objective criteria for determining the appropriate facility level of ATC facilities and that it apply these criteria to evaluating the facility level of the DCA ATCT.

We recommended several actions to improve FAA oversight and facility response to serious incidents and accidents. These include revising postaccident and postincident drug and alcohol testing determination procedures to ensure that on-site supervisors can quickly make and document testing determinations without waiting for remote approvals and providing recurrent training and knowledge checks for all personnel responsible for those decisions. We also recommended that the DOT require the FAA to demonstrate that all FAA air traffic control facilities can complete required postevent testing within the time frames specified by DOT policy.

We also recommended that the FAA ensure that annual reviews of helicopter route charts were being conducted as required; that the FAA conduct a safety risk management (SRM) process to determine whether additional changes to the remaining helicopter route structure near DCA are necessary to safely deconflict helicopter and fixed-wing traffic, and to provide the NTSB with the results; that the design criteria and approval process for helicopter route charts be amended to ensure that future helicopter routes provide separation from airport arrival and departure paths; and that the FAA evaluate all existing helicopter routes to ensure compliance with the amended criteria.

To improve pilot and controller situation awareness in the complex airspace surrounding DCA, we recommended that the FAA add helicopter routes to published approach and departure procedures to ensure that these routes are visible to fixed-wing operators.

We recommended that the FAA require ADS-B In capability with a cockpit display of traffic information that provides alerting audible to pilots in all airspace where ADS-B Out is currently required. We also recommended that the FAA modernize airborne collision avoidance capabilities across the NAS. We recommended that the FAA modify ACAS to provide enhanced traffic advisories (TA) and modify ACAS displays to provide directional traffic symbols.

We urged the FAA to require installation of the appropriate variant of the ACAS X on new production aircraft and retrofit existing aircraft that are subject to TCAS equipage regulations. We recommended that the FAA evaluate reducing the inhibit altitudes that limit ACAS X alerting at low altitude, and, if demonstrated to be safe, for the FAA to require the retrofit of aircraft accordingly. We recommended that the FAA prioritize adoption of the ACAS standard for rotorcraft (ACAS Xr) and require all rotorcraft operating in Class B airspace to be equipped with that technology.

We also recommended that the FAA and its safety partners improve data analysis and communication related to midair collision risk. Specifically, we urged development of standard indexes of aircraft proximity to identify potential conflict areas and the establishment of a timely process for notifying involved parties after close proximity events such as near midair collisions or TA activations.

We recommended that the DOT Office of Inspector General complete an audit of the ATO's safety management and data sharing activities to determine whether all relevant stakeholders are included and to ensure that SMS functions and data sharing activities at air traffic facilities also include collaboration with external stakeholders, and that the results of that audit be reported to the Secretary of Transportation and the FAA Administrator and be made publicly available. We also recommended that the DOT convene an independent panel to review the safety culture within the FAA's ATO, and that its findings be used to enhance the FAA's SMS.

To the US Army, we recommended improved training for flight crews on fixed-wing aircraft operations at DCA. We also recommended improvements to flight data integrity and safety management practices, including implementing recurring checks to verify the accuracy of recorded flight data, incorporating guidance in aircraft manuals about potential barometric altimeter error—including that associated with the external stores support system configuration—and establishing a recurrent inspection procedure to ensure accurate transponder and ADS-B performance.

We also recommended that the Army establish a flight data monitoring program for its rotary wing aircraft operating in Class B or Class C airspace, review barriers to pilot participation in safety reporting systems, strengthen safety management resource allocation to identify and mitigate midair collision hazards involving civil traffic, and develop a flight SMS that is separate from its occupational and environmental health management system and fully integrate that system with units conducting operations in the NAS.

We recommended that the DOW PBFA conduct a study to evaluate the quality of radio transmissions and reception for armed services aircraft operated within the NAS in order to identify factors that degrade communications equipment performance and adversely affect the safety of civilian and military flight operations, and to implement enhancements based on the findings of that study.

We recommended that the DOW PBFA develop procedures to regularly verify proper transponder and ADS-B configuration and address assignment, and update their policies to maximize the military's use of ADS-B Out when operating in high-density airspace such as Class B areas.

We also urged the DOW PBFA to require that all military aircraft operating in the NAS be equipped with ADS-B In with a cockpit display of traffic information configured to provide alerting audible to the pilot and/or flight crew, and that such a requirement by the military for its aircraft apply in the NAS wherever the FAA requires any aircraft to operate with ADS-B Out.

Finally, we recommended that the RTCA Program Management Committee finalize and publish the minimum operational performance standards for ACAS Xr, which will enable certification and adoption of this next-generation collision avoidance technology across the rotorcraft fleet.

1. Factual Information

1.1 History of Flight

On January 29, 2025, about 2048 eastern standard time (EST), a Sikorsky UH-60L, operated by the US Army under the callsign PAT25 (Priority Air Transport Flight 25), and an MHI (Mitsubishi Heavy Industries) RJ Aviation (formerly Bombardier) CL-600-2C10 (CRJ700), N709PS, operated by PSA Airlines as American Airlines flight 5342, collided in flight about 0.5 miles southeast of Ronald Reagan Washington National Airport (DCA), Arlington, Virginia, and impacted the Potomac River in southwest Washington, DC. The 2 pilots, 2 flight attendants, and 60 passengers on board the airplane and all 3 crew members on board the helicopter died. Both aircraft were destroyed as a result of the accident.

Flight 5342 was operating under the provisions of Title 14 *Code of Federal Regulations* (*CFR*) Part 121 as a scheduled domestic passenger flight from Wichita Dwight D. Eisenhower National Airport (ICT), Wichita, Kansas, to DCA. PAT25 originated from Davison Army Airfield (DAA), Fort Belvoir, Virginia, for the purpose of the pilot's annual standardization evaluation flight with the use of night vision goggles (NVGs). Night visual meteorological conditions (VMC) prevailed in the area of DCA at the time of the accident.

The crew of flight 5342 reported at ICT for the accident flight at 1733 EST.[1] The accident flight crew were in good spirits, according to interviews with the flight crew that flew the accident airplane into ICT, the gate agent, and ramp personnel. Flight 5342 departed ICT at 1838 on an instrument flight rules (IFR) flight plan.[2]

A review of cockpit voice recorder (CVR) and flight data recorder (FDR) data revealed that the departure from ICT, enroute cruise, and initial descent toward DCA were uneventful. Just after 2030 (or 17:59 before the collision), the airplane passed south of Washington Dulles International Airport (IAD), about 20 nautical miles (nm) west of DCA, and began turning south to prepare for a northbound approach for landing.

[1] Unless specified otherwise, all times in this report are EST.

[2] Instrument flight rules refers to the procedures for flights conducted in instrument meteorological conditions, which are those conditions that do not meet the visibility, distance from clouds, and cloud ceiling requirements for visual meteorological conditions.

The flight crew of PAT25 filed a visual flight rules (VFR) flight plan with DAA base operations and departed on the accident flight at 1845.[3] The instructor pilot (IP) was seated in the right seat and the pilot was seated in the left seat. The crew chief was seated in the left crew chief seat.[4] The helicopter flew west from DAA, landed at a private grass airfield in Culpeper, Virginia, then flew north before proceeding east into Maryland around 2002. The crew landed at a heliport in Laytonsville, Maryland, at 2025, then departed at 2028 and began flying south toward Washington, DC.

At the time of the accident, the local control (LC) controller at the DCA airport traffic control tower (ATCT) was handling both airplane and helicopter traffic in the area; however, airplanes and helicopters used discrete radio frequencies to communicate with the controller.[5] While all pilots could hear the controller's transmissions to all aircraft, airplane and helicopter crews could not hear each other's transmissions to the controller.

At 2032 (or 15:59 before the collision), the pilot of PAT25 contacted the DCA tower controller and requested to transition the DCA airspace to DAA via Helicopter Routes 1 and 4. The controller issued an altimeter setting of 29.89 inches of mercury (inHg), which the crew read back correctly. About this time, the IP, who was flying the helicopter, transferred control to the pilot. For the remainder of the flight, the pilot was the pilot flying, and the IP was the pilot monitoring and communicating with the controller.

In a two-pilot operation, one pilot is designated as pilot flying and the other is designated as pilot monitoring. The pilot flying is always engaged in flying the aircraft and avoids activities that would divert their attention from that task. The role of the pilot monitoring is to support the pilot flying by monitoring the aircraft's flight path, systems, and often, by handling radio communications. Crew chief inflight duties

[3] Visual flight rules refers to the regulatory framework—primarily in 14 *CFR* 91.155 and related sections—that allows pilots to operate an aircraft by reference to outside visual cues, provided required visibility and cloud clearance minimums are met.

[4] There was one crew chief on board the accident helicopter. The helicopter was equipped with two crew chief seats, one on each side of the helicopter, located behind the pilots' seats. The CVR recording for the accident flight captured the crew chief calling out traffic on the left side of the aircraft at various points throughout the flight; therefore, it is likely that the crew chief was seated in the left crew chief seat, behind the pilot, during the accident flight.

[5] Flight 5342 was communicating with the DCA tower controller via the published control tower frequency of 119.1 MHz; PAT25 was communicating with the tower controller via the published helicopter frequency of 134.35 MHz. See section 1.7.2 for more information.

included assisting the pilots by monitoring instruments and fuel load and providing additional airspace surveillance by visually identifying traffic or obstacles.[6]

About 1 minute later, at 2033:16 (or 14:43 before the collision), the controller requested that the crew "IDENT."[7] The controller then informed the crew that he had radar contact with the helicopter and again approved their requested route of flight. The helicopter's CVR captured conversations between the crew of PAT25 around this time that discussed the poor reception quality of the tower's radio transmissions, many of which were incomplete or broken. Additionally, review of the recorded air traffic control (ATC) communications on the night of the accident revealed that the transmissions made by PAT25 were accompanied by static interference, making intelligibility difficult.[8]

About 2038:30 (or 9:29 before the collision), while descending from 1,400 ft mean sea level (msl), the helicopter reached Cabin John, Maryland, where Helicopter Route 1 began. The pilot initially turned west before the IP advised that they had turned the wrong direction. The helicopter subsequently circled toward the east while continuing its descent, joined Route 1, and continued south along the Potomac River at 800 ft msl (see figure 1).

[6] Specific tasks assigned to crew chiefs were defined in the Army's *Aircrew Training Manual, Utility Helicopter, H-60 Series* (Department of the Army, 2021) and included crew briefings, weight and balance, aviation life support equipment, preparing aircraft for the mission, preflight inspection, before starting and takeoff checks, maintaining airspace surveillance, radio communications, fuel management, slope operations, extended range fuel tank operations, responding to emergencies, auxiliary power unit operations, employing NVGs, and after-action briefings. Other inflight duties included managing any additional crewmembers, such as door gunners, and passengers or cargo.

[7] "IDENT" is a request frequently used by controllers to have pilots activate the aircraft's transponder identification feature, which helps the controller identify the aircraft on their radar display.

[8] The airplane and helicopter CVRs were transcribed by separate, independent NTSB groups. Phrases may differ between transcripts for several reasons, including transmissions being "stepped on" by other radio traffic; internal conversations between the crew, which could obscure radio calls; static or poor-quality sound produced by the radio, alerts or other ambient sounds in the flight deck blocking radio calls; and groups interpreting words differently during the transcription process.

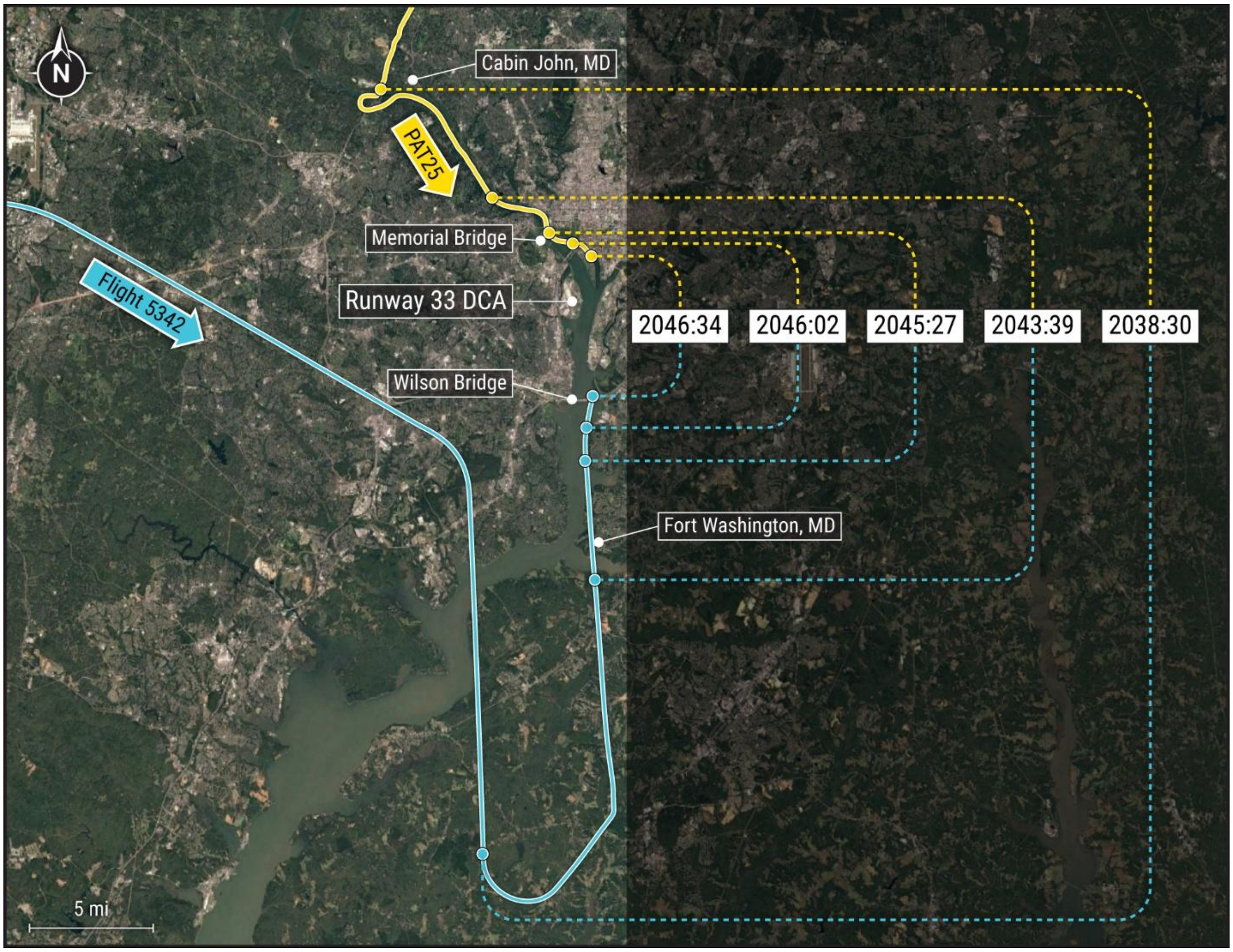

Figure 1. Locations and flight paths of flight 5342 and PAT25 showing aircraft positions from 2038:30 to 2046:34.

At 2039:10 (or 8:49 before the collision), the crew of flight 5342 was cleared by Potomac Consolidated Terminal Radar Approach Control (Potomac TRACON) for the Mount Vernon Visual Approach to runway 1 at DCA. The captain was the pilot flying, and the first officer (FO) was the pilot monitoring. At 2043:06 (or 4:53 before the collision), the FO contacted the DCA tower controller. The controller provided the current wind conditions and asked if the crew could switch to runway 33 for landing.[9] The CVR recording indicated that, following this question from the controller, the captain asked the FO whether they had "the numbers," or landing performance, for runway 33. The FO confirmed that they did. The captain then stated, "I really don't want to but I guess uhh tell 'em…nah its fine we got the numbers for it yeah tell 'em

[9] The reason for this request was to increase spacing between airplanes arriving to runway 1 to allow time for aircraft to depart and is discussed in further detail in section 1.7.6.

we're fine we'll do three three…" The FO subsequently informed the controller that they could accept runway 33.

At 2043:39 (or 4:20 before the collision), the controller instructed the crew to circle to runway 33 at the Wilson Bridge and cleared the airplane for landing; the crew acknowledged.[10] The CVR indicated that shortly thereafter, the captain stated, "three three…thousand feet at the highway. Five hundred over the church," referring to target altitudes at predetermined landmarks along the runway 33 visual approach as specified by PSA procedures.[11] The FO confirmed. FDR information indicated that, at 2045:27 (or 2:32 before the collision), the autopilot was disconnected and the airplane turned to the right, away from the runway 1 localizer course.[12] The airplane was at an altitude of about 1,700 ft msl and about 5 nm south of DCA. The crew did not use the autopilot for the remainder of the flight.

The helicopter CVR indicated that, about the time that flight 5342 was cleared to circle to runway 33, the pilot of PAT25 remarked that it was, "gettin choppy close to the ground," and the IP agreed. Passing the Georgetown Reservoir, at 2043:48 (or 4:11 before the collision), the pilot stated, "we're at three hundred," to which the IP replied, "roger got you at four looking for [unintelligible]." Approaching Key Bridge at 2044:27 (or 3:32 before the collision), the IP stated, "alright there's three hundred for two hundred." Passing the northeast corner of Roosevelt Island, at 2044:55, the pilot stated, "two hundred." At 2045:14 (or 2:45 before the collision), the PAT25 IP reported the helicopter's position at Memorial Bridge.[13] The IP then stated to the pilot, "lots of right pedal ma'am," which she acknowledged, then advised the pilot to begin a left turn toward the Tidal Basin.

Shortly thereafter, the crew chief called out a crane on the left side of the helicopter. The pilot replied, "clear left. crane. no factor." At 2045:32 (or 2:27 before the collision), the IP stated to the pilot, "you're at three hundred feet. Come down for me." The pilot acknowledged, "go down two hundred." The IP called out the position of a crane on the helicopter's right side at 2045:51 (or 2:08 before the collision).

At 2046:02 (or 1:57 before the collision), the DCA ATCT control tower audio recording indicated that the controller contacted PAT25 and stated, "PAT two five

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[10] The Woodrow Wilson Memorial Bridge (identified as Woodrow Wilson Bridge or Wilson Bridge on aeronautical charts) spans the Potomac River between Virginia and Maryland and is located about 3.5 nm south of DCA.

[11] For additional information on this procedure, refer to section 1.12.1.1.

[12] A localizer is the component of an instrument landing system that provides course guidance to the runway.

[13] The Arlington Memorial Bridge (identified as Memorial Bridge on aeronautical charts) spans the Potomac River between Virgina and Washington, DC, and is located about 2.2 nm north of DCA.

traffic just south of Wilson Bridge is a C-R-J at one thousand two hundred feet circling runway three three"; however, the helicopter's CVR recording captured this transmission as, "PAT two five traffic just south of Wilson Bridge is a C-R-J at one thousand two hundred feet for runway three three," and did not contain the word "circling." The IP responded, "PAT two five has the traffic in sight request visual separation," which the controller approved. At this time, the helicopter was crossing the Tidal Basin, and flight 5342 was 6.5 nm south of the helicopter's position, one of five airplanes approaching DCA in darkness from the south.

At 2046:34 (or 1:25 before the collision), flying southeast over the Washington Channel, the IP remarked to the pilot, "He's got 'em stacked up tonight," and the pilot responded, "(yeah/kinda) busy."[14] Over the next 20 seconds, the IP and pilot exchanged comments regarding the wind conditions, which the IP described as, "…a right quartering tailwind that's going to be pushing you." The pilot acknowledged and subsequently described her control inputs to compensate for the conditions, stating, "crabbing…better not to fight the wind…right pedal." As it rounded Hains Point, the helicopter proceeded southwest down the Potomac River east of DCA.

At 2047:29 (or 30 seconds before the collision), flight 5342 was turning left onto its final approach for runway 33. The flight crew received an automated callout that the airplane was at 500 ft, and the FO confirmed that the airplane was on glidepath by announcing, "I got two white two red," referring to the precision approach path indicator (PAPI) lights.[15,16]

[14] During review of the helicopter's CVR recording, investigators determined that the pilot may have spoken either "yeah" or "kinda" during this response, but could not conclusively determine which of those words was used.

[15] The 500-ft annunciation was a standard advisory provided by the airplane's enhanced ground proximity warning system (EGPWS).

[16] According to the FAA *Aeronautical Information Manual*, a PAPI uses a single row of either two or four light units, each projecting a beam of light having a white segment in the upper part of the beam and a red segment in the lower part of the beam (FAA, 2025d). The lights are arranged to provide visual descent guidance information during approach to a runway and are normally set to depict a glidepath of 3°.

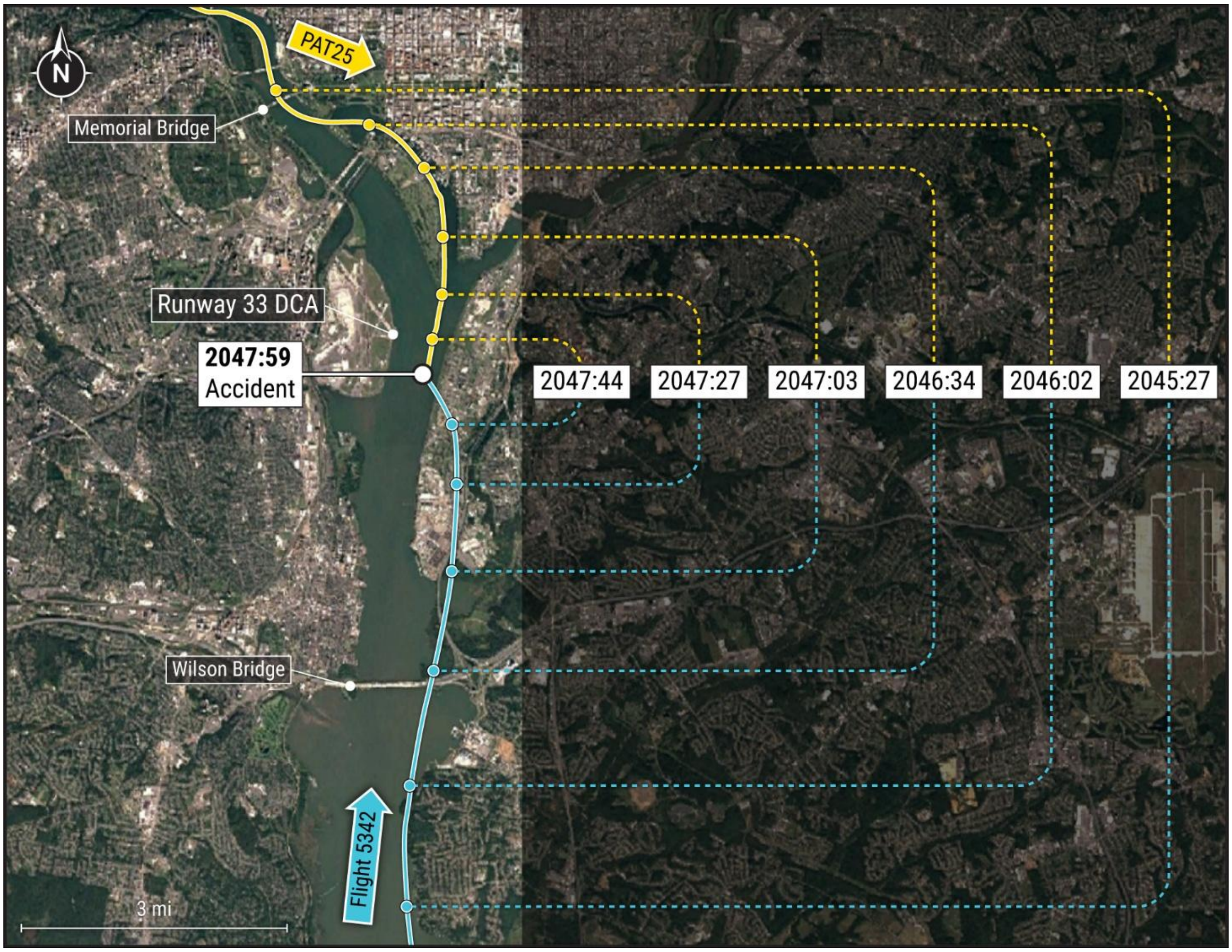

Figure 2. Locations of flight 5342 and PAT25 from 2045:27 through 2047:59.

According to radar data, the controller received a conflict alert beginning at 2047:33 (or 26 seconds before the collision).[17] At 2047:39 (see figure 2), the controller contacted the helicopter, stating, "PAT two five do you have the C-R-J in sight?" The conflict alert was audible in the background of this transmission.[18] The controller's query to PAT25, with the conflict alert audible in the background, was audible on the airplane's CVR. Data from the airplane's FDR and CVR also indicated that, about this time, at a radio altitude of 448 ft, the crew received a traffic alert and collision avoidance system (TCAS) traffic advisory (TA), which included the aural annunciation, "Traffic. Traffic." Information recorded on the FDR did not indicate if the TA on the TCAS display provided the crew with information on the bearing, or

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[17] A conflict alert provides visual and aural alerting to controllers when a potential conflict is detected. This system is discussed in section 1.7.8.4.

[18] Radar data indicated that the conflict alert remained active until 2047:52, then activated again at 2047:59 and remained active through the time of the collision.

position, of the conflicting traffic. The CVR indicated that the crew did not verbally acknowledge the TA, nor did they discuss looking for the traffic. The aircraft were about 1 nm apart with a closure rate of about 200 knots. Figure 3 shows the final portions of the flightpaths of both aircraft as they converged.

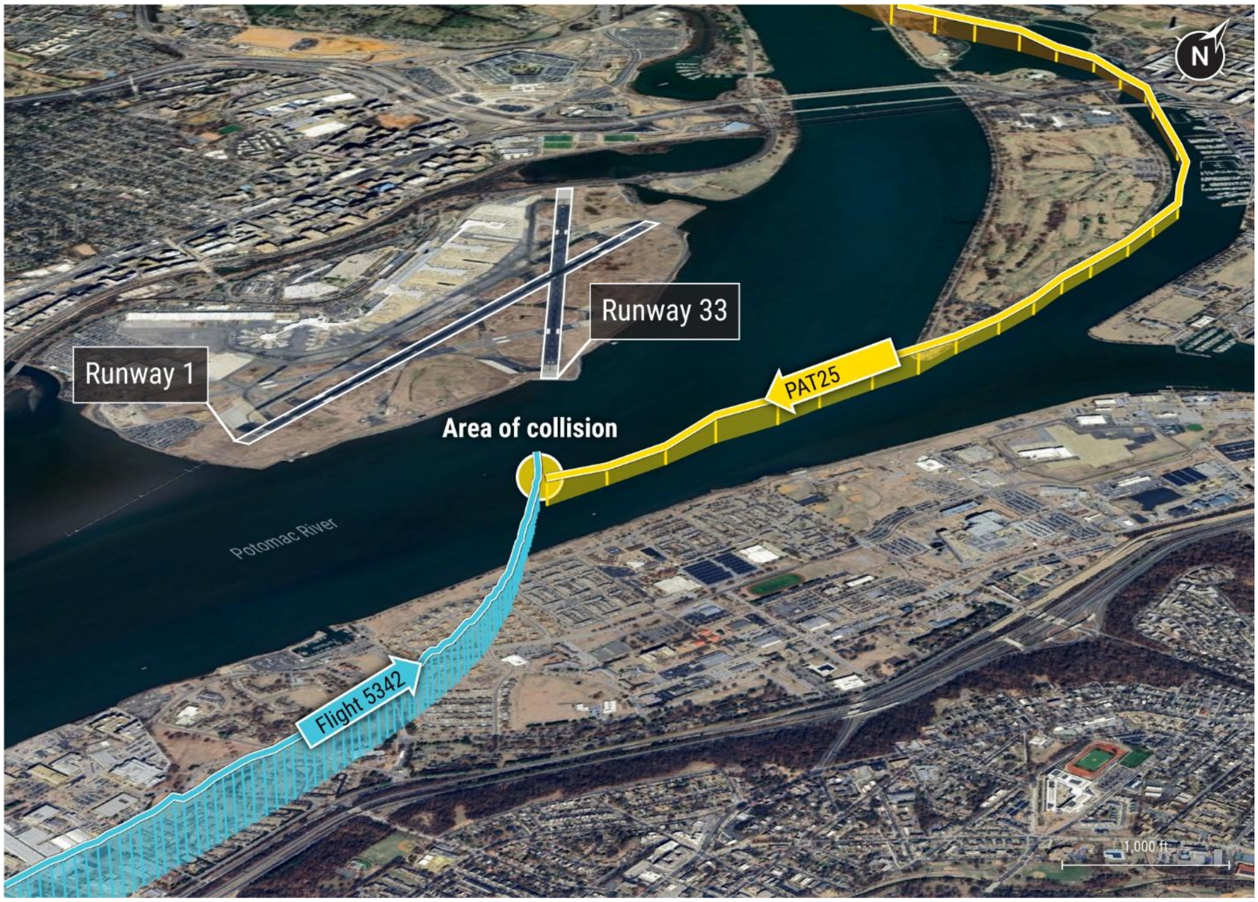

Figure 3. Oblique aerial illustration of the Automatic Dependent Surveillance–Broadcast flight track for flight 5342 (yellow line) and the composite data-derived flight path for PAT25 (blue line) converging near DCA.

At 2047:42 (or 17 seconds before the collision), the controller stated, "PAT two five pass behind that C-R-J"; however, the helicopter CVR recording indicated that one of the helicopter pilots pressed the radio push-to-talk switch for 0.8 seconds, blocking the words "two five pass behind that " in the controller's transmission. At 2047:44 (or 15 seconds before the collision), the IP replied, "PAT two five has a– aircraft in sight, request visual separation," to which the controller responded, "vis separation."[19] At this point, the aircraft were about 0.84 nm apart. The helicopter's recorded radio altitude was 281 ft.

[19] This transmission is transcribed as received by the controller.

At 2047:53 (or 6 seconds before the collision), the IP of PAT25 stated, "alright kinda come left for me ma'am, I think that's why he's asking…we're kinda…out towards the middle," which the pilot acknowledged. At this time, the helicopter's recorded radio altitude was 266 ft and its indicated airspeed was 74 kts. Also at this time, the airplane rolled wings level onto the final approach for runway 33 at a radio altitude of 341 ft.

Starting about 2047:55 (or 4 seconds before the collision), the helicopter's roll angle increased to about 5° left and then decreased to about 3° left. There were no abrupt changes in pitch attitude. The helicopter's last recorded radio altitude, at 2047:59, was 278 ft.

At 2047:58.0, the airplane's control column moved from 3° to 11° nose up, and the elevators moved from a deflection of 1° to a maximum of 24° nose up in less than 1 second. At this point, the airplane's recorded radio altitude was 313 ft. At 2047:58.6, the CVR recorded an exclamation by the captain, followed by the FO. At 2047:59.3, a significant longitudinal deceleration was recorded, consistent with impact. The airplane's attitude at this time was 7° nose up with an 11° left roll. The recording ended at 2048:04.

1.2 Personnel Information

1.2.1 Flight 5342 Crew

1.2.1.1 Captain

The captain, age 34, held an airline transport pilot (ATP) certificate with a rating for airplane multiengine land and a type rating on the CL-65, which included CRJ200, CRJ700, and CRJ900 airplanes. As of the accident date, the captain possessed a current Federal Aviation Administration (FAA) first-class medical certificate with no limitations.

The captain had been employed by PSA Airlines since January 2019 and received his initial CL-65 type rating as first officer in March 2019. He upgraded to captain in May 2022, and his most recent proficiency check was in March 2024. PSA records indicated that, at the time of the accident, the captain had 3,950 total hours of flight experience, of which 3,024 hours were in the accident airplane make and model. He had accumulated about 158 hours in the 90 days before the accident.

One colleague described the captain as a good pilot, "very, very smooth," "exceptional at flying," and stated that he flew in accordance with company procedures. Another stated that he was an exceptional captain with excellent crew resource management (CRM) skills. A third colleague reported that the captain was helpful and a mentor to first officers.

PSA Airlines' training records for the captain included the events shown in table 1.

Table 1. Flight 5342 captain's training events.

Training event	Completion date
First officer initial type rating (CL-65)	March 31, 2019
Captain upgrade (CL-65)	May 1, 2022
Most recent pilot-in-command line check	April 30, 2023
Most recent proficiency check	March 27, 2024
Recurrent ground training	March 28, 2024

PSA records indicated that the captain had flown into DCA 39 times in the 2 years before the accident. Of these flights, 12 were nighttime arrivals. It is not known how many of these arrivals were to runway 33. The accident trip was the first time the captain and the FO had flown together.

1.2.1.2 Captain's Recent Activities

The captain's activities during the 72 hours preceding the accident were documented using scheduling records from PSA Airlines, hotel records, and family statements. Sunday, January 26, 2025, was a day off. He woke between 0930 and 1000 and spent most of the day doing household chores with his partner. He went to sleep around 2200 to 2300. On Monday, January 27, he woke about 0830 and prepared for work, departing between 1200 and 1230 to commute from his home in Ormond Beach, Florida, to his base at Charlotte-Douglas International Airport (CLT), Charlotte, North Carolina.

The accident flight occurred on day three of a four-day trip pairing in which the accident captain and FO flew together.[20] The captain reported for duty in CLT at 1950 EST on January 27 and the crew arrived at Lafayette Regional Airport (LFT), Lafayette, Louisiana, at 2206 central standard time (CST). After going to dinner with the crew, the captain used his keycard to enter his hotel room at 0110 CST on Tuesday, January 28. He had almost 20 hours between duty periods; he reported for duty at 1755 CST, and ended his duty day at ICT at 2312 CST on January 28. He used his keycard to enter his hotel room at 2339 CST, went to dinner with the FO and

[20] The captain dropped the first two flights of the pairing, from CLT to Daytona Beach International Airport (DAB), Daytona Beach, Florida, and back to CLT.

another crew member, and then entered his room again at 0205 CST on Wednesday, January 29. He reported for duty to ICT at 1633 CST for the accident flight.

1.2.1.3 First Officer

The FO, age 28, held an ATP certificate with a rating for airplane multiengine land and a type rating for the CL-65. As of the accident date, the FO possessed a current FAA first-class medical certificate limited by a requirement to use corrective lenses to meet vision standards at all distances.

The FO was hired by PSA Airlines in August 2022 and received his CL-65 type rating in November 2022. His most recent proficiency check was completed in November 2024. PSA records indicated that at the time of the accident, he had 2,469 total hours of flight experience, of which 965 hours were in the accident airplane make and model. He had accumulated about 158 hours in the previous 90 days.

A captain who had flown with the FO stated that he was, “standard to the T, incredibly sharp.” Another captain described the FO as very knowledgeable, very professional, and a very good FO.

PSA Airlines’ training records for the FO included the events shown in table 2.

Table 2. Flight 5342 first officer’s training events.

Training event	Completion date
First officer initial type rating (CL-65)	November 27, 2022
Recurrent ground training	September 19, 2024
Most recent proficiency check	November 11, 2024
Most recent second-in-command line check	November 19, 2024

PSA records indicated that the FO had flown into DCA 43 times in the 2 years before the accident. Of these flights, 13 were nighttime arrivals. It is not known how many of these arrivals were to runway 33.

1.2.1.4 First Officer’s Recent Activities

The FO’s activities during the 72 hours preceding the accident were documented using scheduling records from PSA Airlines, hotel records, and family statements. Sunday, January 26, 2025, was a day off. He was awake by 0600 EST to drive his partner to work. He went to a restaurant with friends in the evening and returned to his residence. His partner returned home around 0000 on January 27 and they went to sleep no later than 0200. He woke up around 1000. He again drove his partner to work, then reported for duty at CLT at 1500.[21] That night, after arriving at LFT, the FO used his keycard to enter his hotel room at 2217 CST.

According to the FO's partner, the FO told her that the crew then went to dinner. The FO reentered his room at 0051 CST on January 28. He texted his partner at 0647 CST. She reported that, at 1530 CST, he texted that he was going to take a nap. He reported for duty at LFT at 1755 CST. He used his keycard to enter his hotel room at ICT at 2338 CST, went to dinner with the captain and another crew member, and entered his room again at 0205 CST on Wednesday, January 29. He texted his partner at 0944 CST; they texted sporadically between 1300 and 1554 CST. The FO reported for duty to ICT at 1633 CST for the accident flight.

1.2.2 PAT25 Flight Crew

1.2.2.1 Pilot

The pilot, age 28, held an FAA commercial pilot certificate with ratings for rotorcraft-helicopter and instrument helicopter, and a type rating in the S-70 helicopter (the civilian designation for the UH-60 Black Hawk). US Army records indicated that she completed flight school in July 2021. At the time of the accident, the pilot had 454 total hours of flight experience, of which 326 hours were in the accident helicopter make and model, with 56 hours in the previous year and 4.4 hours in the previous 60 days. The pilot had 136 hours of NVG time, 2.9 hours of which were in the previous 60 days.

The pilot held the rank of captain in the US Army and was assigned to Headquarters Company, 12th Aviation Battalion, The Army Aviation Brigade (TAAB), Military District Washington, as a staff officer. She was commissioned as a second lieutenant on November 3, 2019. She was stationed at Fort Belvoir shortly after completing flight school, and was assigned as platoon leader for B Company, 12th Aviation Battalion, in July 2022.

In April 2023, the pilot was named B Company's executive officer and, in December 2023, she was named assistant operations officer for the 12th Aviation Battalion but remained with B Company's aircrew training program for flying purposes. In August 2024, the pilot was assigned as platoon leader for a new petroleum oils and lubricants platoon, an assignment she maintained until the time of the accident.

As of the accident date, the pilot possessed a current upslip, meaning that she had been found medically qualified for flight duty by a trained Army aeromedical

[21] The FO's residence was a short drive from CLT.

provider, with approval by the company commander. The upslip carried limitations that vision correction devices were required in the performance of flight duties, and that the pilot must carry extra spectacles.

A standardization instructor pilot who provided training to the accident pilot when she arrived at the 12th Aviation Battalion stated that the pilot was eager to learn but struggled with “stick and rudder skills” in the UH-60L.[22] He noted that, for pilots who initially trained on the more automated UH-60M model (such as the accident pilot), the UH-60L was “particularly taxing to fly to maintain altitude and airspeed,” while “understanding and utilizing” its manual trim system.

The UH-60L, an earlier model, features analog cockpit instrumentation and less advanced avionics. The UH-60M, a modernized variant, incorporates a “glass cockpit” (digital displays), improved engines, and enhanced mission systems. He recalled working extensively with the pilot on the proper use of the trim system and the collective friction lock when instrument flying. He signed off the pilot as readiness level 1 (RL1), the highest readiness level, in January 2022.

A second standardization instructor pilot, who flew an annual combined standardization and NVG evaluation with the accident pilot in February 2022, found her performance “well below average.” He reverted her to the lowest readiness level (RL3) and trained her extensively until he determined that she demonstrated full readiness (RL1) in March 2022.[23]

The first standardization instructor pilot conducted an instrument evaluation with the accident pilot in January 2023 and found that her performance was standard. A third standardization instructor pilot, who conducted an instrument evaluation with the pilot in January 2024, described her as “incredibly professional,” diligent, and thorough. He recalled that “her performance was always very good” and that she had a good reputation as an aviator and officer.

B Company’s commander recalled flying with the pilot twice in 2023. He said that the pilot knew the mission well and was a “highly achieving, high motivated and driven aviator who was actually capable of accomplishing a lot more than I’ve seen some of the more junior pilots of her hour level who were similar to her, being able to

[22] According to Army Regulation 95-1, “Aviation Flight Regulations,” a standardization instructor pilot may train and evaluate all personnel in the designated aircraft per approved aircrew training tasks.

[23] According to Army Training Circular TC 3-04.11, Commander’s Aviation Training and Standardization Program, readiness levels (RLs) identify the training phase in which aircrew members (ACM) are participating and measure ACM readiness. ACMs are designated RL3 for qualification, refresher, and/or deficiency training; ACMs designated RL2 train in tactical/mission tasks to gain initial proficiency in their unit’s mission; and ACMs designated RL1 have completed all RL progression training and are considered fully trained in their assigned tasks.

accomplish in some of the combat aviation brigades." He added that she was "great on controls, great at process management and workload management in the aircraft."

The US Army's training records for the pilot included the events shown in table **3**.

Table 3. PAT25 pilot's training record.

Training event	Completion date
Completed US Army Helicopter flight school (Including initial Aircrew Coordination Training)	July 9, 2021
Commander's Evaluation, designated RL3	July 30, 2021
Completed FAA DC Special Flight Rules Area training	August 24, 2021
Completed RL3 training	November 29, 2021
Completed RL2 training, designated RL1	January 6, 2022
Failed combined annual standardization and NVG evaluation	February 17, 2022
Completed NVG evaluation, designated RL1	March 16, 2022
Completed instrument evaluation	January 31, 2023
Completed NVG annual evaluation	February 6, 2023
Temporary medical suspension from flight duty	March 1, 2023
Completed performance flight evaluation	May 15, 2023
Completed instrument evaluation	January 8, 2024
Completed annual NVG evaluation, received initial pilot-in-command designation	January 11, 2024
Annual aircrew coordination training	January 26, 2024
Temporary medical suspension from flight duty	March 16, 2024
Completed performance flight evaluation (including NVG)	August 15, 2024
Air mission commander academic training	November 15, 2024

1.2.2.2 Pilot's Recent Activities

The pilot's activities during the 72 hours preceding the accident were documented using phone records and statements from friends and family members. On the evening of Sunday, January 26, the pilot and her partner attended a dance class, then conducted a video call with the pilot's family. The pilot's sister reported that the pilot appeared cheerful. The pilot called and texted her partner between 2210 and 0025, and the pilot's partner thought that she likely went to sleep afterward.

On January 27, the pilot texted her partner at 0843, and they spoke by phone shortly thereafter. The pilot conducted a flight that day with a show time of 1200. The pilot texted her partner that she departed at 1736 and landed at 1936. A pilot who flew with the accident pilot stated that she practiced basic flight maneuvers and NVG tasks in preparation for her upcoming evaluation flight. He recalled that the pilot seemed "rusty" due to a lack of recent flying but that, otherwise, nothing stood out about her performance. Phone records indicated that the pilot texted her sister at 0115.

According to her partner, the pilot woke around 0630 on January 28. Cell phone records indicated that the pilot received a phone call at 0734 that lasted 52 minutes. The pilot did not have a flight that day but was scheduled to work in the office from 0900 to 1700. Colleagues who reported seeing her in the office stated that the pilot appeared fine and "focused." The pilot's last cell phone activity that night was a routine text to her partner at 2325.

The pilot's partner called her at 0707 on the morning of the accident and they spoke for about 10 minutes. He recalled that she sounded happy. He expressed concern about the forecast for high wind conditions, and she responded that the forecast was okay. According to her partner, the pilot attended physical therapy near her home at 0900.[24] Her show time for the accident flight was 1300. Colleagues who saw the pilot before the flight reported that she appeared fine; one reported that she seemed excited and not apprehensive about the evaluation flight.

1.2.2.3 Instructor Pilot

The IP, age 39, held an FAA commercial pilot certificate with ratings for rotorcraft-helicopter and instrument helicopter, and an S-70 type rating. US Army records indicated that the IP completed flight school in May 2019 and completed the IP course in August 2023. At the time of the accident, the IP had 968.2 total hours of flight experience, of which 301 hours were in the accident helicopter make and model. The IP had flown 269 hours in the previous year and 25.5 hours in the previous 60 days that included 12 hours of NVG time.

The IP held the rank of Chief Warrant Officer Two (CW2) and was assigned to B Company, 12th Aviation Battalion, as a platoon instructor pilot. After serving in the US Navy in a nonflying role starting in 2007, the IP transitioned to the US Army in 2017 and was commissioned as a warrant officer in 2018. After completing flight school, he was stationed at Fort Belvoir, Virginia, and was assigned to A Company, 12th Aviation Battalion, as a pilot. He was deployed to Honduras for about one year before returning to Fort Belvoir and being assigned to 12th Aviation Battalion, B Company, in October 2024.

As of the accident date, the IP possessed a current upslip, meaning that he had been found medically qualified for flight duty by a trained Army aeromedical

[24] The pilot was visiting a private physical therapy practice as part of her plan of care after ACL surgery on her left knee in March 2024. She had been medically cleared for return to flight duties in August 2024 after demonstrating good recovery from her surgery. At her visit on the day of the accident, her left knee strength and range of motion were good, and she reported no left knee pain. See section 1.10 for additional flight crew medical information.

provider, with approval by the company commander. The upslip carried no limitations.

A battalion standardization pilot reported that the IP was one of his best instructors and thought that the IP was very objective. Another company pilot who had received instruction from the IP thought that he was an average instructor. The 12th Aviation Battalion commander, who had flown with the IP, considered him "very good." B Company's safety officer, who had received instruction from the IP, described him as "by the book."

The US Army's training records for the IP included the events shown in table 4.

Table 4. PAT25 instructor pilot's training events.

Training event	Completion date
Completed US Army Helicopter flight school (Including initial Aircrew Coordination Training)	May 2, 2019
Completed FAA DC Special Flight Rules Area training	June 12, 2019
Completed RL3 training, designated RL2	September 9, 2019
Completed RL2 training, designated RL1	September 23, 2019
First Pilot-in-Command (PC) designation on the UH-60	October 15, 2021
Completed IP course	August 30, 2023
Completed UH-60M to UH-60L training	October 16, 2023
PC designation on the UH-60L	November 2, 2023
Completed IP evaluation and designated as an IP	January 24, 2024
Completed annual aircrew coordination training	November 12, 2024
Instrument and standardization day/NVG evaluation	November 14, 2024

1.2.2.4 IP's Recent Activities

The IP's activities during the 72 hours preceding the accident were documented using phone records and statements from friends and family members. The IP was off duty on January 26. His last cell phone activity was a phone call that ended at 2236. On January 27, the IP was on duty from 0530 to 1700, then spent the evening with his children. His last cell phone activity was a call that ended at 2342. The IP's wife reported that she left for work at 0600 on January 28 and did not know when the IP woke but that he was scheduled to be in the office that day, which typically involved working from 0900 to 1700. His last cell phone activity was a call that ended at 0005 on January 29.

The IP reported to work later than usual on January 29 due to the scheduled evaluation flight that evening. The mission briefing officer who briefed the IP for the accident flight recalled that the IP appeared normal, and the company commander who approved the mission reported that the IP seemed "very alert."

1.2.2.5 Crew Chief

The crew chief, age 28, held the rank of staff sergeant. He joined the Army in July 2014 and was assigned to the 12th Aviation Battalion in 2017. In 2020, he was reassigned to 2nd Battalion, 3rd Combat Brigade in Georgia and deployed to Europe. He returned to the 12th Aviation Battalion in 2023 and was assigned to B Company as a helicopter repairer (mechanic) and crew chief. Since that time, he had also become an instructor and was responsible for providing ongoing training to other crew chiefs. According to Army records, the crew chief had 1,149 total hours of flight experience, of which about 186 hours were in the UH-60L, with the remainder in other UH-60 models. The crew chief also held FAA airframe and powerplant mechanic certificates.

As of the accident date, the crew chief possessed a current upslip, meaning that he had been found medically qualified for flight duty by a trained Army aeromedical provider, with approval by the company commander. The upslip carried limitations that vision correction devices were required in the performance of flight duties and that the crew chief must carry extra spectacles.

A battalion standardization pilot stated that he had recently completed the crew chief’s annual performance evaluation, and he considered the crew chief one of the best and most intelligent instructors he had worked with. He stated that the crew chief “was always teaching somebody something.” He added that the crew chief was very good at spotting and calling out traffic using the battalion’s standard terminology.

1.2.2.6 Crew Chief’s Recent Activities

The crew chief’s activities during the 72 hours preceding the accident were documented using phone records and statements from friends and family members. The crew chief’s wife stated that the family woke about 0700 on January 27 and that they went to sleep around 2130. On January 28, he left the house “early,” and returned home around 1100, after which he napped for two or three hours. The crew chief’s last cell phone activity was at 2244. Cell phone records for the day of the accident indicated that he woke around 0600. A friend and colleague reported that the crew chief arrived at DAA between 1300 and 1400 and began examining the accident helicopter’s maintenance logbook. They had a brief conversation, and the friend stated that the crew chief looked “normal.”

1.3 Aircraft Information

1.3.1 CRJ700 General Information

The MHI RJ Aviation CL-600-2C10 (CRJ700) is a narrow-body, transport category airplane equipped with a T-tail and retractable, tricycle landing gear and powered by two General Electric (GE) Aerospace CF34-8C5B1 engines. The accident airplane was delivered new to PSA Airlines in January 2005.

1.3.1.1 CRJ700 Traffic Alert and Collision Avoidance System

The accident airplane was equipped with TCAS II Version 7.0.[25] The system comprises a Collins Aerospace transceiver, a directional antenna mounted on the top of the fuselage, and an omnidirectional antenna mounted on the bottom of the fuselage. The transceiver interfaces with the aircraft's transponders, radio altimeters, radio tuning units, the primary flight displays (PFDs), multifunction displays (MFDs), and the engine indication and crew alerting system.

The airplane's FDR indicated that the captain's MFD TCAS display range was set to depict traffic within a 10-nm radius. The FO's MFD display range was adjusted from 10 nm to 5 nm about 2041, about 2 minutes before the FO contacted the DCA tower controller while inbound on the approach for runway 1.

Additional discussion of TCAS, including exemplar CRJ700 PFD and MFD displays depicting active advisories, is provided in section 1.4.2.1.

1.3.2 UH-60L General Information

The Sikorsky UH-60L is a military helicopter equipped with a four-bladed, fully articulated main rotor system that provides lift and thrust, and a four-bladed, fully articulated tail rotor that provides directional control. The helicopter is powered by two GE Aerospace T700-GE-701D turboshaft engines. The UH-60L has nonretractable wheel landing gear in a reverse tricycle configuration. The accident helicopter, serial number 702614 and US Army tail number 00-26860, was manufactured and delivered to the US Army in March 2001.

The accident helicopter was equipped with an external stores support system (ESSS), two wing-like structures installed on the upper cabin frame of the helicopter and supported by two struts that attach to the lower cabin frame (see figure 4). Each ESSS wing has two mounting provisions, one inboard and one outboard. At the time

[25] According to FAA briefing materials, TCAS II is an onboard system that operates independently of ATC to reduce midair collision risk by displaying traffic information and providing alerting to the flight deck.

of the accident, the accident helicopter's ESSS was configured with an external crash-resistant fuel tank attached to each outboard mounting provision.

Figure 4. Photograph of exemplar 12th Aviation Battalion UH-60L equipped with ESSS and external fuel tanks.

As of the morning of the accident, the accident helicopter had accumulated an airframe total time of 4,803.6 hours. The helicopter's most recent phase maintenance inspection (PMI) was completed on October 8, 2024, at an airframe total time of 4,769.9 hours and was followed by a maintenance test flight. According to documentation provided by the Army, a PMI was required every 480 hours and was required to include, but was not limited to, operational checks of the pitot-static system, communications equipment, radar altimeter, and external lights.[26] The maintenance test flight included, before starting the engines, verifying that the barometric altimeters, when set to the local barometric pressure setting, indicated a difference not greater than ± 70 ft of airfield elevation (see section 1.3.2.3 for more information on the helicopter's altimeters).

1.3.2.1 UH-60L Transponder

An aircraft transponder is an onboard electronic device that aids in automatic communication between an aircraft and ATC secondary surveillance radar or other nearby aircraft. This communication allows controllers and other aircraft to identify, locate, and determine the altitude of an aircraft. Transponders are available in different modes.

[26] The pitot-static system comprises sensors that detect air pressure and provides information regarding the aircraft's altitude, airspeed, and vertical speed.

Mode A transponders respond to radar interrogations by transmitting a temporary identifier, which is a four-digit code between 0000 and 7777. Codes may be assigned by ATC or a default code is selected by the pilot when operating without ATC services (for example, 1200 for VFR in the US). Mode A is synonymous with the military transponder Mode 3. Mode A capabilities are normally combined with other modes.

Mode C transponders transmit the Mode A code along with pressure altitude. Mode C is required in most controlled airspace and enables ATC and TCAS to provide vertical separation and traffic advisories.

Mode S transponders transmit additional data, such as a unique 24-bit International Civil Aviation Organization (ICAO) address, airspeed, and magnetic heading. Mode S transponders are the backbone of modern TCAS systems because they enable avoidance maneuvers to be coordinated between two converging aircraft. Some Mode S transponders support Automatic Dependent Surveillance–Broadcast (ADS-B) Out when connected with an approved GPS source.

Consistent with standard equipment for US Army UH-60L helicopters, the accident helicopter had an AN/APX-123A transponder system. The system comprises a transponder receiver-transmitter installed within the avionics nose bay, and a remote control unit (RCU) installed in the cockpit center console, which is depicted in figure 5.[27]

[27] According to the FAA *Aeronautical Information Manual*, a transponder is an airborne radar beacon transmitter-receiver that receives signals from a ground-based radar system, or interrogator, and selectively replies with a specific pulse group, or code, only to those interrogations being received on the mode to which it is set. In addition to Modes 3/A, C, and S, the APX-123A also supported Modes 1, 2, 4, and 5, which are military-only modes and not relevant to the circumstances of the accident flight.

Figure 5. A UH-60L transponder with the ADS-B squitter turned off. (Source: BAE Systems)

Note: Mode S can be enabled by pushing the two highlighted buttons, MS-7 and ENT, in sequence.

The APX-123A supports Modes 3/A and C, Mode S, as well as ADS-B Out (see section 1.4 for more information). The ADS-B squitter is tied to the Mode S function such that, when Mode S is turned off, the ADS-B squitter stops broadcasting ADS-B Out.[28] The Mode S function can be turned off independently of the other transponder modes, and the ADS-B squitter can be turned on or off independently when the Mode S function is enabled. The transponder allows for the Mode S function to be turned on or off while the helicopter is on the ground or airborne. When operated in Modes C and S, the transponder replies to TCAS interrogations from nearby aircraft, enabling TCAS aboard those aircraft to derive bearing and range to the helicopter as

[28] A squitter is a broadcast of data without interrogation, such as from ground radar.

traffic. Nearby aircraft equipped with TCAS can use Mode C and S replies to display targets' relative altitude and to calculate vertical speed trend information.

1.3.2.2 UH-60L Air Data System

The pitot-static system of the UH-60L comprises two pitot-static probe assemblies, pitot lines, and static 1 (S1) and static 2 (S2) lines. The pitot-static probe assemblies are installed on the left and right sides of the cockpit roof, immediately aft of the cockpit doors. Each pitot-static probe assembly has two ports each for S1 and S2, with all four static ports located on the outboard side of the probe. Figure 6 shows the pitot-static system installation on the UH-60L.

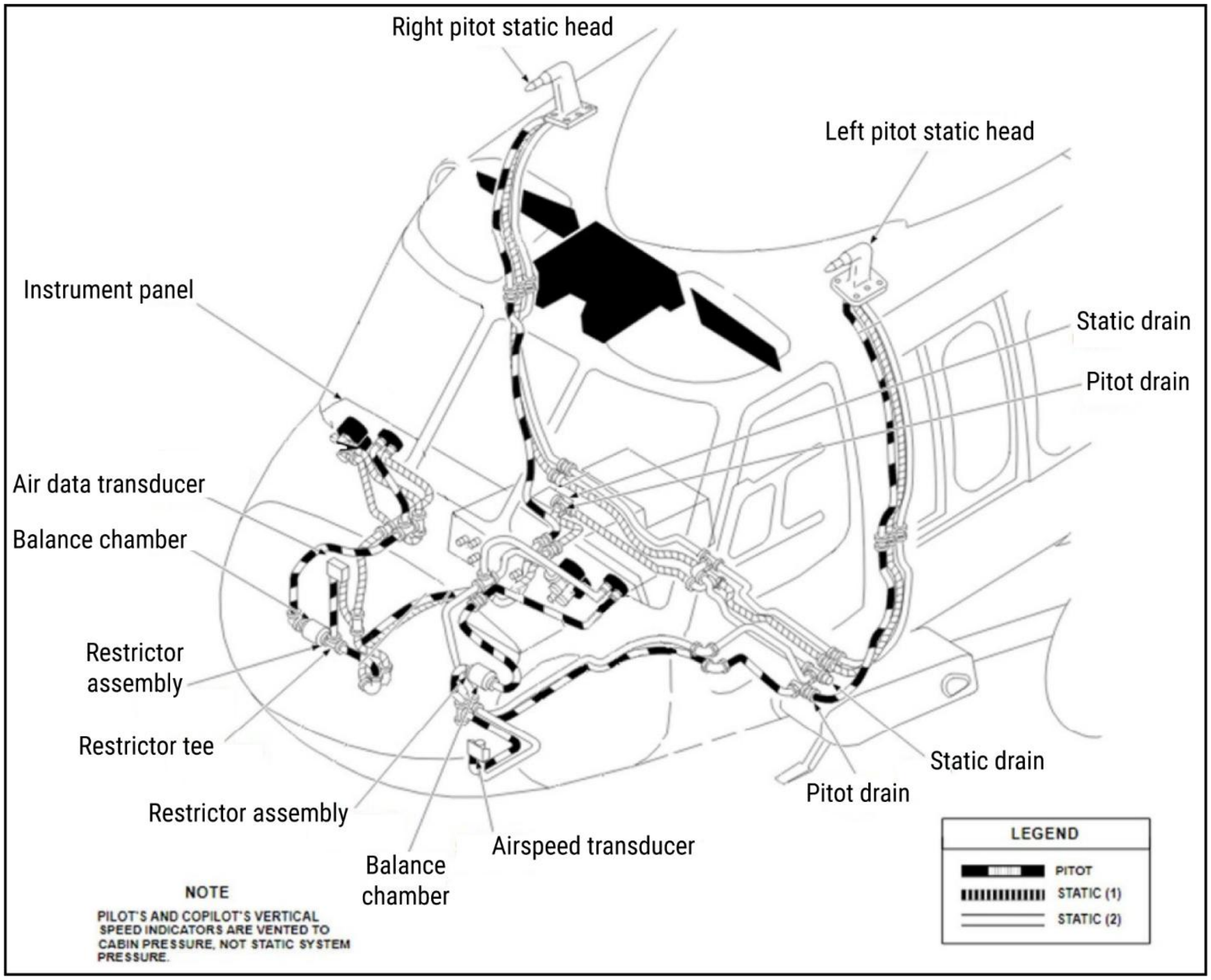

Figure 6. Diagram showing the UH-60L pitot-static system installation. (Source: US Army; modified by the NTSB for clarity)

The left pitot probe provides stagnation (total) pressure information to the airspeed transducer and to the left pilot's airspeed indicator. The right pitot probe provides stagnation pressure information to the air data transducer, the right pilot's airspeed indicator, and the electronic standby instrument system (ESIS). The air data transducer supplies pressure altitude, indicated airspeed, and altitude rate data to the integrated vehicle health monitoring system (IVHMS), including the integrated vehicle health monitoring unit (IHVMU) and the multipurpose cockpit voice and flight data recorder (MPFR).

Information from the air data transducer is used by the stability augmentation system (SAS)/flight path stabilization (FPS) computer and the heads-up display (HUD). When the HUD is not in use, information from the air data transducer is not available in a form that is displayed to either pilot. The S1 lines provide static pressure information to the right barometric altimeter. The S2 lines provide static pressure information to the left pilot's barometric altimeter, airspeed indicator, and to the airspeed transducer. Information from the airspeed transducer is provided to the SAS/FPS computer and is not available in a form that is displayed to either pilot.

An entry in the helicopter's maintenance logs dated September 13, 2024, at an airframe total time of 4,769.9 hours, stated that the pitot-static system failed initial checks.[29] The corrective action, dated September 23, 2024, noted that the pitot-static system attachments were tightened and an operational check without aircraft power applied resulted in an acceptable result. The entry did not specify which attachments on the pitot-static system were tightened.

The helicopter was also subject to a pitot-static system inspection every 12 months.[30] According to maintenance records, the accident helicopter's most recent pitot-static inspection was completed in May 2024 at an airframe total time of 4,724.1 hours with no noted discrepancies. The inspection includes an operational test of the pitot-static system (performed on the ground by mechanics without the rotors turning) using a test set that simulates different total and static pressure values to verify the operation and accuracy of the system, including the barometric altimeters. Defined altitudes between 0 ft and 10,000 ft are replicated on the test set for the static system to sense and display on the barometric altimeters.

According to US Army maintenance procedures, at a test set altitude of 0 ft, the barometric altimeter was required to indicate between -50 ft and 50 ft. At a test set altitude of 500 ft, the barometric altimeter was required to indicate between 470 ft and 530 ft. At a test set altitude of 1,000 ft, the barometric altimeter was required to

[29] The helicopter was not flown between September 4, 2024, and the phase maintenance inspection (PMI) on October 8, 2024. It was not determined whether this failure occurred during start-up procedures for an intended flight, or if it was a discrepancy noted from a previous flight and recorded on September 13.

[30] This pitot-static system operational test is distinct from the maintenance test flight check described previously that included a flight test by pilots to ensure that the barometric altimeters indicate within 70 ft of field elevation. The requirements of the 12-month pitot-static system inspection and operational test were the same between UH-60L helicopters that had ESSS installed and those that did not have ESSS installed.

indicate between 965 ft and 1,035 ft. At a test set altitude of 2,500 ft, the barometric altimeter was required to indicate between 2,430 ft and 2,570 ft. At a test set altitude of 5,000 ft, the barometric altimeter was required to indicate between 4,920 ft and 5,080 ft. At a test set altitude of 10,000 ft, the barometric altimeter was required to indicate between 9,900 ft and 10,100 ft.

1.3.2.3 UH-60L Altimeters

The UH-60L was equipped with three barometric altimeters and two radar altimeter indicators; one of each type of altimeter was located on the left and right sides of the cockpit. The ESIS contained the third barometric altimeter.[31] Figure 7 shows the instrument panel on the left side of the cockpit. The barometric altimeter provides pressure altitude information via an analog pointer.[32] The barometric altimeter setting (displayed in the Kollsman window) is presented in inHg and can be adjusted independently on each altimeter based on local pressure correction factors.[33]

Figure 7. Photograph of the instrument panel on the left side of a UH-60L cockpit, as viewed when looking below NVGs.

[31] The design of the left barometric altimeter, model AAU-31/A, was controlled by military specification MIL-A-81851B. The design of the right barometric altimeter, model AAU-32/A, was controlled by military specification MIL-A-81852A.

[32] According to the FAA *Pilot's Handbook of Aeronautical Knowledge* (FAA-H-8083-25C), a barometric altimeter is an instrument that measures the height of an aircraft above a given pressure level.

[33] Pressure altitude is the altitude that the international standard atmosphere (ISA) model assigns to the atmospheric pressure measured by the aircraft. The model uses a standard pressure of 29.92 inHg at sea level and an aircraft's air data system measures the outside static pressure, which is then converted to an altitude according to the ISA model.

The right-side pilot's barometric altimeter contains an encoding function that provides pressure altitude from the analog altimeter to the digital transponder. This interface uses binary code to provide height information to the transponder in 100-ft increments. The ESIS, installed centrally on the cockpit instrument panel, is a backup to the helicopter's analog instruments and shows a digital display of attitude, airspeed, heading, and barometric altitude. The barometric altimeter setting can be adjusted independently on the ESIS.

The radar altimeter system comprises two cockpit indicators and two identical, flush-mounted radar altimeter antennas on the underside of the cockpit structure.[34] The radar altimeter on the left side of the cockpit is an indicator/receiver-transmitter (IRT), while the right-side radar altimeter is only an indicator that receives radar altitude information from the left side IRT. Each radar altimeter indicator has an analog pointer, which indicates altitude on a scale from 0 to 1,500 ft, as well as a four-digit digital display. On each indicator, a high and low bug can be set with associated warning lights embedded into each radar altimeter display when the helicopter's altitude drops below the low bug or exceeds the high bug.[35]

1.4 Automatic Dependent Surveillance–Broadcast and Collision Avoidance Technologies

1.4.1 ADS-B Overview

ADS-B is a surveillance technology that comprises GPS, aircraft avionics, and a network of ground stations to determine an aircraft's location with more precision than legacy radar technology. Radar relies on radio signals and antennas to determine an aircraft's location and is limited to line-of-sight, meaning that radar signals cannot travel long distances or penetrate solid objects such as mountains. ADS-B ground stations, however, are smaller and more adaptable than radar towers and can be placed in locations not possible with radar. As a result, ADS-B provides air traffic control with better visibility of airborne traffic, regardless of terrain. ADS-B includes two different services: ADS-B Out and ADS-B In.

ADS-B Out works by broadcasting information from an aircraft at least once per second regarding the aircraft's GPS location, altitude, ground speed, and other data to ground stations and other (ADS-B In-equipped) aircraft. ADS-B In receives position information directly from nearby ADS-B Out-equipped aircraft. Most ADS-B

[34] The radar altimeter calculates height above terrain by sending a beam of radio waves downward and timing how long it takes to travel to the surface, reflect, and return to its antenna.

[35] A bug is an adjustable pointer on a flight instrument that provides pilots with a quick visual reference for a desired parameter, such as speed, altitude, or a power setting. These can be set or changed in flight.

In systems include a flight deck traffic display, known broadly as a cockpit display of traffic information (CDTI). A CDTI may be part of the aircraft's installed avionics, such as on a dedicated navigation display or multifunction display, or it could be hosted on a portable device, such as a smartphone or tablet computer.

When an ADS-B In-equipped aircraft is within range of a ground station, the system is also capable of receiving position information, broadcast from the ground station, of nearby aircraft that are equipped with a Mode S or Mode C transponder but not ADS-B Out. This capability is known as Traffic Information Service–Broadcast (TIS-B) and provides altitude, ground track, speed, and distance of aircraft flying within a 15-nm radius, up to 3,500 ft above or below the receiving aircraft's position, as long as both aircraft are within the radar service volume. Figure 8 provides an illustration of the ADS-B system.

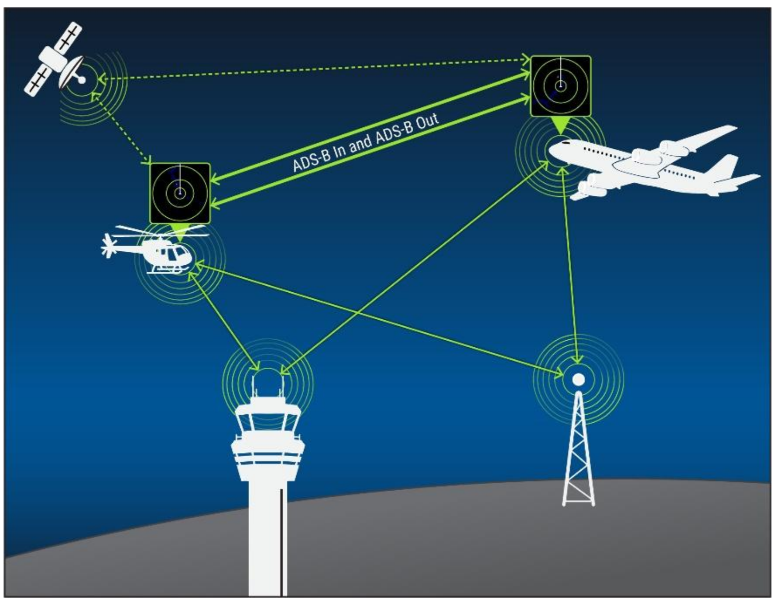

Figure 8. Conceptual depiction of ADS-B system architecture.

Note: The illustration is a generalized depiction of ADS-B information flow and includes an example of a traffic display for illustrative purposes only; it does not depict a specific operational configuration or system installation, and display formats and symbology vary by system and aircraft equipage.

ADS-B In avionics are also capable of producing visual and aural alerts regarding predicted collision threats. ADS-B Traffic Advisory System (ATAS) is an ADS-B application intended to reduce the number of midair collisions and near midair collisions involving general aviation aircraft. ATAS utilizes ADS-B information to generate verbal alerts indicating the clock position, relative altitude, range, and vertical tendency of proximate traffic. ATAS can also utilize a CDTI to also provide visualization of proximate traffic. ADS-B In is also capable of receiving weather information.[36] This traffic and weather display significantly increases a pilot's situation awareness.

Since January 1, 2020, ADS-B Out is required on all aircraft in most controlled airspace within the NAS, as shown in figure 9. This includes operations above 10,000 ft msl and within or above Class B and C airspace with certain exceptions.[37] ADS-B In is currently not required by the FAA. In recent decades, the FAA's strategy toward ADS-B In has been to encourage and incentivize its use, without going so far as to mandate it. At the time of the accident—and through the date of this report's publication—the FAA has no regulation requiring aircraft to receive ADS-B In.

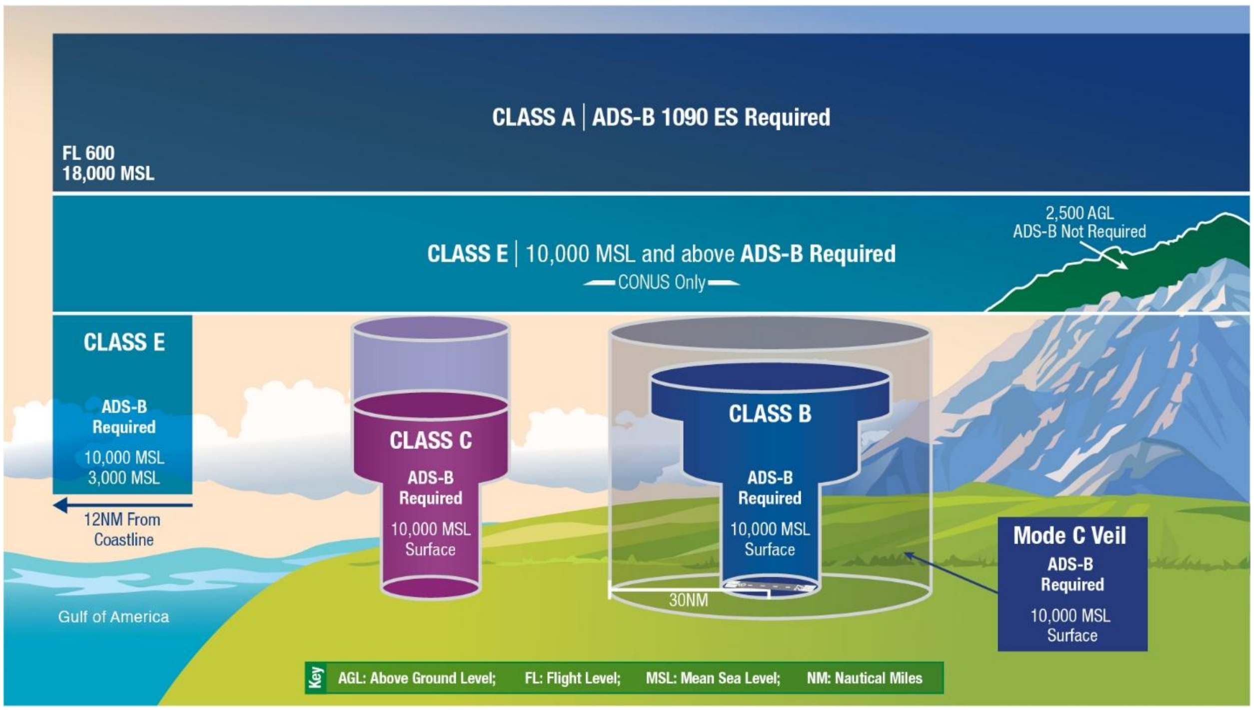

Figure 9. ADS-B Out equipage mandates in the NAS, by categories of airspace. (Source: FAA)

[36] This capability is known as flight information service-broadcast (FIS-B). FIS-B broadcasts graphical weather information as well as text-based advisories, including notices to air missions (NOTAMs), which provide information such as temporary flight restrictions or closed runways. FIS-B is only available on the Universal Access Transceiver ADS-B link.

[37] 14 *CFR* 91.225 contains exceptions to the ADS-B requirement, such as aircraft originally not certificated with an electrical system or not subsequently certified with such a system, including balloons and gliders. Also according to this section, each person operating an aircraft equipped with ADS-B Out must use transmit mode at all times with two exceptions: (1) if authorized by the FAA when the aircraft is performing a sensitive government mission or (2) if directed by ATC when transmitting would jeopardize the safe execution of ATC functions.

Two ADS-B Out standards are approved in the NAS:

- 1090 megahertz (MHz) Extended Squitter (1090ES) ADS-B Out broadcasts aircraft position and identification on the 1090 MHz radio frequency and is permitted in all ADS-B–required airspace worldwide, including Class A airspace and at all altitudes.

- 978 MHz Universal Access Transceiver (UAT) ADS-B Out broadcasts on the 978 MHz radio frequency, is permitted only within the United States, and is not permitted in Class A airspace (i.e., at altitudes above 18,000 ft msl).

Ground-based ADS-B rebroadcast (ADS-R) technology translates and rebroadcasts traffic information between 1090ES and 978 UAT so pilots of aircraft equipped with either standard can see each other on compatible ADS-B In CDTIs.

Boeing and Airbus product lines have incorporated ADS-B In. Boeing offers ADS-B In on the Boeing 787 and 777X. Airbus offers ADS-B In on its Airbus A350 and on new A319/A320/A321 aircraft.

American Airlines has implemented an ADS-B In system on its Airbus A321 fleet, with over 300 aircraft equipped. The airline stated that, in two separate 2-year trials with the FAA, ADS-B In improved arrival efficiency for its aircraft (American Airlines, 2025). These aircraft are equipped with an auxiliary guidance display, which displays ADS-B traffic information. According to testimony provided by an American Airlines captain during the National Transportation Safety Board's (NTSB's) investigative hearing, ADS-B In with a CDTI can provide a pilot with increased situation awareness of nearby aircraft with information such as directionality, flight number identification, and relative altitude.

1.4.2 Airborne Collision Avoidance and Traffic Awareness Systems

According to FAA Advisory Circular (AC) 90-120, "Operational Use of Airborne Collision Avoidance Systems," Airborne Collision Avoidance System (ACAS) was developed as a safety-enhancing system to reduce the likelihood of midair collisions between aircraft. ACAS is the general term for an onboard safety system for a broad spectrum of aircraft types that function independently of the ground-based air traffic control system. ACAS iterations include TCAS I, TCAS II, and ACAS X. Table 5 presents a comparison of airborne collision avoidance systems' features.

Table 5. Comparison of features of airborne collision avoidance systems (ACAS) and Automatic Dependent Surveillance–Broadcast (ADS-B) In applications.

	TCAS II 7.0	TCAS II 7.1	ACAS Xa (airplanes)	ACAS Xr (helicopters only)	ADS-B In applications
Functionality	Real-time collision avoidance advisories (TAs and RAs)				Enhancement of ATC and ACAS surveillance and flight deck situation awareness
Surveillance source	Active interrogations of nearby aircraft transponders (Mode C/S) to determine range, bearing, and altitude		Active interrogations of nearby aircraft transponders (Mode C/S) to determine range, bearing, and altitude. ACAS Xa and ACAS Xr also include ADS-B In surveillance.		GPS-derived position data broadcast automatically by aircraft every second. Best navigation source feeds the position/velocity vector reported.
Alerting categories	• Traffic advisories (TAs) • Resolution advisories (RAs)				No collision avoidance alerts; some systems issue aural alerts for situation awareness (ADS-B traffic advisory system, or ATAS)
RA commands	• Climb • Descend • Crossing climb • Crossing descend • Adjust vertical speed • Monitor vertical speed • Maintain vertical speed				No collision avoidance alerts issued
RA reversals	Yes	Improved logic			No collision avoidance alerts issued
Speed/lateral RA commands	No			Yes	No collision avoidance alerts issued
Alerting inhibits (±100 ft)	• Increase descent RA < 1,450 ft above ground level (agl) • Descend RA < 1,100 ft agl • All RAs < 1,000 ft agl • All TCAS aurals including TA < 500 ft agl			Alerting cutoff altitude 100 ft or 200 ft	No collision avoidance alerts issued
Nuisance alerts	Alerting inhibits designed to reduce nuisance alerts at low altitudes		Reduces false or unnecessary RAs by including the ADS-B-based velocity vector into the target threat analysis		No collision avoidance alerts issued
Collision avoidance logic	Rule-based logic and altitude rates. Elongated "hockey puck"		Probabilistic threat modeling and machine learning-based algorithms		No collision avoidance alerts issued

	TCAS II 7.0	TCAS II 7.1	ACAS Xa (airplanes)	ACAS Xr (helicopters only)	ADS-B In applications
Target directionality	No	Only with ADS-B In capable units	Possible; not required	Possible	Yes
Commercial availability for CRJ fleet	Yes		Standards developed; no hardware available	Standards in draft; no hardware available	No installed avionics hardware available

Note: ACAS-Xr standards are in development, and the final alerting cutoff altitude is still being evaluated.

1.4.2.1 TCAS

Between 1967 and 1987, the NTSB issued 116 safety recommendations to the FAA addressing the need for actions to reduce the potential for midair collision accidents. Eleven of those recommendations specifically addressed the need for a collision avoidance system aboard airplanes to provide pilots with conflict warning and evasive maneuver guidance.

In 1969, the NTSB called for the FAA to "support the expeditious development of low-cost collision avoidance systems for all civil aircraft" (NTSB, 1969). In 1971, the NTSB asked the FAA to "encourage the expeditious development of a collision avoidance system for installation in air carrier aircraft and larger general aviation aircraft" and to fund the ground equipment necessary to support collision avoidance systems (NTSB, 1971).

In 1986, a midair collision between a McDonnell Douglas DC-9 and a single-engine Piper Cherokee airplane near Cerritos, California, claimed a total of 82 lives. In January 1989, the FAA issued its final rule to require the installation and use of TCAS in large transport category airplanes and certain smaller turbine-engine powered airplanes.

TCAS I provides traffic advisories (TAs) to assist the pilot in visually locating aircraft that it detects as a potential collision threat. TAs comprise a visual warning, depicted to pilots by means of a dedicated display, shared display, or pop-up display, depending on the aircraft's avionics configuration, as well as an auditory "Traffic, Traffic" annunciation. On the display, the symbol representing the aircraft that caused the TA will change shape and color, and a yellow "TRAFFIC" text caution will be depicted. Some versions of TCAS I are still an acceptable means of compliance with collision avoidance mandates for some aircraft operating in US airspace.[38] Technical Standard Order (TSO) C118 and TSO-C118a specify the certification

[38] Per 14 *CFR* 121.356, TCAS I or newer must be installed in turbine-powered airplanes with fewer than 10–30 seats or piston-powered airplanes over 33,000 pounds.

standards for TCAS I (FAA, 1988; FAA 2014b).[39] The former was discontinued on April 27, 2016.

Like TCAS I, TCAS II interrogates transponders of nearby aircraft and presents traffic information on a display. Unlike TCAS I, TCAS II is also able to provide vertical path guidance to flight crews, known as resolution advisories (RAs). RAs provide pilots with instructions to perform vertical maneuvers, such as climbing, descending, or leveling the aircraft, in order to resolve traffic conflicts. RA annunciations include instructions such as, "Climb, Climb," "Descend, Descend," or "Level Off, Level Off," among others, but does not include lateral path (turning) instructions.[40]

TCAS RAs are electronically coordinated between aircraft to increase separation. When the airplane is descending and the airplane's radar altimeter indicates less than 900 ft above ground level (agl), TCAS reverts to "TA ONLY" mode, meaning that it inhibits, or blocks, RAs below 900 ft agl during descent. When climbing, RAs are inhibited below 1,100 ft agl. These inhibit altitudes are designed to prevent nuisance alerts.[41] Below 900 ft agl on descent, TCAS issues a TA when the intruding aircraft is about 20 seconds from the closest point of approach, or 0.3 nm range, whichever occurs first. As the aircraft descends below 400 ft agl, or is below 600 ft agl while climbing, the aural annunciation associated with the TA is inhibited; however, the yellow "TRAFFIC" warning still appears on the PFD.

Figure 10 shows a PFD depicting an active TA (left) and RA (right). Figure 11 shows an MFD depicting an active TA.

[39] A TSO is a minimum performance standard defined by the FAA, used to evaluate a material, part, component, process, or appliance.

[40] In addition, RA annunciations are provided for numerous other scenarios, and can include instructions to "increase climb," "increase descent," "climb NOW" (RA reversal), "descend NOW" (RA reversal), "maintain vertical speed," and "level off." Once the aircraft diverge, a "clear of conflict" is announced.

[41] The TCAS RA inhibit altitude threshold was established based on technological limitations available at the time it was developed. Original RA inhibit altitudes resulted in traffic on the ground waiting to depart causing RAs to activate in arriving aircraft. Mode S transponders allow for transmission of whether an aircraft is on the ground or in the air, making it possible to reduce this type of nuisance alert; however, the inhibit altitudes were never adjusted.

Figure 10. PFD depicting an active traffic advisory (TA) shown on left, and an active resolution advisory (RA) shown on right.

Note: The PFD on the right indicates an active RA through information displayed in the lower-right quadrant: red and green arcs appear across the vertical speed scale to indicate that the pilot should fly out of the red vertical speed range and into the green vertical speed range, in this example by climbing away from the threat aircraft. The word “TRAFFIC” in red capital letters also appears.

Figure 11. MFD in an exemplar CRJ700 showing an active TA.

Note: This photograph was taken in an exemplar CRJ on the ground. The conflicting traffic in this TA is depicted by the yellow diamond, annotated with "00," which is shown over the ownship depiction (white airplane) in the bottom center of the image, indicating that the traffic is at nearly the same altitude as the own-ship. The text "TA ONLY" shown in yellow on the upper right side of the image indicates the mode of the TCAS system: RAs are automatically inhibited below 1,000 ft agl (±100) feet; the crew can also manually select TA ONLY mode.

Large transport-category airplanes engaged in air carrier or commercial operations are generally mandated to have TCAS II installed and active. TCAS II is available in various software versions including 6.04a, 7.0, and 7.1. The software versions reflect incremental safety and performance improvements. Most notably, version 7.1 refined RA logic and alert phrasing.

Title 14 *CFR* Section 121.356 requires TCAS II be installed on turbine-powered airplanes with a maximum certificated takeoff weight greater than 33,000 pounds, and 14 *CFR* Section 135.180 imposes similar mandates for certain Part 135 operations. The minimum operating performance standards (MOPS) for TCAS II do not require directional traffic symbols that show the direction the target is moving.

ACAS serves as a backup to visual collision avoidance, the application of right-of-way rules, and ATC separation services. FAA AC 90-120 states:

> The nomenclature 'advisory' notwithstanding, the FAA considers that TAs generally require immediate flight crew awareness and potentially a subsequent flight crew response. RAs generally require immediate flight crew awareness and immediate flight crew response by complying with the RA in a timely manner.

The FAA states that there are recognized incompatibilities between TCAS and air traffic control procedures or airspace design. For instance, aircraft leveling off 1,000 ft above or below conflicting traffic, that is, in level flight, may result in RAs being issued to the level aircraft when its TCAS detects the climbing or descending aircraft's high rate of vertical speed.

Although improvements were made to the TCAS algorithm to reduce these kinds of alerts, RAs related to high vertical speed rates still occur (FAA, 2011a). Additionally, RAs are frequently generated during VFR operations and visual separation because the TCAS logic does not consider the reduced vertical separation distances that may occur in these situations. Such alerts are often considered by pilots and controllers as unnecessary, or nuisance, alerts.

1.4.2.2 ACAS X

ACAS X was developed as the next evolution of collision avoidance technology. The goal was to create a system that improved existing collision avoidance alerting while reducing the number of nuisance alerts. ACAS X uses ADS-B In information to supplement transponder interrogations and replies. ADS-B Out transmissions include position and velocity vector, which allows targets to be displayed on a CDTI and can indicate the target's direction of travel.

With this information, it is possible for a pilot to glance at a target on the display and instantly know where it is headed, thereby allowing a pilot to rapidly assess whether the target poses a collision threat. ACAS X has several variants, including ACAS Xa and Xo, designed for airplanes; ACAS Xu for unmanned aircraft; and ACAS Xr, which is designed specifically for use in rotorcraft and is still under development.

Technological advances since the development of the TCAS MOPS also allow ACAS X systems to utilize ADS-B In and probabilistic models based on machine learning in order to provide better alert phrasing for pilots and enhanced prediction of the threat level posed by a target, resulting in higher quality alerting when compared to TCAS II. Generalized FAA safety studies indicated that ACAS Xa improves safety by 20% and reduces the overall alerting rate by 65% (ICAO, 2021).[42]

Work began on standards development for ACAS Xa in 2013 at the direction of the RTCA (formerly Radio Technical Commission for Aeronautics) Program Management Committee (PMC). ACAS Xa MOPS were completed in 2018; however, no operational ACAS Xa systems have been deployed. The European Union Aviation Safety Agency (EASA) did not recognize the ACAS Xa standard as a suitable collision avoidance standard until they implemented Commission Implementing Regulation (EU) 20s25/343, effective March 2025. Before this time, Boeing and Airbus would not modify their aircraft with a system that could not be certified for operation in European airspace.

While EASA approval is no longer a barrier to ACAS Xa deployment, there is not currently a regulatory requirement to migrate from TCAS to ACAS Xa. The FAA terminated TSO C-119e in March of 2022, meaning that no new TCAS systems can be certified in the United States. TCAS systems currently in production can continue to be produced indefinitely; however, migration to ACAS Xa would be required if TCAS system component parts become unavailable.

The functionality of ACAS depends on the transmitter modes available on the aircraft involved, as shown in table 6. In the table, TCAS I is referred to as ACAS I; TCAS II and ACAS Xa are referred to as ACAS II.

Table 6. Levels of protection provided by ACAS II-equipped aircraft. (Source: FAA Advisory Circular 90-120)

Other aircraft (equipment and operating mode)	ACAS II (TA only) or ACAS I	ACAS II (TA/RA)
No transponder/transponder off	No ACAS protection	No ACAS protection
No transponder, but transmitting 1090 MHz ADS-B Out	ADS-B only TA-only (ACAS Xa only)	ADS-B only TA-only (ACAS Xa only)
Non-altitude reporting	TA (no protection above 15,500 ft pressure altitude)	TA (no protection above 15,500 ft pressure altitude)
Transponder with altitude reporting	TA	TA and RA
ACAS II (TA-only) or ACAS I	TA	TA and RA
ACAS II in TA/RA mode	TA	TA and coordinated RA

[42] An improvement in safety is defined in simulations using real world encounter sets that contrast the collision avoidance results of the ACAS systems being compared (ICAO, 2021).

1.4.3 ADS-B In and ACAS Comparison

ADS-B In CDTI systems that adhere to ATAS standards display the same traffic information elements as ACAS but also display directional traffic symbols, which is not currently a requirement for TCAS and ACAS Xa products (see figure 12). An important distinction between TCAS and ADS-B is that ADS-B Out equipped aircraft can also transmit additional data besides the aircraft position, including horizontal velocity vector and vertical speed (rate of climb).

An ADS-B In equipped aircraft receiving ADS-B Out information can use the positions of surrounding ADS-B targets to compute the relative location of those targets and present them on a traffic display. This additional information can be used by ADS-B In aircraft with the appropriate avionics applications to compute the track angle of the target and its ground speed, which allows the application to depict the direction of travel of the target on the traffic display (the "directionality" depicted by an arrowhead), as shown in the symbol on the right in figure 12. The depiction of directionality in turn allows pilots, at a glance, to see not only where the traffic targets are relative to their own aircraft, but also how they are moving relative to their own aircraft.

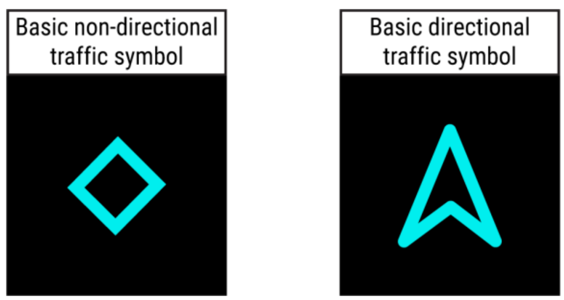

Figure 12. Comparison of basic non-directional and directional traffic symbols. (Source: RTCA DO-317C)

TCAS, however, is limited by the fact that it cannot measure bearing, or the relative angle of the target aircraft, precisely enough to determine the direction of the target's travel. TCAS targets are displayed as symmetrical symbols that do not contain directionality information. To determine the direction these targets are moving, a pilot has to monitor the TCAS display to observe how the target's position on the display changes over time. Because the primary purpose of TCAS is to assist the pilot in visually acquiring traffic identified by a TA, its use in providing pilots with a complete picture of the behavior of surrounding traffic is limited.

As previously stated, ATAS utilizes ADS-B information to generate verbal alerts indicating the clock position, relative altitude, range, and vertical tendency of nearby traffic. This enables a pilot to immediately direct their attention outside the aircraft in the proper direction in order to spot the traffic. A CDTI can provide a supplemental visual display of the traffic's position. TCAS TAs currently only provide an annunciation of "Traffic, Traffic," with no additional information regarding the target's position. This requires the pilot to first refer to the TCAS display inside the cockpit and determine the relative location of the target before they are able to focus their visual search in a specific location outside the aircraft.

One key distinction between ATAS and ACAS is the alerts provided. ATAS was optimized for general aviation operations in a VFR traffic pattern and includes traffic callouts intended for those operations. According to FAA AC 90-114C, "Automatic Dependent Surveillance-Broadcast Operations," an ADS-B In CDTI "is not intended to be used for self-separation or to deviate from an ATC clearance" (FAA, 2025e). It additionally states that, "Unless specifically certified for the function, the traffic display is not intended for collision avoidance or self-separation." ATAS does not provide RAs.

Conversely, TCAS and ACAS X provide TAs optimized for commercial transport category aircraft operations in congested airspace. TCAS II and ACAS X provide RAs coordinated with the conflicting aircraft that require the crew to initiate a timely maneuver.

Furthermore, ATAS is solely dependent on ADS-B information, whereas ACAS X leverages both ADS-B information and interrogation replies from nearby aircraft transponders. ACAS X uses transponder interrogations to validate the integrity of the ADS-B transmissions. If it determines that the ADS-B data are invalid, ACAS X can still provide TAs and RAs based on transponder replies. ATAS affords no such protections.

1.4.4 Accident Aircraft Equipment

The accident airplane was not equipped with avionics that utilized ADS-B In, nor was a certified ADS-B In product approved for installation into the CRJ700 at the time of the accident. Both aircraft were equipped with ADS-B Out-capable transponders; however, only the airplane was transmitting ADS-B Out at the time of the accident, whereas the helicopter was operating with transponder Mode S.

Because the airplane was equipped with TCAS and the helicopter was operating with Mode S, the crew of flight 5342 received traffic information about the helicopter through the airplane's TCAS, including the helicopter's identifier and pressure altitude. The airplane's TCAS could use the helicopter's Mode S transponder reply to calculate the helicopter's bearing, range, relative altitude, and vertical tendency. Additionally, although the helicopter's transponder was not transmitting ADS-B Out, its Mode S transponder capability allowed it to be tracked by FAA radars;

therefore, the helicopter's position could be broadcast to ADS-B In equipped aircraft through TIS-B.

The helicopter was not equipped with TCAS or an integrated ADS-B In-capable CDTI, nor was it required to be. An integrated collision avoidance system provides aural alerts to the crew members' headsets and, when available, cabin speakers. If the collision avoidance system has a CDTI, "integrated" implies that it is built into the aircraft's flight deck and located within the crew's primary field of view.

Two iPad Mini tablets were recovered separate from the helicopter main wreckage. According to the Army, the tablets had the ForeFlight Mobile application installed, which, when connected to an Appareo Stratus portable ADS-B receiver, could depict ADS-B traffic information on a moving map display. A Stratus receiver belonging to the 12th Aviation Battalion could not be accounted for in the battalion's inventory following the accident, nor was one located at the accident site; however, recorded ForeFlight track data from one of the tablets indicated that it was connected to a Stratus receiver during the accident flight.[43]

Interviews with Army pilots indicated that it was common for pilots to use the tablets, which they secured to a thigh, for assistance with navigation and traffic awareness. The tablets were normally referenced in flight by the pilot monitoring. Crew chiefs were not issued tablets and did not normally reference them in flight; however, one Army standardization instructor pilot testified during the investigative hearing that, when operating under instrument flight rules, pilots might occasionally pass their tablet to the crew chief, who could assist with airspace surveillance.

1.4.4.1 Accident Helicopter ADS-B History

Most military aircraft are equipped with transponders that provide ADS-B Out capability; however, an FAA–Department of Defense (DOD) Memorandum of Agreement, signed May 10, 2024, stated that the Secretary of Transportation could not require the installation of ADS-B equipment on special mission aircraft, and that DOD was to maintain a list of airframes that would not be equipped with ADS-B Out due to imminent retirement or operational security risks.[44] The MOA was to be reviewed triennially. Additionally, 14 *CFR* Part 91.225 allows operation of military aircraft without ADS-B.

[43] The battalion had several portable ADS-B receivers available in the pilot briefing area for flight crew use. These units were not considered a controlled item and were not required to be checked out.

[44] On September 5, 2025, Executive Order 14347 redesignated the Department of Defense as the Department of War. Consistent with the provisions of this executive order, when discussing events prior to its issuance—such as at the time of the accident—this report refers to the Department of Defense and otherwise refers throughout to the Department of War.

At the time of the accident, all UH-60L helicopters at the 12th Aviation Battalion were equipped with transponders that had the capability of transmitting ADS-B Out. The TAAB standard operating procedures (SOP) specified that aircrews conducting sensitive or classified operations would emit transponder Mode 3/A or C in lieu of ADS-B Out and that transponder modes should not be switched during flight (Army, 2024a). Per the TAAB SOP, sensitive or classified missions include but are not limited to flights conducted in support of local area orientation and training conducted to mission sites, and/or utilizing mission routing. While the accident flight was conducted for purposes of a standardization flight to ensure pilot proficiency, the flight was considered under TAAB SOPs as training conducted to mission sites.

During the accident flight, the helicopter's transponder began to respond to Mode S interrogations near Cabin John, Maryland, and continued to respond to Mode S interrogations until the accident occurred. Between the helicopter's departure from DAA and Cabin John, radar stations at other airports in the area tracked the helicopter via Modes 3/A and C. For the accident flight, Mode S multilateration (MLAT) data were populated in publicly available ADS-B databases, meaning that the helicopter's flight track information could be seen on these databases during the time the transponder was emitting Mode S, but ADS-B data were not transmitted by the accident helicopter.[45]

A review of historical data for the accident helicopter, which was provided by the FAA on February 19, 2025, showed that there was no historical ADS-B data for the 730 days (2 years) before the accident. However, intermittent MLAT data for the accident helicopter was found since December 2022. Since at least October 2023, the accident helicopter's transponder intermittently swapped its assigned aircraft address and a different, incorrect aircraft address. The incorrect aircraft address is discussed further in section 1.9.3.

1.5 Meteorological Information

1.5.1 Observations at DCA

At 2052, DCA reported an average wind from 300° at 14 kts with gusts to 23 kts, with a variable wind direction between 270° and 330°, 10 statute miles or greater visibility, clear skies, a temperature of 10°C (50°F), dew point temperature

[45] MLAT is a method that determines the location of an object by triangulation, that is, by measuring the difference in arrival times of signals transmitted from the object and received by multiple satellites or ground stations. An aircraft's transponder emits signals that are received by multiple nearby ground stations at slightly different times due to varying distances. By analyzing these time differences, the system triangulates the aircraft's precise location.

of -7°C (19°F), and an altimeter setting of 29.90 inHg. Remarks noted that a peak wind occurred at 2008 from 300° at 33 kts.

1.5.2 Crew Discussions of Wind and Turbulence

The PAT25 CVR contained numerous references to the windy, turbulent conditions that were present throughout the accident flight, as shown in table 7. Such conditions can require frequent heading and altitude corrections to maintain a desired altitude and flight track.

Table 7. Excerpted PAT25 crew CVR statements concerning wind and turbulence.

Time	Transmission	Distance from DCA
1939	Pilot: “A little turbulent” IP: “little bump”	35 nm
1956	Pilot: “is that turbulence or do you need assistance?” IP: “no that’s just turb. I’m trying to turn with uh – yeah we’re just gettin’ pushed pretty far out of trim…”	35 nm
2002	IP: “you’ve got flight controls just know the wind kickin’ out of the left definitely…want to keep it in trim.”	30 nm
2012	IP: “this wind is uh…” Pilot: “quite a headwind”	20 nm
2018	IP: “If you turn right then you’re going to get that booming tailwind…”	20 nm
2020	IP: “feels like you’re gettin’ your # kicked with some uh wind to the left right?” Pilot: “yes”	20 nm
2024	IP: “that wind definitely makes it tricky”	20 nm
2043	Pilot: “Gettin’ choppy close to the ground” IP: “oh yeah down low it’s definitely gonna get choppy”	5 nm
2046	Pilot: “Crabbing…better not to fight the wind…right pedal”	2 nm

1.5.3 Environmental Pressure Study

A cold front passed through the Washington, DC, area on the afternoon of the accident, after which barometric pressure increased through the remainder of the day and into the following day. VFR conditions prevailed in the area, with mostly clear skies and gusting wind.

A subject matter expert from the National Weather Service examined the reported conditions just before the time of the accident, with a particular focus on atmospheric pressure variations within the Potomac River basin around DCA, to determine whether there was potential for a local atmospheric pressure anomaly that could have significantly impacted the helicopter’s barometric altimeters. This study revealed that there were no hyper-local pressure anomalies in the vicinity of DCA that could have adversely affected the helicopter’s barometric altimeter readings.

1.6 Helicopter Routes

According to FAA Order JO 7210.3DD, "Facility Operation and Administration," section 12-4, Helicopter Route Chart Program, helicopter route charts are graphic portrayals of discrete and/or common helicopter routes or operating zones to facilitate helicopter access to, egress from, and operation within high density traffic areas.[46] The charts depict helicopter routes, heliports, navigational aids, and obstructions. They also show pictorial symbols, roads, and easily identified geographical features.[47]

Helicopter routes are depicted only on helicopter route charts and are not displayed on VFR sectional charts, terminal area charts, or terminal procedures publications.[48,49] Helicopter route charts are updated every 56 days. The order provided the following criteria for determining the need for a new or revised helicopter route chart:

a. Routes:

1. Recommended altitudes/flight ceilings/floors must avoid restricted/military airspace requiring prior authorization or clearance to enter.

2. All routes depicted on a helicopter route chart must, to the maximum extent practicable, reference ground objects that can be readily identified from the air.

b. Operating zones: Airspace encompassed by a helicopter route chart must, when necessary and required by operational considerations, be divided into a sufficient number of operating zones or sectors to permit

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[46] All FAA orders referenced in this report are cited with their current version as of the time of the accident. Order JO 7210.3DD was canceled and replaced by Order JO 7210.3EE on February 20, 2025.

[47] FAA Aeronautical Chart Users' Guide: Chart Users' Guide

[48] According to the FAA *Aeronautical Information Manual*, VFR sectional charts are designed for visual navigation of slow- to medium-speed aircraft. Terminal area charts depict the airspace designated as Class B in a manner similar to a sectional chart but with more detail because the scale is larger. Terminal procedures publications include airport diagrams, instrument approach procedures (IAP) charts, which provide data required to execute instrument approaches to airports; departure procedures (DP) charts, which are designed to facilitate transition between takeoff and enroute operations; and standard terminal arrival (STAR) charts, which facilitate transition between enroute and instrument approach operations and depict instrument flight rules arrival procedures. See Types of Charts Available.

[49] Helicopter route charts can be selected as an overlay on the ForeFlight application, but are not automatically enabled to display.

local law enforcement agencies to operate within them on an exclusive basis.

c. Altitudes and flight ceilings/floors: Each segment of a helicopter route may contain recommended altitudes or flight ceilings/floors. It is the discretion of the local air traffic tower if such altitudes will be depicted, or, assigned at a later date when the pilot contacts the tower.

1. Recommended altitudes/flight ceilings/floors must avoid airspace requiring prior authorization or clearance to enter.

2. Care should be exercised to avoid recommending altitudes or flight ceilings/floors which could cause helicopters operating on a designated route to encounter inflight wake turbulence generated by large, fixed wing traffic.

3. When altitude/flight ceiling changes are required, they should be based on a descent rate of 250–350 feet per nautical mile.

d. Communications information: Each helicopter route chart must include sufficient radio communications information to permit pilot compliance with all pertinent regulatory requirements, and facilitate the acquisition and dissemination of air traffic advisory information.

e. Military considerations: Avoid establishing helicopter routes or operating zones which would conflict with military ground control radar approach paths. When charting a route or operating zone which crosses or is located in close proximity to a MTR [military training route], include communications instructions that will permit pilots to determine the status of the MTR.[50]

f. Helicopter routes may be changed or modified whenever a new chart is updated. It is recommended that all route modifications be coordinated with operating groups in the local area.

According to testimony provided by personnel from the FAA's Aeronautical Information Services office at the NTSB's investigative hearing, the routes depicted on a helicopter route chart do not have lateral limitations unless explicitly outlined on the chart's route description. The routes were described as "non-regulatory" and "recommended paths" that served to streamline traffic flow and facilitate easier

[50] MTRs are defined by the FAA as airspace of defined vertical and lateral dimensions established for the conduct of military flight training at airspeeds in excess of 250 knots indicated airspeed. Although DCA area helicopter routes are used by the military for training, they are not MTRs.

communication between pilots and controllers regarding expected flight paths, reporting points, and area ingress and egress locations. Their hearing testimony also indicated that helicopter routes were established based on local traffic flow and density, but were not specifically designed to provide separation between helicopters and fixed-wing traffic.

Review of products listed on the FAA Aeronautical Information Services' website revealed a total of nine helicopter charts in the NAS, including the Baltimore-Washington chart. Eight of these charts were associated with Class B airspace.[51] Class B airspace surrounds the nation's busiest airports and generally extends from the surface to a maximum altitude of 10,000 ft msl, as illustrated previously in figure 9. Review of these charts indicated that most helicopter routes did not have published recommended altitudes; rather, altitudes were assigned by air traffic control. Routes that specified a recommended altitude were above 1,000 ft msl, except for the Los Angeles, California, helicopter route chart, which contained several routes below 900 ft msl and a 2-mile section along the coast west of Los Angeles International Airport below 150 ft msl, and the routes depicted on the Baltimore-Washington Helicopter Route Chart.

1.6.1 Baltimore-Washington Helicopter Route Chart

The DCA Class B airspace contains a high volume of helicopter activity from numerous operators, including local and state law enforcement, military, government, and medical transport. The helicopter routes for the Washington, DC, area are contained on the Baltimore-Washington Helicopter Route Chart; figure 13 shows an excerpt from the chart in effect at the time of the accident depicting the area immediately surrounding DCA.

[51] The charts listed in addition to Baltimore-Washington associated with Class B airspace were Boston, Chicago, Dallas-Ft. Worth, Detroit, Houston, Los Angeles, and New York. The FAA also listed on this website the US Gulf Coast VFR Aeronautical Chart, which is designed primarily for helicopter operations within the Gulf of America and depicts offshore mineral leasing areas and blocks, oil drilling platforms, and high-density helicopter activity areas.

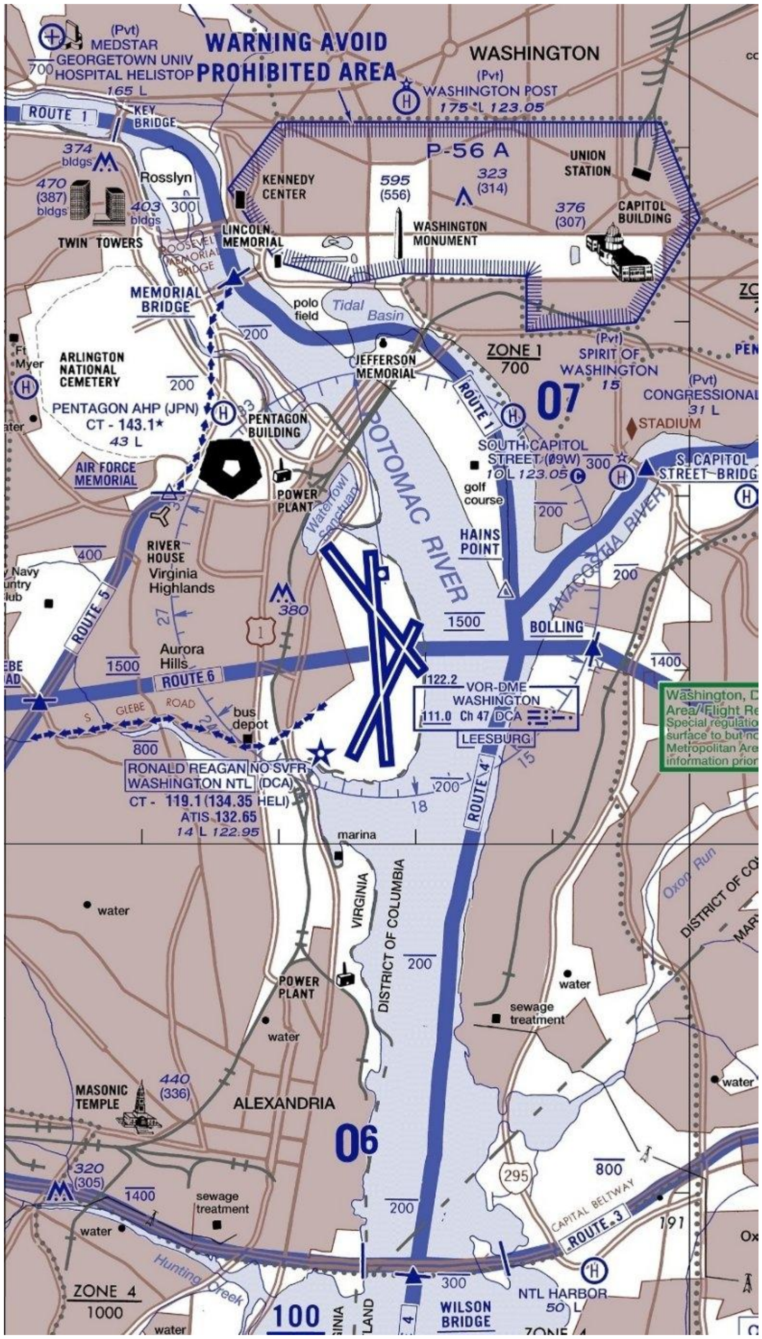


Figure 13. Excerpt of FAA Baltimore-Washington Helicopter Route Chart, current at the time of the accident, showing the area surrounding DCA. (Source: FAA.)

PAT25's route on the night of the accident included Route 1, which began at Cabin John, Maryland (not shown in figure 13), and followed the western shore of the Potomac River southeast toward Washington, DC. After crossing Key Bridge when flying south, the route followed the eastern shore of the Potomac with the Kennedy Center and Lincoln Memorial to the east and Roosevelt Island to the west, then crossing Memorial Bridge, which was a compulsory reporting point.[52] After Memorial Bridge, the maximum recommended altitude on Route 1 was 200 ft msl.

Route 1 then continued south of the Washington Monument, crossing West Potomac Park and the Tidal Basin before following the Washington Channel along East Potomac Park. Hains Point, the southernmost tip of East Potomac Park and located at the confluence of the Potomac and Anacostia rivers, was identified as a non-compulsory reporting point and the area where Route 4 began and intercepted Route 1, which continued northeast up the Anacostia River. Route 4 continued south toward the Woodrow Wilson Bridge along the Potomac River's eastern shore, with DCA to the west. DCA approach and departure paths for fixed-wing traffic were not shown on the chart.

The chart legend contained additional information regarding the symbology depicted on the chart. The information provided regarding route altitudes was labeled "Recommended Altitudes," and was depicted with a bar below the listed altitude indicating a minimum recommended altitude, a bar above indicating a maximum recommended altitude, and bars both above and below indicating a specific recommended altitude, as shown in figure 14.

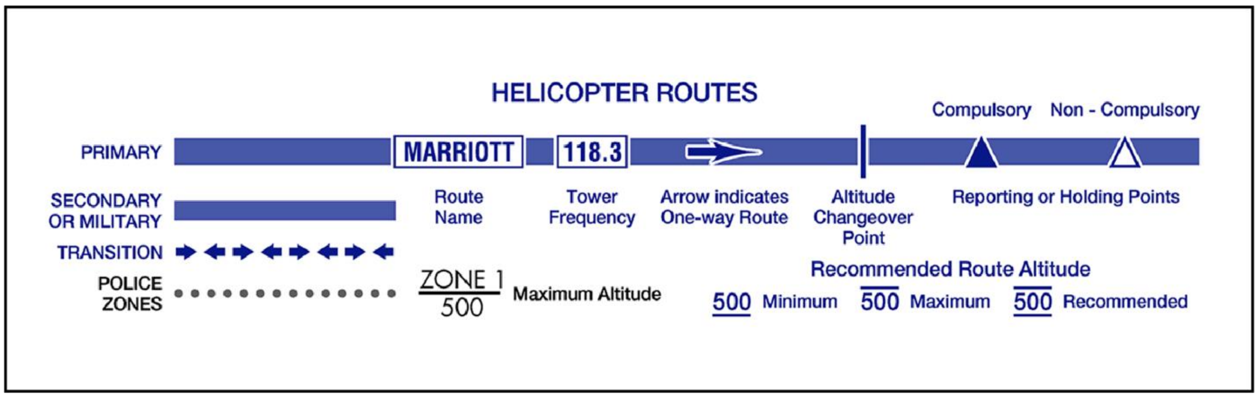
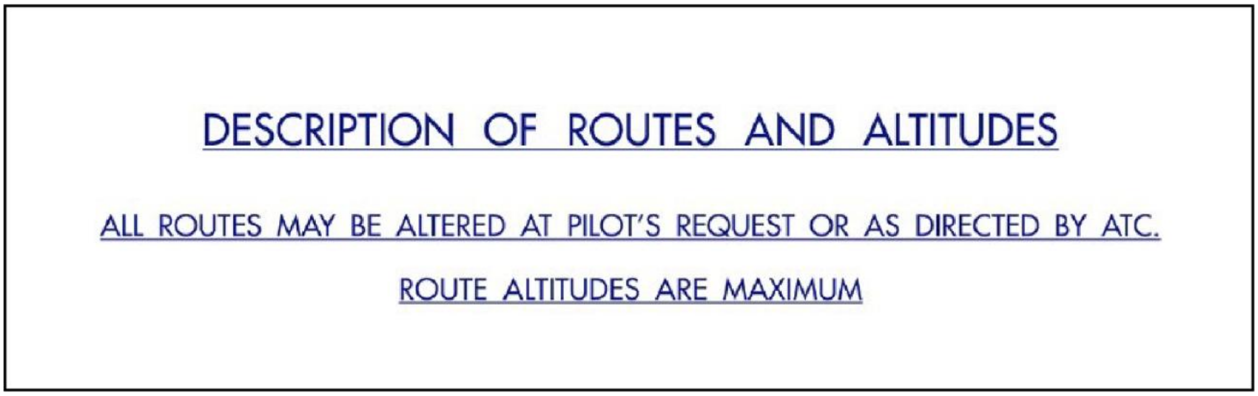


Figure 14. Helicopter route chart excerpt showing altitude information. (Source: FAA)

The section of the chart that provided textual description of the routes stated, "Route Altitudes are Maximum," as shown in figure 15.

52 A reporting point is a predetermined geographical location depicted on a chart to aid air traffic control in maintaining awareness of aircraft position. A pilot is required to report their position at the reporting point to air traffic control if the reporting point is designated compulsory; pilots are not required, but may be asked, to report upon reaching a non-compulsory reporting point.


DESCRIPTION OF ROUTES AND ALTITUDES

ALL ROUTES MAY BE ALTERED AT PILOT'S REQUEST OR AS DIRECTED BY ATC.

ROUTE ALTITUDES ARE MAXIMUM

Figure 15. Excerpt of helicopter route chart route and altitude description. (Source: FAA)

While the chart did not describe any lateral boundaries associated with each route, the description of Route 4 stated (route described from south to north), "Fort Washington over Potomac River to Wilson Bridge, then via east bank of Potomac River to Anacostia River. Intercept Route 1 at Anacostia River."

In an additional information section, the chart stated, "All routes are recommended routes which pilots may expect to receive when authorized to operate in the Class B airspace. Unless otherwise indicated, altitudes will be assigned when contacting air traffic control. Helicopter route and altitude assignments do not relieve pilots from their duty to comply with FAR 91.119 and 135.203(b). Pilots are expected to request an alternate clearance if necessary for compliance."[53]

1.6.2 Helicopter Route Development and Modification

The first edition of the Baltimore-Washington Helicopter Route Chart was published in February 1986, and remained unchanged until 1991, when a compulsory reporting point was added at the Wilson Bridge.[54] Between 1991 and the

[53] Title 14 *CFR* 91.119 and 135.203(b) provide minimum altitudes under which pilots may not operate unless necessary for takeoff or landing while operating under the provisions of Parts 91 (private aircraft operations) and 135 (commuter and on-demand operations), respectively.

[54] The chart was developed following an NTSB recommendation (A-86-8) to publish a chart depicting VFR helicopter routes for civilian and military operators in the DC area. This recommendation was the result of an investigation into an incursion between a Boeing 727 and a Bell 206 helicopter in which both aircraft were cleared for takeoff from DCA about the same time (NTSB, 1986). The helicopter's most direct flightpath to its intended route of flight intersected the airplane's departure runway. During takeoff, the pilots of both aircraft recognized the conflict. The 727 captain rejected the takeoff and the airplane came to rest on the grass overrun off the end of the runway approximately 130 ft from the Potomac River. There was no damage to the airplane and no injuries to the passengers or crew. The helicopter pilot maneuvered to avoid crossing the runway and returned to the helicopter pad without further incident.

time of the accident, there had been changes to the route altitudes and police zone boundaries; however, there were no significant alterations to the route structure.[55]

FAA Order JO 7210.3DD, "Facility Operation and Administration," chapter 12, section 4, Helicopter Route Programs, described the process by which an ATC facility's air traffic manager (ATM) was required to develop and/or revise helicopter route charts.[56] The order stated that, when initially seeking to develop a helicopter route chart, the requesting ATM must establish a task force composed of local air traffic, FAA flight standards district office (FSDO), military, law enforcement, and helicopter operator personnel to recommend the area of chart coverage and the paths, routes, and operating zones to be included in the chart. Revisions to existing helicopter route charts were to be initiated by the ATM and proposed to the task force for collaboration.

The order also noted:

> ATMs must seek the cooperation of local FSDO personnel in informing local aviation interests about the Helicopter Route Chart program. Special emphasis should be placed on:
>
> 1. The voluntary nature of pilot adherence to designated routes, operating zones, altitudes/flight ceilings, and procedural notes;
>
> 2. The importance of chart use to operational safety and IFR [instrument flight rules] traffic avoidance; and
>
> 3. The "see and avoid" nature of operations within the chart area.

The order additionally stated that Terminal Operations Service Area Directors were responsible for reviewing and approving new or revised helicopter route chart proposals and assuring that they complied with all prescribed criteria. These directors were also responsible for conducting annual reviews of existing VFR helicopter route charts to determine their accuracy and continued utility. Revisions to existing helicopter route charts could be initiated by any facility ATM, but could only be approved by Terminal Operations Service Area Directors.

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[55] Police zones on VFR helicopter route charts are depicted operating areas where police helicopters, once they contact ATC upon entry, may operate with minimal further coordination up to a specified maximum altitude within the zone, providing access and designated altitude ranges to facilitate their missions while minimizing conflict with other traffic.

[56] Section 1.7.2 contains more information on ATC positions and responsibilities.

The FAA was unable to provide documentation of the required annual reviews for the Baltimore-Washington Helicopter Route Chart.

1.6.3 Helicopter Working Groups

1.6.3.1 DCA Tower Helicopter Working Group

According to interviews and information provided by current and former members, in 2013, controllers at DCA ATCT formed a helicopter working group (HWG) to address the challenges inherent to the high density, mixed operations of fixed-wing and helicopter traffic within the DCA Class B airspace. The group met on an ad-hoc basis to review identified safety issues. The initiating events for a meeting were a general concern about an issue, or an event or events that had been reported via the mandatory occurrence reporting (MOR) process.[57] The group also performed outreach activities with local helicopter operators to become familiar with their aircraft and operations, and provided local area helicopter pilots the opportunity to visit the tower and learn more about operations around DCA from an ATC perspective.

Three previous participants in the HWG described, in postaccident interviews and testimony during the NTSB's investigative hearing, two major proposals the group made to mitigate collision risk between airplanes and helicopters. Following a near midair collision (NMAC) between a military helicopter and a regional jet in 2013, the HWG made a formal proposal to relocate Route 4 between Hains Point and the Wilson Bridge east over Interstate 295, away from the runway 33 approach path.

One participant stated that this recommendation was made to the ATM at the time, but was not aware of any subsequent action taken by the ATM nor any formal responses to the group's request. The other participants interviewed indicated that discussions to move Route 4 had continued since that time, and had been proposed again after the initial proposal following the 2013 NMAC. One participant recalled that the HWG was told that the route could not be removed "due to continuity of government operations or security." The NTSB was unable to obtain documentation of any of the HWG's requests to move Route 4 nor of any responses to the requests.

In 2021, the HWG convened a safety risk management panel (SRMP) to review changes to the helicopter operating zones to address noise issues raised in a United States Government Accountability Office (GAO) study regarding helicopter noise in

[57] Air traffic controllers are required to report certain types of events through the MOR process. MORs are discussed in further detail in section 1.14, Flight Safety Data. Air traffic occurrences that meet certain criteria as described in FAA Order JO 7210.632A, "Air Traffic Organization Occurrence Reporting," including "airborne loss of separation," must be reported by controllers using a MOR.

the Washington, DC, area (GAO, 2021). The group subsequently proposed several changes to zone lateral boundaries in 2022.

In addition to these suggested changes, the proposal included the addition of three "hotspots" to the helicopter route chart, which were areas that the HWG had identified as posing an increased risk of midair collision based on review of Preliminary Aviation Risk Identification and Assessment (ARIA) Reports (PARs).[58,59] The intent of the proposed hotspots was to increase pilot and controller awareness and vigilance in those areas. The proposed hotspots included the area of Route 4 and the runway 33 final approach path (where both the 2013 NMAC and this accident occurred), Route 1 in the vicinity of South Capitol Street, and Route 1 near the Memorial Bridge (see figure 16).

The manager of the FAA's Aeronautical Information Services office testified at the NTSB's investigative hearing that her office did receive a request for multiple changes to the Baltimore-Washington Helicopter Route Chart in 2023. While the changes to zone boundaries proposed by the HWG were implemented, the hotspots were not added to the helicopter route chart because "hotspots are associated with ground or surface movement and are not within the VFR aeronautical chart specification."

[58] The FAA's Pilot/Controller Glossary defines "hot spot" as a location on an airport movement area with a history of potential risk of collision or runway incursion, and where heightened attention by pilots/drivers is necessary. Although the hot spots proposed by the HWG were airborne and did not meet this definition, the intent was the same—to increase pilot awareness of areas that had been identified as having an increased potential for midair collision.

[59] ARIA, which stands for Aviation Risk Identification and Assessment, is an automated tool that analyzes radar and other flight tracking data to identify encounters between aircraft that could pose a safety concern. ARIA is discussed further in section 1.14, Flight Safety Data.

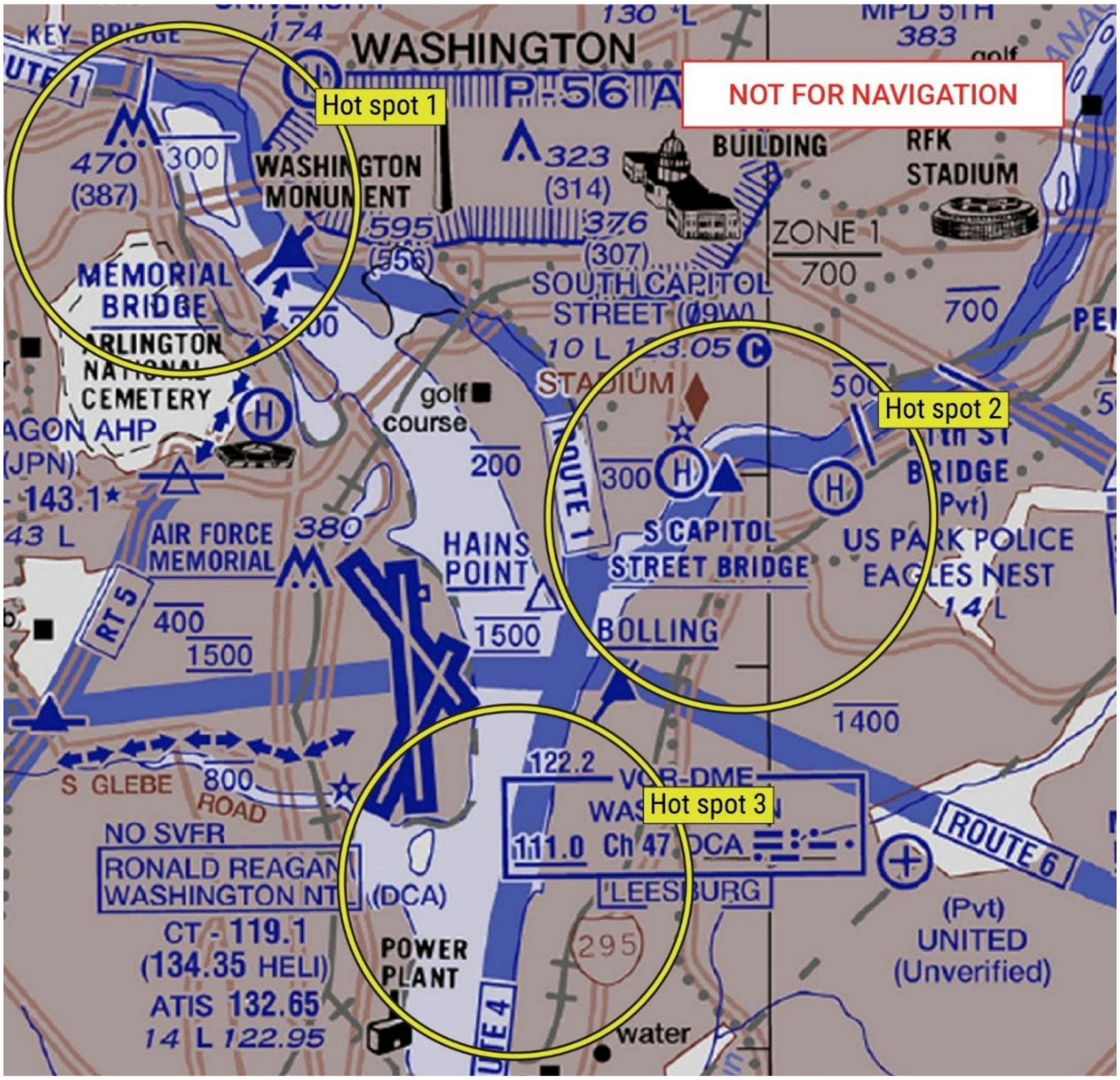

Figure 16. Helicopter route chart excerpt with proposed hotspots circled.

1.6.3.2 National Capital Region Operators' Group

The commander and chief pilot of the aviation section of a law enforcement agency local to the DCA area stated that he and his pilots had participated in the DCA ATCT HWG for many years, particularly in addressing the issues raised by the GAO noise study, and that they were involved in developing proposals to alter the boundaries of the helicopter zones to reduce noise complaints. He stated that local operators, including military, often met with FAA representatives to discuss operational issues before special events in the DCA area. He also stated that he organized a quarterly fly-in event in the Washington, DC, area that comprised local civilian and military helicopter operators, control tower personnel, and representatives from the National Capital Regional Coordination Center.[60] The intent of this gathering was to "bridge the gap" between civilian operators and DOD operators who may not be familiar with each other's operations.

1.6.4 Helicopter Route Use and Expectations

Many of the helicopter operators in the area, including military, government, law enforcement, and medical transport, had letters of agreement (LOAs) with DCA tower that outlined specific procedures operators were expected to adhere to while operating within DCA Class B airspace. The LOA that applied to the 12th Aviation Battalion stated, "Routes and altitudes described in the Baltimore-Washington Helicopter Route Chart must apply unless otherwise authorized by ATC." TAAB SOPs stated that air crews were to fly "no less than 100 feet below the maximum altitude for the route or zone to be flown."

Regarding altitude limitations, a US Army standardization pilot stated in testimony provided at the NTSB's investigative hearing that Army pilots are expected to maintain route altitude; however, consistent with pilot performance standards, which specified that pilots should maintain altitude plus or minus 100 ft, "the reasonable expectation is that being off an altitude by 50 or 70 feet, one way or the other, would not lead to a catastrophic event." He also stated that a pilot who was flying "continuously above" a published route altitude would be expected to apply corrections to return to the published altitude. A representative for medical transport and law enforcement helicopter operators at the hearing stated that his group interpreted the route altitudes as "a hard ceiling."

The medical transport and law enforcement helicopter operators group representative also stated that the operators in his group did not have an expectation that Route 4 provided procedural separation from runways 15/33 and that, as a whole, the operators' procedures prohibited helicopters from flying under airplanes on final approach. An Army standardization instructor pilot stated that 12th Aviation Battalion procedure prescribed that helicopters should hold at points north or south of DCA on Route 4 when an airplane was on approach to runway 33 or departing from runway 15; however, he later stated that this was not a written procedure or policy.[61] Other Army pilots interviewed stated that it was not unusual for ATC to issue holding instructions when there was traffic landing on runway 33. Pilots also stated that they would voluntarily enter a hold if they perceived a potential traffic conflict.

[60] The National Capital Regional Coordination Center is an interagency group that continuously monitors the prohibited airspace around the Washington, DC, area.

[61] A hold procedure is a predetermined maneuver that keeps aircraft within a specified airspace while awaiting further clearance from air traffic control.

Postaccident interviews and investigative hearing testimony, which included a 12th Aviation Battalion chief warrant officer and a former standardization pilot with the battalion, indicated that some Army helicopter pilots had, on occasion, descended to pass beneath fixed-wing aircraft arriving to or departing from DCA after receiving traffic information and requesting pilot-applied visual separation; however, the frequency of this practice could not be determined.

According to testimony provided by the DCA ATCT operations manager (OM) at the time of the accident, "the majority" of air traffic controllers at DCA tower were aware that Helicopter Route 4 was not procedurally separated from the runway 33 approach path or runway 15 departure corridor.[62] In a postaccident interview, the accident LC controller stated that Route 4 and the runway 33 approach path were not procedurally separated. The accident assistant local control controller (ALC) stated that a helicopter flying on Route 4 would be separated from traffic approaching runway 33 if the helicopter was "flying the route properly," then indicated that she was uncertain and would "need to look at it to be sure." The controllers interviewed indicated that holding helicopters was a technique that they could use to deconflict traffic, but the use of holding was based on controller judgment in any given situation and was not dictated by procedure.

NTSB investigative hearing testimony indicated that Army pilots operating from DAA received initial local area training when initially assigned to the National Capital Region (NCR) that included ground orientation covering mission areas, a local area orientation flight incorporating several DC helicopter routes and landmarks, and FAA-required DC special flight rules area (SFRA) special awareness training. Crews reported being generally aware of fixed-wing departure and arrival paths but not specific instrument approach procedures. Testimony also indicated that the SFRA training—which focused on security-related access and compliance requirements for operating in the region under VFR—was not intended to provide DCA-specific operational familiarization and did not include review of the airport's instrument approach procedures.

A standardization instructor pilot from TAAB stated that the helicopter routes were the battalion's preferred method of training their pilots around Washington, DC, and they adhered to the routes as much as possible. Of the twelve 12th Aviation Battalion pilots interviewed after the accident, most stated that they would typically fly below 200 ft msl while on Route 4, while referencing the barometric altimeter to avoid exceeding the maximum route altitude; others stated that they would fly at 200 ft msl. Pilots reported that they would fly over the Potomac River while hugging the east bank, maintaining a distance from shore that was sufficient to avoid terrain

[62] That is, Route 4 did not inherently provide the minimum required separation between a helicopter and an aircraft on approach to runway 33 or departing from runway 15.

and obstacles. There was no common agreement among the interviewed pilots regarding how much they could deviate laterally from the perceived centerline of the route, except that they would deviate as necessary to maintain clearance from other traffic. During the NTSB's investigative hearing, an Army standardization instructor pilot stated that there was no written guidance for Army pilots regarding lateral positioning from the shoreline; rather, "tribal knowledge" was that pilots should "hug the shoreline" unless traffic conditions required them to deviate.

Pilots of the 12th Aviation Battalion reported that it was not typical to see traffic landing on runway 33, and those who had encountered airplanes on approach to runway 33 reported that they had been instructed by ATC to hold until the traffic had landed. The most common holding points along Route 4 were Hains Point, northeast of DCA, and a building with prominent round, white, radome structures, commonly referred to by pilots and controllers as "the golf balls," southeast of DCA on the east bank of the Potomac.[63] However, the pilots interviewed generally believed that, if their helicopter remained at or below the published maximum altitude on Route 4, they would have adequate clearance from airplanes landing on runway 33.

Several 12th Aviation Battalion personnel were asked about their understanding of the separation provided by the helicopter routes. One pilot stated that, "if there's traffic that's landing and tower has them and we're on Route 4, the way I understand it is like we should be fine. It shouldn't be an issue." Another pilot was asked if he assumed that the route altitude provided separation from traffic landing on runway 33. He answered, "Yeah that's why the routes are published, 200 feet and below. So, you imagine it's going to separate you from other traffic."

A third pilot, who was also the battalion commander, stated that the helicopter route altitudes were meant to deconflict traffic. The brigade standardization pilot who qualified the pilot as RL1 in January 2022 and performed several additional evaluations with her between January 2023 and January 2024 estimated that, in four years and nearly 1,000 flight hours flying in the DC area, he had flown Route 4 about two hundred times and encountered traffic landing on runway 33 "less than 10 times."

The same pilot estimated that fixed-wing traffic approaching runway 33 for landing crossed the east bank of the Potomac at 500 or 600 feet, a "few hundred feet" above his altitude when flying on Route 4. Consequently, it had "never even crossed his mind" that he might conflict with traffic landing on runway 33 when transiting Route 4. However, every time he had been nearing the final approach path for

[63] Radomes are weatherproof enclosures that protect a radar system or antenna.

runway 33, DCA tower had asked him to hold to avoid crossing the flight path of the landing traffic.

A company standardization pilot who had flown the Washington, DC, helicopter routes about 1,000 times stated that, "between the maximum altitude [on Route 4] and ATC" a helicopter would remain clear of airplanes on final approach to runway 33. He stated, "I think that's kind of the common assumption, really." He stated that ATC had typically instructed him to hold or to not use Route 4 when runway 33 was in use.

Three captains and one first officer from PSA Airlines, all of whom were based at DCA, were interviewed regarding their knowledge of the Washington, DC, helicopter routes. Only one of the captains, who was previously a military pilot in the area, had specific knowledge of the helicopter routes, locations, and altitudes. Another captain was aware that there were helicopter routes but was not aware of their associated lateral or altitude limitations. The other two pilots had no knowledge of the helicopter routes. One of the captains stated that, although he saw helicopters "all the time" at DCA, he was unaware that there were specific helicopter routes, and he reported that having additional information about the routes would have enhanced pilot awareness of the operations in the DCA area.

Representatives from the United States Coast Guard (USCG) stated that it was common practice for USCG helicopter crews to avoid the helicopter routes near DCA when runways 1 and 33 were in use, and that it was common for DCA ATCT to deny a request to use Route 4 or to issue a hold to helicopter traffic when the tower was utilizing runway 33. USCG pilots interviewed expressed the opinion that visual separation was a useful tool that allowed efficient use of the DCA airspace, and crews frequently initiated a request to use visual separation when traffic was pointed out by DCA tower controllers.

USCG SOP stated that, when flying on a charted route, helicopter crews should fly the maximum published altitude. Policy also stated that crews should monitor traffic conditions and avoid flying between the Memorial Bridge and Wilson Bridge if there was a high volume of commercial fixed-wing traffic.

Representatives from the United States Air Force (USAF) 1st Helicopter Squadron stated that they flew the maximum allowable altitude on any particular route, and no lower than 100 ft agl. Pilots stated that they occasionally encountered traffic landing on runway 33 when operating on Routes 1 and 4. They reported that they followed controller guidance and initiated a request for visual separation if they identified traffic ahead of them; they also stated that there were instances when they chose to enter a hold to maintain separation from traffic.

1.7 Airport Information

1.7.1 Overview

DCA is located about 3 nm south of downtown Washington, DC, at an elevation of 14 ft msl. DCA was equipped with an ATCT which was operational 24 hours each day. The Class B airspace surrounding DCA is complex and contains many layers and restrictions, including three Class B primary airports, numerous general aviation airfields, military airfields, restricted areas, an SFRA, a flight restricted zone (FRZ), and extensive charted helicopter operating areas and routes (see figure 17).[64]

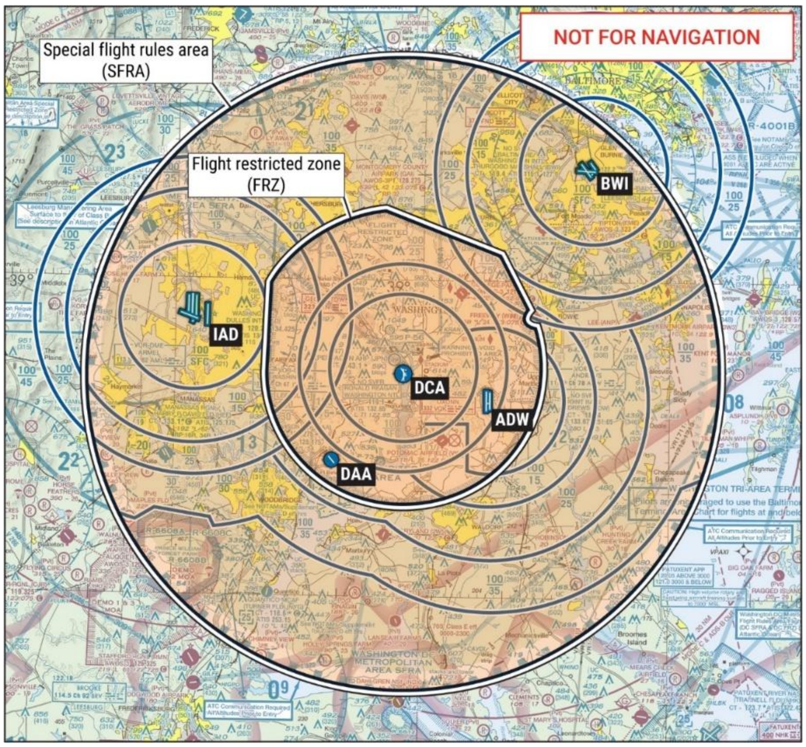

Figure 17. Annotated sectional chart of the airspace surrounding DCA.

Note: Blue lines indicate layers of Class B airspace.

DCA is equipped with three runways, designated 1/19, 15/33, and 4/22, as shown in figure 18. At the time of the accident, runway 4 was closed to landings, and

[64] The Washington DC SFRA is a roughly circular area of airspace with a 30-nm radius around Washington, DC, in which the ready identification, location, and control of aircraft is required in the interests of national security. The SFRA contains the FRZ, which extends about 15 nm around DCA. With limited exceptions, the only non-governmental flights allowed within the FRZ are scheduled commercial passenger flights into and out of DCA.

runway 22 was closed to takeoffs and landings. Runway 1/19 was 7,169 ft long and runway 15/33 was 5,204 ft long. Runway 33 was equipped with a four-light PAPI on the left side of the runway near its approach end. The PAPI provided a 3.0° visual approach path to the runway. Runway 15/33 was part of the airport's original four-runway configuration when DCA opened in 1941; the fourth, an east–west oriented runway 9/27, was closed in 1956.

DCA's airport geometry is highly constrained due to the airport's location on the Potomac River, with three sides surrounded by water; as a result of this geography and its layout, DCA is capacity constrained. Since 1991 (the earliest year for which data are available), annual air carrier tower operations increased from 175,224 to a peak of 294,312 in 2024.[65] Over the same period, tower operations attributable to air taxi and general aviation declined substantially. Air taxi operations peaked in 2007 at 118,228 operations but fell to 1,594 operations in 2024. General aviation operations declined sharply after 2001, from 32,286 to fewer than 3,000 operations per year in every subsequent year.

As a result of these shifts, air taxis, general aviation, and military operations accounted for 43.8% of all fixed-wing IFR operations in 2007, but only 1.3% by 2025. This change also altered the mix of aircraft operating at DCA, with smaller airplanes increasingly replaced by larger air carrier category aircraft. Because larger, heavier airplanes have more restrictive performance margins on DCA's shorter runways, demand for runway 1/19, the airport's longest runway, increased, creating additional workload and coordination demands for local and ground controllers at this physically constrained and congested airport.

[65] According to FAA's Operations Network, "tower operations" refers to all takeoffs and landings at the airport, as well as other aircraft worked by the tower.

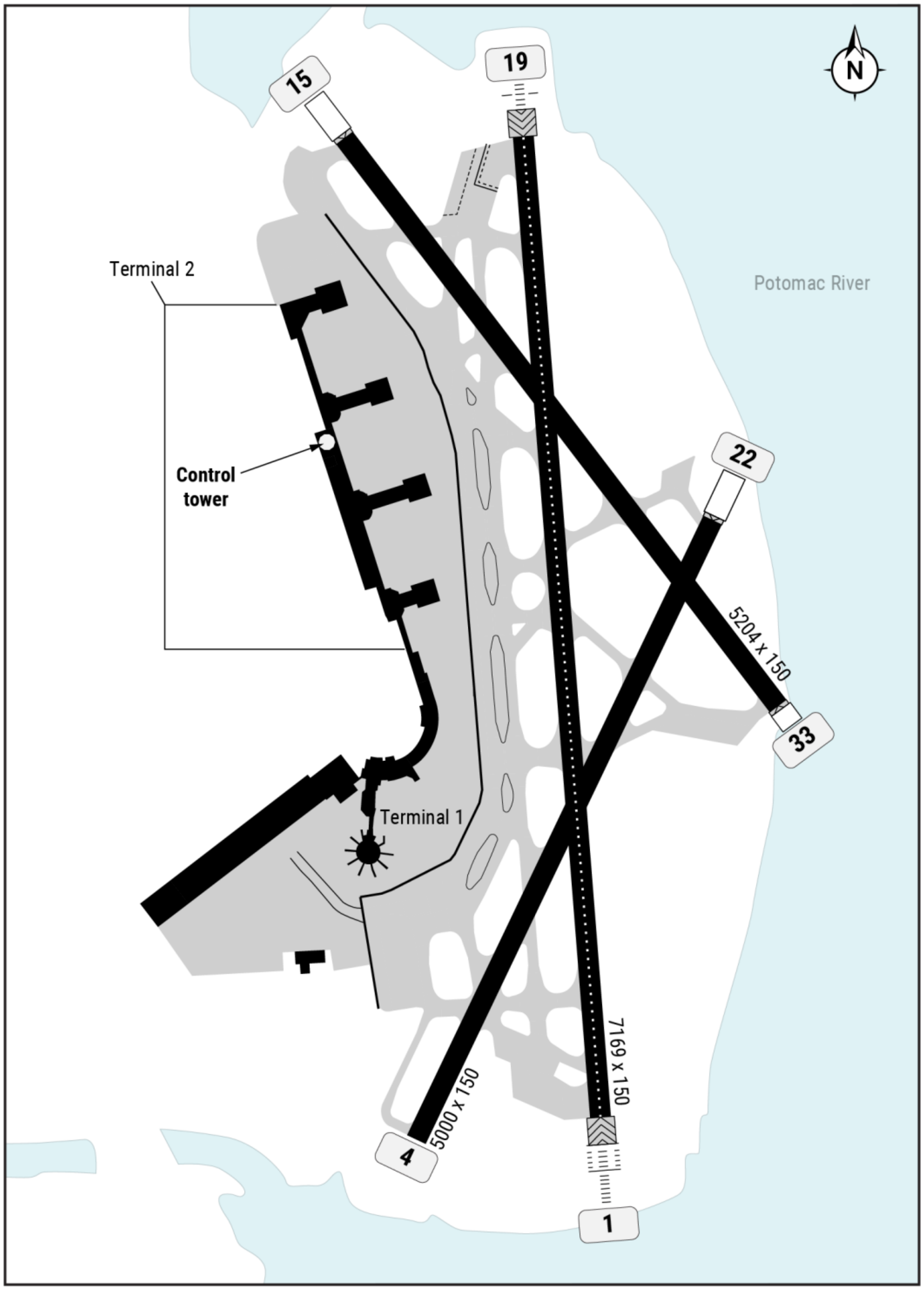

Figure 18. DCA airport diagram.

The DCA ATCT faced east looking out across the Potomac River. On the day of the accident, DCA was in a "North Operation," meaning that traffic was landing and departing runway 1, with intermittent arrivals to runway 33. Figure 19 shows a diagram of the tower cab layout, with the controller positions labeled as they were staffed at the time of the accident. Although not staffed separately at the time of the accident, the helicopter control (HC) position has also been labeled.

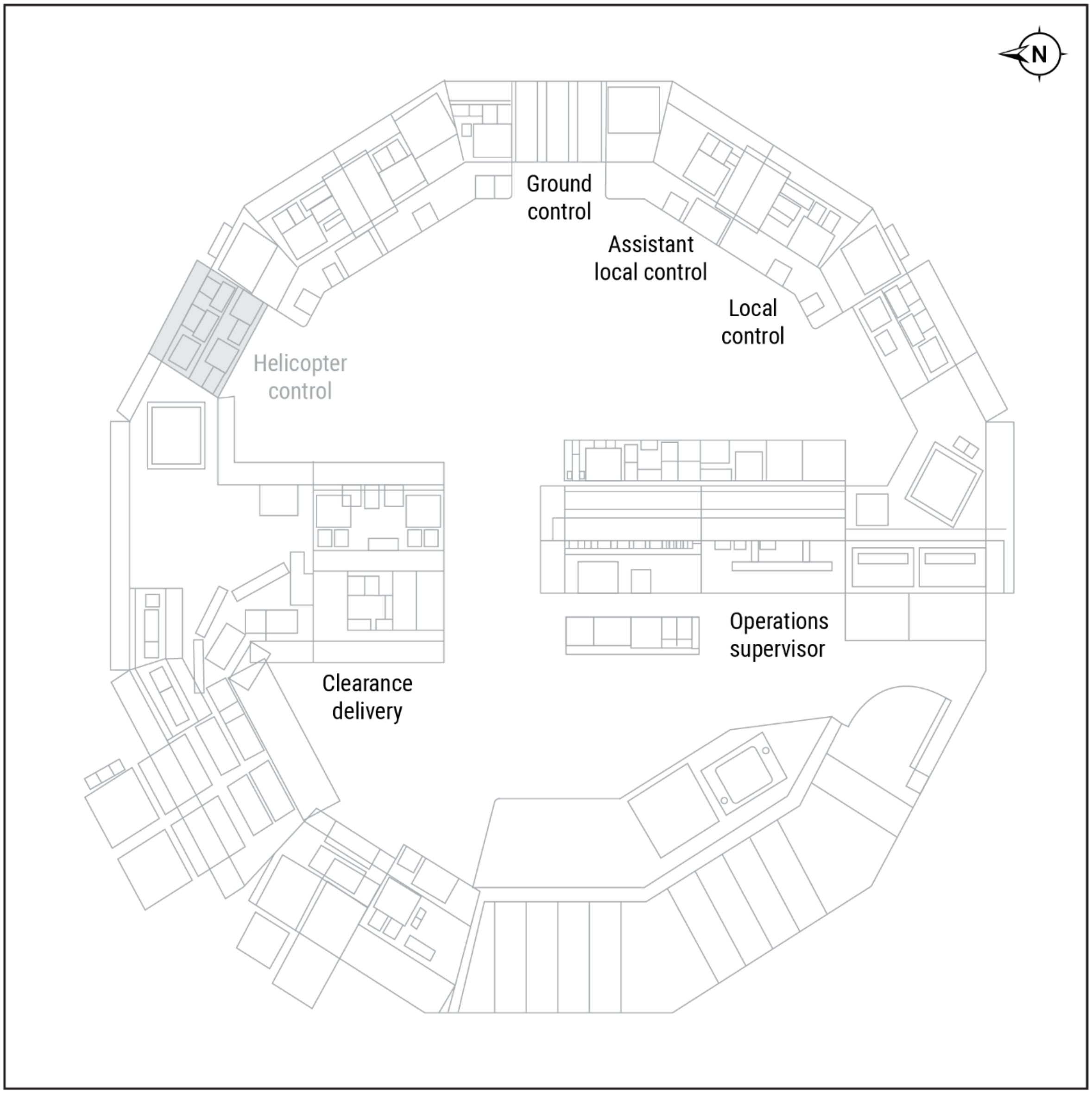

Figure 19. DCA ATC tower cab layout diagram.

Note: The helicopter control position was not physically occupied at the time of the accident and was staffed, in a combined operation, by the local controller from the local control position.

1.7.2 Air Traffic Control Tower Staffing

At the time of the accident, the authorized staffing at DCA ATCT included 28 certified professional controllers (CPCs), 3 traffic management coordinators (TMCs), 6 operations supervisors (OSs), 1 OM, 3 staff support specialists (SSSs), 1 support manager (SM), and 1 ATM. The actual facility staffing at the time of the accident were 28 (25 operational) CPCs, 2 TMCs, 6 (4 operational) OSs, 1 OM, 1 SM, and 1 (temporary) ATM.[66] The DCA ATCT SOP described the primary duties and responsibilities of the various controller positions as shown in table 8.

Table 8. DCA ATCT primary duties and responsibilities by position.

Position	Primary duties and responsibilities
LC (Local Control)	• Provide initial separation between successive departures. • Provide separation between arrivals and departures. • Coordinate with the final controller if the tower issues any control instruction that affects the sequence or separation established by the final controller. • Initiate corrective action and coordinate with appropriate sectors if a loss of standard separation may occur within the tower's airspace.
HC (Helicopter Control)	• Separate VFR traffic from DCA arrivals and departures. • Issue safety alerts and traffic advisories as required. • Clear VFR aircraft on routes or into zones as depicted on the Baltimore-Washington Helicopter Route Chart.
ALC (Assistant Local Control)	• Alert LC of any unusual situations or traffic conflicts. • Maintain surveillance of the local traffic pattern and landing area. • Assist LC with monitoring traffic on final via control tower radar display (CTRD).

Operations Supervisor (OS)	• Provide operational supervision and direct the tower operation to ensure an efficient flow of air traffic.
	• Make necessary notifications of:
	  • Suspected operational errors
	  • Pilot deviations
	  • Near midair collision (NMAC) reports
	  • Other incidents requiring notifications
	• Combine and de-combine positions.

Ground Control (GC)	• Control aircraft and vehicles operating on movement areas, excluding runways. • When Airport Resource Management Tool (ARMT) is out of service, verbally request departure releases from the TMC, FD, or OS. • Review proposed departure times and ensure that flight plans do not time out. • Notify the OS/controller in charge (CIC) of ODO requests.
Clearance Delivery (CD)	• Review proposed flight plans for anomalies. • Issue ATC clearances, traffic management initiatives, Expect Departure Clearance Time (EDCT) times and any other pertinent information as necessary. • Mark strips in accordance with Chapter 3, Strip Marking. • When duplicate flight plans are received, verify the requested flight plan with the pilot and remove the undesired flight plan.

[66] "Operational" refers to those that were qualified and available to work in the staffing rotation, and "temporary" refers to those on temporary details awaiting permanent replacements. As of January 5, 2026, DCA ATCT was authorized 30 CPCs, 3 TMCs, 8 OSs, 2 OMs, 3 SSSs, 2 SMs, and 1 ATM. Actual facility staffing at that time was 25 (20 operational) CPCs, 2 (0 operational) TMCs, 3 (3 operational) OSs, 2 OMs, 2 SMs, and 1 (temporary) ATM. In addition, the facility had multiple trainees on board, including an OS in training, two TMCs in training, and several CPC trainees.

Position	Primary duties and responsibilities
Flight Data (FD)	• Remove and post strips from the flight strip printer or copy and post ATC clearances as received from the Air Route Traffic Control Center (ARTCC). Replace Electronic Flight Strip Transmittal System (EFSTS) printer strips as necessary. Ensure that all positions of operation in the tower have a supply of blank strips. • Transmit and receive Flight Data Input/Output (FDIO) messages. Take prompt action to make proper distribution and notification on all revisions and remove strip (RS) messages. Forward general information (GI) messages as appropriate. • Forward all traffic management messages to the TMC/OS. • When FD is combined with Clearance Delivery (CD), and the TMC position is not staffed, the OS/CIC will coordinate aircraft release times through the Washington ARTCC (ZDC) TMC or the PCT TMC, in accordance with the APREQ schedule posted on the IDS. • When directed by the OS/CIC, call ZDC FD to coordinate reentry of flight plans that have timed out into the FDIO. Forward the new transponder code to the appropriate position. • Coordinate with PCT FD for flight plan amendments for aircraft that are not capable of flying RNAV SIDs.

Traffic Management Coordinator (TMC)	• Monitor and analyze traffic management programs and procedures for DCA.
	• Coordinate with the OS when local traffic management initiatives are proposed or considered.
	• Advise the OS of projected heavy traffic flows and suggest alternate courses of action to minimize the impact.
	• Participate in designated TELCONS and on the “Hotline” when activated.
	• Implement and post flow restrictions as requested by adjacent facilities, PCT, ZDC, and ATCSCC TMUs.
	• Obtain releases as required and mark the flight progress strip accordingly.
	• Obtain reroutes when necessary. Advise the appropriate operating positions.
	• Advise PCT TMU and/or ATCSCC of any known component changes that could have a significant operational impact.
	• Inform PCT TMU:
	    • When delays are expected to exceed each 15 minute increment.
	    • When delays fall below each 15 minute increment.
	• Record on the National Traffic Management Log (NTML):
	    • Departure stop and start times
	    • TMC initiatives
	    • Ground delay programs
	    • Miles in trail
	    • Traffic delay information
	    • Operational configuration
	    • Tarmac Rule deplanement request
	• Enter the Aviation System Performance Metrics data from the CountOps program daily.
	• Ensure delay information is entered into OPSNET prior to the end of each shift.
	• Advise ATCSCC and ATM when delays reach 90 minutes except for EDCT delays.

Air Traffic Manager (ATM)	• The ATM or designee has the responsibility to direct all administrative and operational activities of the DCA ATCT. • Disseminate agency guidance and direction on performance management information to the workforce. • Issue a Standard Operating Procedures (SOP) Directive. The directive must specify, as a minimum, the required procedures for maintaining a safe and efficient operation and the jurisdictional boundaries for each operational position/sector. • Review SOPs at least annually and update as necessary. • Develop and maintain binders for each position/sector within the facility. • Maintain current sets of orders, facility directives, Letters of Agreement (LOAs), aeronautical charts, pertinent ICAO documents and related publications so that they may be readily available for operational use and study by facility personnel.

At the time of the accident, there were five CPCs, one TMC, one CPC in training (IT), one OS, and one OS in training on duty. According to interviews conducted with the OS working at the time of the accident, no personnel had been released from their shift early and all personnel who were on duty were available at the facility. The ALC, ground control (GC), and OS positions were each staffed individually, by the TMC, a CPC, and an OS, respectively.

The clearance delivery (CD) and flight data (FD) positions were combined and staffed by the OS in training and had been combined throughout the day of the accident; this was a normal configuration for DCA ATCT, and authorized in accordance with the DCA ATCT SOP. The LC and HC positions were combined and staffed by a CPC, which was allowed by DCA ATCT SOP and will be discussed further in section 1.7.6.1. There were three CPCs and one CPC in training on break and not in the tower cab at the time of the accident.[67]

1.7.3 Local Control Controller

The CPC who was serving as the LC controller at the time of the accident, age 36, was hired by the FAA in June 2016 and transferred to DCA in October 2022. The controller initially certified in the CD and FD positions in December 2022. He certified on the GC position in August 2023 and certified on the ALC, LC, and HC positions in May 2024. As of the accident date, the LC controller possessed current FAA ATC specialist medical clearance, with a limitation that he must possess vision corrective lenses and use those lenses as appropriate while on duty.

The controller's activities in the 72 hours before the accident were documented in interviews, cell phone records, and DCA ATCT schedules. On January 26, 2025, the controller woke around 0430 to 0500 and worked from 0600 to 1400. He reported that he went to bed that night between 2300 and 0000. He was off from work on January 27 and 28 and reported that he woke around the same time on those days. On the day of the accident, the controller woke around 0500, and his shift began at 1400.

Records from the tower indicated that he was signed on to the ALC position from 1413 to 1452, the CD/FD position from 1545 to 1659, and the ALC position from 1748 to 1835 before he signed onto the LC position (with the HC position combined) at 1928. He reported "feeling fine" while on shift, and also reported that he thought he needed about 5 hours of sleep to feel rested.

[67] While on break, personnel were not required to be present in the tower cab.

The LC controller stated that, on the night of the accident, there was an evening "push," or period of increased arrivals and departures, around 2000; however, he believed that the workload around the time of the accident was decreasing. He described the traffic as "a little complex" about 10 to 15 minutes before the accident and stated that he was "starting to become a little overwhelmed," but that it became more manageable after "one or two" helicopters departed the airspace.

When asked to rate the traffic volume and complexity for his position at the time of the accident, with 1 being the lowest volume or least complexity, and 5 being the highest volume or greatest complexity, the LC controller recalled the traffic volume as a 4 and thought that it was "a little heavier than normal." He described the complexity as a 3 or 4, given the inbound aircraft with varying speeds, departing aircraft, helicopter traffic, and gusty wind conditions.

The LC controller stated that, around the time of the accident, the tower "wasn't getting spacing on final," and after flight 5342 checked in on the tower frequency, he asked if they could accept runway 33 because there were airplanes waiting to depart runway 1. He also stated that the wind conditions were favoring runway 33, and that PSA crews often requested to use that runway. The crew of flight 5342 accepted the circling approach, and he cleared the airplane to land on runway 33.

The LC controller stated that he subsequently issued a traffic advisory to PAT25, who reported that they had the traffic in sight and requested visual separation, which he approved. He then turned his attention to "other priority duties" on the runway, including issuing a takeoff clearance to an airplane departing from runway 1. He stated that he intended to go back and issue flight 5342 a TA regarding the helicopter, but, based on the aircraft speeds, he believed that the airplane would have already landed before the helicopter reached the airplane's approach path and that there would not be a conflict.

Before the LC controller could return to flight 5342 and issue a traffic advisory, he recognized the conflict and asked PAT25, who confirmed and again requested visual separation. He instructed PAT25 to pass behind the airplane, and then the collision occurred. The LC controller stated that PAT25 had been proceeding down Route 4 "on the normal route," until he looked out the window just before the collision and noted that the helicopter was closer to the runway than normal. He stated that his expectation when issuing visual separation was that PAT25 had visually acquired flight 5342 and would maintain separation from the airplane and cross behind it.

Review of recorded radar information and radio communications revealed that, about 20 minutes before the collision, the LC controller was managing 8 total aircraft on his frequency, including 3 helicopters. About 13 minutes before the collision that number increased to 10 aircraft, 5 of which were helicopters. Seven minutes before the collision, the number of aircraft decreased to 8, of which 4 were helicopters. About 3 1/2 minutes before the collision, the number of aircraft on the LC controller's frequency increased again to 10, of which 4 were helicopters, and about 90 seconds before the collision there were 12 aircraft on the LC controller's frequency, including 5 helicopters.

Additionally, the LC controller's rate of radio transmissions increased before the collision, as shown in figure 20. During earlier 6- to 7-minute intervals, the controller averaged about 4.5 transmissions per minute; however, in the 3 minutes before the accident, this increased to about 7.7 transmissions per minute.

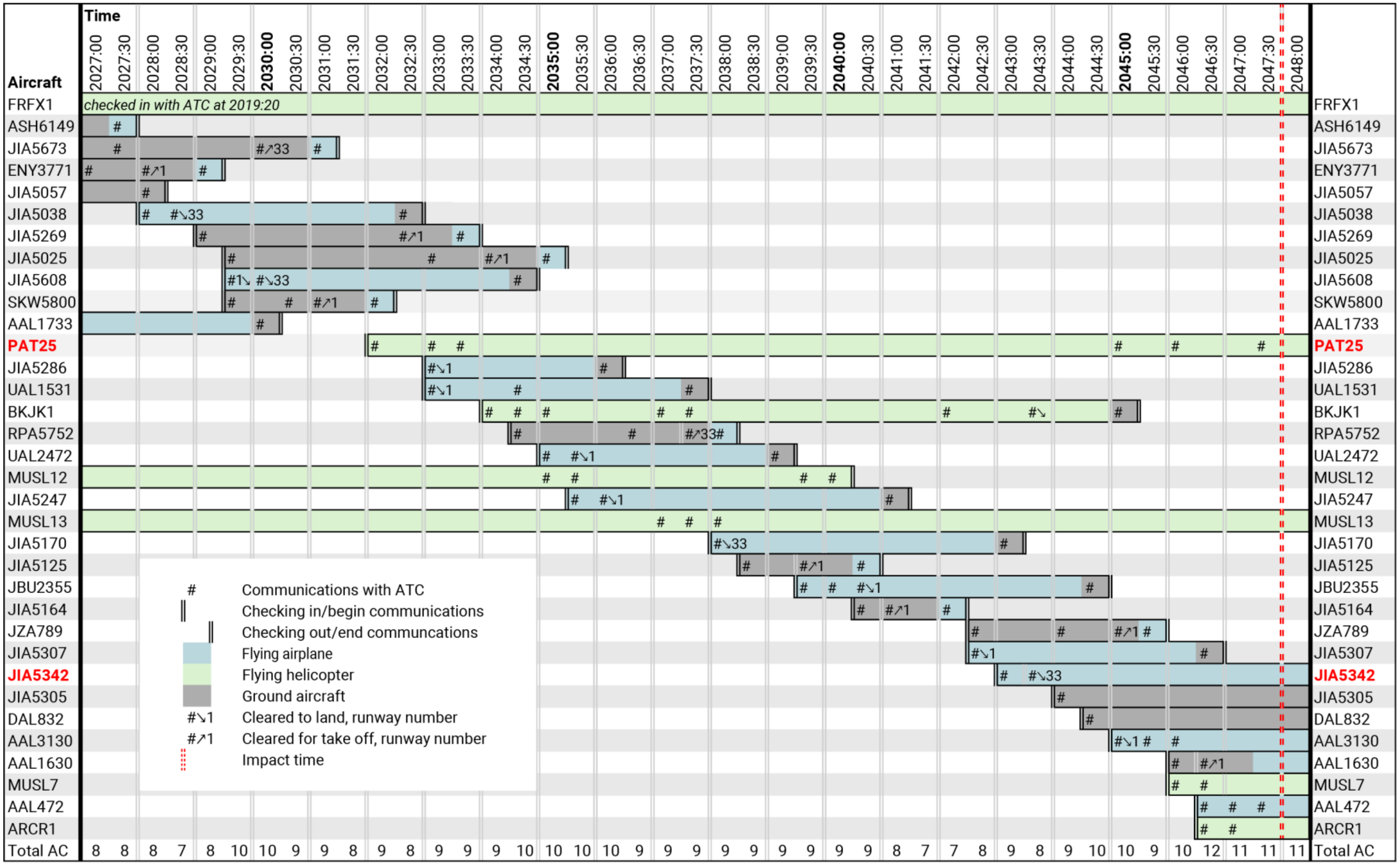

Figure 20. Local controller communications with aircraft from 2027:00 to 2048:00.

Note: “JIA5342” refers to flight 5342 by its ICAO designation.

After initially approving PAT25's request to maintain visual separation from flight 5342 at 2046:10, the LC controller immediately turned his attention to an airplane waiting to depart (American Airlines [AAL] 1630), informing them about additional traffic inbound to runway 1 and instructing them to line up and wait on the runway. At 2046:19, an Air Force helicopter (callsign "Muscle 7," or MUSL7) checked in on frequency, along with a simultaneous transmission from another American Airlines airplane (AAL472, which was inbound for landing on runway 1).

The LC controller instructed MUSL7 to standby at 2046:24, then instructed another PSA CRJ (callsign "Bluestreak 5307," or JIA5307), which had just landed on runway 1, to continue their landing roll to taxiway November. A medical transport helicopter (callsign "AirCare 1," or ARCR1) contacted the tower at 2046:45; however, this transmission was partially stepped on by the LC controller, who was clearing AAL1630 for an "immediate takeoff" from runway 1. About 2046:58, the LC controller replied to MUSCL7, which was west-southwest of the airport, and approved their requested route of flight.

At 2047:13, AAL472 reported that they were inbound on the Mount Vernon visual approach to runway 1; however, that transmission was partially stepped on by ARCR1's second attempt to contact the tower. The LC controller subsequently approved ARCR1's request to transition through the Class B airspace at 2047:25. Figure 21 depicts a spatial representation of the distribution of the time that the LC controller spent in radio communications with aircraft between 2030 and 2047:59 (collision), according to direction and distance of the aircraft relative to his position in the tower cab.

Of the 17 minutes and 59 seconds before the collision, the LC controller was engaged in radio communications with aircraft—either speaking or receiving—for 8 minutes and 46 seconds, or about 49% of the time. A complementary heatmap focusing on the 2 minutes before the collision is presented in figure 22; during this period, the LC controller was attending to radio communications with aircraft for 72 seconds, or 60%, of the time.

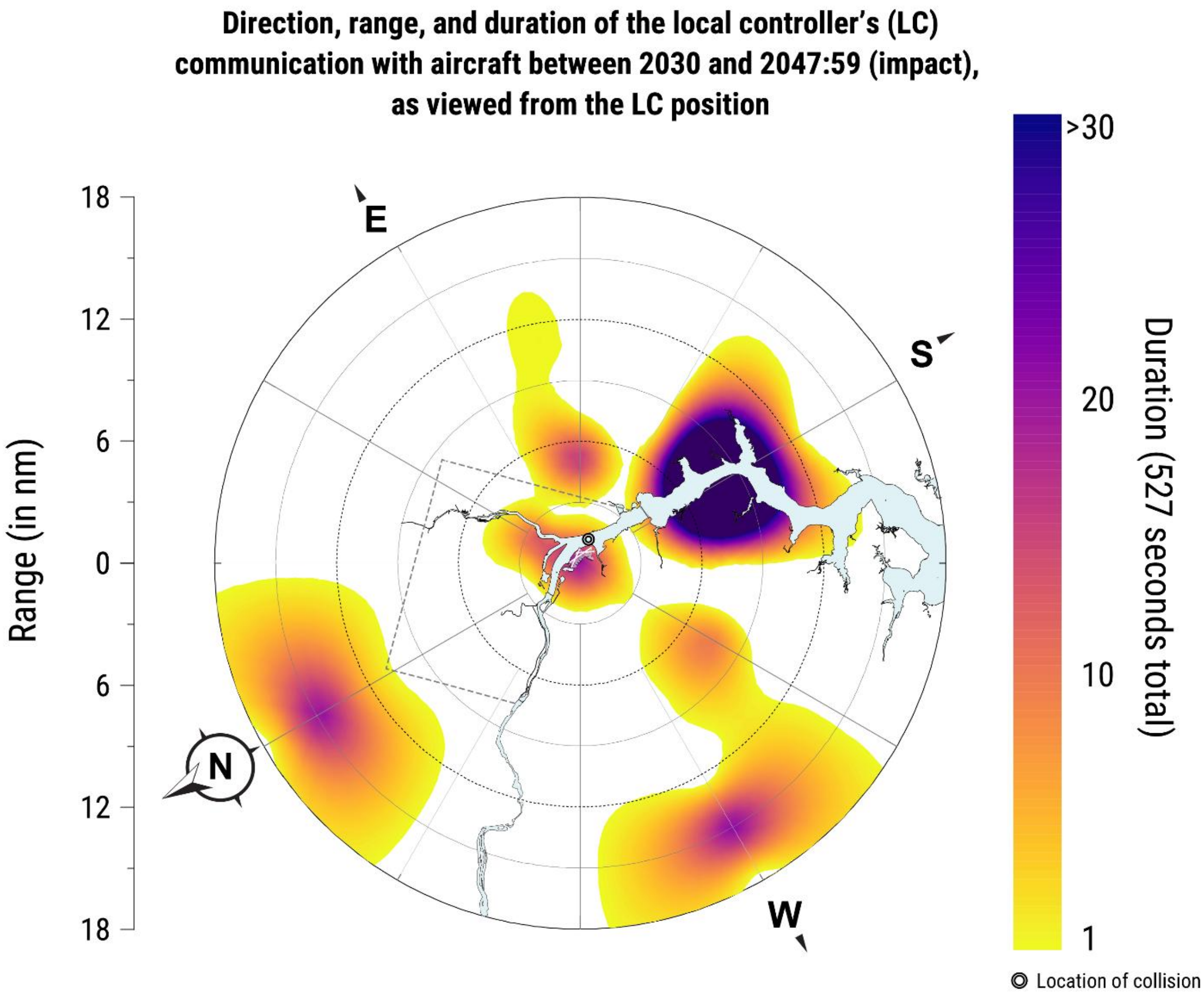

Figure 21. Heatmap of the direction, distance, and duration of the LC controller's communications with aircraft from 2030 to 2047:59 (impact), as viewed from the LC position.

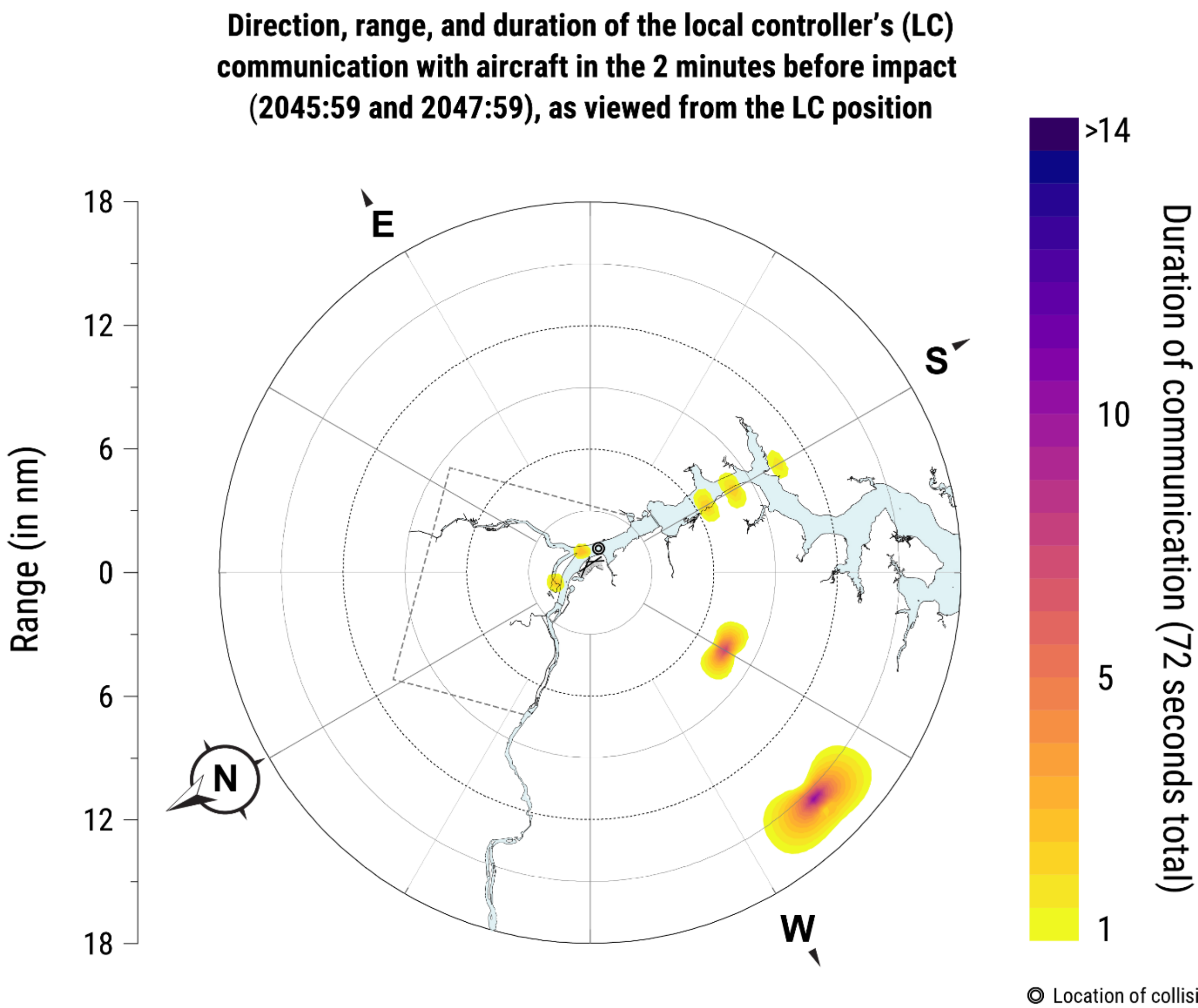

Figure 22. Heatmap of the direction, distance, and duration of the LC controller's communications with aircraft in the 2 minutes before impact (2045:59 to 2047:59), as viewed from the LC position.

The conflict alert was audible during two brief mic keys from the controller at 2047:37.8, and would have been visible on the controller's control tower radar display (CTRD). Less than 2 seconds later, about 20 seconds before the collision, the LC controller asked PAT25 if they still had the CRJ in sight. Three seconds later, the LC instructed PAT25 to pass behind the CRJ. PAT25 confirmed the aircraft was in sight and requested visual separation; the LC controller then stated "vis separation." At 2047:54 (5 seconds before the collision), AAL472 contacted the tower a third time, and the LC controller was communicating with that airplane when the collision occurred.

1.7.4 Assistant Local Control Controller

The TMC who was working as the ALC controller at the time of the accident, age 41, was hired by the FAA in 2011 and began working at DCA ATCT in January 2022. She certified on the LC and ALC positions in February 2023. As of the accident date, the ALC controller possessed a current FAA ATC specialist medical clearance, without limitation.

The ALC controller was assigned to DCA ATCT as a TMC and usually worked control positions to meet currency requirements, which prescribed a minimum of 1 hour on each position and a total of 8 hours across all positions each month. At the time of the accident, the ALC controller was obtaining currency on the ALC position.[70] For the month before the accident, she worked 1 hour, 37 minutes; 1 hour, 32 minutes; and 0 hours on the ALC, LC, and HC positions, respectively.

The ALC controller was off work on January 26 and 27, 2025, and worked from 0600 until 1200 the day before the accident. On the day of the accident, she woke up around 0830 and started her shift at 1400. She was signed on to the TMC position from 1415–1429, the GC position from 1446–1635, the CIC/TMC position from 1733-1822; the TMC position from 1823–1824, and GC from 1825–1859 before she signed onto the ALC position at 1956. She reported feeling fine on shift. When asked to rate the traffic volume and complexity around the time of the accident, the ALC controller described the traffic volume as a 3 or 4 and complexity as a 4, both of which she considered normal for that time of day.

The ALC controller stated in a postaccident interview that she recalled the LC controller issuing a traffic advisory to PAT25. She recalled the next call to PAT25 asking them to pass behind the airplane, then turned her attention to “writing down what the different helicopters were doing.” She heard an exclamation in the tower and looked up and saw that the aircraft had collided.

1.7.5 Operations Supervisor

The OS working in the tower at the time of the accident was 36 years old and was hired by the FAA in 2011. He transferred to the DCA ATCT in April 2015 before transferring to a different facility in June 2017. He returned to DCA in June 2018 and certified on the OS position in May 2024. As of the accident date, the OS possessed a current FAA ATC specialist medical clearance, with a limitation that he must possess vision corrective lenses and use those lenses as appropriate while on duty.

[70] “Obtaining currency” refers to completing the minimum monthly required on-position time and task demonstrations needed to remain “current” and certified on a particular control position.

The OS was off duty during the 3 days before the accident. He stated that, on days when he was not working, he typically woke around 1000 and went to sleep around 0100 to 0200. He reported that he woke about 1000 on the morning of the accident and reported for duty about 1300. The OS stated that he "felt good" that day. According to position logs, the OS worked the following positions on the night of the accident (table 9):[71]

Table 9. OS control position assignments on the night of the accident.

Time	Position worked	Time on position (minutes)
1630–1732	OS	62
1733–1747	ALC	14
1750–1821	LC	31
1823–2129	OS	186
2200–2205	OS	5

In a postaccident interview, the OS stated that it had been "a normal night" before the accident. He was listening to the LC controller's transmissions, which were broadcast on a speaker in the tower cab, and looking out the window. He could not recall the specifics of the traffic situation at the time of the accident and did not recall the conflict alert activating. On a scale from 1 to 5, the OS rated the traffic volume as a 3 and complexity a 2, stating that it was normal for the time of day.

1.7.6 DCA Traffic Management, Volume, and Flow

1.7.6.1 Combined Control Positions

The LC/HC positions had been combined since 1540 on the day of the accident. The OS on duty at the time of the accident stated that he was not the OS who decided to initially combine the HC and LC positions that day; however, he stated that having the positions combined was "standard," and he did not feel that the conditions warranted separate staffing of those positions on the night of the accident. Particularly in the hour before the accident, he felt that traffic "complexity went…way down," and that the tower was only working "one helicopter at a time." He also indicated that there were sufficient personnel on duty on the night of the accident to staff the positions separately had he needed to do so.

The DCA ATCT SOP current at the time of the accident, issued in June 2024, stated that the HC position "should normally be de-combined" from 1000–2130

[71] The OS was in the tower cab for the entire duration working various positions.

Monday through Friday, and from 1000–1700 Saturday through Sunday.[72] The OS or Controller-in-Charge (CIC) was authorized to combine the HC and LC positions at their discretion after considering the following:

- Weather conditions
- VIP movements
- Special helicopter operations
- Training initiatives
- Staffing
- Air carrier traffic volume
- Helicopter traffic volume within the DCA Class B airspace

Previous iterations of the DCA ATCT SOP, issued in June 2016 and May 2020, required approval by the facility manager or OS to combine the HC and LC positions.

A June 2023 change to the DCA ATCT SOP removed a previous requirement for the OS or CIC to document in the daily facility log when the HC position was combined or de-combined. The June 2024 iteration of the DCA ATCT SOP eliminated a requirement that had been introduced in the January 2023 edition that the OS/CIC document in the daily facility log the reason that the HC position was combined/de-combined.

Records indicated that, for the entire day of the accident, the HC and LC positions had only been staffed separately for about 1 hour and 20 minutes.

During postaccident interviews, controllers described the advantages and disadvantages of combining the HC and LC positions. One controller stated that they preferred to combine the positions when helicopter traffic was light because it eliminated the “back and forth” coordination between the HC and LC controllers that was required when the positions were staffed separately. He felt that combining the positions helped him “build a bigger picture” of the traffic environment.

Another controller stated that the advantages to having the positions separately staffed included having an extra set of eyes and less frequency congestion. It also made it easier on controllers to manage a sudden influx of helicopter traffic. He also cited reduced coordination between controllers as an advantage of combining the positions.

[72] A previous iteration of the DCA ATCT SOP issued in May 2020 specified that the HC position be staffed Monday through Friday, 0800-2000, Saturday 0900-1900, and Sunday 0900-2000.

A third controller stated that combining the positions could result in decreased situation awareness because it required the controller to continuously divide their attention between arrivals and departures and helicopter traffic.

1.7.6.2 Visual Separation Between Helicopters and Airplanes

The FAA's Pilot-Controller Glossary contains the following definition of visual separation:

> VISUAL SEPARATION—A means employed by ATC to separate aircraft in terminal areas and en route airspace in the NAS [National Airspace System]. There are two ways to effect this separation:
>
> a. The tower controller sees the aircraft involved and issues instructions, as necessary, to ensure that the aircraft avoid each other.
>
> b. A pilot sees the other aircraft involved and upon instructions from the controller provides his/her own separation by maneuvering his/her aircraft as necessary to avoid it. This may involve following another aircraft or keeping it in sight until it is no longer a factor.
>
> (See SEE AND AVOID.)

As described above, visual separation may be either tower-applied or pilot-applied. No minimum separation standards are defined when visual separation is being utilized; however, standard minimum separation standards must exist both before and after the application of visual separation. At DCA, standard Class B radar separation would require a minimum of 1 1/2 mile lateral or 500 feet vertical separation between an IFR and a VFR aircraft when either is > 19,000 lbs or a jet (in this case, the IFR aircraft was a jet).

In postaccident interviews, current and former controllers at DCA stated that the tower routinely used both tower- and pilot-applied visual separation as a means of efficiently separating helicopter and fixed-wing traffic in VFR conditions. A former OM stated that the tower relied on pilot-applied visual separation "99% of the time" due to the structure of the helicopter routes. He didn't believe that most controllers were comfortable using tower-applied visual separation because it could be difficult to determine where a helicopter was in relation to the route or area boundaries, particularly at night or when the aircraft being separated were both flying in the same direction.

In the NTSB's investigative hearing, the DCA ATCT OM at the time of the accident stated that the use of visual separation between helicopters and fixed-wing commercial traffic was "paramount" to operating efficiently given the volume of traffic and complexity of the DCA airspace. He stated that, in his opinion, helicopter operators that were familiar with the area understood the necessity of visual separation in moving aircraft efficiently around the DCA area.

In a postaccident interview, an Army standardization instructor stated that he had, in the past, requested visual separation from traffic that he had not yet visually acquired. He gave the following example indicating that, if he were flying southbound on Route 1 and advised about traffic south of the Wilson Bridge:

> I couldn't hit that aircraft if I tried because it's parallel with me. It's no factor…I know where I'm at. I know where the traffic is, and I know it's not a factor. So, I will say visual separation, and I'll have the traffic 15 to 20 seconds later. …I know if I, if I don't say it [traffic in sight], I may have to hold. And I know I'm going to see the traffic, and even if I don't, I know it's not a factor. Now I've never taught that to anybody…But if I've done it as an experienced guy, I would assume that probably other pilots do it. I can't be the only one.

In the investigative hearing, the same Army standardization instructor testified that, when using NVGs, it was possible to see airplanes lining up at the Wilson Bridge from Cabin John, Maryland, and because of that, it was common practice to identify and request visual separation from an aircraft at a distance. He stated that it would be more difficult to maintain visual contact with an airplane circling for runway 33, particularly as the helicopter descended to 200 ft. He further stated that operating with two pilots made it "much easier" to maintain visual separation because one pilot scans for traffic and handles radio communications while the other flies the helicopter.

When asked how NVG use affects depth perception, the Army standardization instructor stated that, when viewing a distant cluster of lights through NVGs (such as several aircraft on approach to runway 1), "the brighter light may appear to be closer but that's not necessarily the case." He stated that an aircraft with a particularly bright position or landing light may appear to be closer, even if it is actually behind another aircraft.

USCG representatives stated in postaccident interviews that USCG helicopter crews frequently requested visual separation when traffic was pointed out by DCA ATCT. The USCG pilots interviewed expressed the opinion that visual separation was a useful tool that allowed efficient use of the DCA airspace.

USAF helicopter pilots reported that they occasionally encountered traffic landing on runway 33 when operating on Routes 1 and 4, and that there were instances when their flight crews chose to enter a hold unprompted from DCA ATCT. They generally initiated a request for visual separation if they saw traffic.

Review of reports in the Aviation Safety Reporting System (ASRS) database for "close call" airborne encounters between airplanes and helicopters near DCA yielded 33 reports of close calls (0.9 reports per year) between 1988 and 2024.[73] These reports, as well as other sources of safety data, are discussed in detail in section 1.14.

1.7.6.3 Airport Arrival Rate and Miles-in-Trail

According to FAA Order JO 7210.3DD, "Facility Operation and Administration," airport arrival rate (AAR) is a dynamic parameter specifying the number of arriving aircraft that an airport, in conjunction with terminal airspace, can accept under specific conditions throughout any consecutive 60-minute period. Optimal AAR values were calculated for each primary runway configuration for given weather conditions, including VMC, marginal or low VMC (LVMC), instrument meteorological conditions (IMC), and low IMC (LIMC).[74]

The order stated that an airport's AAR should be reviewed in February of each year or at more frequent intervals if required. Conditions that could reduce the maximum arrival capacity of a runway included intersecting arrival/departure runways, dual purpose runways (shared arrivals and departures), availability of high speed taxiways, airspace limitations/constraints, procedural limitations (missed approach protection, noise abatement, etc.), and taxiway layouts. The AAR at DCA on the day of the accident, with the airport in a northbound configuration and VFR conditions prevailing, was 36 arrivals per hour.

According to an internal FAA memorandum from May 2023, the Potomac TRACON requested a decrease to the existing AARs for reasons that included flight schedule increases that did not allow for use of reduced separation of aircraft on final approach, airspace and weather constraints, and an inability to regulate traffic flow based on time, also referred to as "metering," and changes to the mix of aircraft types serving DCA over the previous decade. When DCA's AAR was reviewed in 2014, aircraft serving DCA included smaller regional jets and turbopropeller-equipped airplanes that were able to accept takeoff and landing clearances on the airport's shorter runways (runway 15/33 or runway 4). As airlines upgraded their fleets to larger aircraft, which could not always operate from the shorter runways, greater

[73] The term "close calls" commonly refers to events in which the proximity between two aircraft was perceived as potentially unsafe. See, for example, Ending Serious Close Calls (FAA). Other terms, such as near misses, close proximity events, and airborne encounters have been used by different groups to describe similar types of events.

[74] FAA Order 7210.3DD, "Facility Operation and Administration," defined these weather conditions as follows: VMC – Weather allows vectoring for a visual approach; LVMC – Weather does not allow vectoring for a visual approach, but visual separation on final is possible; IMC – Visual approaches and visual separation on final are not possible; LIMC – Weather dictates Category II or III operations, or 2.5 miles in trail (MIT) on final is not available.

demand was placed on runway 1/19 for takeoffs and landings, causing the approaches for runways 1/19 to become saturated and allowing inadequate time for departures to take place between arrivals, resulting in backups on the ground. The 2023 Potomac TRACON request included the following changes to DCA's AARs, shown in table 10:

Table 10. Comparison of existing and requested airport arrival rates (AAR), by runway and condition.

Runway	Condition	Existing AAR (flights per hour)	Requested AAR (flights per hour)
19	VMC	32	28
19	LVMC	30	26
19	IMC	28	24
19	LIMC	26	24
1	VMC	36	32
1	LVMC	34	30
1	IMC	32	28
1	LIMC	30	28

The DCA ATCT OM at the time of the accident said in postaccident interviews that district management stated the request to reduce the AARs was "too political," and that they were to "stand down on the memo."

On February 21, 2025, the FAA implemented a temporary operational readjustment to the DCA AAR. As of the date of this report, the following AARs remain in effect at DCA (table 11):

Table 11. DCA AARs as of February 21, 2025.

Runway	Condition	Existing AAR (flights per hour)
19	VMC	30
19	LVMC	28
19	IMC	26
1	VMC	30
1	LVMC	28
1	IMC	26

Potomac TRACON handles arrival traffic at DCA until such traffic is within about 5 nm of the airport, at which time the traffic is handed off to the tower.[75] The location where the handoff occurs is known as the transfer of control point. Typically, an LOA

[75] According to Skybrary.aero, TRACONs are FAA facilities that house air traffic controllers who guide aircraft approaching and departing airports. TRACON controllers generally handle airspace within a 30- to 50-mile radius of an airport and up to 10,000 ft, as well as aircraft flying over that airspace. Once an approaching aircraft that is landing is within 5 miles of an airport and below 2,500 ft, TRACON controllers hand off the aircraft to controllers in the airport tower.

between a TRACON and ATCT outlines how a particular TRACON feeds traffic to an ATCT, and often prescribes that the TRACON space arriving aircraft a specific distance apart at an agreed-upon location, a concept referred to as miles-in-trail (MIT). The LOA between Potomac TRACON and the DCA ATCT, however, was not explicit in this regard, and stated that the DCA ATCT should coordinate with Potomac TRACON for final spacing separation required between arrivals based on runway conditions, weather, and other factors. Additionally, it stated that Potomac TRACON must comply with final spacing requirements coordinated with the tower.

According to interviews conducted with DCA ATCT and Potomac TRACON personnel, the agreement between the facilities stated that when additional spacing was needed, the DCA ATCT would call Potomac TRACON and implement arrival restrictions of 4 MIT to the runway threshold, meaning that for each airplane arriving at the runway threshold at DCA, the next closest airplane behind it for the same runway could be no closer than 4 miles. This spacing allowed adequate time for departures to take place between arrivals.

Personnel from both facilities reported that receiving the agreed-upon MIT spacing from Potomac TRACON had been a long-standing problem and source of frustration, and DCA ATCT would routinely receive arrival traffic with spacing less than 4 MIT. DCA ATCT controllers described that their primary challenge was having adequate space for departures between arriving aircraft, which was important to prevent backups on the ground given DCA's complex and limited airport surface area. The primary challenge for Potomac TRACON in providing the requested MIT spacing was their inability to hold aircraft inbound to DCA due to their complex and limited airspace.

In a postaccident interview, the ATM at Potomac TRACON stated that, in order to provide the requested 4 MIT spacing to DCA ATCT given DCA's high AAR, Potomac TRACON controllers would often "take measures other controllers wouldn't take" to regulate the flow of traffic, including providing vectors or issuing holds or slower speeds. He described one nonstandard procedure referred to as "tromboning," in which an aircraft is vectored away from the airport, then turned back toward the airport to build additional spacing. He also stated that sometimes Washington Air Route Traffic Control Center, which feeds traffic to Potomac TRACON, did not provide their agreed-upon MIT, and that there were five different traffic "feeds" that entered Potomac TRACON bound for DCA.

The accident LC controller stated that the tower "wasn't getting spacing on final" on the night of the accident. Review of DCA ATCT records and communications information indicated that the tower requested that Potomac TRACON provide 4 MIT spacing between 2015 and 2115. From 2015 until the time of the accident, there were 16 arrivals at DCA. Of these 16 arrivals, there were 9 instances when there was spacing of less than 4 MIT at the runway threshold. These 9 instances included the spacing between flight 5342 and the previous arrival. Around 2038, about 10 minutes before the accident, Potomac TRACON contacted the OS by phone and asked to remove the spacing requirement; the OS agreed. At this time, flight 5342 was south of DCA and beginning its turn north to align with the runway 1 approach.[76]

On January 30, 2025, the FAA conducted a systemic issue review (SYSIR) to evaluate the MIT that Potomac TRACON was providing to the DCA ATCT.[77] The SYSIR review team found that, for 90% of arrivals, Potomac TRACON was supplying 4 MIT at the transfer of control point; however, by the time the aircraft reached the runway threshold, only 60% of arrivals were still spaced at 4 MIT. The SYSIR concluded that spacing of 5 MIT at the transfer of control point was necessary to effect spacing of 4 MIT at the runway threshold.

The team concluded that there was a systemic issue with the DCA AAR calculations for runway 1/19, resulting in over-delivery of aircraft and non-compliance with associated MIT requirements. The SYSIR recommended that the DCA AAR be adjusted to reflect the compacted demand at DCA, airspace constraints, fleet mix, and runway availability. The SYSIR also cited lower arrival rates at the following airports that utilized similar runway configurations to DCA for comparison:

San Diego International Airport (SAN), San Diego, California – AAR 24

Palm Beach International Airport (PBI), West Palm Beach, Florida – AAR 26/28

Long Beach International Airport (LGB), Long Beach, California – AAR 24

1.7.6.4 Slot Controls

The FAA uses "slots" to limit scheduled air traffic at certain capacity-constrained airports, including DCA, and John F. Kennedy International Airport (JFK) and LaGuardia International Airport (LGA) in New York. A slot is an IFR reservation required for each takeoff or landing. Slot controls do not supersede AAR limitations. Airlines flying to and from DCA are subject to slot and perimeter rules set by federal law and regulation.[78]

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[76] Although the MIT restriction was removed at this time, flight 5342 and the previous arrival had been placed in sequence for arrival while it was in effect, and the two aircraft should have had spacing of 4 MIT.

[77] A Systemic Issue Review is a review used by the FAA Air Traffic Organization for the evaluation and improvement of services and to validate suspected systemic issues or best practices. The January 30, 2025, SYSIR had been scheduled before this accident occurred and was not conducted in response to the accident.

[78] See 49 *United States Code (USC)* 41718 and 14 *CFR* 93.123.

DCA is limited to a maximum of 67 slots per hour; 60 of those slots are established by regulation and the additional 7 are allowed by statute. Slots at LGA are allocated in 30-minute blocks.

In postaccident interviews, DCA controllers stated that airlines often group all of their allotted departure or arrival slots for a given 2-hour block into the last half hour of the first hour and the first half hour of the second hour rather than spreading them evenly throughout the 2-hour block, resulting in times of “compacted demand” on controllers as they work to accommodate the surge of traffic.

1.7.6.5 Offloading to Runway 33

In the minutes leading up to the time of the accident, there were multiple airplanes taxiing and holding for departure, and multiple additional airplanes on approach to runway 1. The LC controller asked the airplane on final immediately preceding flight 5342 if they could accept runway 33, and the flight crew declined.[79] When the crew of flight 5342 were asked, they accepted after deliberation, and the controller then instructed the crew to circle to runway 33 and cleared the airplane for landing.

Interviews with DCA ATCT personnel, as well as review of ATC audio and personal observation by investigators, indicated that “offloading” arrivals to another runway was common practice at DCA to build spacing between aircraft. Particularly during times of heavier traffic flow and when the airport was in a north configuration (airplanes landing on runway 1), controllers routinely offloaded every few arrivals to runway 33 to build space for departing aircraft.

The change to runway 33 from runway 1 required flight crews to turn away from the runway 1 final approach course and circle to the final approach course for runway 33, then continue their descent and land (see figure 23).[80] Flight crews were under no obligation to accept a circling approach to runway 33, and due to its shorter length, larger or heavier aircraft with longer landing distances were often unable to use it.

[79] This exchange occurred between 2042:42 and 2042:49; flight 5342 was the next airplane to check in with the tower at 2043:06.

[80] According to Skybrary.aero, a circling approach is a visual phase of an instrument approach to bring an aircraft into position for landing on a runway that is not suitably located for a straight-in approach.

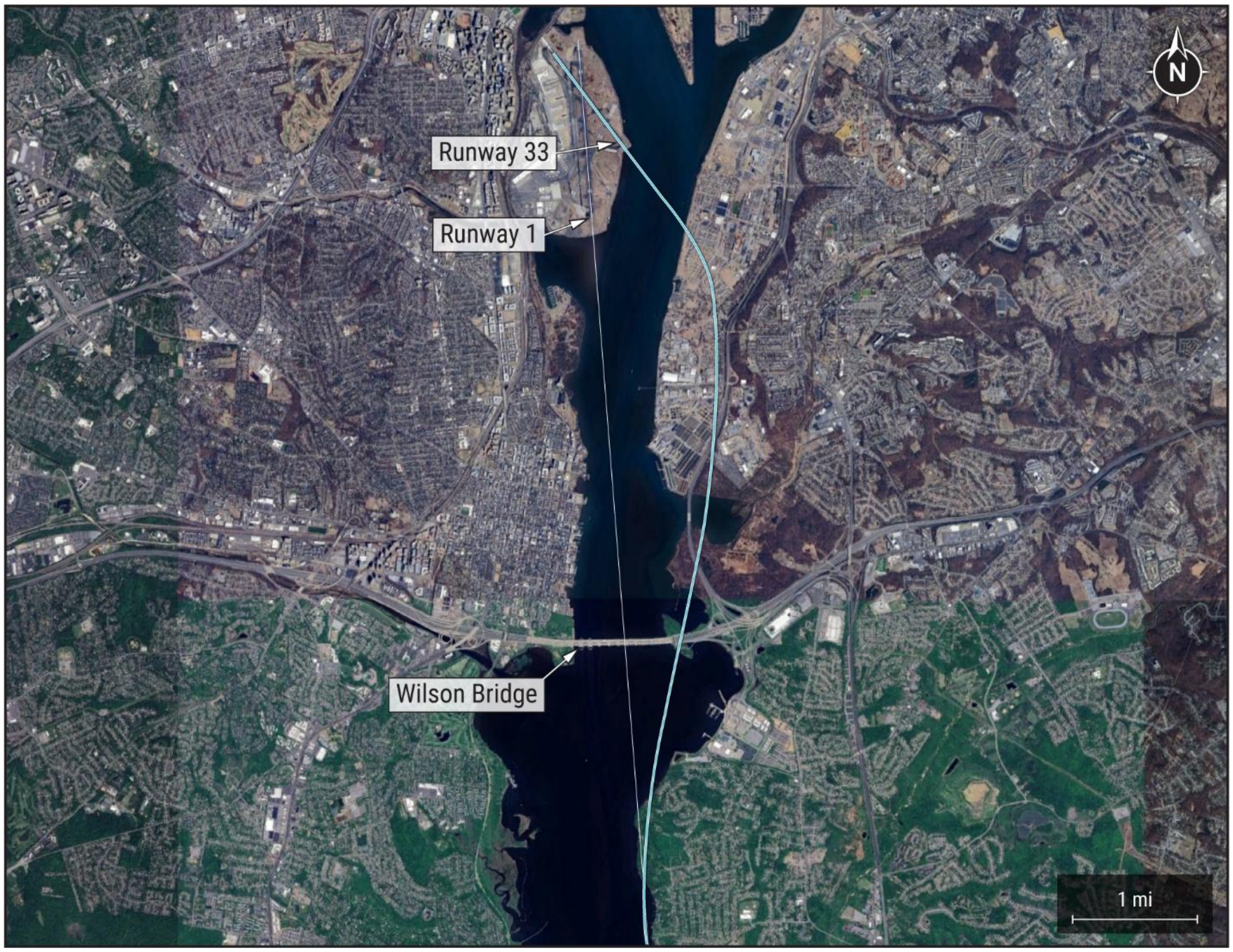

Figure 23. Circling approach to runway 33, annotated with an extended centerline from runway 1.

The DCA ATCT OM also stated that controllers routinely offloaded traffic on approach to runway 1 by having them circle to runway 33. Although there were other methods available to controllers to build additional spacing between aircraft, the OM stated that offloading traffic to runway 33 was a preferred mitigation because it continued the flow of arrivals and departures during compacted demand times. In contrast, having an airplane slow their speed on final approach to increase separation would create a buildup of traffic behind that aircraft that could also affect Potomac TRACON.

The OM stated in the investigative hearing that the controllers at DCA would "just make it work" by utilizing all available tools to compensate for the traffic volume. DCA was a high volume, complex airport with "not a lot of real estate," and controllers had to "keep things moving" in order to provide safe and efficient service. He stated that this "make it work" mentality had become normalized at DCA ATCT before the accident and that "it can be taxing on a person…constantly having to give, give, or push, push, push in order to efficiently move traffic."

1.7.6.6 Time-Based Flow Management

Time-based flow management (TBFM) is a decision support tool for time-based traffic management in the enroute and terminal (airport) environments. The core function of TBFM is to schedule aircraft within a stream of traffic to reach a defined point at a specified time, creating a time-ordered sequence of traffic. The scheduled times allow for merging of traffic flows while minimizing coordination, reducing the need for vectoring/holding, and efficiently utilizing airspace and airport capacity. The TBFM schedule is based on aircraft time of arrival at the defined point(s) based on wind forecast, aircraft flight plan, and the desired separation between aircraft.[81]

According to postaccident interviews conducted with the Potomac TRACON ATM, the TBFM system had been installed at Potomac TRACON for 10 to 12 years and controllers had been trained on its use; however, the system had never been activated. According to records provided to the NTSB by the FAA after the accident, the system had not been activated "due to budget constraints and other program priorities," and its activation was "on hold until further notice."

The FAA's Washington District traffic management officer testified during the investigative hearing that she was unaware of why TBFM had not been activated for DCA at the time of the accident, and that the request had been made to do so, but there was "a line or a wait."[82] She further stated that TBFM would allow for better management of the compacted demand at DCA. A manager at Potomac TRACON testified that he believed TBFM would help improve Potomac TRACON's ability to provide more consistent MIT to DCA ATCT. He stated that they had "not seen it yet, and it is supposed to come in March of [20]26." A representative of American Airlines testified that TBFM was in use at several of the airline's other hub airports and that it "smooths out the volume" of traffic while providing more accurate MIT.

According to the FAA, the TBFM system has been partly operationalized since October 2025 at Potomac TRACON, and full implementation is expected by March 2026.

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[81] See JO 7210.3DD, section 18-25-1, Time-Based Flow Management.

[82] According to the FAA's *Traffic Management Officer (TMO) Reference Guidebook*, the TMO serves as a traffic management liaison between national and district-level leadership and as the focal point for traffic management across facilities within their district (air route traffic control center, TRACON, and ATCTs). They provide oversight to ensure appropriate coordination is established within facilities to plan and direct traffic management initiatives and support activities, such as temporary flight restrictions and special events. TMOs also ensure that the controller workforce remains informed of and trained on chart changes and updates to decision support tools.

1.7.7 External Compliance Verifications

FAA JO 7210.634A, "Air Traffic Organization Policy," states that compliance verifications are a way of assessing air traffic control facility performance and identifying areas of improvement. Internal compliance verifications (ICVs) are planned assessments accomplished through the use of a checklist and random sampling methods such as direct operational observation, discussions with facility personnel, review of voice/radar data, and equipment parameters. All FAA air traffic control facilities and federal contract towers must conduct an ICV annually each fiscal year.

An external compliance verification (ECV) is an externally initiated assessment of a facility, conducted primarily by the Quality Control Group and/or additional personnel, in response to data-driven indicators of potential risk and/or practices. An ECV may be conducted on site, using a customized checklist, to assess a facility's overall performance. ECVs are conducted on an as-needed basis as determined via indicators of potential risk and non-compliance. Determinations to conduct ECVs are based on data analysis that identifies potential risk within specific facilities. ECVs are not intended to be conducted at regular time intervals or on a regularly scheduled basis.

A current Leidos and retired FAA air traffic control specialist who performed ECVs at DCA from 2017 until July 2023 testified during the NTSB's investigative hearing about an ECV that he participated in at DCA in June 2022. He stated that the ECV team arrived on Monday, toured the facility, and began evaluations on Tuesday morning. By Tuesday afternoon, the team had identified 33 items as "non-compliant," at which point the ECV team lead and ATCT managers determined that they would suspend the ECV and switch to an ICV to assist the tower team with bringing operations back into compliance.[83] He stated that he had never seen so many noncompliant items during an ECV and had never previously stopped an ECV due to a high rate of noncompliance.[84]

The specialist worked with DCA ATCT for about 9 months and stated that, during his time at the facility, he identified issues such as a lack of staff support and poor communication between Potomac TRACON and DCA ATCT. He also identified concerns about potential conflicts with the helicopter routes, which he raised to the ATM at the time.

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[83] According to FAA JO 7210.634A, an internal compliance verification is a facility's self-evaluation that is conducted by the facility/designated personnel using the checklists contained in the Compliance Verification Tool and the procedures outlined in the order.

[84] Noncompliant items included nonstandard phraseology, procedures, application of visual separation, call signs, radio communications, and training records.

According to FAA memos, a February 2020 ECV identified instances in which the HC position was combined or de-combined without required documentation in the facility logs and "pervasive shortcutting of standard phraseology." In June 2023, the ECV team observed special VFR helicopter operations in close proximity to and flying underneath the final approach course. The facility has alternate separation minima from 1/2 mile to 1 mile depending on aircraft location during special VFR conditions.

The ECV team observed many instances in which helicopters flew in close proximity to arriving fixed-wing aircraft and traffic information was not issued to either aircraft. The team also identified instances where fixed-wing traffic was not advised regarding helicopters operating in close proximity to the final approach course. These were not instances in which a safety alert was required to be issued.[85]

During a November 2024 ECV, the team noted "a few occurrences" in which the LC controller advised aircraft on final approach that helicopters operating near the final approach course had them in sight and were maintaining visual separation. However, at the time these transmissions were made, the helicopter had not reported the traffic in sight and had not been advised to maintain visual separation. The LC controller appeared to be anticipating that the helicopters would visually acquire the arrival traffic, report traffic in sight, and then be instructed to maintain visual separation.

1.7.8 Air Traffic Control Procedures

Air traffic controllers in the US are governed by FAA orders and instructions alongside facility-specific SOPs. FAA orders and instructions establish standards for FAA personnel and serve as authoritative references for the aviation industry and the public, describing organizational responsibilities, safety programs, and detailed operational requirements. At DCA, these orders and facility SOPs prescribe how controllers are to prioritize duties, provide separation services, issue safety alerts, and balance safety with efficiency and national security considerations.

1.7.8.1 Duty Priority

FAA Order JO 7110.65AA, "Air Traffic Control," paragraph 2-1-1, ATC Service, stated:

a. The primary purpose of the ATC system is to prevent a collision involving aircraft operating in the system.

[85] Safety alerts are discussed in section 1.7.8.4

b. In addition to its primary purpose, the ATC system also:

1. Provides a safe, orderly, and expeditious flow of air traffic.

2. Supports National Security and Homeland Defense missions.

Paragraph 2-1-2, Duty Priority, provided procedures and guidance for controllers in prioritizing their duties and stated in part:

a. Give first priority to separating aircraft and issuing safety alerts as required in this order. Good judgment must be used in prioritizing all other provisions of this order based on the requirements of the situation at hand.

NOTE – Because there are many variables involved, it is virtually impossible to develop a standard list of duty priorities that would apply uniformly to every conceivable situation. Each set of circumstances must be evaluated on its own merit, and when more than one action is required, controllers must exercise their best judgment based on the facts and circumstances known to them. That action which is most critical from a safety standpoint is performed first.

1.7.8.2 Traffic Advisories

FAA Order JO 7110.65AA, "Air Traffic Control," paragraph 2-1-21, Traffic Advisories, stated in part:

Unless an aircraft is operating within Class A airspace or omission is requested by the pilot, issue traffic advisories to all aircraft (IFR or VFR) on your frequency when, in your judgment, their proximity may diminish to less than the applicable separation minima. Where no separation minima applies, such as for VFR aircraft outside of Class B/Class C airspace, or a TRSA [terminal radar service area], issue traffic advisories to those aircraft on your frequency when in your judgment their proximity warrants it. Provide this service as follows:

a. To radar identified aircraft:

1. Azimuth from aircraft in terms of the 12−hour clock, or

2. When rapidly maneuvering aircraft prevent accurate issuance of traffic as in 1 above, specify the direction from an aircraft's position in terms of the eight cardinal compass points (N, NE, E, SE, S, SW, W, and NW). This method must be terminated at the pilot's request.

> 3. Distance from aircraft in miles.
>
> 4. Direction in which traffic is proceeding and/or relative movement of traffic.
>
> NOTE– Relative movement includes closing, converging, parallel same direction, opposite direction, diverging, overtaking, crossing left to right, crossing right to left.
>
> 5. If known, type of aircraft and altitude.

Paragraph 3-1-6, Traffic Information, stated in part:

> a. Describe vehicles, equipment, or personnel on or near the movement area in a manner which will assist pilots in recognizing them.
>
> b. Describe the relative position of traffic in an easy to understand manner, such as "to your right" or "ahead of you."
>
> c. When using a CTRD [control tower radar display], you may issue traffic advisories using the standard radar phraseology prescribed in paragraph 2−1−21, Traffic Advisories.

1.7.8.3 Visual Separation

FAA Order 7110.65AA, section 7-2-1, Visual Separation, provided controllers with requirements on the use of visual separation and stated in part:

> Visual separation may be applied when other approved separation is assured before and after the application of visual separation. To ensure that other separation will exist, consider aircraft performance, wake turbulence, closure rate, routes of flight, known weather conditions, and aircraft position. Weather conditions must allow the aircraft to remain within sight until other separation exists.

The order stated the conditions under which tower-applied visual separation could be used, which included:

> a. Maintain communication with at least one of the aircraft involved or ensure there is an ability to communicate immediately with applicable military aircraft as prescribed in paragraph 3-9-3, Departure Control Instructions, subparagraph a2.

b. The tower visually observes the aircraft, issues timely traffic advisories, and applies visual separation between the aircraft.

c. Issue control instructions as necessary to ensure continued separation between the applicable aircraft.

For pilot-applied visual separation, the requirements stated in part:

a. Maintain communication with at least one of the aircraft involved and ensure there is an ability to communicate with the other aircraft.

b. The pilot sees another aircraft and is instructed to maintain visual separation from the aircraft as follows:

    1. Tell the pilot about the other aircraft. Include position, direction, and type, and, unless it is obvious, the other aircraft's intention.

    2. Obtain acknowledgement from the pilot that the other aircraft is in sight.

    3. Instruct the pilot to maintain visual separation from that aircraft.

c. If the pilot reports the traffic in sight and will maintain visual separation from it (the pilot must state both), the controller may "approve" the operation instead of restating the instructions.

d. If aircraft are on converging courses, inform the other aircraft of the traffic and that visual separation is being applied.

e. Advise the pilots if the targets appear likely to merge.

PHRASEOLOGY –

[aircraft ID] TRAFFIC, (clock position and distance), (direction) BOUND, (type of aircraft), (intentions and other relevant information).

If required,

[aircraft ID], REPORT TRAFFIC IN SIGHT or DO YOU HAVE IT IN SIGHT?

If the pilot reports traffic in sight, or the answer is in the affirmative,

[aircraft ID], MAINTAIN VISUAL SEPARATION.

(c) if the pilot reports traffic in sight and will maintain visual separation from it (the pilot must state both), the controller may "approve" the operation instead of restating the instructions.

NOTE –

Pilot-applied visual separation between aircraft is achieved when the controller has instructed the pilot to maintain visual separation and the pilot acknowledges with their call sign or when the controller has approved pilot-initiated visual separation.

Pilot-applied visual separation was in effect between PAT25 and flight 5342 at the time of the accident.

FAA guidance does not prescribe minimum distances by which aircraft must remain separated when operating under visual separation.

FAA Order 7110.65AA, "Air Traffic Control," paragraph 5-1-4, Merging Target Procedures, stated in part:

a. Except while they are established in a holding pattern, apply merging target procedures to all radar identified:

    1. Aircraft at 10,000 feet and above.

    2. Turbojet aircraft regardless of altitude.

b. Issue traffic information to the aircraft listed in subparagraph a whose targets appear likely to merge unless the aircraft are separated by more than the appropriate vertical separation minima.

1.7.8.4 Conflict Alerts

The DCA ATCT was equipped with multiple CTRDs, which showed controllers radar information from the Potomac TRACON standard terminal automation replacement system (STARS). The system integrated safety logic to provide visual and aural alerting to controllers via a conflict alert (CA), which is designed to draw a controller's attention to a potential conflict and is presented in three ways: an aural alert, a flashing "CA" on the CTRD next to each of the involved aircraft, and the conflict list, which contains a text display of the aircraft involved on the top left of the CTRD screen. Figure 24 depicts the active conflict alert between the accident aircraft as displayed on the CTRD.

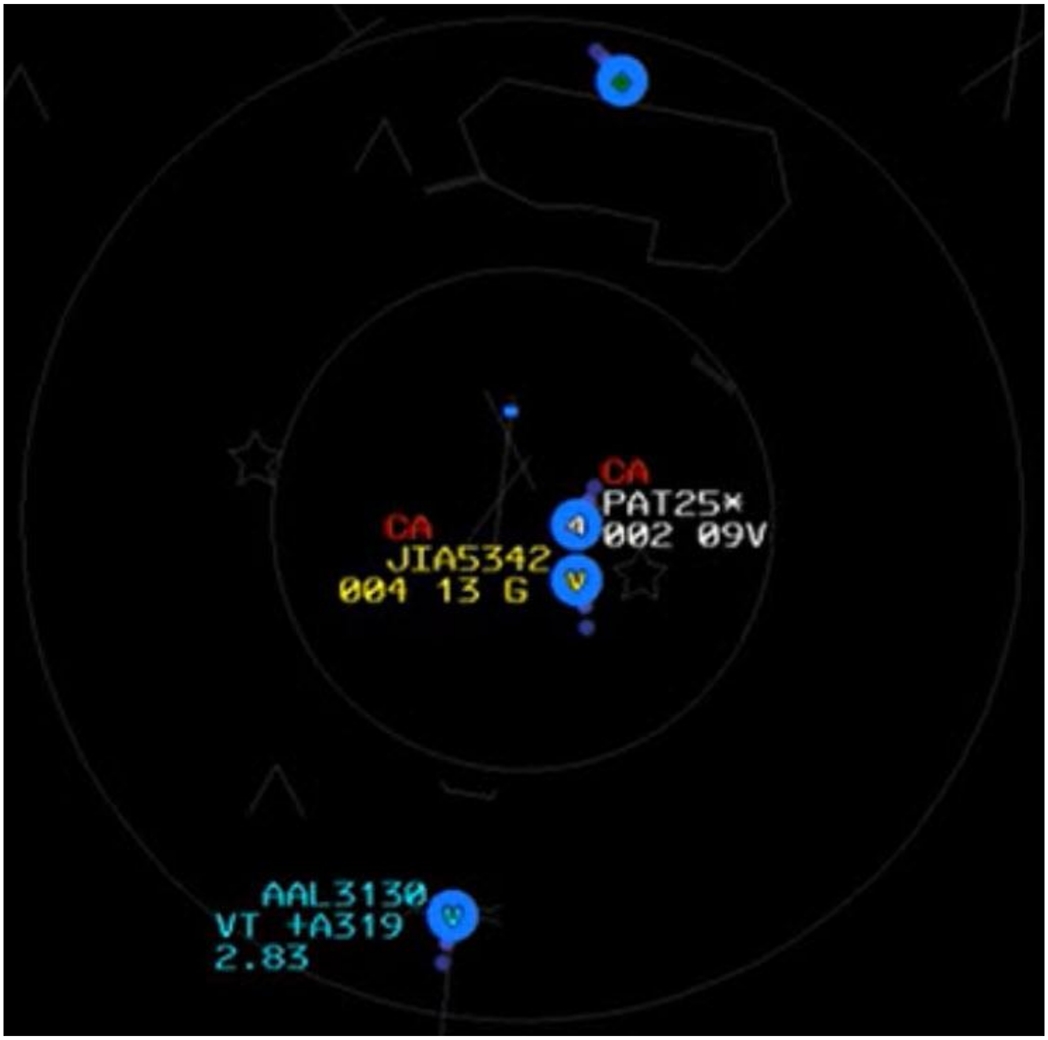

Figure 24. Photo of a CTRD screen showing the active conflict alert between PAT25 and flight 5342 (shown as JIA5342). The conflict alert activated at 2047:33 (about 26 seconds before the collision).

The CA activation criteria comprises three algorithms that each detect potential conflicts independently, sensing potential linear, maneuver, and proximity conflicts. Some of these logics predict the flight path of the aircraft, while others consider where the aircraft is located at that time. The CA presented to the controller is the same regardless of which algorithm is activated, which requires the controller to identify and interpret the severity of the conflict and evaluate the action they should take based on other available information.

Interviews with DCA ATCT personnel indicated that CAs were heard “often” and were “pretty common” at DCA. In the 30 minutes before the accident occurred, CA aural tones were audible during 18 controller radio transmissions; however, these instances did not necessarily represent 18 distinct CA activations. Review of available radar display replay data for the final 18 minutes before the accident identified five separate CA activations, several of which persisted long enough to be audible across multiple transmissions.

Controllers reported that they often received CAs for non-conflicts, such as when aircraft are on diverging paths, or that the CA will continue to activate even after the controller has taken action to mitigate the conflict.

FAA Order 7110.65AA, "Air Traffic Control," paragraph 2-1-6, Safety Alert, prescribed procedures for the issuance of safety alerts to pilots, and stated in part:

> Issue a safety alert to an aircraft if you are aware the aircraft is in a position/altitude that, in your judgment, places it in unsafe proximity to terrain, obstructions, or other aircraft.
>
> NOTE – 1. The issuance of a safety alert is a first priority once the controller observes and recognizes a situation of unsafe aircraft proximity to terrain, obstacles, or other aircraft. Conditions, such as workload, traffic volume, the quality/limitations of the radar system, and the available lead time to react are factors in determining whether it is reasonable for the controller to observe and recognize such situations. While a controller cannot see immediately the development of every situation where a safety alert must be issued, the controller must remain vigilant for such situations and issue a safety alert when the situation is recognized.
>
> b. Aircraft Conflict/Mode C Intruder Alert. Immediately issue/initiate an alert to an aircraft if you are aware of another aircraft at an altitude that you believe places them in unsafe proximity. If feasible, offer the pilot an alternate course of action. When an alternate course of action is given, end the transmission with the word "immediately."
>
> PHRASEOLOGY-
>
> *TRAFFIC ALERT (call sign) (position of aircraft) ADVISE YOU TURN LEFT/RIGHT (heading), and/or*
> *CLIMB/DESCEND (specific altitude if appropriate) IMMEDIATELY.*
>
> EXAMPLE-
>
> *"Traffic Alert, Cessna three four Juliet, 12 o' clock, 1 mile advise you turn left immediately."*
>
> *Or*

"Traffic Alert, Cessna three four Juliet, 12 o'clock, 1 mile advise you turn left and climb immediately."

1.7.8.5 Positive Control

The term "positive control" is defined in FAA Order JO 3120.4, "Air Traffic Technical Training," Appendix B, Instructions for Completing FAA Form 3120-25, under Job Subtasks:

> Takes command of control situations and does not act in a hesitant or unsure manner. Observes present and considers forecasted traffic to predict if an overload may occur, and takes appropriate action to prevent or lessen the situation.

FAA Air Traffic Procedures Bulletin, Issue September 2022-1, stated in part:

> Positive Control is the Key:
>
> Controllers are trained that VFR aircraft is to "see and avoid" other aircraft. When traffic conflicts arise, the controller may issue traffic to the aircraft but leaves the separation responsibility to the pilots.[86] The common belief is, *the aircraft know about each other, so I have fulfilled my obligation*. On the contrary: The VFR status of an aircraft does not alleviate the duty of a controller to issue instructions, traffic calls, or safety alerts to those VFR aircraft. Take positive control. *Take action.* Keep them apart. Keep the pilots informed…
>
> An air traffic controller's number one responsibility is to make sure aircraft do not collide; nothing else tops this requirement. FAA Order 7110.65, paragraphs 2-1-1 and 2-1-2, clearly identify the controller's duty priority and refer to the controller's responsibilities for separation and issuing necessary safety alerts. There appears to be a misperception that these only refer to IFR aircraft. However, these refer to ***all*** users in the NAS regardless of the type of flight.

FAA Air Traffic Procedures Bulletin, Issue April 2023-2 stated in part:

> VFR "see and avoid" does not alleviate the responsibility of controllers from issuing instructions, traffic advisories, or safety alerts to VFR aircraft. When conflicts arise between IFR and any VFR aircraft, controllers shall take action to maintain safety by providing information and positive control. The duties of the controller are to take action to keep aircraft

[86] "Traffic," as used in this sentence, refers to traffic advisories.

separated, maintain positive control, and keep the pilots informed of other traffic, obstructions, and terrain.

1.7.8.6 Tower Team Position Responsibilities

FAA Order 7110.65AA, "Air Traffic Control," paragraph 2-10-3, Tower Team Position Responsibilities, described the team concept and the primary responsibilities of the tower team and stated in part:

> a. Tower Team Concept and Intent: There are no absolute divisions of responsibilities regarding position operations. The tasks to be completed remain the same whether one, two, or three people are working positions within a facility/sector. The team, as a whole, has responsibility for the safe and efficient operation of that facility/sector.

1.7.9 Facility Level Classification

One of the factors that influences air traffic controller compensation is the facility level. The FAA classifies air traffic control facilities, both enroute and terminal, on a level from 4 to 12. Level 4 facilities are located in areas of the least traffic volume or complexity, and level 12 facilities handle the highest volume and complexity of air traffic. In 2018, the DCA ATCT was downgraded from a level 10 facility to a level 9 facility, and remained a level 9 facility at the time of the accident.

In June 2023, the Metropolitan Washington Airports Authority (MWAA) newsletter, "On Good Authority," reported on efforts to increase the number of flights at DCA, increasing already heavy congestion on the "busiest runway in America." The article included the graphic shown in figure 25, with additional annotations showing the facility level of the ATCT of each airport. DCA runway 1/19 was shown with an average of 819 daily operations. Of the ten busiest runways depicted on the chart, all but DCA and SAN were classified as level 11 or 12 ATCT facilities.

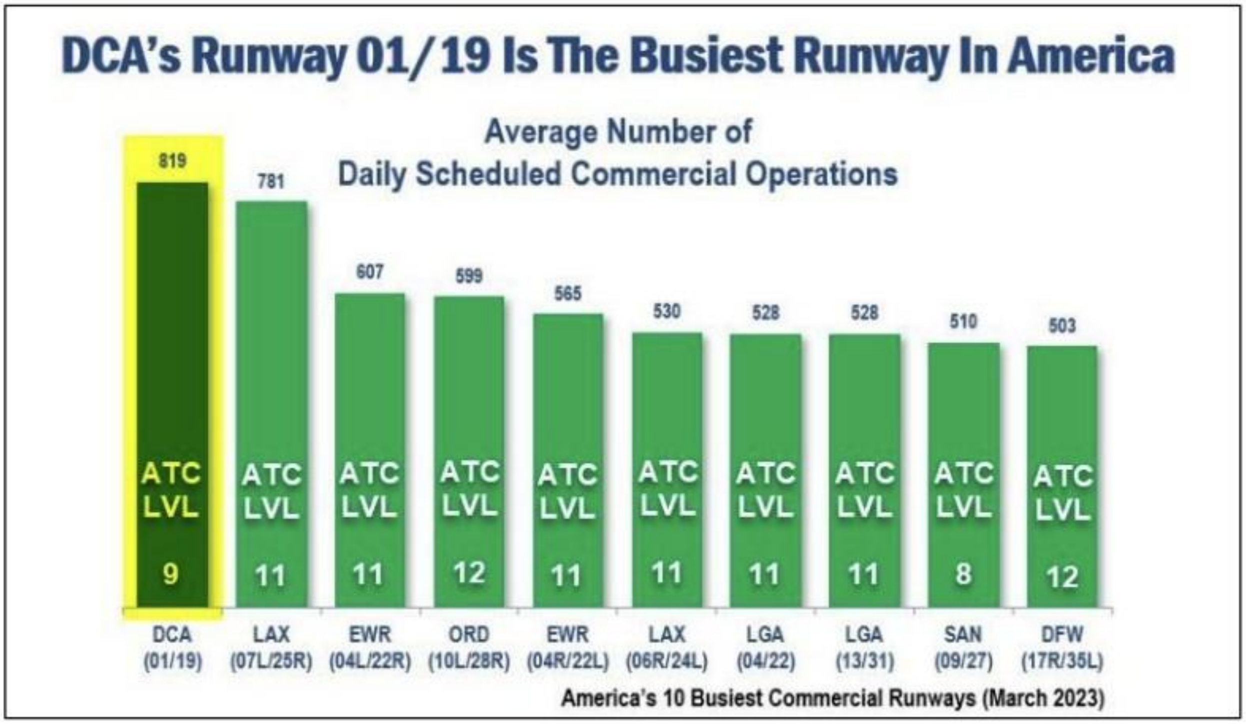

Figure 25. Graph showing average number of daily scheduled commercial aircraft operations on the nation's busiest runways and the ATC facility level associated with each airport.

Note: "Operations" represents scheduled commercial aircraft movements, with each arrival and each departure counted as one operation; general aviation, military, and other unscheduled movements are not included in these totals. Figure edited by NTSB to show facility levels associated with each ATCT. (Source: MWAA, obtained from Airline Schedules for March 2023 via Cirium Diio mi, May 30, 2023, and historical public runway utilization data.)

During the NTSB's investigative hearing, the FAA ATO's acting deputy chief operating officer (COO) testified that a facility classification takes into account that facility's traffic volume and also applies a "complexity formula." The FAA, in conjunction with the National Air Traffic Controllers Association (NATCA), has a National Validation Team that, among other duties, monitors traffic at facilities over a 12-month period and upgrades or downgrades the facility based on traffic levels.

The NTSB obtained an appeal memorandum filed in October 2018 by the DCA ATCT ATM at the time following the facility downgrade. The memo stated that, beginning in 2016, the National Validation Team had directed the discontinuance of automated counting of aircraft that had been assigned transponder codes by Potomac TRACON and subsequently transferred to the tower. This resulted in those aircraft being attributed only to Potomac TRACON, despite the fact that they were also handled by DCA ATCT controllers. This change subsequently reflected a 70% decrease in the VFR helicopter traffic counted at DCA ATCT and an increase in Potomac TRACON's traffic count even though the actual traffic numbers remained the same. The increased traffic count at Potomac TRACON resulted in that facility being upgraded from level 11 to level 12.

The memo also described numerous other issues affecting the traffic count index, and requested changes to the way traffic count was performed at DCA ATCT to more accurately reflect controller workload. Anecdotal information indicated that changes were subsequently made to more accurately count helicopter traffic, but the increased traffic count was not adequate to meet the threshold of a level 10 facility. The NTSB requested all information regarding the factors considered in the DCA ATCT facility level downgrade, as well as any and all documentation regarding the denial of their appeal; however, none of the requested documentation in regard to the facility level downgrade was provided.[87]

The DCA ATCT OM stated in the investigative hearing and during a postaccident interview that the tower had experienced staffing challenges since the downgrade. Controllers may typically select a level 9 facility to work their way up to a higher paying facility, but were less inclined to choose DCA ATCT because of the high cost of living associated with the Washington, DC, area and complexity associated with the DCA airspace. He stated that the tower had become "more of a continuous training facility," and not a facility where people chose to stay long-term.

A former DCA ATCT controller and previous OM stated that the downgrade from level 10 to level 9 resulted in a "major impact" to the morale of personnel at the tower, and that the tower subsequently lost experienced radar qualified controllers who left for higher paying facilities. It also resulted in difficulty recruiting controllers to transfer to DCA ATCT. He indicated that, given the choice between DCA ATCT and a less complex level 9 facility, controllers would likely choose the less complex facility. He could not recall all of the specific metrics used to determine a facility level, but stated that it was a measure of volume and complexity, and that DCA ATCT was downgraded due to its "helicopter count."

Another DCA ATCT controller, who arrived at the facility in 2019 following the downgrade, wrote a report that was submitted to NATCA and FAA leadership in 2023. The report stated that the traffic count index formula used to determine facility level was outdated and limited in its ability to account for the workload associated with complex operations. The report then summarized the significant complexities of operations at DCA, including:

[87] The FAA informed the NTSB on July 23, 2025, that this data request was outside the scope of the investigation and that the FAA would not provide any information to satisfy this request.

- the constrained surface area, which required frequent crossings of active runways;
- the mix of aircraft operated at DCA and the increased use of larger aircraft by air carriers; and
- the design of the terminal and gate areas, which required ground controllers to handle requests from aircraft pushing back from the gates and thus imposed a higher workload on controllers.[88]

1.7.10 Airport Response

About 2048, DCA ATCT notified aircraft rescue and firefighting (ARFF) of an Alert 3 incident involving the midair collision between PAT25 and flight 5342. The alert phone was immediately activated, and an audible tone and message—"Crash, Crash, Crash, Alert 3"—was transmitted three times to ARFF Station 301, initiating the emergency response at approximately 2049. Responding units proceeded via the southern vehicle service road to Levee Road and the north and south boathouse areas. In accordance with existing mutual aid agreements, MWAA Dispatch mobilized multiple external response agencies.

About 2050, the DCA ATCT confirmed that the wreckage was located in the water near the approach end of runway 33, and closed runway 15/33. Battalion Chief 301 cleared the airfield to facilitate response operations, and MWAA ARFF rescue boats were launched about 2053. At 2054, MWAA established Potomac River Command, and rescue boats began search operations for wreckage and occupants. MWAA Fire and Rescue Department personnel were advised that response boats from DC Fire, the Metropolitan Police Department, DC Harbor Patrol, and the Alexandria Fire Department were operating in the river to assist. About the same time, airport personnel received notification of the accident via text message, and airport operations issued a notice to air missions closing the airport at 2055.

About 2058, MWAA Public Safety Communications Center activated a Northern Virginia Mass Casualty Alarm, and responding fire and emergency medical services were staged at the north boathouse, which was designated as the casualty collection point due to its dock access and enclosed structure. Medic 301 established medical operations at that location, and responding boat crews were instructed to

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[88] Gates are typically contained within the non-movement area of an airport, in which aircraft or vehicles can move without air traffic control clearance. The report stated that, at other large airports, pushback requests into the non-movement area are normally handled by a separate ramp control; however, at DCA, they are handled by the ground controller, who must direct the flow of taxiing aircraft into and out of the narrow "alleyways" between each "pier" of gates. This is required since there are multiple gates that push back onto active taxiways, adding additional complexity.

transport recovered occupants to the boathouse. During the response, DC Fire established a separate command post on the DC side of the river near the Metropolitan Police Department helipad. According to MWAA Fire and Rescue Department personnel, the establishment of this command post was not consistent with the National Capital Region Mutual Aid Agreement and resulted in some initial confusion regarding command coordination and the appropriate transfer locations for recovered occupants.

MWAA Fire and Rescue Department subsequently deployed a mobile command post on runway 33, where a unified command post was established that included MWAA Fire Department, MWAA Police Department, MWAA Airport Operations, DC Fire, the Federal Bureau of Investigation, the NTSB, the Metropolitan Police Department, and the Virginia Department of Emergency Management. The unified command posture remained in place until approximately 0600 on January 30, 2025, when operations transitioned to a larger command post established on airport property.

DCA was certificated under 14 *CFR* Part 139 as a Class I, Index C, airport and was required to operate in accordance with its Airport Certification Manual, Airport Emergency Plan, the National Capital Region Mutual Aid Agreement, and the MWAA River Rescue Operational Manual. Airport records reviewed by investigators indicated that personnel involved in the response were qualified and current under Part 139 requirements, and that operational logs, audio recordings, video recordings, and incident documentation were maintained. Following the response, airport operations conducted a special inspection of the airfield prior to reopening on January 30, 2025, including verification of airport-owned navigational aids and a full operability review of the runway 33 runway end identifier lights.

1.8 Flight Recorders

1.8.1 CRJ700

The airplane was equipped with L3 Harris/Fairchild solid state CVR and FDR units. The CVR was designed to record 2 hours of digital cockpit audio, and the FDR was designed to record a minimum of 25 hours of flight data. Both recorders were recovered intact and data were successfully downloaded from each unit's respective memory module.

1.8.2 UH-60L

The helicopter was equipped with a Goodrich IVHMS, which included an IVHMU recorder and a health and usage monitoring system (HUMS). The IVHMU included a Penny & Giles MPFR, which served as the survivable component containing flight and cockpit voice data in the event of a severe impact. The HUMS system contains a mirror of the flight data portion of the MPFR stored on memory cards in two locations, within the IVHMU and in the center console between the pilots, but these are not designed to be crash survivable. The IVHMU was recovered intact with some water ingress to the MPFR's crash survivable memory module.

The MPFR was downloaded and contained about 13 hours, 15 minutes of FDR data and 2 hours of digital audio. The accident flight was the last flight of the recording. Helicopter position (latitude and longitude) and time were not recorded, nor were they designed to be recorded. Radio microphone transmission keying was designed to be recorded per recorder documentation; however, those data were not present on the recorder.[89] The MPFR did not include external time data, and timing was determined by comparing the recorded time of impact, reflected by rotor rpm and longitudinal acceleration values, to the impact time recorded by the airplane's FDR.

The HUMS memory cards were wet, and the card from the center console displayed minor external bending; however, the data were able to be recovered from both. The data were reviewed and found to be similar to that recorded by the MPFR.

1.9 Wreckage and Impact Information

1.9.1 General

The wreckage of both aircraft were located in the Potomac River in water depths ranging between 1 and 8 ft depending on location and tidal conditions. The helicopter wreckage was about 3,730 ft southeast of the approach end of runway 33 and included most of the major structure. The airplane was fragmented into several pieces centered about 2,345 ft southeast of the approach end of runway 33. The outboard left wing was recovered away from the main airplane wreckage, about 2,790 ft southeast of the approach end of runway 33. Figure 26 shows the wreckage locations in relation to the airport.

The Army Corps of Engineers and the US Navy Supervisor of Salvage and Diving (SUPSALV) surveyed the accident site using sonar and divers equipped with helmet cameras. SUPSALV was assigned responsibility for aircraft recovery operations, which the NTSB supervised. The wreckage was recovered to a secured hangar at DCA.

[89] "Keying" refers to activating the transmit function. This can occur with or without accompanying voice transmission.

Figure 26. Diagram of main wreckage locations in the Potomac River.

1.9.2 Airplane Examination

The airplane sustained extensive water impact damage to most of its structure. The fuselage was recovered in 13 major sections comprising the entire length of the airplane, from the radome (nose) to the aft fuselage and tail cone. More than 90% of the wreckage was recovered and comprised all major structural components of the airplane.

The vertical stabilizer and rudder remained attached to the aft fuselage and tail cone. The horizontal stabilizer and attached elevators separated from the top of the vertical stabilizer. The right wing was largely intact and remained attached to a portion of the right center fuselage. The right slats and flaps were in the fully extended position. The right landing gear remained attached and was in the extended position.

Two areas of damage were noted to the lower right side aft fuselage wing-to-body fairing. There was a puncture in the right side of the fairing about 10 inches by 8 inches, and a slash through the lower surface of the fairing, internal structure, and lavatory access door about 29 inches long by 2 inches wide. An approximately 2-ft-long section of one of the helicopter's tail rotor blades was embedded in the slash (see figure 27).

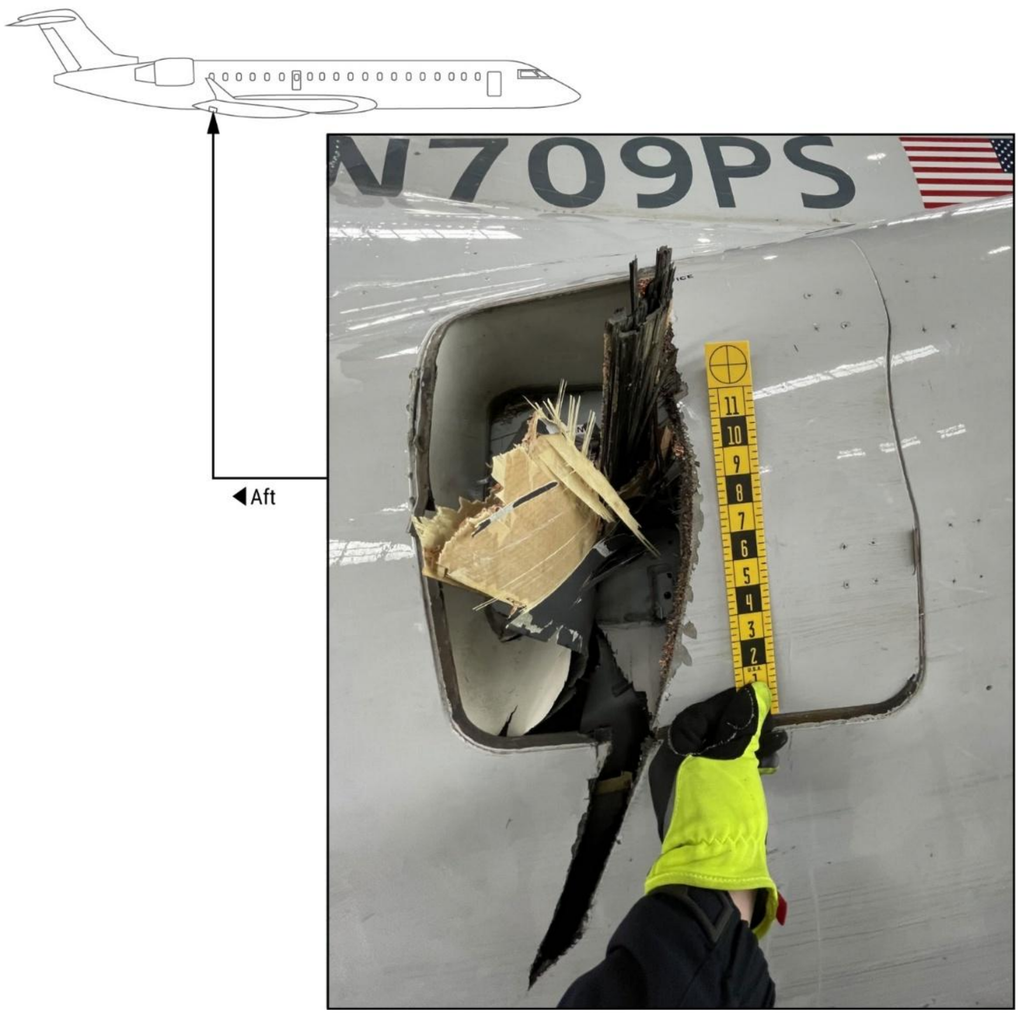

Figure 27. Aft fuselage of airplane embedded with a helicopter tail rotor blade.

The inboard left wing was significantly fragmented. The upper portion of the left main landing gear remained attached to a section of the left wing and the lower portion was separated; the outboard tire displayed a diagonal slash through all its layers. The outboard left wing was separated and recovered in the debris field. The inboard end of the left wing center leading edge slat displayed a linear slash mark about 52 inches long (see figure 28). The slat skin aft of the leading edge of the slash was gouged and abraded linearly aftward. The left wing forward spar aft of the slat was also cut along the same diagonal line, and the interior wing structure was damaged and deformed aft and inboard. There was some black paint transfer on the interior wing structure.

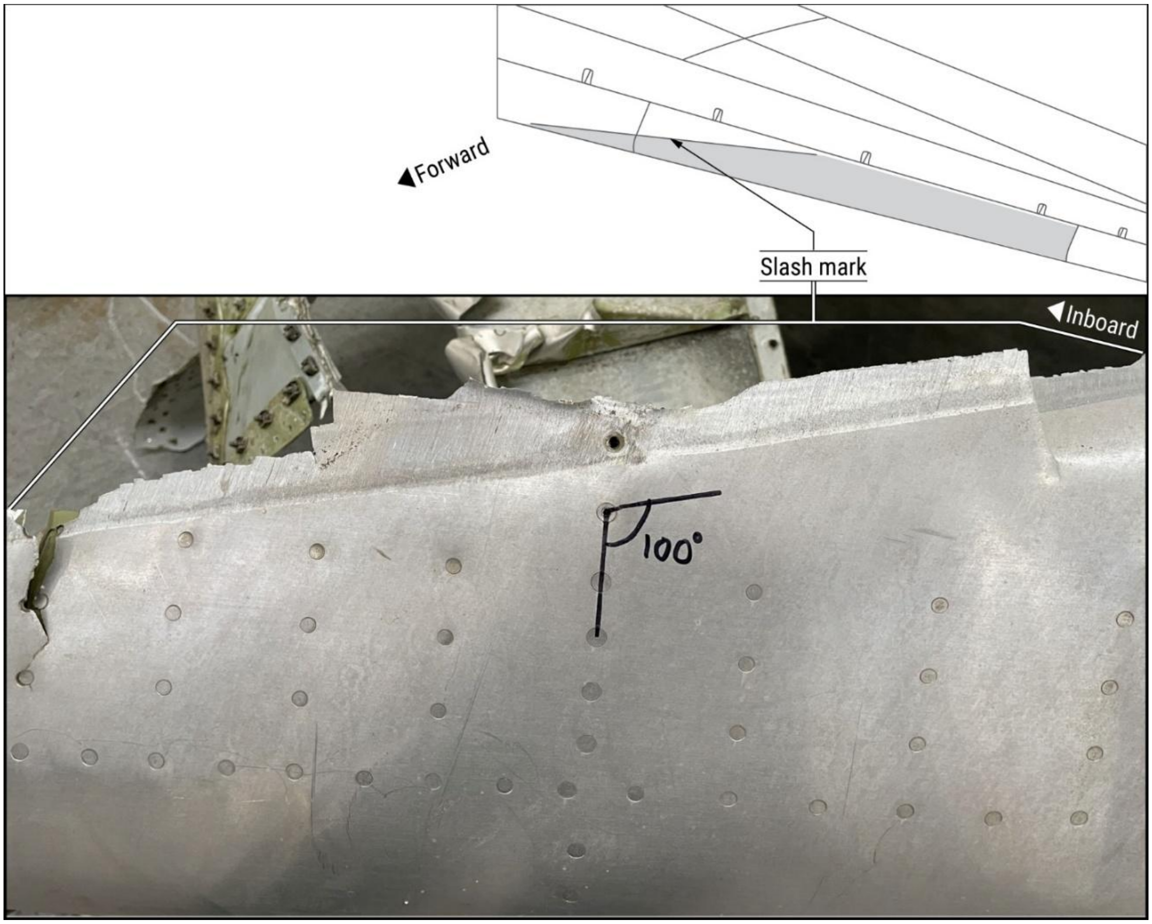

Figure 28. View of slash mark displayed on the airplane's left wing center leading edge slat.

Two other sections of the inboard left slat displayed impact/denting and associated black paint transfer (see figure 29 and figure 30). Various pieces of fibrous materials were found in multiple sections of the airplane, including the left wing and vertical stabilizer. Samples of the fibrous material were collected for documentation and identification at the NTSB Materials Laboratory. Samples taken from the left wing and left main landing gear were consistent with material from a main rotor blade of a UH-60L.

Figure 29. Wide view of impact mark on the airplane's left wing inboard leading edge slat.

Figure 30. Close-up view of impact mark on the airplane's left wing inboard leading edge slat.

The left (No. 1) engine was recovered separated from its pylon with the core mostly intact. Both fan core cowl doors separated from the engine during the accident. The nacelle displayed no evidence of external fire or uncontainment. All fan blades were bent aft and their leading edges exhibited dents, gouges, and missing material. One fan blade was fully fractured at the platform, and one blade was fractured at midspan.

The right (No. 2) engine was recovered mostly intact with its pylon still attached. The nacelle displayed no evidence of external fire or uncontainment. All fan blades were intact and bent opposite the direction of rotation, except for one blade that was fractured and separated about midspan. Multiple blades exhibited deformation near their tips.

The airplane's auxiliary power unit (APU) was recovered intact and secured inside the tail section. There was no evidence of external fire or uncontainment.

1.9.3 Helicopter Examination

The helicopter came to rest inverted with the tail structure partially separated from the fuselage around the tail transition section, as shown in figure 31. The main fuselage had fractured into multiple pieces and was primarily held together during recovery by cabling, hoses, and remnant structure. The two internal crash-resistant fuel tanks (CFT) were present in their normally installed location; the right internal CFT was partially detached and the left internal CFT remained attached to the airframe.

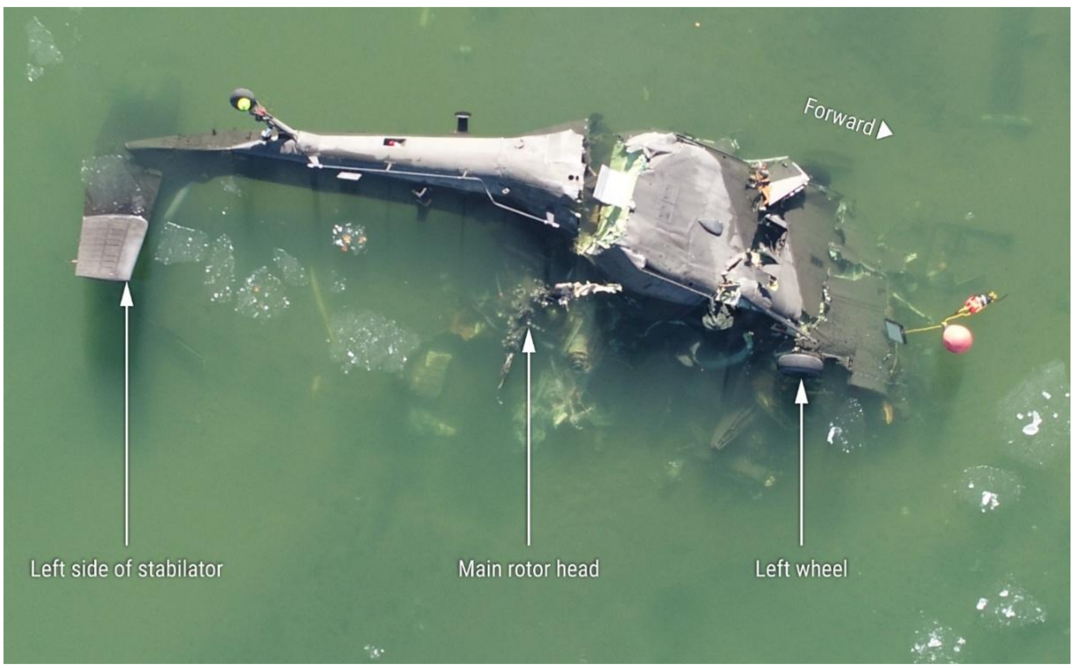

Figure 31. Helicopter main wreckage as it came to rest in the Potomac River.

The tail boom was intact and exhibited damage limited to wrinkled skin. The vertical fin was mostly intact, except for its upper end, which was fractured and deformed to the right. The stabilator was intact and exhibited impact deformation in the forward direction about the middle and aft end of the stabilator.

The main gearbox (MGB) remained attached to the structural roof beams, which had separated from the main fuselage. The MGB housing was whole and the main rotor shaft remained installed. The main rotor hub remained installed on the main rotor shaft. All four main rotor blades were fractured near the hub.

The tail rotor hub inboard and outboard retention plates were recovered as an assembly and remained installed on the tail rotor gearbox output shaft. One of the four tail rotor blades remained mostly intact but exhibited damage to its tip and trailing edge. Remnants of the other three tail rotor blades remained in the retention plate assembly, as shown in figure 32.

Figure 32. The helicopter's tail rotor as recovered, attached to the tail rotor gearbox.

Note: Of the four tail rotor blades, only one remained largely intact.

The cockpit area was heavily fragmented. The pilot's barometric altimeter and horizontal situation indicator were found separate from the cockpit area. The pilot's barometric altimeter Kollsman window read between 29.88 and 29.89 inHg and the altimeter pointer was found near 650 ft, as shown in figure 33. The pilot's radar altimeter was found separated from the wreckage with the glass face fractured and the IRT pointer indicating near 250 ft.

Figure 33. The left (pilot's seat) barometric altimeter.

A portion of the IP's instrument cluster was found separated from the cockpit structure but remained connected via hoses and cables. The right barometric altimeter Kollsman window read 29.87 inHg and the altimeter pointer was found near 150 ft (see figure 34). The IP's radar altimeter indicator pointer was found near 300 ft.

Figure 34. The right (IP's seat) barometric altimeter.

Both the pilot and IP barometric altimeters, as well as the pilot and IP radar altimeter indicators and their antennas, were retained for additional examination. The ESIS was found partially separated from the instrument panel and remained attached via wiring. The glass cover was fractured, but the screen was not cracked.

The pitot-static system was highly fragmented, with fractured pieces found in the cockpit area of the main wreckage. One whole pitot-static probe (right side) and one partial pitot-static probe (left side) were recovered, both of which were separated from the helicopter fuselage. The pitot and static lines from the left and right side pitot-static probes were traced along the airframe and exhibited fractures in multiple locations. The fittings at the unions along these lines were checked for security and confirmed to be tight. The fittings on the fractured pieces of the pitot-static system were confirmed to be tight except for one fitting for a pitot outlet line found near the cockpit nose wreckage. Further examinations of the lines and fittings at the NTSB Materials Laboratory found that all fractures were in overload and that no fittings showed damage consistent with pre-accident looseness or vibratory wear.

The aft portion of the left (No. 1) engine from the diffuser and midframe assembly to the exhaust frame was recovered intact with no evidence of external fire or uncontainment. Additional pieces recovered by dive teams included the accessory gearbox, one compressor case half, the compressor stage 2 bladed disk, the power takeoff shaft bevel gear, two pieces of the main frame, and the swirl frame. The engine output drive high-speed shaft was separated from the engine but was recovered with a portion of the forward support tube. The aft side of the high-speed shaft contained the fractured end of the power turbine drive shaft.

The No. 2 (right) engine appeared intact with no evidence of external fire or uncontainment. Hand rotation of the high-speed shaft resulted in corresponding smooth and continuous rotation of the power turbine.

The helicopter's APU was recovered intact, but separated from the helicopter. There was no evidence of external fire or uncontainment.

Examination of the helicopter's transponder revealed that the wire for pin 24 of the RCU connector, which is involved with determination of the aircraft's transponder address that is transmitted, was separated from its connector cup. The other wires were intact and only limited corrosion was observed. Separation of the pin 24 wire is consistent with the incorrect aircraft address that was intermittently transmitted via Mode S MLAT since at least October 2023, as previously discussed in section 1.4.4.1. The accident transponder's input/output circuit card was installed into an exemplar RCU to review the accident transponder's settings for the accident flight. The "ADS SQTR" setting was found off, and the time source setting was incorrect.[90]

[90] When ADS SQTR is "OFF," the ADS-B squitter is set not to broadcast. The time source setting is used to control the time and position data source that is used by the RCU. The accident helicopter's transponder time source setting at the time of the accident was "153." This issue is also discussed in section 1.4.4.

Four NVG cases were recovered from the accident area, two of which were white phosphor type; the two others were green phosphor. A hand-written receipt indicated that the IP had checked out all four NVGs before departing on the accident flight. Three of the cases were empty except for some lens caps. The fourth contained a damaged pair of NVGs (green phosphor). Three crew helmets were also recovered from the wreckage area. Although the helmets could be correlated to each member of the flight crew, which NVGs were mounted to each helmet could not be determined, as there were no matching broken wires or fracture surfaces.

1.9.3.1 Helicopter Altimeters

Examination of the helicopter's left and right barometric altimeters revealed corrosion and silt contamination consistent with water immersion, as well as impact damage. The damage precluded functional testing of both altimeters; however, disassembly did not reveal any anomalous damage that would have precluded normal operation.

Examination of the radar altimeter indicators revealed that the right radar altimeter housing was impact damaged. The altimeter powered on when connected to a test bench and indicated near but slightly below its required altitudes when corresponding voltages were applied. The left radar altimeter IRT dial pointer indicated about 250 ft. The four connector plugs on the back side of the IRT were fractured and separated, which precluded functional testing. The indicator portion of the IRT was disassembled and revealed no anomalies other than corrosion due to water immersion. The indicator pointer rotor could be manually turned.

1.10 Medical and Pathological Information

1.10.1 Flight 5342 Crew

1.10.1.1 Captain

The captain's most recent FAA medical examination was in January 2025. At that time, he reported no medication use and no active medical conditions. No significant issues were identified, and he was issued a first-class medical certificate without limitation.

Reviewed personal medical records from the practice of the captain's primary care provider generally were consistent with the medical information documented in the captain's FAA medical certification file. The captain's primary care provider was his aviation medical examiner.

According to the captain's autopsy report, his cause of death was multiple blunt force injuries, and his manner of death was accident. The extent of the captain's injuries severely limited autopsy evaluation for natural disease; within these limitations, his autopsy did not identify significant natural disease.

Toxicological testing by the FAA Forensic Sciences Laboratory did not detect any tested-for substances in postmortem specimens from the captain.[91]

1.10.1.2 First Officer

The first officer's most recent aviation medical examination was in October 2024. At that time, he reported no medication use and no active medical conditions. No significant issues were identified, and he was issued a first-class medical certificate limited by a requirement to use corrective lenses to meet vision standards at all distances.

According to the FO's autopsy report, his cause of death was multiple blunt force injuries, and his manner of death was accident. His autopsy did not identify evidence of significant natural disease.

Toxicological testing by the FAA Forensic Sciences Laboratory did not detect any tested-for substances in postmortem specimens from the FO.

1.10.2 PAT25 Crew

1.10.2.1 Pilot

The pilot's most recent aeromedical upslip was dated August 2024, and was valid through the end of February 2025.[92] It carried limitations that vision correction devices were required in the performance of flight duties, and that the pilot must carry extra spectacles.

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[91] Specimens from pilots fatally injured in US civil aviation accidents routinely are submitted to the FAA Forensic Sciences Laboratory for toxicological testing. The FAA Forensic Sciences Laboratory has the capability to test for around a thousand substances including alcohol, illicit drugs, prescription and nonprescription medications, and toxins. Additional information may be found on the laboratory's methodology web page. The comparative capabilities of the FAA Forensic Sciences Laboratory and the Armed Forces Medical Examiner System (AFMES) Division of Forensic Toxicology were considered for this investigation, with input from forensic toxicology supervisors at both institutions. Broadly, FAA and AFMES screening capabilities are similar in scope, except that AFMES has the capability to screen for a larger number of synthetic cannabinoids. Therefore, AFMES testing of the US Army aircrew and FAA testing of the airplane captain and first officer were broadly comparable.

[92] An aeromedical upslip documents that a crew member has been found medically qualified for flight duty by a trained Army aeromedical provider, with approval by a commander.

At the time of the accident, the pilot also possessed an aeromedical waiver for Class 2 flying duties due to history of adjustment disorder.[93] As of the accident date, there was no indication in reviewed records that she had ongoing psychiatric symptoms or an active diagnosis of any psychiatric condition. Her past adjustment disorder had been treated with behavioral health therapy, without medication. She and her therapist mutually agreed to discontinue therapy in 2023 with her goals met; she had been recommended for full flying duties after her last aeromedical psychological evaluation, and had been granted her waiver after a multi-stage Army aeromedical review process. She had been found medically qualified for flight duty by a trained Army aeromedical provider, with approval by a commander.

According to the pilot's autopsy report, her cause of death was multiple blunt force injuries, and her manner of death was accident. Her autopsy did not identify significant natural disease.

Toxicological testing by the Armed Forces Medical Examiner System (AFMES) Division of Forensic Toxicology did not detect any tested-for substances in postmortem specimens from the pilot.

1.10.2.2 Instructor Pilot

The IP's most recent aeromedical upslip was dated November 2024, which was when he had his last flight physical examination. The upslip carried no limitations and was valid through the end of November 2025.

According to the IP's autopsy report, his cause of death was multiple blunt force injuries, and his manner of death was accident. Examination of his coronary arteries identified narrowing of his left anterior descending coronary artery by plaque. Fibrous adhesions were present in his right chest cavity. The remainder of his autopsy did not identify other significant natural disease.

Toxicological testing by the AFMES Division of Forensic Toxicology did not detect any tested-for substances in postmortem specimens from the IP.

1.10.2.3 Crew Chief

The crew chief's most recent aeromedical upslip was dated November 2024, and was valid through the end of June 2025. It carried limitations that vision

[93] Adjustment disorder, as defined in the *Diagnostic and Statistical Manual of Mental Disorders* (*DSM-5*), is a stress-related condition in which emotional or behavioral symptoms develop in response to an identifiable stressor and cause distress or impairment that exceeds expected reactions. Symptoms typically resolve once the stressor or its consequences have diminished (APA, 2022).

correction devices were required in the performance of flight duties, and that the crew chief must carry extra spectacles.

At the time of the accident, the crew chief also possessed aeromedical waivers for Class 3 flying duties due to a history of defective stereopsis (depth perception) and alternating esotropia (one eye turning inward more than the other, affecting each eye alternately), as well as to a history of motion sickness.

The crew chief's last flight physical examination was in July 2024. His aeromedical waivers were noted. His corrected visual acuity met standards. He passed a depth perception test. No significant medical concerns were identified. He was recommended for continuation of his waivers, and was given an upslip. Records indicated that motion sickness was not typically an issue for the crew chief, except possibly upon return to flying after a period off. During September and November 2024, the crew chief had voluntarily undergone medical grounding due to family stressors; however, he was cleared by an aeromedical provider for return to flight duties after responding well to counseling.

According to the crew chief's autopsy report, his cause of death was multiple blunt force injuries, and his manner of death was accident. His autopsy did not identify significant natural disease.

Toxicological testing by the AFMES Division of Forensic Toxicology did not detect any tested-for substances in postmortem specimens from the crew chief.

1.10.3 Controllers

1.10.3.1 Local Control Controller

The LC controller's last ATC specialist medical clearance examination before the accident was August 15, 2024. At that time, he also was applying for second-class pilot medical certification. He reported no medication use and no active medical conditions. He received ATC specialist medical clearance, with a limitation that he must possess vision corrective lenses to meet the ATC Specialist Health Program standards and use those lenses as appropriate for ATC duties. He also was issued a second-class pilot medical certificate. His Department of Transportation (DOT) workplace postaccident urine drug testing was negative, as discussed in section 1.10.4.3.

1.10.3.2 Assistant Local Control Controller

The ALC controller's last ATC specialist medical clearance examination before the accident was April 11, 2024. At that time, she reported no medication use and no active medical conditions. She received ATC specialist medical clearance without limitation. Her DOT workplace postaccident urine drug testing was negative, as discussed in section 1.10.4.3.

1.10.3.3 Operations Supervisor

The OS's last ATC specialist medical clearance examination before the accident was February 8, 2024. At that time, he reported no medication use and no active medical conditions. He received ATC specialist medical clearance, with a limitation that he must possess vision corrective lenses to meet the ATC Specialist Health Program standards and use those lenses as appropriate for ATC duties. His DOT workplace postaccident urine drug testing was negative, as discussed in section 1.10.4.3.

1.10.4 Controller Postaccident Drug and Alcohol Testing

1.10.4.1 Testing Requirements

As the FAA is part of the DOT, FAA-employed air traffic controllers are subject to federal workplace drug and alcohol testing requirements for DOT employees as outlined in DOT Order 3910.1D, "Drug and Alcohol-Free Departmental Workplace Program." According to the order, controllers must undergo postaccident drug and alcohol testing as soon as possible after a fatal accident if their performance at or about the time of the accident provides reason to believe that such performance may have contributed to the accident or if their job performance cannot be completely discounted as a contributing factor to the accident. In addition to accidents involving fatalities, accidents and incidents involving a need for medical treatment away from the accident site, substantial damage to aircraft or other vehicles/property, or other specifically defined unsafe practices trigger required postaccident or postincident drug and alcohol testing.

DOT Order 3910.1D states that, whenever possible, required postaccident drug testing must be completed within 4 hours after the accident and alcohol testing within 2 hours after the accident; however, the order allows for drug testing up to 5 days after the accident and alcohol testing up to 8 hours after the accident.[94] A controller who may be subject to postaccident testing, but who has not yet been tested, must remain available for testing and may not use alcohol for 8 hours following the accident. The order also specifies requirements for FAA reporting of postaccident testing information, including notification timeline and reasons why any testing did not occur within required timeframes, to the DOT Departmental Drug Office.

[94] DOT Order 3910.1D, chapter III, paragraphs 6.i(6) and 6.i(7).

1.10.4.2 Testing Determination Process and Implementation

FAA Order JO 1030.3B, "Initial Event Response," specifies Air Traffic Organization (ATO) procedures and responsibilities for notification and response to accidents and other significant events (FAA, 2014a). According to the order, a drug and alcohol testing determination review should normally be held concurrently with a services rendered telephone conference (SRT).[95] An SRT is typically convened the "administrative day" following the event to allow time for notification of the appropriate operations and quality control personnel and a preliminary investigation, which includes preparing audio communications and radar display information for playback to determine the quality of service provided. However, in a significant event such as a major air carrier accident or a fatal accident involving air traffic control services, the SRT should be established as soon as possible but no later than 3 hours following notification.[96]

If it is determined during the SRT that postaccident/incident drug and/or alcohol testing will proceed, the facility manager or district manager contacts the service center drug program coordinator, who contacts the testing contractor via a 24/7 telephone number and obtains an estimated response time for the contractor to be onsite.

1.10.4.3 Accident Controller Testing Timeline and Results

As previously noted, the collision occurred at 2047:59. FAA and DOT records revealed that the SRT regarding this accident took place at 2330 on the night of the accident. The controllers were released at 0000, and the determination to conduct drug testing without alcohol testing was made 15 minutes later, at 0015 on January 30. The drug program coordinator was notified at 0022.

The DOT Post-Accident/Incident Drug/Alcohol Test Collection Report indicated that the testing contractor was immediately available by telephone when contacted by the drug program coordinator at 0049 on January 30. The LC and ALC controllers, as well as the OS, were administered drug tests the day after the accident, using urine collected at 1508, 1658, and 1521, respectively. No tested-for substances were detected.[97] Alcohol testing was required under DOT Order 3910.1D, but was

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[95] An SRT is a management review to assess the ATO services associated with an event. The SRT is intended to give all participants a snapshot of the conditions surrounding the event, and for managers to be able to openly discuss critical operational information associated with the event.

[96] FAA Order JO 1030.3B, chapter 3, paragraph d.

[97] Tested-for substances and cutoffs were in accordance with the applicable Mandatory Guidelines for Federal Workplace Drug Testing Programs Using Urine, published at 88 *Federal Register* 70768, section 3.4.

not conducted for any of the controllers who were working at the time of the accident.

The DOT Post-Accident/Incident Drug/Alcohol Test Collection Report stated that the reason alcohol testing was not performed within 2 hours of the accident (and why drug testing was not performed within 4 hours of the accident) was that the decision to test was made almost 4 hours after the accident and the employees had already left the building.

In testimony provided at the NTSB's investigative hearing, the FAA ATO acting deputy COO attributed the decision not to conduct alcohol testing of the controllers on position at the time of the accident to "holding out hopes it was a rescue operation" before fatalities had been confirmed, and to the fact that decision-making ATO managerial staff were not present on scene until they had been notified through the official notification process. However, testing was required because substantial aircraft damage was present and clearly apparent to any of the witnesses, regardless of fatalities.

Additionally, the FAA's vice president for air traffic services arrived on scene 18 minutes after the collision and the FAA's event response team arrived on scene soon thereafter. The FAA ATO acting deputy COO stated that the controllers were released because they had already been on duty for over 10 or 11 hours and that they were warned that they should abstain from drug and alcohol use pending probable testing. He further stated that, because they had already missed the 2-hour window, the decision was made to forgo alcohol testing and conduct drug testing the following day. He subsequently clarified that the limiting factor for making the testing determination was deciding which controllers were required to be tested, referring to the SRT process.

When asked whether the ATO had prepared a required memorandum for the DOT stating why postaccident drug and alcohol testing was not accomplished in a timely manner, the acting deputy COO stated that he didn't believe this had been done. He stated that this was likely due to staff's lack of knowledge about the requirement for a memorandum and because a major accident such as this one "is not a normal experience for…most of the people in those positions." He further stated the following:

> A lot of things dropped off during the pandemic…we had a rotation of the on-call specialists that take these kind of calls, that handle the drug testing, and people retire, we got new folks in without the experience, and so they have never been involved in some major accident like this.

When asked if the ATO had made any changes to the drug testing process following the accident, he stated that the initial event response procedures pertaining to SRTs and drug and alcohol testing determinations were "under revision."

As of this report's date, the FAA was unable to provide a copy of its required memorandum to the DOT, and FAA Order JO 1030.3B remains unchanged.

1.11 Tests and Research

1.11.1 Night Vision Goggles

Night vision goggles are image intensification devices that amplify low ambient lighting levels. They present an image to the user that more closely resembles vision during the day and allows operations to be performed in very low lighting conditions. The Army uses various models of NVGs; the accident helicopter crew was equipped with Aviator's Night Vision Imaging System (ANVIS) AN/AVS-6 NVGs. The pilots' NVGs were attached to their helmets along with a battery pack. Counterweights were attached near the rear of the helmet to offset the weight of the NVGs. The binocular system could be rotated up on its mount to allow for rapid transition from "aided" (with NVGs) to "unaided" (without NVGs) vision, as shown in figure 35.

Figure 35. Pilot wearing AN/AVS-6 helmet-mounted night vision goggles.

Note: The left image shows the binocular system in an "unaided" (without NVGs) position. The center and right images show the binocular system in an "aided" (with NVGs) position.

Four helicopter operators in the area—the USAF 1st Helicopter Squadron, the USCG National Capital Region Air Defense Facility helicopter detachment, the Prince George's County Police, and MedSTAR—all stated in postaccident interviews that they use NVGs during night operations. NVGs provide improved night visual acuity, allowing the user to more effectively fly by reference to external visual cues and allowing them to see potential hazards such as towers, cranes, terrain, and other aircraft. The use of NVGs generally results in safer night helicopter operations, especially when operating at low altitudes.

Army training materials indicated (and NTSB testing confirmed) that ANVIS AN/AVS-6 NVG tubes provided a 40° field of view. The green phosphor model provided monochrome green images with approximate 20/40 visual acuity. The white phosphor model had improved light amplification capabilities and resolution, presenting a white-colored monochrome image permitting 20/25 acuity. According to 12th Aviation Battalion personnel, there was no policy requiring pilots to use one type over the other, and no policy requiring crew members to use the same type.

A standardization pilot from the TAAB stated in an interview that it was somewhat challenging to use NVGs in the area of DCA due to the prevalence of cultural lighting and related dimming of NVG images; however, he did not consider these challenges to be "prohibitive."[98]

When asked how cultural lighting affected operations with NVGs, an Army standardization instructor testified in the investigative hearing that it would be much higher risk to fly without NVGs in areas with less cultural or ground lighting; however, when flying in the DCA area, the use of NVGs is an increased risk, as the cultural lighting could negatively impact a pilot's ability to see other aircraft. When asked if it was possible to discern aircraft lights from ground lights at a distance of several miles, he stated that "those [aircraft] just appear as point lights. It's very difficult to tell."

The NTSB took observation photos from the top of a building located about 2 nm northeast of DCA when airport operations were in a north configuration (airplanes approaching from the south). The photos were taken through white phosphor ANVIS 9 NVGs, which have the same optical performance as the accident helicopter crew's NVGs. The photos captured multiple airplanes approaching runway 1 at DCA. The airplanes appeared as points of light with no obvious aircraft structure and their relative distance from the observation point was difficult to discern. Figure 36 shows an example of a view through the white phosphor ANVIS 9 NVGs, as captured in a frame from a video recorded by an iPhone held to one of its viewing lenses.

[98] The FAA uses the term "cultural lighting" to describe man-made lighting, such as the built-up area of a city.

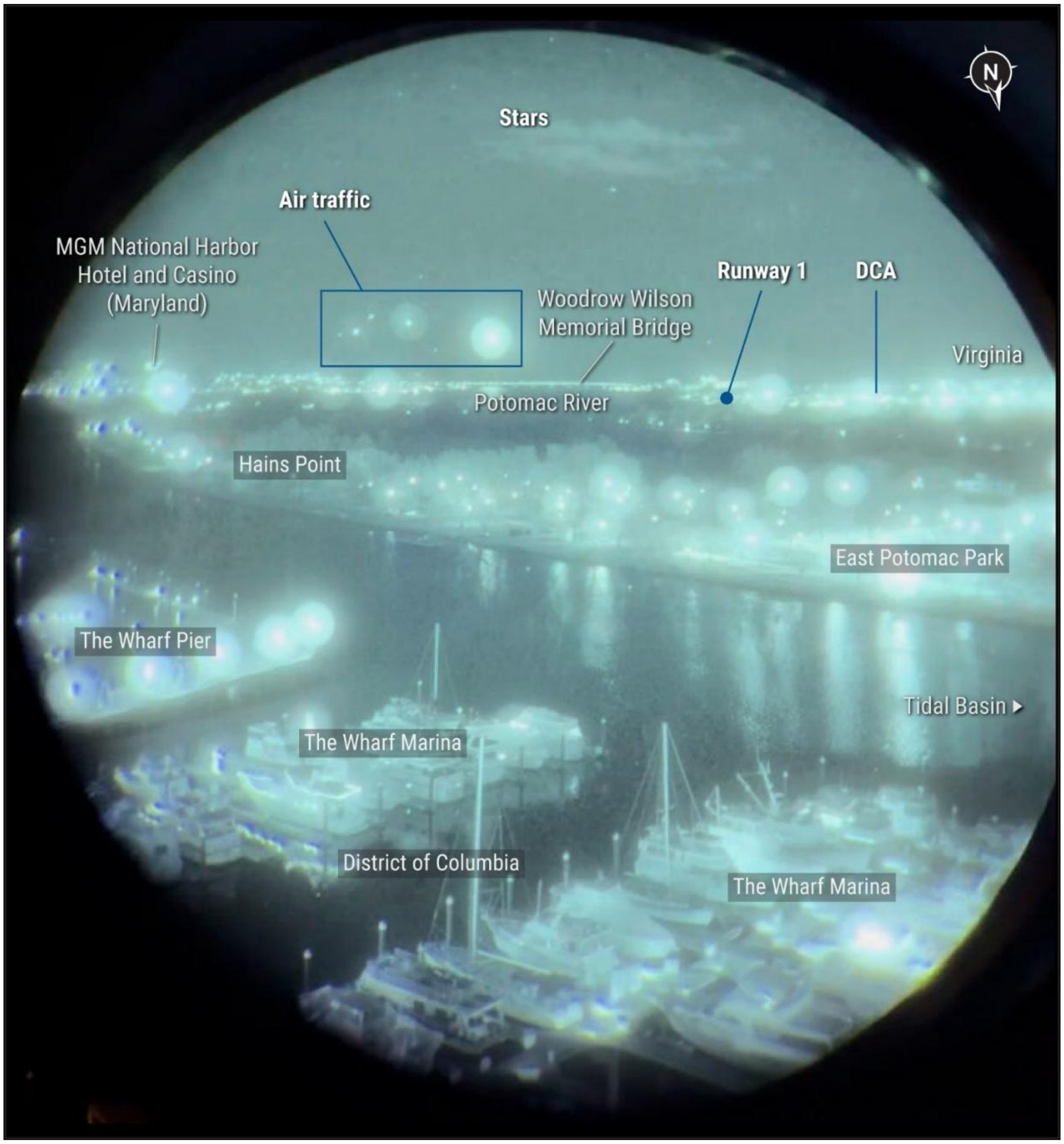

Figure 36. White phosphor night vision goggle view of airplanes approaching runway 1 at DCA.

Note: Image was captured in a frame from a video recorded by an iPhone held to one of the NVG's binocular viewing lenses. Capturing clear images through the NVGs' eyepieces is difficult; investigators found that the actual view through NVGs is sharper and clearer than depicted in the figure. The image is provided to depict the appearance of ground cultural lighting and airborne aircraft in the accident area when viewed through NVGs. The vantage point from which this image was captured (160 ft agl) is about 100 ft lower than the altitude at which the helicopter was flying (about 260 ft agl) and offset about 800 ft from the centerline of its flight path. However, at a distance of over 5 nm, the difference in angular displacement of the aircraft above the horizon would be imperceptible to the viewer. Thus, the cluster of aircraft above the horizon approaching DCA is similar to what the crew would have seen from the helicopter.

Figure 37 shows an example of the view looking south from Hains Point through green phosphor ANVIS 9 NVGs, as captured in a frame from a video recorded by an iPhone held to one of its viewing lenses.

Figure 37. Green phosphor night vision goggle view of airplanes approaching DCA from the south, as seen from Hains Point.

Note: Image was captured in a frame from a video recorded by an iPhone held to one of the NVG's binocular viewing lenses. Capturing clear images through the NVGs' eyepieces is difficult; investigators found that the actual view through NVGs is sharper and clearer than depicted in the figure.

1.11.2 Exterior Lighting Study

The NTSB Vehicle Recorder Division reviewed multiple video files that captured the accident from cameras located at various sites to determine the status of the exterior lights on both aircraft before the collision. The helicopter was equipped with seven exterior lights; left, right, and tail position lights, upper and lower anti-collision beacon lights, a landing light, and a search light, as shown in figure 38.

Figure 38. Left view of a UH-60L showing landing light (A), left navigation light (B), flashing lower anti-collision beacon (C), flashing upper anti-collision beacon (D), and tail position light (E).

Note: The search light, which was not illuminated at the time of the accident, is similarly not illuminated, labeled, or depicted in this figure.

The airplane was equipped with exterior lights as shown in figure 39. The airplane's exterior lights did not utilize light-emitting diode (LED) technology.

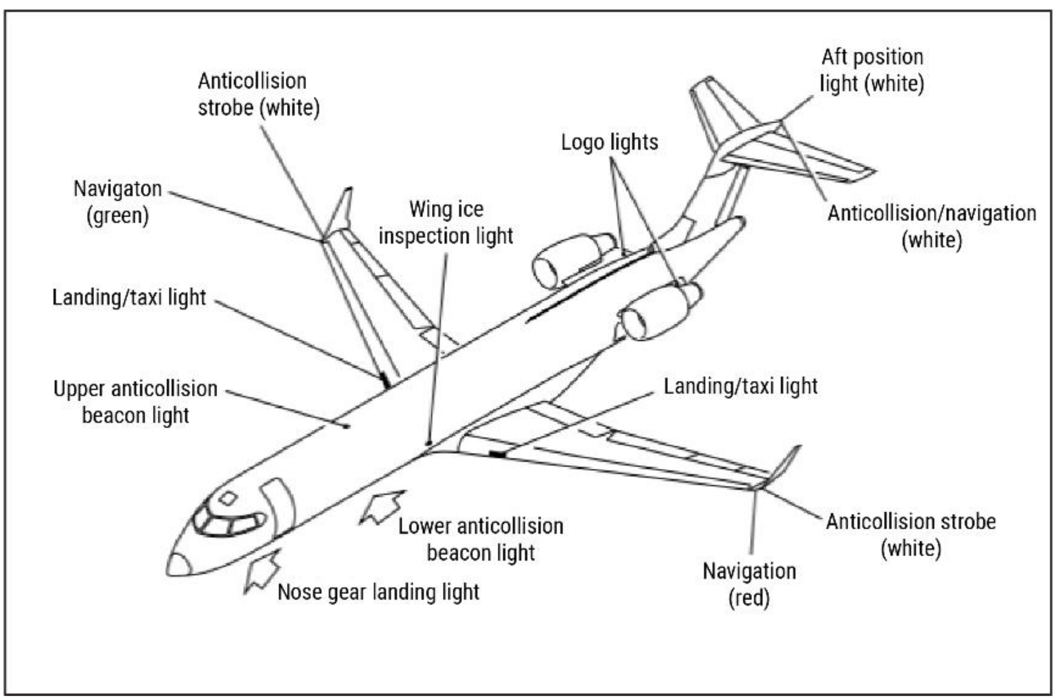

Figure 39. CRJ700 exterior lighting diagram. (Source: MHI RJ Aviation)

A frame-by-frame analysis of the videos determined the operational status of each aircraft's exterior lights as shown in table 12 and table 13.

Table 12. Airplane exterior lighting findings.

Light location	Color	Status
Right Wing Ice Inspection	White	Inconclusive
Left Wing Ice Inspection	White	Inconclusive
Aft Position	White	Inconclusive
Nose Gear Landing	White	Operational
Right Wing Navigation	Green	Operational
Left Wing Navigation	Red	Operational
Right Wing Landing/Taxi	White	Operational
Left Wing Landing/Taxi	White	Operational
Upper Anti-collision Beacon	Red	Operational
Lower Anti-collision Beacon	Red	Operational
Rear Anti-collision Navigation	White	Operational
Right Logo	White	Operational
Left Logo	White	Operational
Right Wing Anti-collision Strobe	White	Operational
Left Wing Anti-collision Strobe	White	Operational

Table 13. Helicopter exterior lighting findings.

Light location	Color	Status
Left Position	Red	Inconclusive
Right Position	Green	Operational
Tail Position	White	Operational
Upper Anti-collision	Red/White	Operational
Lower Anti-collision	Red/White	Operational
Landing	White	Operational
Search	Infrared	Inconclusive

1.11.3 Aircraft Performance Study

1.11.3.1 Altitude Measurements

To address many questions that arose related to the helicopter's barometric altimeters early in the investigation, an aircraft performance study was conducted to examine the altitude parameters recorded by each aircraft during the accident flight. Definitions of the various types of altitude measurements are provided to aid understanding of the altitudes discussed:

- *True altitude:* The vertical distance of the aircraft above mean sea level.
- *Pressure altitude:* The altitude that the international standard atmosphere (ISA) model assigns to the atmospheric pressure measured by the aircraft. The model uses a standard pressure of 29.92 inHg at sea level; pressure decreases as altitude increases. An aircraft's air data system measures the

outside static pressure, which is then converted to an altitude according to the ISA model.[99]

- *Barometric/indicated altitude:* If, due to weather conditions, the pressure in the area is not reflective of the standard atmosphere, it must be corrected with the local barometric pressure setting (provided by ATC and/or automated weather observation broadcasts). The local barometric pressure setting is set into the altimeter in the cockpit and displayed via the Kollsman window so that the altimeter displays the corrected pressure altitude, also referred to as indicated altitude or barometric altitude.[100]

  Figure 40 shows a barometric altimeter displaying pressure altitude (left) and barometric altitude (right). To reflect true altitude, barometric altitude requires an additional temperature correction, which is usually not applied on the barometric altimeter.[101] However, the movement of air over the aircraft's surface changes its static pressure and can make measurement of the pressure of the undisturbed ("freestream") air difficult. Any difference between the freestream pressure and the pressure sensed at the aircraft's static port will result in a "position error" in which indicated altitude differs from barometric altitude.

- *Radio (or radar) altitude:* The aircraft's height above the surface as determined by a radio (or radar) altimeter.[102] The terrain elevation under the aircraft must be added to correct radio altitude to true altitude.
- *Geometric altitude:* The altitude above an ellipsoid model of the earth's surface determined by an aircraft's onboard GPS. To correct geometric altitude, the local correction for the height of the geoid (the difference between msl and the ellipsoid at a given location due to variations in the earth's distribution of mass and gravity field) is added to determine the aircraft's altitude above msl.

[99] Static pressure is defined as the pressure of air that is still or not moving, measured perpendicular to the surface of the aircraft.

[100] This assumes zero instrument error, which is discussed further in section 1.11.3.3.

[101] ISA standard temperature at sea level is 15°C (59°F). At low altitudes, the difference between barometric altitude and true altitude is small if the Kollsman window is set to the local altimeter setting.

[102] A radar altimeter calculates height by sending a beam of radio waves downward and timing how long it takes to travel to the surface, reflect, and return to its antenna.

Figure 40. Comparison between pressure altitude and corrected barometric altitude.

Note: The altimeter on the left does not have the local barometric pressure setting displayed and shows the aircraft's pressure altitude. The right altimeter displays the local barometric pressure setting and indicates 50 ft, consistent with field elevation.

1.11.3.2 Airplane Altitude Parameters

The airplane's FDR recorded pressure altitude and radio altitude. ADS-B Out data from the airplane transmitted geometric altitude and pressure altitude. True altitude was estimated by correcting pressure altitude to 29.90 inHg, the local barometric pressure setting at DCA at the time of the accident, and correcting radio altitude by adding the terrain elevation under the airplane's flight path. Geometric altitude was corrected using the local height of the geoid. These three independent estimates of true altitude showed good agreement, generally within 20 ft of each other.

1.11.3.3 Helicopter Altitude Parameters

The helicopter's FDR recorded radio altitude and a parameter erroneously labeled as barometric altitude. Review of the data and aircraft wiring diagrams revealed that the parameter labeled barometric altitude was actually pressure altitude and did not account for local barometric corrections. Geometric altitude was not available because the helicopter was not broadcasting ADS-B Out during the flight. Radio altitude was corrected using local terrain elevation and pressure altitude was corrected using a barometric setting of 29.90 inHg. Since much of the helicopter's flight path leading to the accident was over the Potomac River, radio altitude was generally equal to true altitude.[103]

The collision occurred at an altitude of 278 ft msl. At the time of the impact, the FDR data for each aircraft showed that their respective radio altitudes were within 10 ft, consistent with the helicopter impacting the underside of the airplane, as confirmed by the wreckage examination. The helicopter's barometric altitude, however, was about 100 ft lower than the other recorded altitudes, as shown in figure 41.

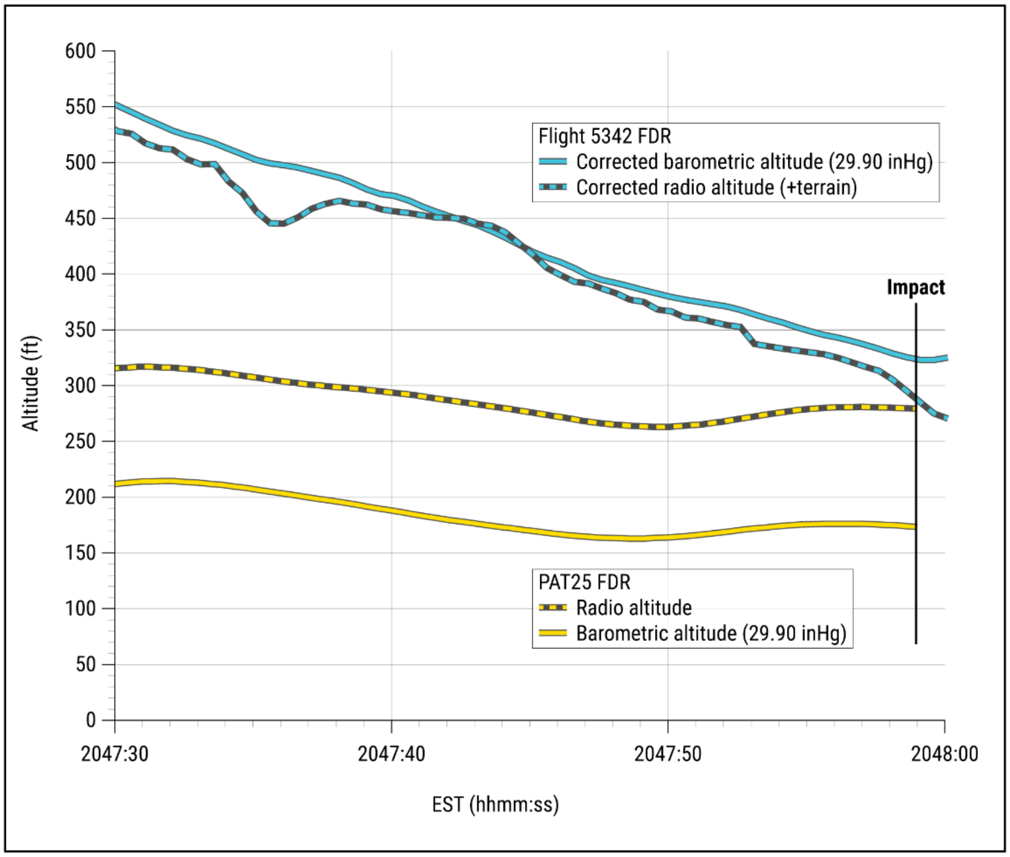

Figure 41. FDR-corrected radio and barometric altitudes for the airplane and helicopter for the flights' final 30 seconds.

Further review of the helicopter's pressure altitude parameters included comparing field elevations at the locations where the helicopter took off and landed

[103] The segment of the Potomac River in the accident area is tidally influenced; the Potomac becomes a tidal river below the Chain Bridge, which is located about 4 miles upstream of downtown Washington, DC. Downstream of the Chain Bridge, radio altitude recorded over water is equal to height above mean sea level. The tidal fluctuation on the day of the accident was between -0.59 ft and 2.4 ft. This difference is smaller than any uncertainty in the measurement of altitude and is not considered when discussing the helicopter's radio altitude parameters.

during the accident flight. Correcting the pressure altitude to reflect barometric altitude found the resulting altitude to be 80 to 100 ft lower than the known field elevations. Although changes in pressure altitude recorded by the helicopter's FDR reflected changes in radio altitude, the absolute values observed were too low to be considered accurate for the purposes of the investigation.

Avionics diagrams showed that the static pressure from the pitot-static system was measured by the air data transducer, where it was converted to an altitude based on the ISA standard model, uncorrected for local atmospheric conditions. This pressure altitude value was subsequently sent to the remote data concentrator, which converted that information into a data stream that was provided to the IVHMS, including the FDR, for recording. Separately, the static pressure was sensed by each pilot's barometric altimeter and converted to an altitude indication independently. Each pilot would adjust their altimeter's barometric setting via their Kollsman window. The uncorrected pressure altitude from the right side barometric altimeter was sent to the airplane's transponder, which transmitted the pressure altitude data when configured to do so. Figure 42 shows a diagram of the helicopter's static system.

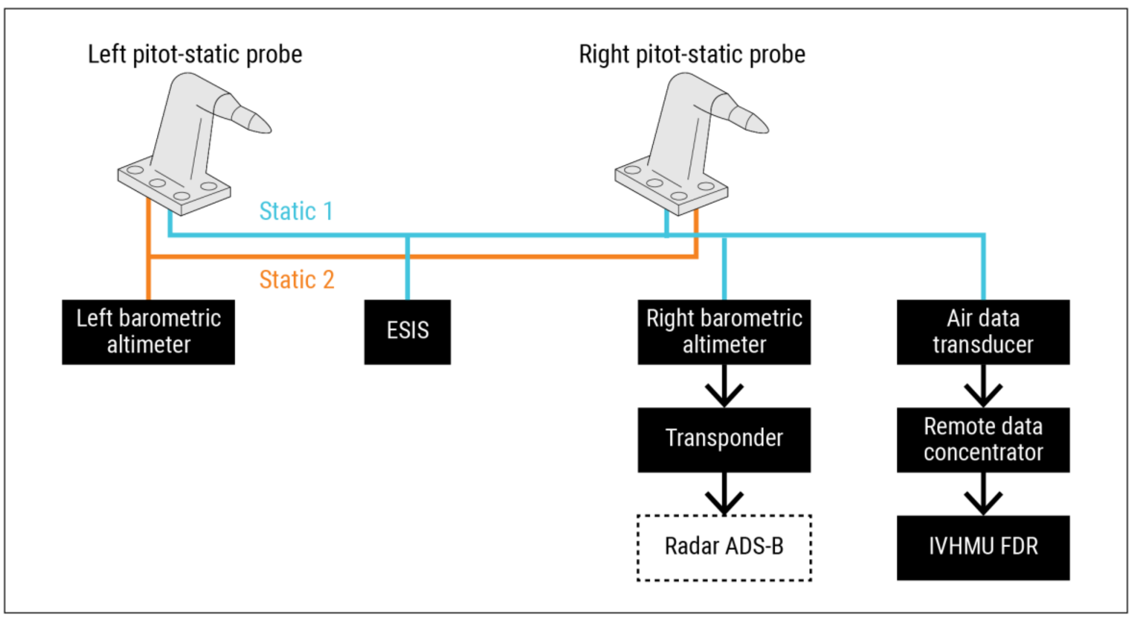

Figure 42. Diagram of the Sikorsky UH-60L static system.

In support of the visibility studies discussed in section 1.11.4, a Sikorsky UH-60L ESSS-equipped helicopter from the 12th Aviation Battalion conducted several flights along Helicopter Routes 1 and 4. Review of the recorded data for that flight revealed that the FDR-recorded pressure altitude values, when corrected for the local barometric pressure setting, were lower than the recorded radio altitude value corrected for terrain elevation and the ADS-B geometric altitude when corrected for local height of the geoid. The difference between the radio altitude and barometric altitude values was similar to the data for the accident helicopter during the accident flight.

To collect more information about the low recorded barometric altitude values, the pilots of three UH-60L helicopters flew a regularly scheduled mission while wearing chest-mounted cameras to capture radio and barometric altimeter readings from the right side of the instrument panel. The cameras captured pre-flight checks, flight over terrain and the Potomac River, and the return to base. After the flights, the FDR and IVHMU data were downloaded. Pilot changes to altimeter settings recorded during the flight were correlated to the recorded data for comparison. All three helicopters showed barometric altimeter values lower than the true altitude, which could be determined from the radio altitude when the helicopters were over the Potomac River.

The Army and Sikorsky provided developmental flight test information related to the altimeter position error versus indicated airspeed for the UH-60 helicopter. In hovering flight, the barometric altimeter can read 80 ft low due to position error associated with main rotor downwash.[104] As the helicopter increases forward speed, the error becomes less, so that by 30 kts indicated airspeed, the altimeter error should decrease to about 35 ft low. By 120 kts indicated airspeed, the barometric altimeter should no longer be affected by the rotor downwash and so should reflect the pressure altitude corrected for local conditions. Above 120 kts, position error will cause the barometric altimeter to read high.

Data from the flights also indicated that the helicopter equipped with ESSS, like the accident helicopter, showed an additional error compared to the other two helicopters. The flight test information showed that the ESSS added additional position error to the barometric altimeter system at speeds over 30 kts, lowering the barometric altimeter reading by 50 ft at those speeds, compared to the 35 ft of error for non-ESSS equipped helicopters. This was consistent with the larger error seen for the ESSS equipped helicopter from the altimeter testing discussed earlier.

Generally, the errors that result in a difference between altitude indicated on a barometric altimeter and the aircraft's true altitude can be divided into instrument errors and position errors. Instrument errors are related to tolerances within the barometric altimeter, and position errors are the result of external aerodynamic effects on the static system, including main rotor downwash as discussed in the earlier paragraphs.

[104] Downwash is the air deflected downwards through the helicopter's main rotor system as part of the production of lift and thrust. Static pressure measured in the area of this downwash is higher than ambient air, which presents a lower altitude indication.

For the previously discussed flight involving three UH-60L helicopters, the Army calculated the additive effects of these allowable errors, referred to as a tolerance stack, for instrument error, position error at an airspeed of 100 kts, and a temperature correction for the day of the altimeter testing. The calculations estimated an instrument error between 20 and 45 ft; a position error of 50 ft for an ESSS-equipped helicopter, and 7 ft for a helicopter with a "clean" configuration (not equipped with ESSS); and an additional 36-ft correction to account for the non-standard temperature.[105] The cumulative effects of these errors and corrections could account for the difference between the altitude displayed on the barometric altimeter and the true altitude, while the pitot-static system and barometric altimeters remained within specifications.

1.11.4 Visibility Studies

The NTSB completed aircraft performance and cockpit visibility studies to determine the position and orientation of each aircraft in the minutes before the collision. This information was then used to estimate the approximate location of each aircraft in the other pilots' fields of view, as well as the view from the LC controller position in the DCA ATCT.

The study comprised data from several sources, including ADS-B, radar, the aircraft FDRs and CVRs, and laser scans of the cockpits of an exemplar CRJ700 and UH-60L and of the DCA ATCT cab. To provide a rough approximation of the perspective of the flight crews and how they evolved over time, a view from each cockpit was recreated in Microsoft Flight Simulator 2024 using the program's inherent included aircraft, environment, and cultural lighting graphics.

1.11.4.1 Airplane Cockpit Visibility

Figure 43 shows an interior view of a CRJ700 cockpit. The cockpit has four windows: the left window, left windshield, right windshield, and right window.

[105] Altimeter testing was done on a day warmer than the 59°F standard at an altitude 1,000 ft above msl, which results in a lower than true altitude reading.

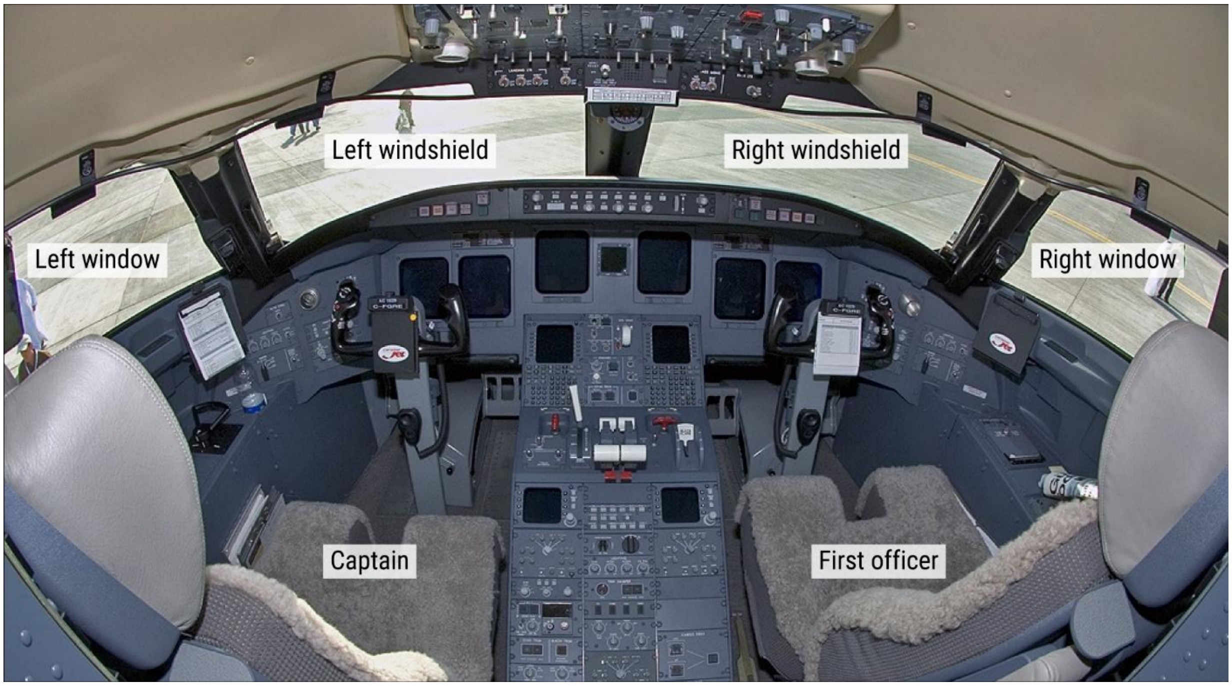

Figure 43. Interior view of a CRJ700 cockpit with seats and windows labeled.

Laser scans of an exemplar CRJ were used to determine how the structure of the airplane would have affected the pilots' view outside. Figure 44 shows the view from the left (captain's) and right (FO's) seats with the structure of the airplane shown in gray and the outlines of the pilot in the opposite seat shown in olive yellow. The shapes are distorted so that the view out all four windows can be shown together. The colored line shows where in the window the helicopter would have been visible to the captain and FO during the final 3 minutes of the flight. From 2045 to 2047:58, the helicopter would have been in the lower right corner of the left windshield for the captain and in the lower third of the right windshield for the FO.

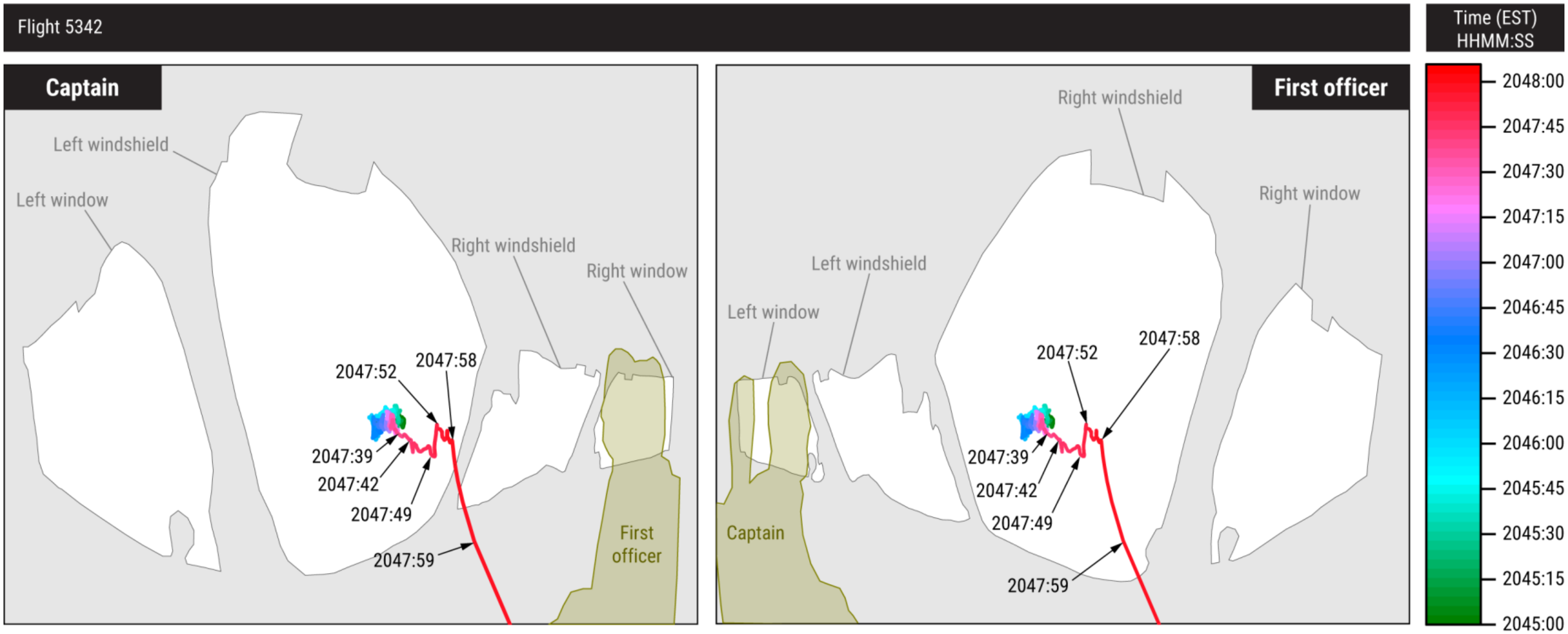

Figure 44. Viewing angles of PAT25 from the captain's (left) and FO's (right) seats of flight 5342, looking straight ahead.

However, during most of the time it was in view, the helicopter would have appeared in the airplane's windscreen as a small object spanning less than 1° of azimuth and elevation.[106] Figure 45 shows a simulated view from the left (captain's) seat of flight 5342; simulated views from the right (FO's) seat are not presented because the background views would be similar.

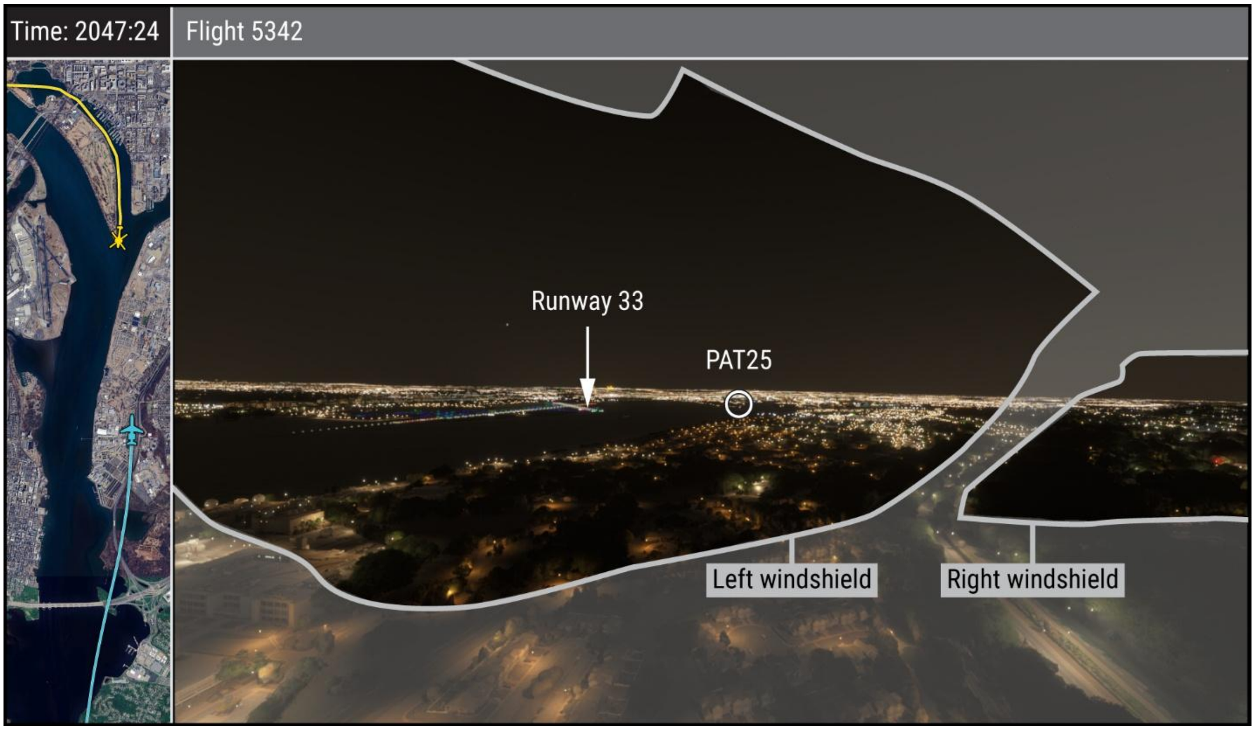

Figure 45. Simulated view from the left seat of flight 5342 at 2047:24 (35.3 seconds before the collision), looking straight ahead.

Note: Icons not to scale.

Until about 10 seconds before the collision, the helicopter would have been difficult to visually detect and identify against the cultural lighting of Washington, DC. Figure 46, a frame from a video recorded on an Apple iPhone inside the cockpit of a CRJ turning for final approach to runway 33 during an NTSB night observation flight (discussed in section 1.11.4.4), shows the extent of this cultural lighting. In the simulation, the helicopter emerged from the city lights and appeared against the dark background of the Potomac River about 2047:49. Between 2047:54 and 2047:58, the helicopter's fuselage would have grown significantly in the pilots' fields of view, and

[106] The azimuth angle is the angle between the airplane's x axis (nose to tail) and the projection of the line of sight onto the plane formed by the x and y (wingtip to wingtip) axes. The elevation angle is the angle between the line of sight itself, and its projection onto the x-y plane. The azimuth and elevation angles depend on both the position (east, north, and altitude coordinates) of the viewer and target aircraft, and the orientation (yaw, pitch, and bank angles) of the viewer. The azimuth and elevation angles of points on the target away from its center of gravity also depend on the orientation of the target.

at 2047:58 (1.3 seconds before the collision), the helicopter was apparent in the simulation, as shown in figure 47.[107]

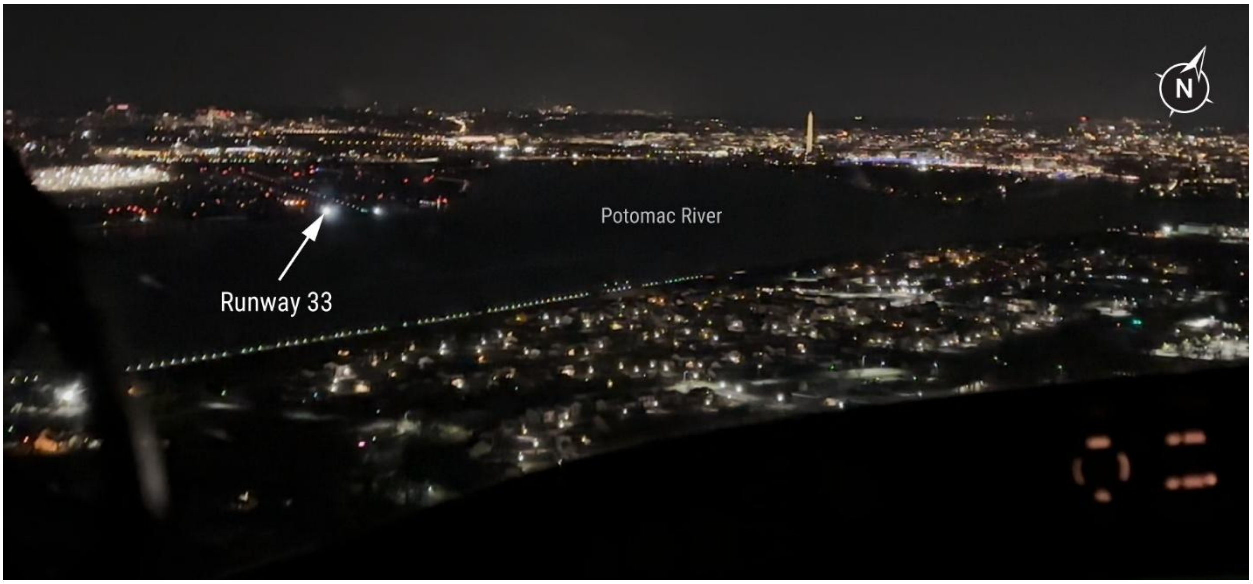

Figure 46. Cultural lighting around Washington, DC, as captured in a video frame recorded on an Apple iPhone inside the cockpit of a CRJ turning for final approach to runway 33 during an NTSB night observation flight.

[107] FAA AC 90-48E, "Pilots' Role in Collision Avoidance," describes the *blossom effect* as "the visual phenomenon where two aircraft on a collision course appear to be virtually motionless to each other. The other aircraft will remain in a seemingly stationary position, without appearing to move or grow in size for a relatively long time, and then suddenly bloom into a huge mass filling one of the windows. Given that we need motion or contrast to attract our eyes' attention, this effect becomes a frightening factor when you realize that a large bug smear or dirty spot on the windshield can hide a converging plane until it is too close to be avoided."

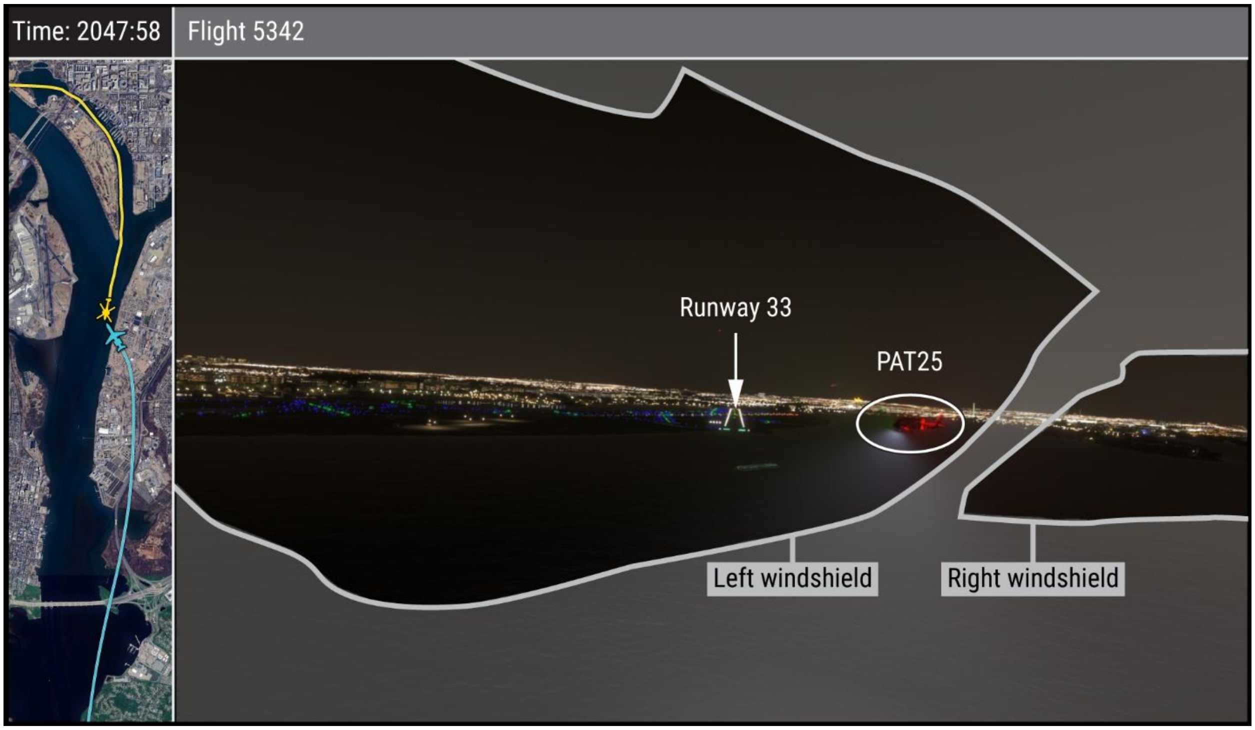

Figure 47. Simulated view from flight 5342's left (captain's) seat at 2047:58 (1.3 seconds before collision), looking straight ahead.

Note: Icons not to scale.

1.11.4.2 Helicopter Cockpit Visibility

Figure 48 shows an interior view of a UH-60L cockpit. The cockpit has five windows: the left window, left windshield, center windshield, right windshield, and right window.

Like the airplane, laser scans of an exemplar UH-60L helicopter were used to determine how the structure would have affected the view outside. Figure 49 shows the view from the perspective of the IP in the right seat. The structure of the helicopter is shown in light gray, the outline of the pilot in the left seat is shown in olive yellow, and the structures of the NVGs and flight helmet are shown in dark gray.[108] The shapes are distorted so that the view out all five windows can be shown together. The solid multicolored line shows where in the helicopter's windows the airplane would have been visible to the IP during the final 3 minutes of flight, with the color of the line corresponding to the time the airplane would have appeared in that location, per the color scale on the right side of figure 49.

[108] The brain merges the separate left- and right-eye views from the binocular NVGs into one circular image.

Except for brief periods when it was obscured by the cockpit window pillars, the airplane would have been in the helicopter IP's field of view for the 3-minute period before the collision.

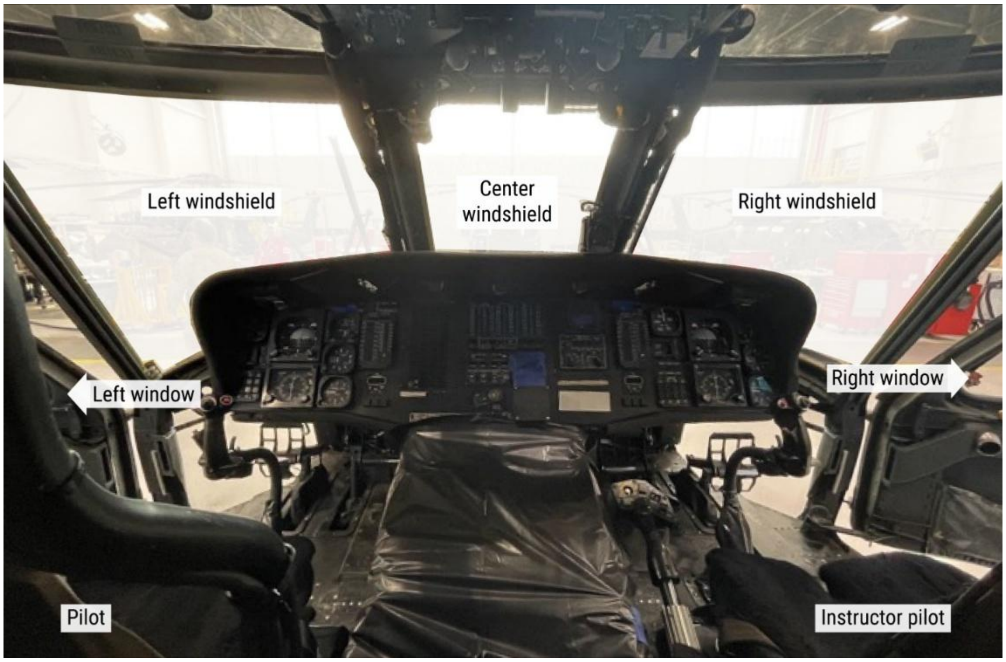

Figure 48. Interior view of the UH-60L cockpit.

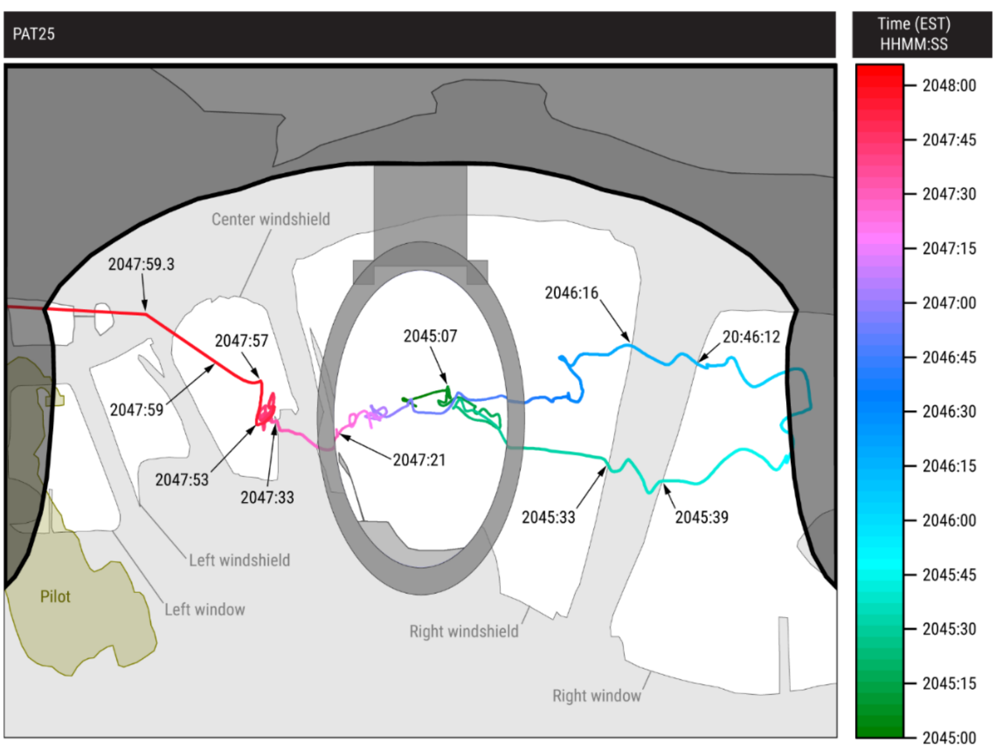

Figure 49. Viewing angles of the airplane from the IP's position (right seat) inside the helicopter, looking straight ahead.

Figure 50 shows the airplane's location for the last 3 minutes of the flight from the perspective of the pilot in the left seat. After about 2046:42 (1 minute 16 seconds before the collision), the airplane would have appeared unobstructed in the left windshield.

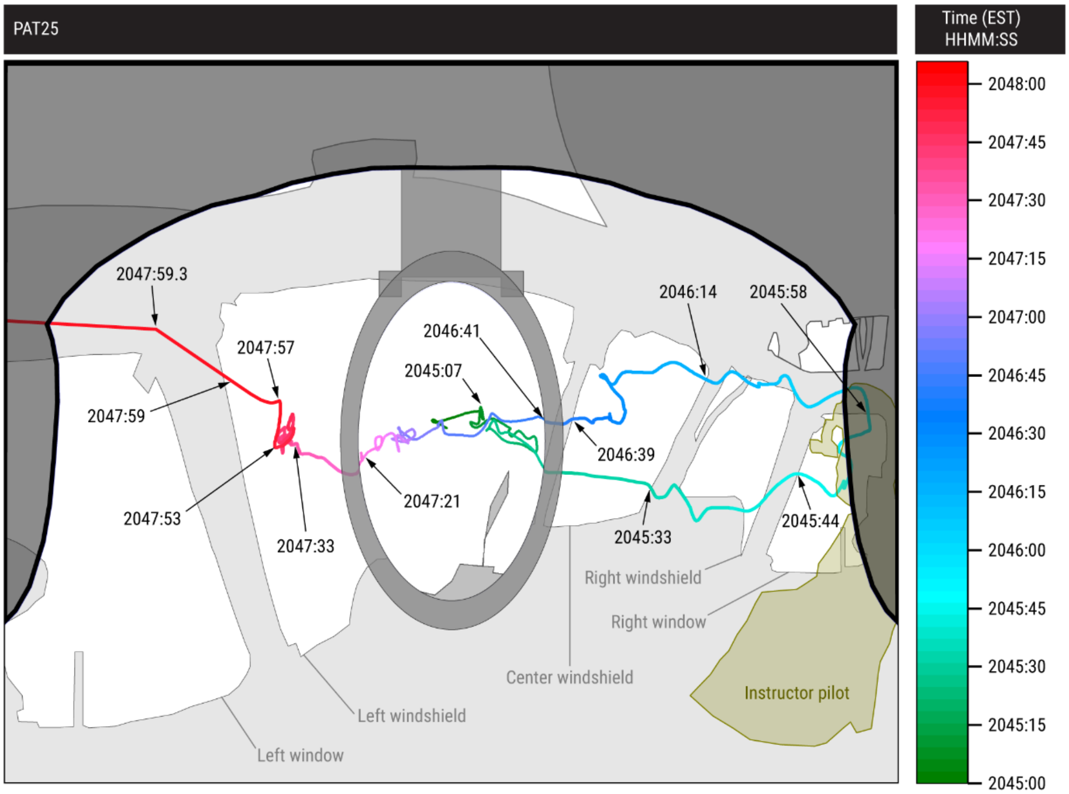

Figure 50. Viewing angles of the airplane from the position of the helicopter pilot (left seat), looking straight ahead.

At the time of the controller's first traffic advisory to PAT25 (2 minutes 57 seconds before the collision) the airplane was in a position that would have required the IP to rotate his head to the right and look out the right cockpit window to visually acquire it, as shown in figure 51. From the pilot's view on the left side of the cockpit, the airplane would have been obscured by the IP and aircraft structure.

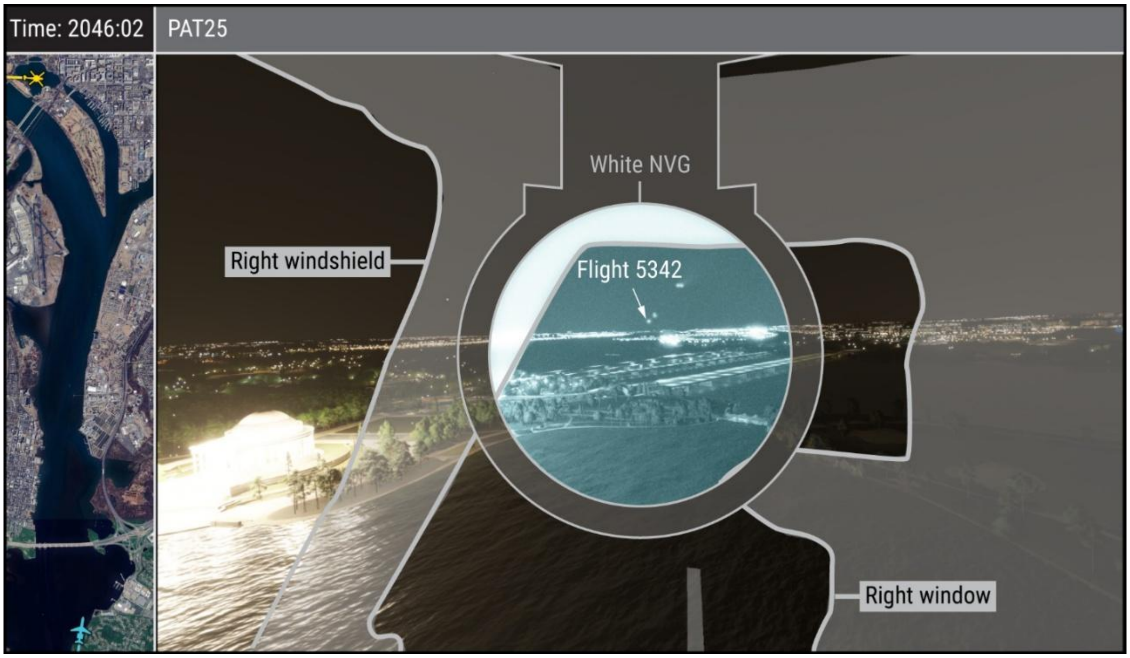

Figure 51. Simulated view from the right seat of the helicopter at 2046:02 (2 minutes 57 seconds before the collision), about the time of the initial traffic advisory, as seen looking 80° to the right.

Note: Icons not to scale.

The airplane, which was about 6.5 nm away at this time, would have appeared to the PAT25 IP as a dot of light surrounded by a soft "halo" when viewed through NVGs, and would have been one point of light among the several other airplanes on approach to DCA. Outside of the 40° field of view of the NVGs, the airplane and other traffic inbound to DCA would have appeared as points of light in the periphery of the IP's vision. Figure 52 shows an unaided view of the cultural lighting surrounding Washington, DC, recorded from a GoPro camera in a UH-60L cockpit during an NTSB night observation flight.

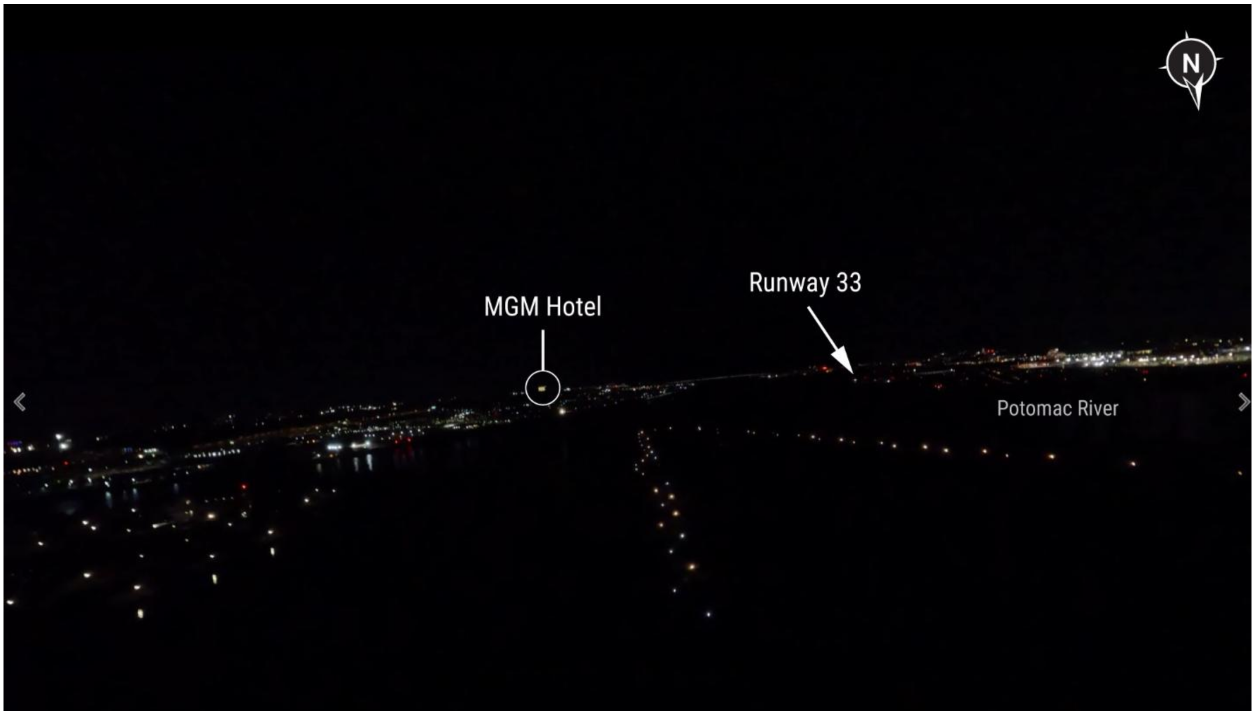

Figure 52. Frame from a GoPro camera in the cockpit of a UH-60L flying south along the eastern edge of East Potomac Park during an NTSB night observation flight.

After 2047:26, about 33 seconds before the collision, the airplane would have passed to the left of the IP's field of view provided by the NVGs when focused straight ahead; therefore, to visually acquire the airplane, the IP would have had to turn his head to the left and look out the center windshield. Figure 53 shows the simulated view from the IP's position about 19 seconds before the collision. Figure 54 shows the simulated view from the pilot's position about 19 seconds before the collision. From the pilot's perspective, the airplane would have appeared in the left windshield, and would have remained in the pilot's left windshield until just before the collision occurred.

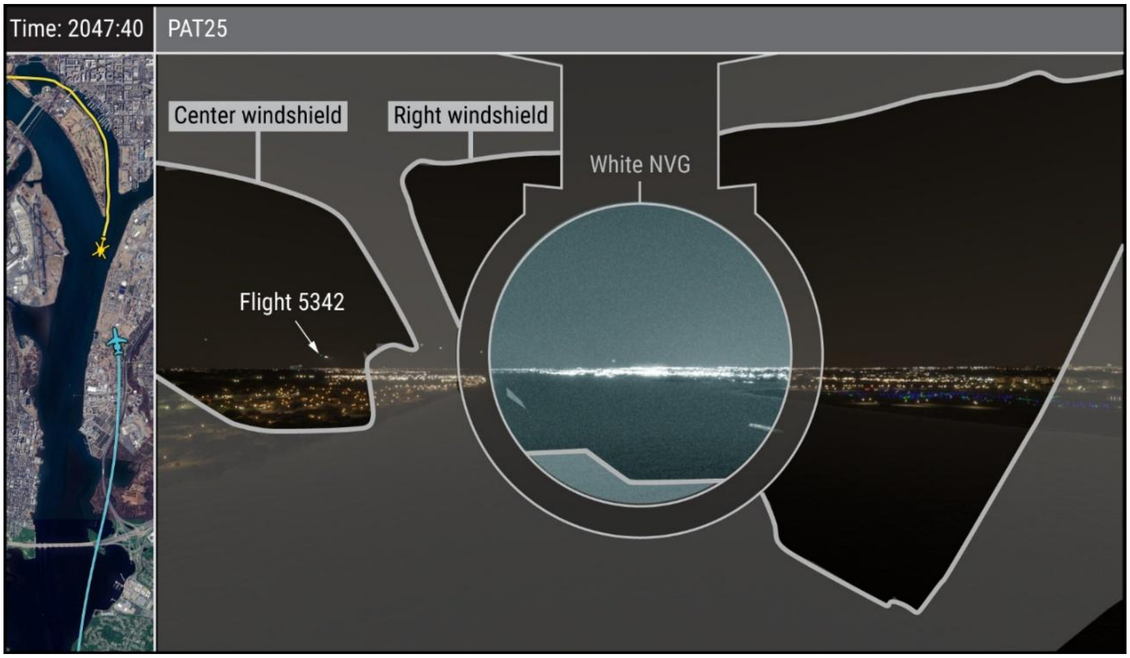

Figure 53. Simulated view from the right (IP's) seat of the helicopter, looking straight ahead, at 2047:40 (19 seconds before the collision) about the time ATC asked if the helicopter had the CRJ in sight.

Note: Icons not to scale.

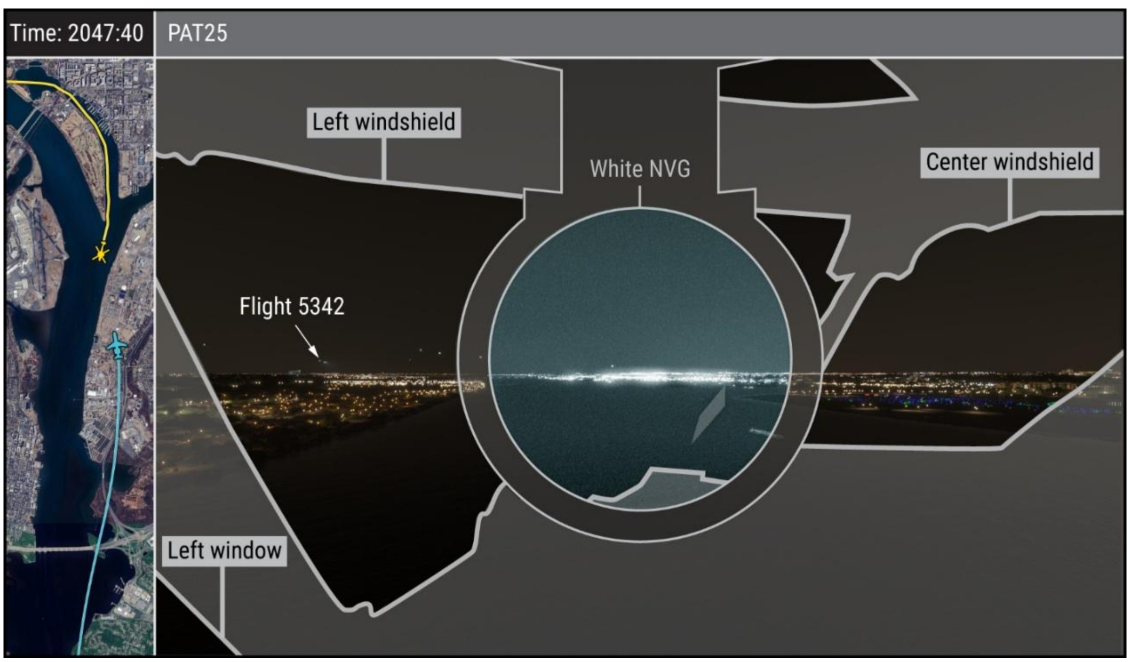

Figure 54. Simulated view from the left (pilot's) seat of the helicopter, looking straight ahead, at 2047:40 (19 seconds before the collision) about the time ATC asked if the helicopter had the CRJ in sight.

Note: Icons not to scale.

From about 2047:44, about 15 seconds before the collision, the airplane appeared in the simulation above the cultural lighting on the ground, but close to the horizon and just above a brightly-lit hotel in the area of the National Harbor southeast of DCA, as shown in figure 55.

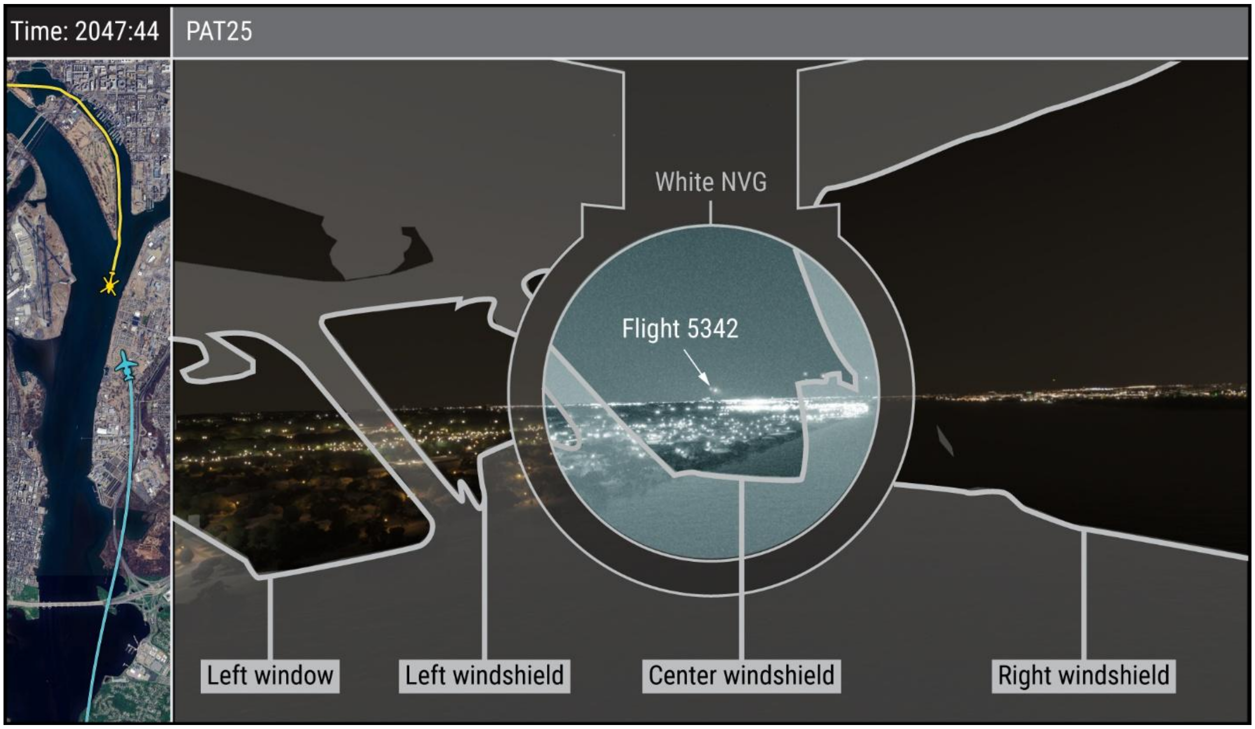

Figure 55. Simulated view from the right (IP's) seat of the helicopter, looking 38° to the left, at 2047:44 (15 seconds before the collision) depicting flight 5342's position just above the horizon through white phosphor NVGs.

Note: Icons not to scale.

Just before the collision, the airplane would have suddenly increased in size in the helicopter's windscreen, as shown in figure 56, which depicts the IP's perspective from the right seat. Figure 57 depicts the view from the pilot's perspective in the left seat at 2047:58.

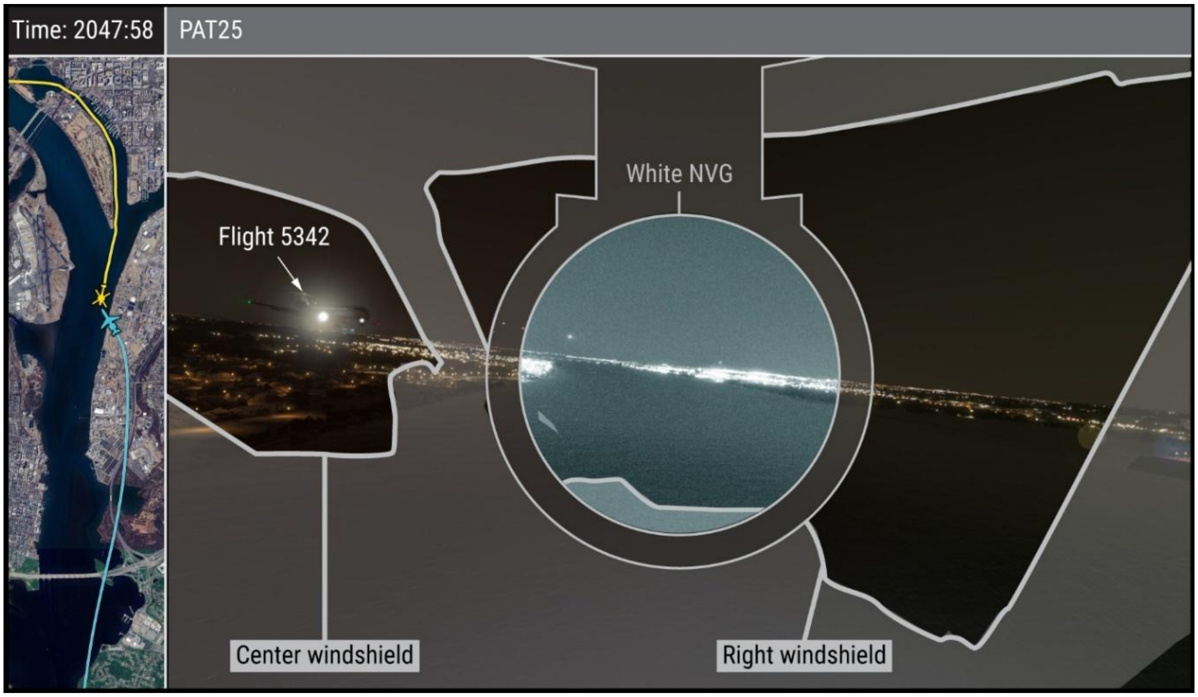

Figure 56. Simulated view from the right (IP's) seat of the helicopter at 2047:58 (1 second before the collision), looking straight ahead.

Note: Icons not to scale.

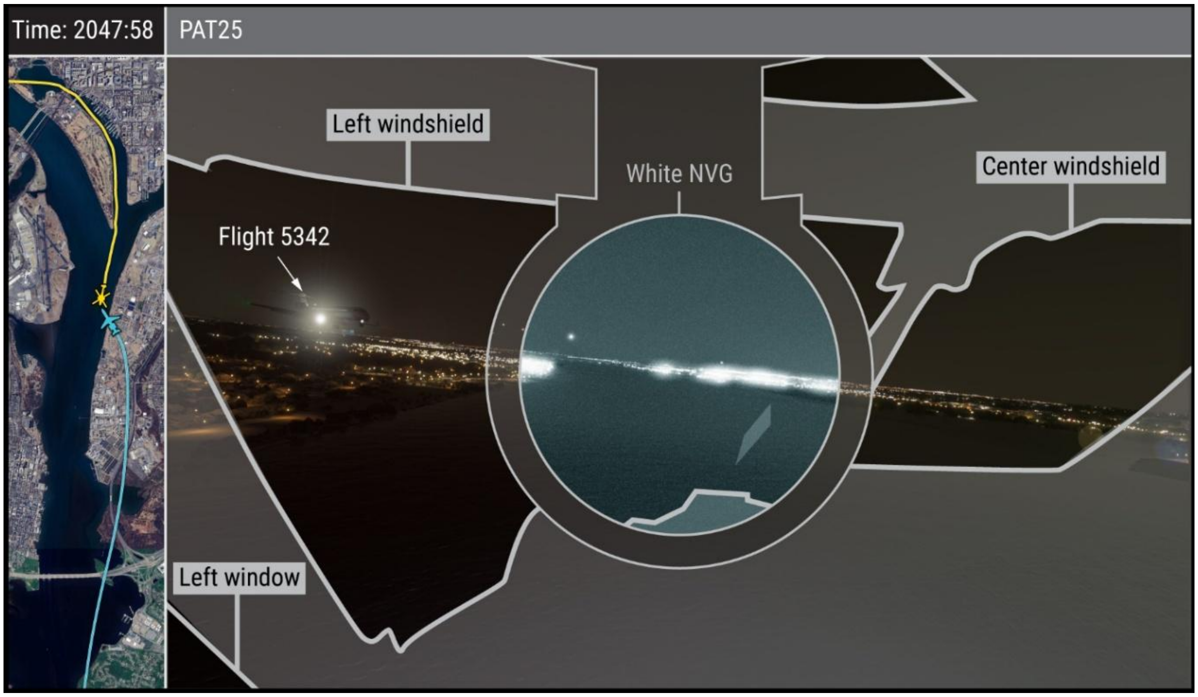

Figure 57. Simulated view from the left (pilot's) seat of the helicopter at 2047:58 (1 second before the collision), looking straight ahead.

Note: Icons not to scale.

Based on the CVR recording, which captured him pointing out traffic on the left side of the helicopter prior to entering DCA airspace, it is likely that the crew chief was seated in the left crew chief station during the accident flight, which is located behind the left pilot's seat and shown in figure 58. Figure 59 shows the view looking outside the helicopter from the left crew chief's station with the window closed on a UH-60L equipped with ESSS. At the time of the collision, the CRJ would have been located about 52° to the crew chief's right.

Figure 58. UH-60L left crew chief station with window closed.

Figure 59. View from the UH60L left crew chief station with the window closed.

1.11.4.3 DCA ATCT Visibility

Laser scans of the DCA ATCT cab were used to define the geometry of the cab's windows and the locations of several screens near the top of the windows. These scans were used to generate a simulation of the view from the LC controller's seat, including any obstructions to vision. Figure 60 depicts the simulated tracks of each aircraft as viewed through the tower cab from the LC controller's perspective, with the cab structure and interior equipment (which would have obscured his view) depicted in gray. Figure 61 presents a plot of the viewing angles of flight 5342 and PAT25 from the LC controller's workstation. These images assume a stationary position, and do not account for uncertainty in the LC controller's actual position or the freedom he had to move around. Figure 62 presents a photograph taken from the LC position during an NTSB observation.

Figure 60. Simulation of the views from the ATC tower cab of the helicopter and airplane during the approximate minute before the accident, with aircraft positions at the labeled times.

Figure 61. Viewing angles from the local control position with the flight paths of flight 5342 and PAT25 overlaid on the tower cab windows.

Figure 62. 360° photograph depicting the view from the LC position taken during postaccident observation.

1.11.4.4 Observation Flights

To provide a measure of the realism of the simulated environment and views, several of the images produced for the visibility study were compared with video frame and still photograph images of similar scenes taken during night observation flights performed during the overnight hours of March 26–27, 2025, and March 27-28, 2025. The purpose of these observations was to document the cultural lighting around DCA, the visibility of each aircraft from the DCA ATCT, and the visibility from the cockpit of each aircraft. To mimic the conditions on the night of the accident, the dates of the observations were chosen so that the wind would be from the north and there was no moon.

During the first night, ground observers from two observation points documented the "evening push," a time period in which there is a high rate of departures from and arrivals to DCA. After midnight, an exemplar UH-60L helicopter flew four passes southbound over the Potomac River and past DCA.[109] On the second night, an exemplar CRJ700 flew four flights northbound over the Potomac River to DCA. During both flights, ground observers at multiple locations documented the aircraft as they appeared from those stations, as well as the surrounding cultural lighting. After the flights, ADS-B data were obtained from the FAA, and each aircraft's FDR was downloaded.

The visibility of each aircraft to the crew of the other aircraft depends greatly on each aircraft's external lighting and on the background against which the aircraft's lights would have appeared. The cultural lighting shown in the simulations contains inaccuracies. For example, the depictions of the Memorial Bridge and the Jefferson Memorial in figure 51 are much brighter than those structures are in reality, which calls into question the brightness/luminosity of the other cultural lighting depicted in the images.

The aircraft lighting also differs from reality; for example, the airplane's landing lights, wing anti-collision lights, and logo lights can appear muted or missing. Additionally, the simulation does not show all of the aircraft south of the Wilson Bridge that were present on the night of the accident. Finally, the images depicting NVGs are rough approximations, created by applying filters and other effects, and do not depict light sources such as stars.

1.11.5 Limitations of See-and-Avoid

Title 14 *CFR* Section 91.113 states:

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[109] Flight activities were conducted after midnight in order to minimize interference with DCA traffic.

> When weather conditions permit, regardless of whether an operation is conducted under instrument flight rules or visual flight rules, vigilance shall be maintained by each person operating an aircraft so as to see and avoid other aircraft.

FAA AC 90-48E, "Pilots' Role in Collision Avoidance," alerts pilots to human contributors to midair collisions and near midair collisions and recommends improvements to pilot education, operating practices, procedures, and improved scanning techniques to reduce midair conflicts (FAA, 2022a). The AC states:

> MAINTAINING VIGILANCE. Air traffic information equipment does not relieve a pilot's regulatory responsibility to see and avoid other aircraft. Pilots should maintain vigilance by managing distractions caused by the use of technology in the flight deck/cockpit, which is critical to the safety of the flight. While new aircraft systems can provide pilots with a wealth of information, they can also cause fixation on the displays and draw a pilot's attention inside the flight deck/cockpit and away from the outside environment.

> AIR TRAFFIC CONTROLLER LIMITATIONS. Remember that an air traffic controller's view of aircraft on the airport surface is often limited by distance, depth perception, aircraft conspicuity, and normal visual acuity problems. Also, radar limitations and air traffic volume can increase a controller's workload and prevent the controller from providing timely TA information. Therefore, the pilot should not solely depend upon ATC TAs for collision avoidance. The pilot must proactively conduct see-and-avoid procedures.

The AC also provided information on the time required for a pilot to recognize an approaching aircraft and execute an evasive maneuver. The total time to identify an approaching aircraft, recognize a collision course, decide on action, execute the control movement, and allow the aircraft to respond was estimated to be around 12.5 seconds.

In 1991, the Australian Transport Safety Bureau (ATSB) published a research report titled "Limitations of the See-and-Avoid Principle" (ATSB, 1991). The report discusses the role of the see-and-avoid concept in preventing collisions and some of its inherent limitations:

> Cockpit workload and other factors reduce the time that pilots spend in traffic scans. However, even when pilots are looking out, there is no guarantee that other aircraft will be sighted. Most cockpit windscreen configurations severely limit the view available to the pilot. The available view is frequently interrupted by obstructions such as window-posts

> which totally obscure some parts of the view and make other areas visible to only one eye…Visual scanning involves moving the eyes in order to bring successive areas of the visual field onto the small area of sharp vision in the centre of the eye. The process is frequently unsystematic and may leave large areas of the field of view unsearched…The physical limitations of the human eye are such that even the most careful search does not guarantee that traffic will be sighted…An object which is smaller than the eye's acuity threshold is unlikely to be detected and even less likely to be identified as an approaching aircraft…The human visual system is better at detecting moving targets than stationary targets, yet in most cases, an aircraft on a collision course appears as a stationary target in the pilot's visual field. The contrast between an aircraft and its background can be significantly reduced by atmospheric effects, even in conditions of good visibility. An approaching aircraft, in many cases, presents a very small visual angle until a short time before impact. In addition, complex backgrounds such as ground features or clouds hamper the identification of aircraft via a visual effect known as 'contour interaction.' This occurs when background contours interact with the form of the aircraft, producing a less distinct image. Even when an approaching aircraft has been sighted, there is no guarantee that evasive action will be successful.

The ATSB report also discusses the value of alerted versus unalerted searches for traffic:

> A traffic search in the absence of traffic information is less likely to be successful than a search where traffic information has been provided because knowing where to look greatly increases the chance of sighting the traffic (Edwards and Harris 1972). Field trials conducted by John Andrews found that in the absence of a traffic alert, the probability of a pilot sighting a threat aircraft is generally low until a short time before impact. Traffic alerts were found to increase search effectiveness by a factor of eight. A traffic alert from ATS or from a radio listening watch is likely to be similarly effective (Andrews 1977, Andrews 1984, Andrews 1987).

The ATSB report concludes, in part, that:

> The see-and-avoid principle in the absence of traffic alerts is subject to serious limitations…Unalerted see-and-avoid has a limited place as a last resort means of traffic separation at low closing speeds but is not sufficiently reliable to warrant a greater role in the air traffic system.

1.11.5.1 Information for Pilots

NTSB Safety Alert SA-045, "See and Be Seen: Your Life Depends on It," highlights accidents that have occurred in which pilots operating near one another did not maintain adequate visual lookout and failed to see and avoid the other aircraft (NTSB, 2021b). All of the accidents occurred in daytime, visual meteorological conditions. The safety alert describes actions pilots can take to prevent midair collision accidents, including the effective use of on-board traffic advisory systems, when available, to help visually acquire and avoid other aircraft.

NTSB Safety Alert SA-058, "Prevent Midair Collisions: Don't Depend on Vision Alone," states that the inherent limitations of the see-and-avoid concept, including human limitations, environmental conditions, aircraft blind spots, and operational distractions, leave even the most diligent pilot vulnerable to the threat of a midair collision with an unseen aircraft (NTSB, 2021c). The alert states that traffic advisory systems and ADS-B can help pilots become aware of and maintain separation from nearby aircraft by helping compensate for the limitations of a visual search, but that aircraft must be equipped with both ADS-B In and ADS-B Out in order to fully benefit from the technology.

The US Air Force, 437th Airlift Wing, Joint Base Charleston, Charleston, South Carolina, published the pamphlet "Mid-Air Collision Avoidance (MACA)" in November 2017 (437th Airlift Wing, 2017). The pamphlet contains actions that pilots can take to help reduce the risk of being involved in a midair collision and provides pilots with information about physiological factors that can affect their visual scan, as well as information specific to pilots operating in the vicinity of Joint Base Charleston, such as local flight routes and the types of aircraft frequently seen in the area.

1.11.6 ADS-B In CDTI and ACAS X Simulations

1.11.6.1 ADS-B In CDTI Simulations

The information provided by ADS-B allows ADS-B In applications to "predict" where traffic targets will be relative to the receiving aircraft, or ownship, at determined times in the future. This predictive feature allows ADS-B In applications to anticipate collision threats and generate aural and visual traffic alerts that occur earlier and contain more information about threats than analogous alerts generated by TCAS.

As previously stated, the helicopter was not equipped with ADS-B In or TCAS; however, the crew had access to tablets running the ForeFlight Mobile application, which could display ADS-B traffic information via the Stratus portable ADS-B receiver. Interviews with other 12th Aviation Battalion pilots indicated that, when using the tablets in flight, they typically secured them to their thighs with a strap; however, whether the accident pilots had the tablets strapped to their thighs at the time of the accident could not be determined. Postaccident observations in a UH-60L simulator indicated that pilots had to physically tilt their heads down toward their lap to see the display, and TAAB pilots told investigators that they did not monitor the tablets when flying low-level on the DC helicopter routes because the flying task was too demanding.

ForeFlight Mobile can provide a display of ADS-B In traffic information overlaid on a moving map display. The traffic symbols indicate direction of travel and can also display the target's expected position in the next 60 seconds. A traffic target's relative altitude is depicted with a plus (+) indicating height above, or a minus (-) indicating height below in hundreds of feet. The application is capable of displaying traffic cautions and alerts, which highlight the conflicting target in yellow and red, respectively. The application can also be configured to provide audible alerts, which can be transmitted from the tablet to a pilot's headset; however, the accident helicopter crews' helmets were not equipped to do so, nor were they required to be. Additionally, audible traffic alerts are not generated below 250 ft agl, though visual alerts are.

As part of the aircraft performance study, the NTSB used recorded ADS-B and TIS-B data to determine what traffic information and alerting might have been presented to each flight crew in the minutes before the collision if both aircraft had been equipped with an ADS-B In-based CDTI with aural alerting capability.[110]

As previously noted, the airplane was not equipped with an ADS-B-capable CDTI, though it was equipped with TCAS II. To assess the traffic information and alerts that an ADS-B In-based CDTI could have provided to the crew of flight 5342, had one been available, the symbology and alerting criteria of such a display were simulated using ADS-B and TIS-B data from the time of the accident.[111]

Figure 63 shows a simulated TCAS display (left), similar to the actual display presented to the pilots of flight 5342, and a simulated CDTI display (right) consistent with what the pilots would have observed at 2047:00 (59 seconds before the collision), had the airplane been equipped with an ADS-B based CDTI. The ADS-B based CDTI would have provided the first alert regarding PAT25 at this time, which was 40 seconds before the crew received the TCAS TA. The CDTI would have provided a second aural alert regarding PAT25 about 35 seconds before the collision and 16 seconds before the crew received the TCAS TA. Figure 64 presents a

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[110] The simulation of ADS-B In CDTI was based on RTCA DO No. 317B, which contains the MOPS for ATAS.

[111] The symbology and alerting criteria used in the simulation conformed to the criteria outlined in FAA Advisory Circular 20-172B, "Airworthiness Approval for ADS-B In Systems and Applications" (FAA, 2015).

simulated view from the captain's (left) seat of flight 5342 at 2047:00, when an ADS-B based CDTI would have provided the first alert regarding PAT25, had the airplane been equipped.

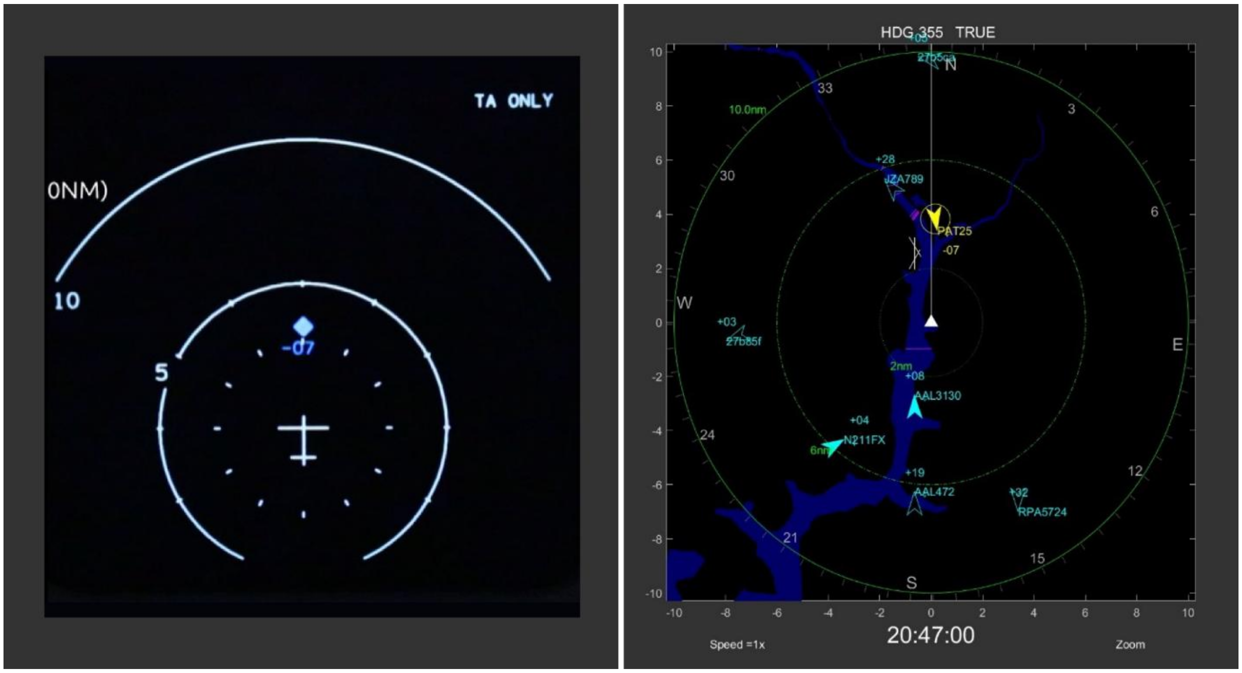

Figure 63. Simulated view of TCAS display at 2047:00 (59 seconds before the collision) from flight 5342's cockpit (left), compared with a simulated ADS-B In–based CDTI display using ATAS symbology and alerting criteria (right), which the airplane was not equipped with.

Note: The simulated TCAS display is simplified compared to an actual display, and PAT25 is the only traffic shown. The CDTI display shown on the right was generated using recorded ADS-B data and the symbology and alerting criteria defined in RTCA DO-317B, "Minimum Operational Performance Standards (MOPS) for Aircraft Surveillance Applications (ASA) Systems," for the ADS-B Traffic Advisory System (ATAS), as described in FAA AC 20-172B (RTCA, 2014; FAA, 2015). Although ADS-B In–based CDTI technology is commercially available, there was not a certified ADS-B In product approved for installation into the CRJ700 at the time of the accident. Therefore, flight 5342 was not equipped with such a display—nor was it required to be.

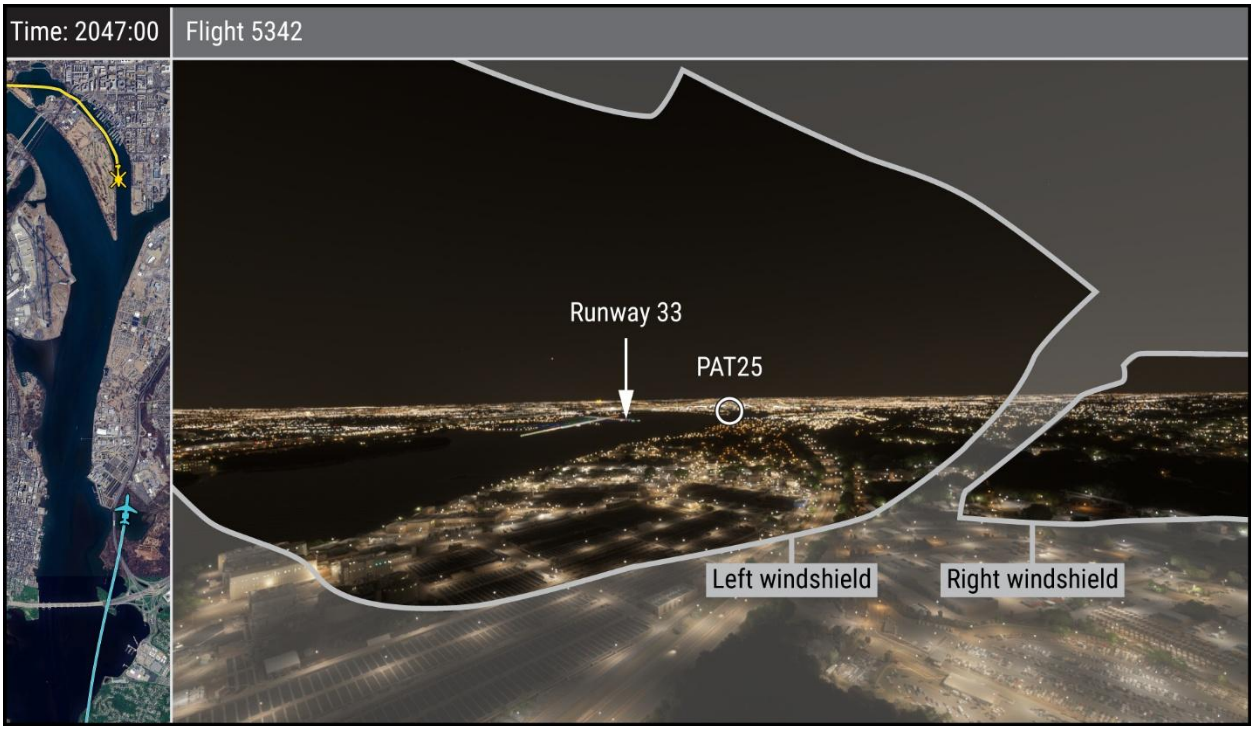

Figure 64. Simulated view from the left (captain's) seat of flight 5342 at 2047:00 (59 seconds before the collision), looking straight ahead.

Note: Had the airplane been equipped with an ADS-B based CDTI, it would have provided the crew of flight 5342 with the first alert regarding PAT25 at this time (2047:00, or 59 seconds before the collision). However, because the airplane was equipped instead with TCAS, the crew only received its first TA alert 40 seconds later, at 2047:40 (or 19 seconds before the collision).

The ForeFlight CDTI display onboard the helicopter could have generated a visual and aural alert concerning the airplane at 2047:11, or 48 seconds before the collision, as shown in figure 65. The aural alert would have comprised the annunciation, "Traffic, 12 o'clock, 2 miles, 500 ft above." At this time, the helicopter was only 9 ft above the 250-ft aural alerting threshold. Figure 66 presents a simulated view from the IP's (right) seat of PAT25 at 2047:11, when the Foreflight CDTI that was onboard the helicopter could have provided a visual and aural alert concerning flight 5342.

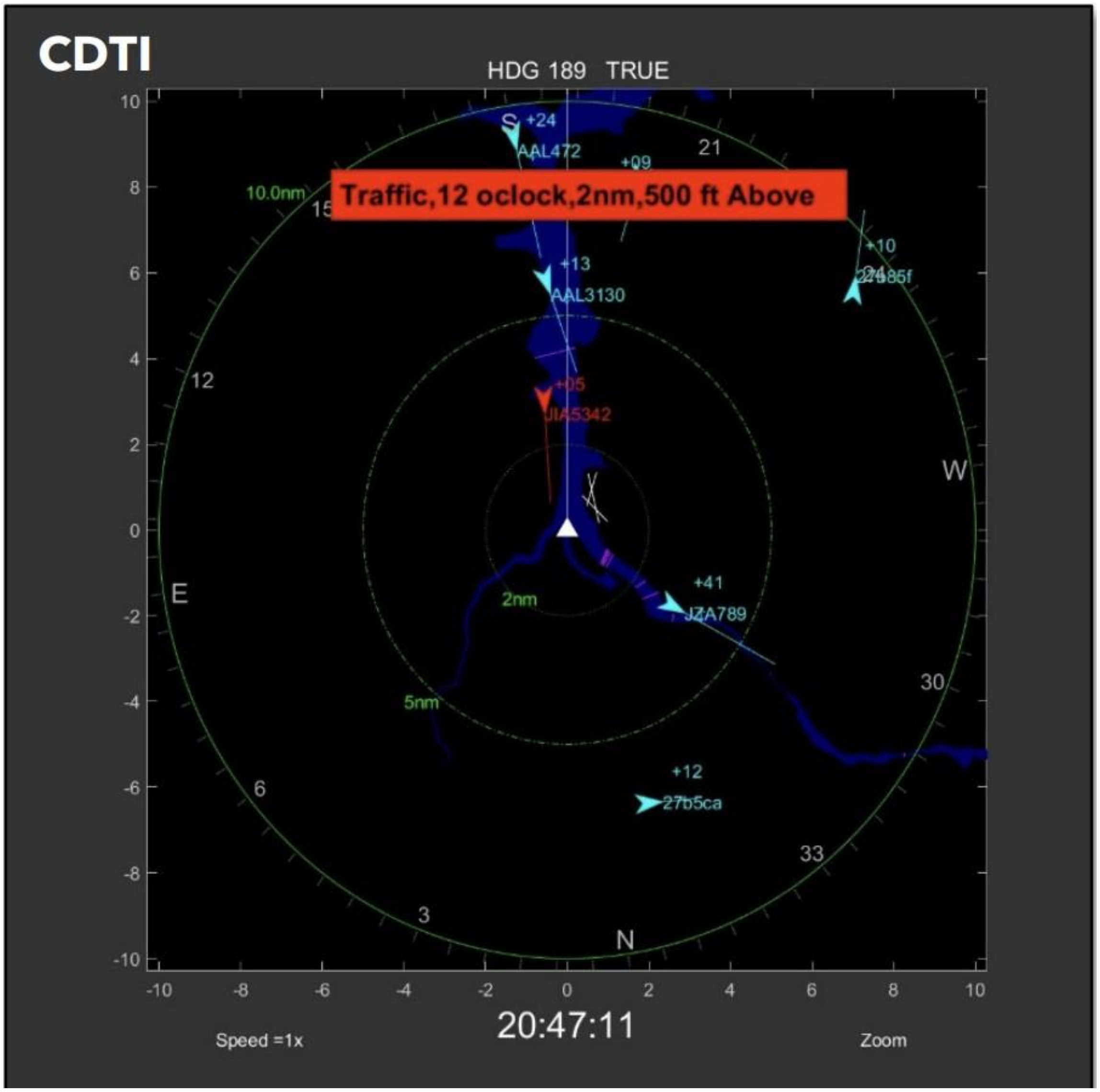

Figure 65. Simulated ForeFlight display and visible text alert (shown in red box) at 2047:11 (48 seconds before the collision).

Note: Flight 5342 is displayed as "JIA5342" with a corresponding red arrow. The text of the alert that appears on the screen would also have been annunciated as an audio alert if the ForeFlight application determined that the helicopter was above 250 ft agl.

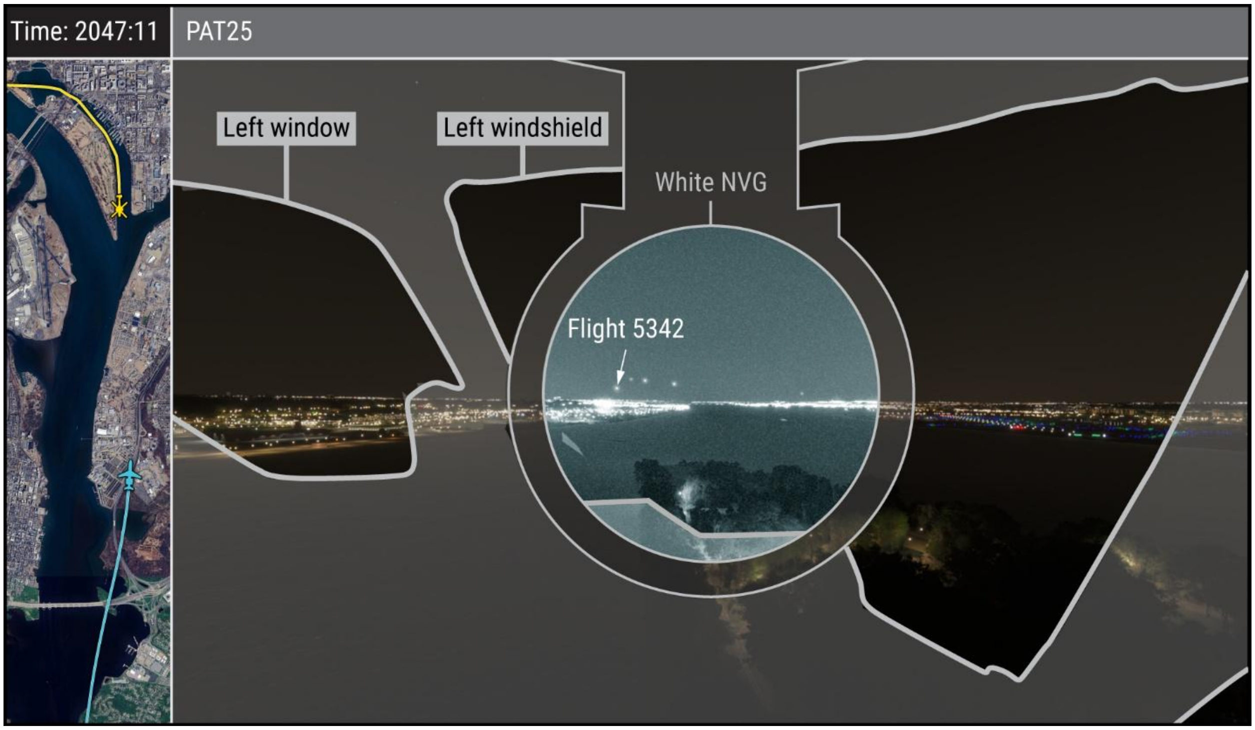

Figure 66. Simulated view from the right (IP's) seat of PAT25 at 2047:11 (48 seconds before the collision), as seen looking straight ahead.

Note: At this moment, the Foreflight CDTI running on the helicopter flight crew's tablets would have displayed the visible text alert shown in the red box in figure 65, and the application would have annunciated an aural alert, "Traffic, 12 o'clock, 2 miles, 500 ft above," which would have been audible to the flight crew, had the flight crew's helmets been equipped to receive audio from the tablets—which they were not. Additionally, Army pilots do not visually monitor the tablets while flying low level on DC helicopter routes because, according to postaccident interviews, the flying task was too demanding.

1.11.6.2 ACAS X Simulations

In order to determine whether ACAS X systems may have provided improved alerting to the accident crews under the circumstances of this accident, the Massachusetts Institute of Technology Lincoln Laboratory (MIT-LL) performed simulations to depict the alerts that would have been provided to the crews with TCAS II (the equipment onboard the accident airplane); TCAS II with RA inhibit altitudes reduced to 300 ft agl; ACAS Xa; ACAS Xa with RA inhibit altitudes reduced to 400 ft agl and 300 ft agl; and ACAS Xr on board the helicopter with TCAS v7.1 on board the airplane.[112] Because ACAS Xr is still under development, this simulation used the draft specifications of ACAS Xr current at the time. The data source for the simulation was radar data, which updated once every 4.7 seconds and contained

[112] Although the accident airplane was equipped with TCAS v7.0, the differences between v7.0 and v7.1 are not relevant to this simulation.

inherent position errors and uncertainties, or NTSB-supplied "truth data," which was derived from analysis of the aircrafts' surveillance and FDR data to determine best estimates of the actual positions of each of the aircraft at one-second intervals.[113] These data were higher fidelity than that generated by extrapolations from the radar data.

Since aircraft dimensions were not represented, the simulation could not directly assess the probability of a midair collision; therefore, an NMAC, defined by MIT-LL as an event in which horizontal separation is less than or equal to 500 ft and vertical separation is less than or equal to 100 ft, was used as a proxy metric.

According to MIT-LL, in general, the probability of a midair collision is about 10% of the probability of an NMAC. For each test condition, 100 or more test runs were conducted using variations of the potential surveillance errors. The probability of an NMAC was estimated by combining the results of the simulations. The simulations assumed that pilots did not maneuver in response to a TA, but complied with the instructions provided in all RAs five seconds after activation (or 3 seconds after activation for a follow-on RA).

The simulations indicated that, when TCAS was modified to allow RAs down to an altitude of 300 ft, the risk of an NMAC was reduced by more than 65%. When ACAS Xa was modified to allow RAs to 300 ft, the risk was reduced by more than 90% compared to TCAS II with its current inhibit altitudes. Current ACAS Xa RA inhibit altitudes are the same as those of TCAS II; therefore, for TCAS or ACAS Xa to issue an RA in this encounter, it would be necessary to lower the RA inhibit altitude.

When the helicopter was equipped with ACAS Xr, the risk of an NMAC in these scenarios was reduced by more than 50% with no modification to TCAS/ACAS Xa RA inhibit altitudes.[114] Because the current ACAS Xr design includes transitioning to "surveillance-only" mode below 200 ft, the system could not alert in some cases. According to MIT-LL, the safety benefit would significantly increase if the "surveillance only" mode was lowered to 100 ft.

1.11.6.3 Summary of Simulation Results

In this accident, the crew of flight 5342 received a TA regarding the helicopter 19 seconds before the collision. The TA consisted simply of the annunciation, "Traffic, traffic." No information about the location of the traffic threat relative to the airplane

[113] "Truth data" refers to the investigation's best-available reference data set, constructed by integrating multiple independent sources into a single, time-aligned reconstruction that serves as the benchmark for comparing/validating other measurements or analyses; its individual data points are not always direct, independent measurements, but rather a "best-estimate" truth constructed from the available record.

[114] In these runs, the airplane was equipped with TCAS v7.1.

was annunciated, and the crew would have had to refer to the TCAS display to determine the relative position of the threat. Section 1.11.7 will discuss why it is unlikely that the crew was able to perform a focused visual search for the helicopter at this time.

In contrast, the NTSB's simulation of how an ADS-B based (DO-317B-compliant) system would have performed in the accident scenario indicated that the crew of flight 5342 would have received two alerts concerning PAT25:

- The first aural and visual alert would have occurred 59 seconds before the collision, annunciating "Traffic, 12 o'clock, low, three miles, descending."
- A second aural alert would have occurred 35 seconds before the collision, annunciating "Traffic, 12 o'clock, low, two miles."

These two alerts would have occurred 40 and 16 seconds, respectively, before the TCAS TA that the crew received before the collision.

The NTSB also performed a simulation of the ADS-B In ForeFlight application available on the iPads carried by the PAT25 crew to determine the traffic depiction and alerts that ForeFlight could have provided on the accident flight. ForeFlight uses different alerting algorithms and conventions than those specified in DO-317B, but produces similar results. The simulation indicated that ForeFlight could have generated a visual and aural alert concerning flight 5342 48 seconds before the collision, annunciating, "Traffic, 12 o'clock, 2 nautical miles, 500 feet above."

1.11.7 ADS-B Out Anomaly with 12th Aviation Battalion Helicopters

Historical ADS-B data provided by the FAA for the 25 helicopters assigned to the 12th Battalion showed that eight helicopters, including the accident helicopter, did not have a recent history of broadcasting ADS-B Out information.[115] All eight helicopters were UH-60L models that had been equipped with APX-123A transponders between April and May 2023. The accident helicopter had no historical ADS-B data since its APX-123A transponder installation.[116] The other seven helicopters showed historical ADS-B data shortly after the installation of their transponders, but their ADS-B data stopped at various times between May and December 2023. All of the UH-60M model helicopters at the 12th Aviation Battalion had recent ADS-B Out activity.

[115] Based on information provided by the 12th Aviation Battalion in February 2025, the battalion had 16 UH-60L helicopters, including the accident helicopter, and 9 UH-60M helicopters.

[116] As discussed in section 1.9.3, the accident helicopter's transponder ADS SQTR setting was found off, and its time source code was incorrect, which resulted in it not broadcasting ADS-B data.

Further examination of the seven UH-60L helicopters that had stopped transmitting ADS-B data revealed that their ADS-B squitter setting on the transponder RCU was set to “ON”; however, their time source setting was improperly programmed.[117] Correcting the time source setting resulted in the successful transmission of ADS-B Out data to ground stations during subsequent flights when Mode S was active.

Army maintenance procedures for APX-123A transponder installation contained instructions to set the time source and included steps to set the ADS-B squitter on the RCU to “ON” after installation. Additionally, instructions included steps to confirm proper functionality of ADS-B, specifically to verify that the flight identification, aircraft address, and GPS position and altitude information were correct.[118]

1.11.8 Simulator Observations

1.11.8.1 CRJ700 Simulator

Investigators performed observations in a CRJ700 simulator in conditions similar to the night of the accident to provide contextual information related to the accident airplane, including the displays, controls, and alerts, as well as of crew operations. As part of the observations, during some of the scenarios, pilots were asked to estimate their subjective workload using the Bedford Workload Rating Scale, shown in figure 67, which is designed to identify an operator’s spare mental capacity while completing a task.[119] The scale ranges from 1, or “workload insignificant,” to 10, “Tasks abandoned. Pilot unable to apply sufficient effort.”

[117] Like the accident helicopter, the time source setting as found on these seven helicopters was “153,” rather than the required setting of “059.”

[118] These instructions were contained in modification work order (MWO) 1-1520-237-50-118, titled, *Modification Instructions for the Improved Digital Transponder (CXP), AN/APX-123A and Automatic Dependent Surveillance-Broadcast (ADS-B) Out Capability on the UH-60A/L Aircraft*. According to this MWO, the purpose was to install the improved digital transponder set AN/APX-123A Common Transponder (CXP) and ADS-B Out capability to meet an FAA mandate on UH-60A/L aircraft. The MWO listed an effective date of April 18, 2019, and a completion date of April 18, 2024.

[119] The Bedford Scale is derived from the Cooper-Harper Handling Qualities Rating Scale (Roscoe, 1984). Illustration developed from NASA 2003.

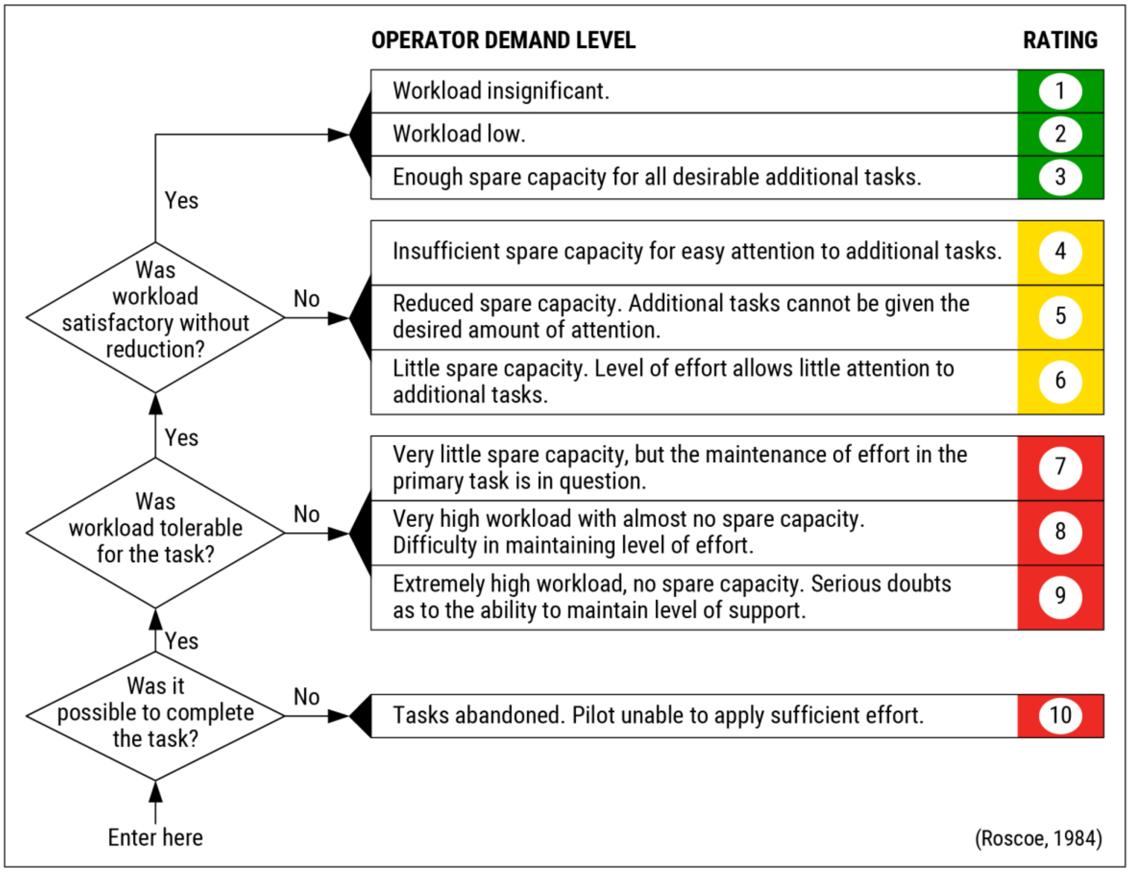

Figure 67. Bedford Workload Rating Scale.

Two qualified and current PSA CRJ700/900 crews performed the Mount Vernon Visual Runway 1 and the Runway 33 Visual circling approaches at night and Crew 1 rated the Mount Vernon Runway 1 approach as a 2 (workload low) on the Bedford scale, and Crew 2 rated it as a 1 (workload insignificant).

Crew 1 performed the Runway 33 Visual circling approach as published by company guidance. The captain was the pilot flying and the FO was the pilot monitoring. The captain estimated the workload as a 4.5 (in a moderate range), and the FO rated it as a 3.5 (between a low and moderate range). Crew 1 then repeated the approach, this time pausing the simulator to rate the workload at various points throughout the approach.

While flying the Mount Vernon Visual Runway 1 (before beginning the circle to runway 33), both pilots rated the workload as a 2. After beginning the circling maneuver, the captain rated the workload as a 3, and the FO rated it a 2. After turning onto final approach and aligning the airplane with runway 33, the captain rated the workload a 5 and the FO rated it a 3.

When asked to describe the focus of his attention during turn onto final approach for runway 33, the captain said that he was reducing the airplane's speed, monitoring the PAPI, and making corrections as necessary. He stated that correcting the airplane's glidepath based on the PAPI indication was the primary factor that increased his workload to a 5.

The FO stated that he had tasks during the turn onto final approach that required his visual attention both outside and inside the cockpit. He was watching for lateral and vertical alignment with the runway outside the cockpit, and he was monitoring the primary flight instruments inside the cockpit so that he could make the 500-ft stable callout.[120] He also needed to briefly focus his attention inside while resetting the airspeed indicator bug to the appropriate speed for the final portion of the approach. Finally, he was scanning outside to verify that the runway 1 departure area was clear, and he was monitoring how quickly the captain corrected for vertical or lateral deviations from the approach path.

Crews 1 and 2 also performed the Runway 33 Visual circling approach with ATC audio recordings of the DCA local control frequency from the night of the accident playing over a speaker in the simulator cab.[121] Crew 1 provided the same workload ratings as they had without the ATC audio. The captain of Crew 1 stated that the ATC audio allowed him to build a mental picture of the traffic situation. Hearing the traffic being cleared for an immediate takeoff from runway 1 caused him to immediately glance at runway 1 and develop an intent to monitor that airplane as a potential conflict. The FO also stated that the ATC audio focused his attention on the airplane that was cleared to take off from runway 1 rather than the helicopter activity.

The captain of Crew 2 stated that his attention was directed away from the cockpit due to the ATC audio, and that he was trying to develop a visual image of the traffic situation around him. He was not familiar with this approach and stated that it was dark and difficult to find external visual cues. The FO was also unfamiliar with the runway 33 approach, and he was focused on the traffic arriving and departing runway 1 in case someone conducted a missed approach or departed at the wrong time. The captain of Crew 2 rated the workload as a 5, and the FO rated it as a 7.

In a third scenario, crews were provided a TCAS TA alert at approximately the same location as the accident crew while flying the circling approach to runway 33. ATC audio from the night of the accident was playing over a speaker in the simulator cab. They were instructed before the scenario that, upon receiving the TA, they were to divert their attention to the TCAS display, scan for traffic outside the airplane for

---

[120] Company procedures dictated that, at 500 ft on approach for landing, the pilot monitoring call out the airplane's speed relative to approach speed (or Vref), the airplane's vertical speed, and the word "stable" if those parameters met required criteria for a stabilized approach.

[121] Unlike the crew of flight 5342, the crews flying the simulator were able to hear all helicopter transmissions in addition to the controller's and those from other airplanes.

5 seconds, then resume flying the approach. The simulation was then paused just before landing to assess the pilots' workload rating.

The captain of Crew 1 stated that, when the TCAS TA occurred, he looked in front of him and all he saw was the Potomac River. He stated that he looked to the right of the airplane because he knew the accident scenario, but if he had not been familiar with the circumstances of the accident, he would have looked both left and right. This diversion of attention to looking for traffic took priority over flying the airplane because he had been instructed to do so. Although it did not affect the airplane's flight path, he stated that it easily could have and that looking for the traffic reduced his spare capacity.

The FO noted that the TCAS TA occurred as he was resetting the airspeed reference, and he kept his hand on the speed bug selector to ensure he remembered that he had an unfinished task. As soon as they received the TA, all his attention was devoted to looking for traffic. The captain rated this scenario as a 5 on the Bedford Scale, and the FO rated it as a 4.

When Crew 2 performed this scenario, the captain stated that, as soon as he received the TA and began looking for traffic, the airplane was high on the approach path and he made the decision to go around. He reported that the workload was high and that the TA resulted in him dividing his attention between looking for traffic outside the window, monitoring the instruments inside, and monitoring the airplane's approach path as indicated by the PAPI. He stated that he had "very little spare capacity."

While debriefing the simulation, the captain remarked that the actual airplane would have been much more challenging with the gusting wind conditions that existed on the night of the accident and that the simulator was "docile." He stated that the turn onto final approach for runway 33 was "the highest workload point on the approach" because the pilot was required to align the airplane with the runway while slowing the airplane to its final approach speed.

The FO stated the following accounting for the gusting wind conditions:

> I'd almost bump the workload rating up another notch because it is dark, you have to turn, it is a short runway…I'd have to keep checking to see all of the indications [airspeed, vertical speed, etc] to determine if the aircraft was on a stable approach.

Both pilots rated this scenario as a 7 on the Bedford Scale, indicating that the level of workload was not tolerable for them.

1.11.8.2 UH-60L Simulator

Investigators also performed simulator observations in a US Army Black Hawk Aircrew Trainer (BAT) at DAA. The cockpit and aerodynamic model were configured as a UH-60L equipped with ESSS. At the time of the simulator observation, the BAT software did not provide a high-fidelity visual display of cultural lighting, buildings, or other infrastructure in the area of DCA.

A current and qualified UH-60 pilot sat in the right pilot seat and operated a simulated flight between the Memorial Bridge and the accident location, following the transition from Helicopter Route 1 to Route 4 at 200 ft msl.[122] The pilot wore NVGs, the environmental conditions were set to nighttime, and the simulated wind conditions approximated those on the night of the accident.

After completing the flight, the pilot was asked to rate his workload using the Bedford Scale, and he estimated his workload during the flight as a 4. He noted that the aerodynamic effects of the ESSS and the programmed wind conditions made it more challenging than usual to maintain altitude, airspeed, and trim. These factors required him to frequently crosscheck the flight instruments and make corrections. He said that if there had been no wind, he likely would have rated the workload as a 2, and if there had been no wind and the flight was in daytime conditions, he would have considered the workload a 1.

Army personnel stated that pilots adjusted their NVGs before flight to ensure proper focus and comfort and to provide adequate space away from the eyes to see under the NVGs to view the cockpit instruments. The pilot who performed the simulated flight stated that his visual scan alternated outside and inside to cross-reference the flight instruments. During a single glance down at the instrument panel, he might look at the attitude indicator, radar altimeter (because he was close to the ground), vertical speed indicator, or airspeed indicator.

A video of the pilot's left eye was recorded during the simulated flight and subsequently reviewed; the review indicated that the pilot looked below the NVGs 19 times during the 2 minute 55-second flight, an average of once every 9.2 seconds, consistent with the pilot's statement that he alternated his visual scan inside and outside the cockpit.

[122] The pilot had 646 total hours of flight experience, with 534 hours in the UH-60M and 38 hours in the UH-60L, and 189 hours of NVG experience.

1.12 Organizational and Management Information

1.12.1 PSA Airlines

PSA Airlines, a wholly owned subsidiary of American Airlines, operated a fleet comprised exclusively of dual-class MHI RJ airplanes, with 61 MHI CRJ700 airplanes and 80 MHI CRJ900 airplanes.

1.12.1.1 DCA Approach Procedures

PSA used Jeppesen electronic approach charts and provided company-specific textual and pictorial guidance for flying the Mount Vernon Visual Runway 1 approach (the approach for which the accident airplane was cleared before being asked to switch to runway 33), as well as the runway 33 visual approach. Figure 68 shows the Jeppesen approach plate for the Mount Vernon Visual, and figure 69 shows PSA's guidance for flying the circle maneuver to runway 33. Approach charts for DCA did not depict the helicopter routes in the area.

PSA's Flight Operations Manual states the following concerning the arrival briefing: "If the assigned approach changes, brief the new approach prior to accomplishing it."

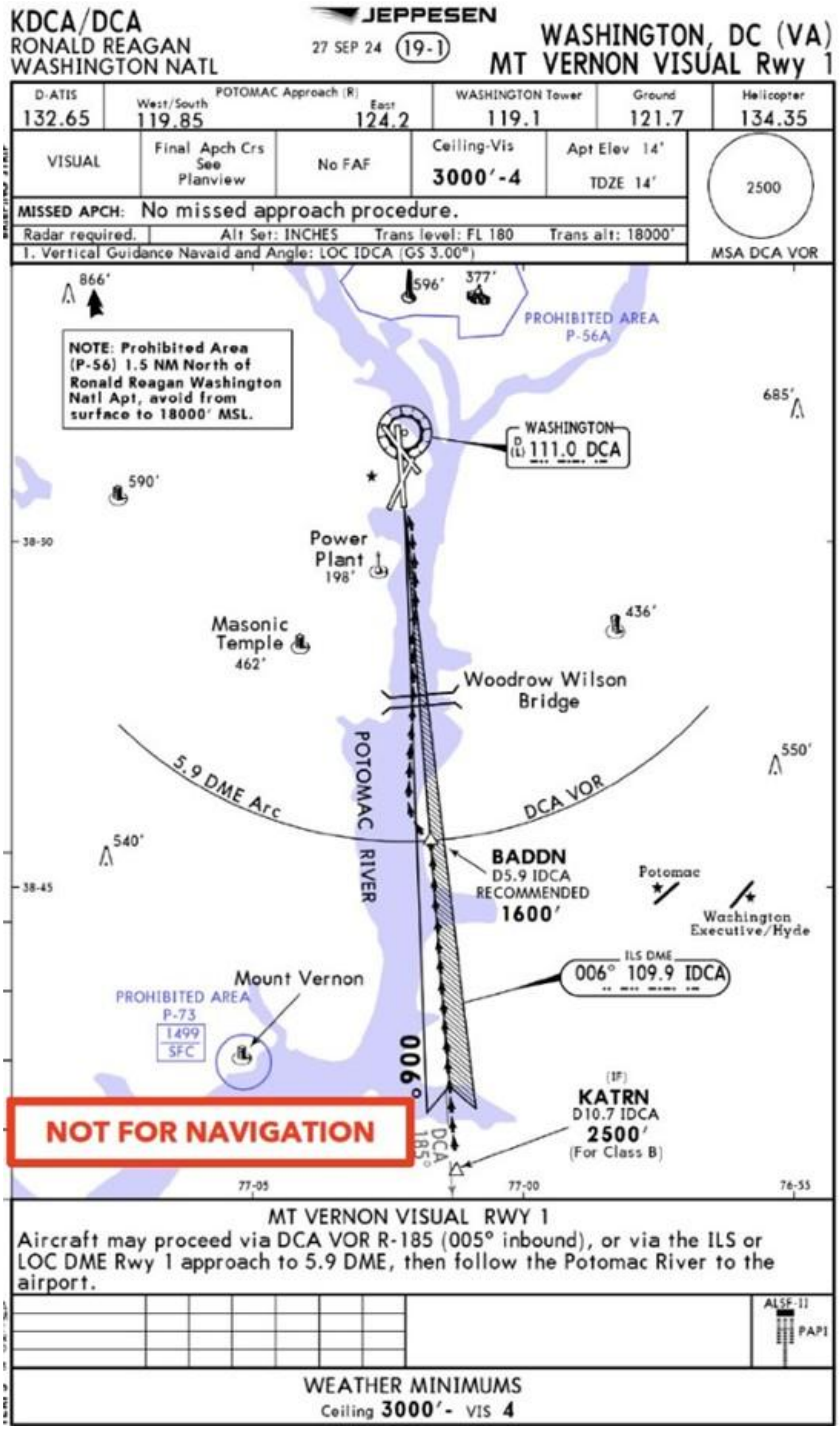

Figure 68. Jeppesen Mt Vernon Visual Runway 1 Approach Plate. (Source: PSA Airlines)

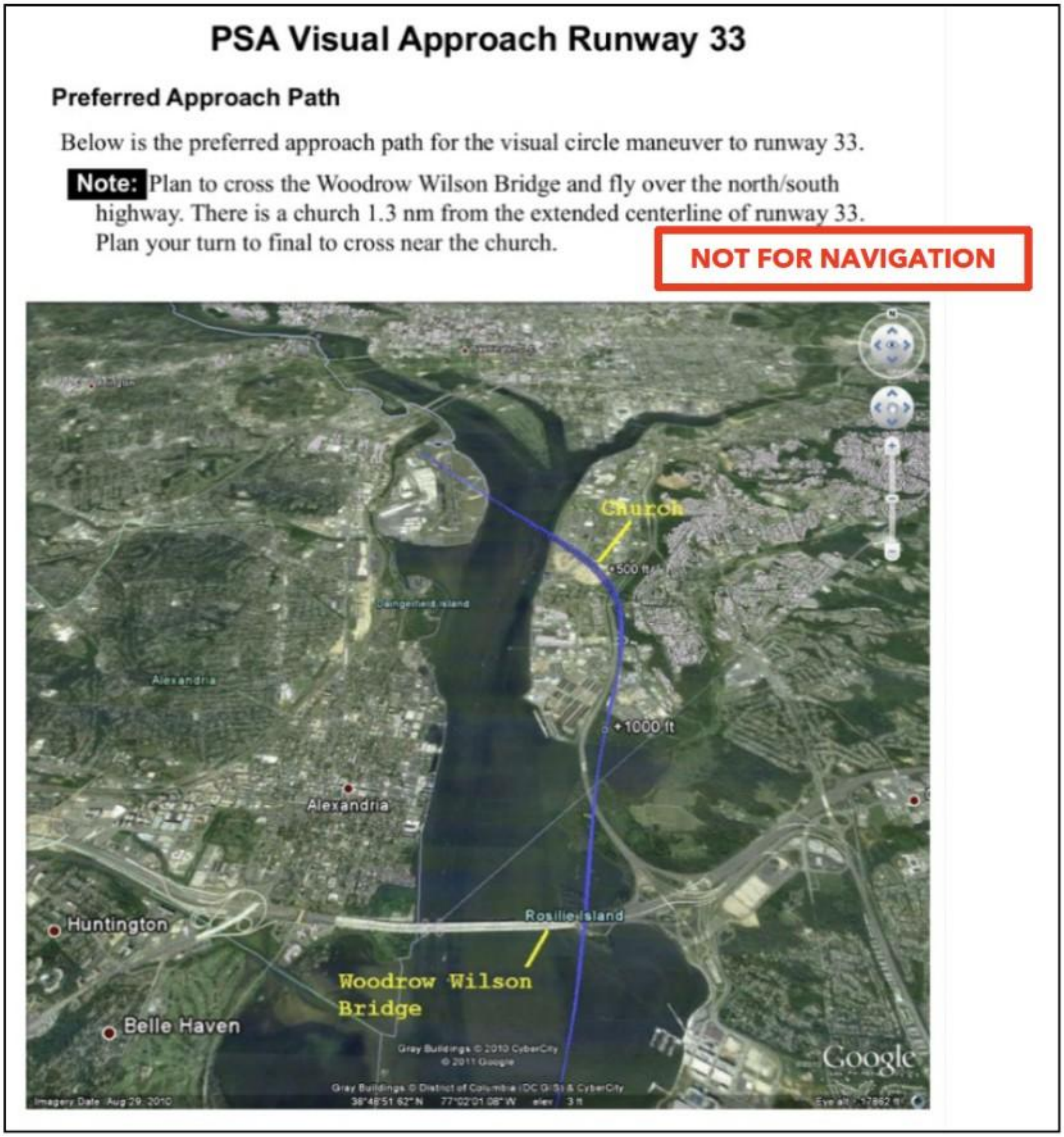

Figure 69. PSA Guidance for Runway 33 Circling Approach. (Source: PSA Airlines)

1.12.1.2 Pilot Experiences at DCA

Thirteen PSA pilots were interviewed, including seven captains, four FOs, and two management chief pilots. Multiple pilots described DCA as “too busy.” Another captain stated that DCA imposed the highest pilot workload out of any of PSA’s hub airports. Many pilots voiced concerns regarding the amount of helicopter traffic in close proximity to DCA.

Five PSA pilots were asked about their experience with TCAS TAs and RAs in the vicinity of DCA. One captain reported that he had received multiple TAs and at least one RA, all of which involved helicopters and occurred while on approach to runway 19. In one instance, the captain was told that the helicopter crew had him in sight and would maintain visual separation.

Three PSA captains were asked about their level of trust in the DCA ATCT to provide separation from helicopters and their comfort level when hearing that the crew of a nearby helicopter had them in sight and would maintain visual separation. One captain said that he would look for traffic but assume that the helicopter crew would maintain visual separation.

Another captain, who had previously served in the Air Force and had 7 years of experience as an Air Force helicopter pilot in the area, described the DC helicopter routes as unique because they were located in controlled airspace. He stated that DCA controllers did not typically "exercise positive control" over the helicopter routes but that they had the option of holding helicopters or employing visual separation, both of which were "very common."

A third captain stated that he trusted the tower "one hundred percent" and that if he received a TA while circling to runway 33, he would be alert for the traffic and listen for the other aircraft to acknowledge, but he would continue to trust the controller.

Several PSA pilots recalled occasional instances of observing helicopters operating below their aircraft in the DCA airspace; however, these accounts generally lacked sufficient detail to determine the frequency of such encounters or the proximities between the aircraft involved.

1.12.1.3 PSA Guidance on TCAS TA and RA Responses

PSA's Flight Operations Manual, chapter 12, discussed pilot responsibilities when a TCAS TA or RA occurs. The manual stated, in part:

> 12.2.1 Policy.
>
> When an RA (resolution advisory) occurs, the PF [pilot flying] should respond promptly to the RA displays and maneuver as indicated. This response should take place even if it conflicts with air traffic control…instructions, unless such action would compromise the safe operation of the flight.
>
> Traffic Advisory (TA).
>
> If receiving a TA…

- Do not maneuver based on a TA alone.
- Attempt to see the reported traffic.

Resolution Advisory (RA).

If receiving an RA…

- Initial TCAS guidance is based on crew action within 5 seconds.
- Increase or reversal TCAS guidance is based on crew reaction within 2 1/2 seconds.
- Avoid excessive maneuvers while aiming to keep the vertical speed outside of the red area of the VSI [vertical speed indicator] and within the green area (if applicable).
- If an initial RA is weakened (for example, a Climb RA weakens to a Do Not Descend RA), adjust the aircraft's vertical speed accordingly but remain out of the red area. The green area will remain displayed for the weakened RA to provide a target vertical speed for the modified RA. Attention to the RA display and prompt reaction to the weakened RA will minimize altitude excursions and potential disruptions to ATC.
- Resolution Advisories (RAs) are inhibited below 900 ft.
- Attempt to see the reported traffic.

The Flight Operations Manual referred to FAA AC 120-55 and the "TCAS Transition Program Industry Alert Bulletin," which contained guidance indicating that crews should "respond to TAs by attempting to establish visual contact with the intruder aircraft and other aircraft which may be in the vicinity" and to "coordinate to the degree possible with other crewmembers to assist in searching for traffic. Do not deviate from an assigned clearance based only on TA information" (FAA, 2011b; FAA, 2002).

TCAS processes target information simultaneously from both antennas; targets received only from the bottom TCAS antenna do not generate a target on the display but will instead show a textual display of traffic range and altitude. The MHI RJ flight crew operations manual (FCOM) described this scenario as a "no bearing" advisory. This document was not available to PSA flight crews, and neither the PSA CRJ700/900 Pilot Reference Manual (for aircraft systems descriptions) nor the CRJ Pilot Operating Handbook discussed the topic of a "no bearing" TA or RA. If the airplane is above 400 ft agl during the descent, TCAS will provide the same "Traffic,

Traffic" aural advisory regardless of whether bearing information is available. Although TA and RA activation is a recorded FDR parameter, the FDR does not capture whether a TA or RA is a "no bearing" advisory.

In testimony provided in the NTSB's investigative hearing for this accident, PSA's assistant director of flight operations stated that pilots received classroom instruction regarding no bearing TAs during initial training; however, their simulator software was unable to generate a no bearing TA, so pilots did not receive simulator training for this scenario.

Five PSA pilots were asked questions related to their knowledge of TCAS TA aural alert inhibit altitudes and RA inhibit altitudes. Only one of the five pilots was able to provide a correct answer regarding the altitude at which TCAS inhibited RAs.

1.12.2 US Army

The accident helicopter and flight crew were assigned to B Company, 12th Aviation Battalion, and were based at DAA. The 12th Aviation Battalion was a helicopter battalion that comprised about 400 soldiers, and whose mission was to support continuity of government operations in the National Capital Region. The battalion comprised three active-duty helicopter companies (A, B, and C), a maintenance company (D), a headquarters company, and an attached, rotating National Guard helicopter company.

B Company comprised about 40 soldiers, including pilots, crew chiefs, and company leaders. The 12th Aviation Battalion's parent organization, TAAB, included a US Army Priority Air Transport Battalion with fixed-wing aircraft at Joint Base Andrews-Bolling, an Operational Support Airlift Activity Battalion with fixed-wing aircraft at DAA, an Airfield Division that operated the DAA airport and provided some air traffic control staff to the Pentagon Heliport, and a headquarters staff based at DAA.

1.12.2.1 Procedures and Guidance

1.12.2.1.1 Annual Proficiency and Readiness Test

In accordance with the Army's Aircrew Training Program, rated crewmembers (RCM) were required to complete an annual proficiency and readiness test consisting of a standardization flight evaluation, NVG flight evaluation, instrument flight evaluation, and an annual written examination. Task standards described the minimum level of performance required for task proficiency used during readiness level progression, training, and evaluations. The following example task standards were listed in the UH-60L Aircrew Training Manual.

All tasks:

- Do not exceed aircraft limitations.
- Perform crew coordination actions IAW [in accordance with] aircrew coordination section in this Aircrew Training Manual.
- Crewmembers will comply with all evaluation considerations, warnings, cautions, and notes in the task.

Hover:

- Maintain heading ±10 degrees (± 20 degrees for automatic flight control system (AFCS) off).
- Maintain altitude, ±3 feet (±5 feet for out of ground effect (OGE)). *
- Do not allow drift to exceed 3 feet (10 feet for OGE hover). *
- Maintain ground track within 3 feet.
- Maintain a constant rate of movement appropriate for existing conditions.

Note. These standards (*) required that the other crewmembers announce drift and altitude changes before exceeding the standard.

In-flight:

- Maintain heading ±10 degrees.
- Maintain altitude ±100 feet.
- Maintain airspeed ±10 KIAS.
- Maintain ground track with minimum drift.
- Maintain rate of climb or descent ±200 FPM [ft per minute].
- Maintain the aircraft in trim ±½ ball width

The Aircrew Training Program allowed for evaluations to be conducted in the "most demanding mode" that most closely replicated the unit mission. In the case of the 12th Aviation Battalion's mission, the most demanding flight mode would be night NVG operations. Combining the pilot's standardization check with the NVG check closely replicated the actual mission environment and eliminated the need to complete an additional evaluation flight. This kind of combined evaluation was the purpose of the accident flight.

1.12.2.1.2 Aircrew Coordination Training

A Basic Aircrew Coordination Training student handout provided by the Army, dated March 2024, stated in part:

> The army calls the incorporation of crewmembers into cockpit management Aircrew Coordination. Other names used for aircrew coordination training programs are Cockpit Resource Management, Integrated Resource Management, and Crew Coordination. In the early 1970's, NW [Northwest] Airlines pioneered development of aircrew coordination through the use of simulators. Adapted by the Army from existing programs used by the civilian airline industry, the US Army Dynamics of Aircrew Communication and Coordination provided the first aircrew coordination training at USAACE [United States Army Aviation Center of Excellence] in 1992.
>
> Aircrew Coordination Training – Basic (ACT-B) is the student pilot trainee's first exposure to crew coordination in aviation. It is designed to present the basic concepts and structure of crew coordination prior to the student pilot's first flight in an attempt to mitigate crew coordination errors and aviation accident rate during the initial entry orientation phase of flight training.
>
> Aircrew Coordination Training – (ACT-IQ) Initial Qualification is a comprehensive course of instruction given to Initial Entry Rotary Wing aviators during the instrument phase of instruction. This course, followed by an evaluation in flight, will be annotated in the student's flight records as their Initial Qualification and occur during the Instrument Stage of training.
>
> Aircrew Coordination Training – (ACT-IQ) Sustainment. It is training completed by the rated aviator after assignment to an aviation unit and is a four-hour class completed annually with aircrew coordination being evaluated during every flight evaluation.
>
> Aircrew Coordination Training (ACT-IC) Instructor Qualification. This level of ACT-IQ is only taught to those aviators assigned to an Instructor Pilot course/position. This course of instruction is designed to train the trainer in the method and technique of ACT-IQ instruction.

The Army's *Aircrew Training Manual, Utility Helicopter, H-60 Series*, chapter 7, Aircrew Coordination Training, stated that crews "must use clear, concise terms that can be easily understood and complied with in an environment full of distractions," and further defined preferred terms for communicating about traffic. Terms included "visual" to indicate that a target, traffic, or obstacle was seen or identified; "traffic," indicating an aircraft that presented a collision hazard, followed by clock position, distance, and reference to altitude; and "no joy," indicating that a target, traffic, or obstacle was not positively seen or identified.

Additional guidance contained in chapter 4, H-60 Crewmember Tasks, stated that aircrews should "immediately inform other crewmembers of all air traffic or obstacles that pose a threat to the aircraft" using the "clock, altitude, and distance method." Review of Army records indicated that all three PAT25 flight crew members had received aircrew coordination training within the previous 12 months.

Investigators reviewed communications on the helicopter's CVR from the accident flight to determine how the crew communicated about potential traffic conflicts. At 1959:55, a Potomac TRACON controller advised the crew, "PAT two five traffic at your ten to eleven o'clock and two miles eastbound altitude indicates one thousand eight hundred it's a helicopter."

At 2000:05, the IP (who was the pilot flying at the time) told the pilot, "That was for you. Two miles eastbound." At 2000:11, the Potomac TRACON controller again advised traffic, "at your nine to ten o'clock in two miles eastbound one thousand eight hundred indicated it's a helicopter." At 2000:11, the pilot asked the IP, "Do you see him?" and at 2000:12, the IP responded, "nope." At 2000:20, the pilot asked again, "Do you see him?" At 2000:21, the IP stated, "No. Nine to ten o'clock." At 2000:25, the IP stated, "Yeah I got it. Tally. Coming left…yup. I got the traffic out the right door." At 2000:48, the pilot transmitted, "PAT two five has the traffic in sight maintaining visual separation."

1.12.3 Federal Aviation Administration

The FAA is an administration within the US DOT as codified at 49 *USC* 106; it is responsible for encouraging the development of civil aeronautics and safety of air commerce in and outside the United States (49 *USC* 40104). FAA Order 1100.1D outlines the agency's organizational structure and defines the responsibilities of operating the National Airspace System (NAS) and enforcing the safety standards that govern its use.

The order establishes responsibility of the FAA's ATO to provide air navigation services across US airspace. That responsibility includes managing civilian air traffic control services, coordinating the use of airspace and procedures, and maintaining the infrastructure. In addition to its operational duties, the ATO implements safety programs designed to identify, assess, and mitigate risks inherent in the design, operation, and maintenance of the NAS.

FAA Order 1100.1D establishes the Aviation Safety (AVS) organization as lead for the agency's regulatory and certification responsibilities. AVS develops and enforces civilian safety regulations, certifies aircraft and air carriers, and sets qualification standards for pilots and other certificated airmen to ensure continued compliance with federal aviation requirements. FAA Order 1100.161B further clarifies that the Air Traffic Safety Oversight Service (AOV) within AVS provides independent oversight of the FAA's air traffic operations, including conducting safety oversight surveillance of ATO operations and monitoring ATO's safety performance to ensure effective implementation of compliance with safety-related laws, regulations, policies, procedures, standards, and SMS requirements.[123]

1.13 Safety Programs

1.13.1 Safety Management Systems

The ICAO is a United Nations agency that establishes standards for 193 member states, including the United States. Member states are required to establish a State Safety Program, including safety management systems (SMS) for manufacturers and service provider organizations.[124] In accordance with ICAO requirements, the FAA established external SMS requirements for Part 121 and Part 135 aircraft operators (contained in 14 *CFR* Part 5), aircraft design and manufacturing organizations (contained in 14 *CFR* Part 21), airports (14 *CFR* Part 139), and internal SMS requirements via policies and orders for its own lines of business.[125]

[123] Order 110.161B further states that, "To provide robust checks and balances and to avoid perceived, potential, or actual conflicts of interest, AOV is part of a separate FAA line of business from ATO, under [the Associate Administrator for Aviation Safety] and is a dual direct report to the FAA Administrator and [Associate Administrator for Aviation Safety]."

[124] See Annex 19 to the Convention on International Civil Aviation, Safety Management. See also ICAO *Safety Management Manual*, Fourth Edition, 2018 (Doc 9859-AN/474).

[125] In 2010, Congress mandated that the FAA conduct rulemaking to require Part 121 operators to implement an SMS in the Airline Safety and Federal Aviation Administration Extension Act of 2010 (Pub. L. 111-216, 124 Stat. 2366). In 2015, the FAA issued 14 *CFR* Parts 5 and 119 requirements for Part 121 operators to develop and implement an SMS and set out the basic requirements for those systems. In 2020, Congress enacted the Aircraft Certification, Safety, and Accountability Act of 2020 (Pub. L. 116-260, 134 Stat. 2309) mandating that the FAA require that manufacturers with a type certificate and a production certificate under 49 *USC* 44704 have an SMS consistent with the Standards and Recommended Practices in ICAO Annex 19 (61 Stat. 1180). The FAA's final rule containing those revisions became effective May 2024.

FAA Order 8000.369C, "Safety Management System," establishes the SMS policy and requirements for the FAA, and defines the roles and responsibilities of the FAA organizations in safety management and safety oversight activities. The order describes SMS as "the formal, top-down, organization-wide approach to managing safety risk and assuring the effectiveness of safety risk controls." It includes systematic procedures, practices, and policies for the management of safety risk, and describes the four main components of an SMS:

Safety Policy: An organization's safety policy contains defined objectives and standards for the organization and its employees and management's commitment to its employees regarding the safety performance of the organization. As safety risk management and safety assurance processes are developed, the organization revisits its safety policy to ensure that its commitments are being realized and its standards are being upheld.

Safety Risk Management (SRM): SRM provides a decision-making process for identifying hazards and mitigating risk based on a thorough understanding of the organization's unique systems and operating environment. SRM allows risk controls to be incorporated into the organization's processes, products, and services, and for those controls to be redesigned when existing controls do not meet the organization's safety expectations as outlined in its safety policy. Change management refers to the set of organizational processes by which intended reforms are translated into sustained changes in everyday practice (Kotter, 1995). Organizational research has shown that policy or procedural changes alone are unlikely to produce durable effects unless they are accompanied by corresponding adjustments to authority, resources, workload allocation, and competing priorities that shape how work is actually performed.

Safety Assurance: The goal of safety assurance is to monitor the organization's processes and operations to ensure that the defined safety objectives and existing risk controls are working. Safety assurance requires monitoring and measuring the safety performance of operational processes and continuously improving safety performance levels. Strong safety assurance processes yield information that can be used to identify weaknesses in existing policy and procedures, thereby assuring the safety performance of the organization.

Safety Promotion: Training and communication ensure that employees understand the organization's safety policies and risk controls, as well as their personal responsibility to the organization's SMS, including safety reporting expectations and procedures. Organizations must ensure that their workforce has the necessary competencies to perform their duties relevant to the operation and performance of the SMS.

Order 8000.369C further describes the importance of organizational culture as being critical to maintaining an effective SMS:

> Organizations must promote a positive safety culture throughout the organization, which is characterized by an adequate knowledge base, personnel competency, communications, training, informed decision making, and information sharing in which lessons learned and best practices are developed and shared. All levels of management must actively promote and provide leadership to foster a positive safety culture. A safety culture consists of the shared values, actions, and behaviors that demonstrate a commitment to safety over competing goals and demands. In the desired safety culture, people acknowledge their accountability and act on their individual responsibility for safety. They trust, use, and rely on the organization’s processes for managing safety. Individuals report/raise safety issues without fear of reprisal, supporting the implementation of a non-punitive safety reporting system. Decision makers promote continual safety improvement through timely action, when appropriate, and provide feedback to the reporters. There is good communication in the organization, and personnel continue to learn and develop through training and coaching. The ways in which an organization works to improve its safety culture are best determined by the organization’s management.

In its guidance to operators, AC 120-92D, “Safety Management Systems for Aviation Service Providers,” the FAA states that:

> Active involvement of operational leaders, maintaining open lines of communication up and down the aviation organization and among peers, staying vigilant in looking for new hazards and identifying associated risks, and ensuring that employees know that safety is an essential part of their job performance are key elements that can have a positive effect on the aviation organization’s SRM decisions.
> (FAA, 2024b)

1.13.2 Organizational Safety Theory and Safety Culture

Commercial aviation, like other complex productive systems, employs multilayered defenses that must be simultaneously defeated for an accident to occur. Organizational safety theory suggests that accidents involving such systems rarely arise from isolated pilot or controller errors. Rather, they emerge from the interaction of operator actions with pre-existing latent hazards created by organizational decisions, system design, and cultural norms. Latent hazards can exist within a system for long periods of time, causing no ill effects until a combination of circumstances renders them operationally consequential and an accident occurs.

Prominent safety theorists have observed that organizations are generally effective at responding to failure, but less effective at detecting and managing risks while systems still appear to be functioning normally. Weak signals, normalization of nonstandard practices, and operational success can mask emerging risk. Safety management systems emerged to fill this gap in awareness, translating the insights of safety theory into a structured, proactive approach to hazard identification, risk assessment, safety assurance, and organizational learning.

Organizational commitment, competence, and allocation of sufficient resources are required for a safety management system to be effective. Only top management can ensure an organization commits to modeling good safety practices, hires competent personnel, and provides resources to the safety function.

These prerequisites provide the foundation for another critical element for the success of a safety management system: a positive safety culture. In his landmark work, *Managing the Risks of Organizational Accidents*, James Reason argued that a positive safety culture has the following attributes: reporting, informed, just, flexible, and learning (Reason, 1997).

A reporting culture is one in which safety reporting is embraced by frontline personnel. Safety reporting is a mechanism by which organizations learn about hazards. An informed culture is one in which the information obtained through safety reporting is analyzed to identify potential risk. A just culture encourages rather than penalizes workers for reporting hazards, even their own errors. A flexible culture is one in which organizational structures, roles, and decision-making authority can adapt in response to changes in operational risk, allowing the system to shift from routine modes of operation to more safety-focused configurations when needed. A learning culture is one in which an organization is able and willing to derive the right conclusions from its safety information system and implement reforms when needed.[126]

1.13.3 PSA Safety Management System

As a 14 *CFR* Part 121 air carrier, PSA Airlines was subject to the 14 *CFR* Part 5 requirements and had an approved SMS.[127] Policies and procedures for PSA's SMS

[126] A safety information system collects, analyzes, and disseminates information about incidents or near misses, as well as other kinds of information derived from proactive checks of safety-related organizational processes.

[127] PSA's SMS was first approved in accordance with 14 *CFR* Part 5 in December 2015.

were defined in the airline's *Safety Policies and Procedures Manual* (*SPPM*). The *SPPM* also defined the organizational structure of the SMS and associated responsibilities. All employees were trained on the basics of the SMS and safety reporting systems. Executives, leaders, and Safety Department personnel were required to complete additional training beyond the SMS basics as required by *SPPM* 5.5.5 "Competencies and Training."

PSA reported that it applied an SRM approach to implementation of systems, revisions to existing systems, development of operational procedures, and new hazards or inefficient risk controls identified through safety assurance activities.

PSA captured safety data via the following operational reporting systems:

- American Eagle Event Notifications
- Aviation Safety Action Program (ASAP)
- Operations Reports
- Internal Evaluation Program (IEP)[128]
- Safety Hotline
- Flight Operations Quality Assurance (FOQA)[129]
- Fatigue Risk Management Plan (FRMP)
- Line Operations Safety Audit (LOSA)[130]
- Commercial Aviation Safety Team (CAST)[131]

[128] FAA AC 120-59B states that the purpose of an IEP is to ensure compliance with external regulatory requirements, identify nonconformance to internal company policies and procedures, and identify opportunities to improve organizational policies, procedures, and processes.

[129] FAA AC 120-82 states that FOQA is a voluntary safety program that is designed to make commercial aviation safer by allowing commercial airlines and pilots to share de-identified aggregate information with the FAA so that the FAA can monitor national trends in aircraft operations and target resources to address operational risk issues. The fundamental objective is to allow the FAA, pilots, and operators to identify and reduce or eliminate safety risks, as well as minimize deviations from the regulations. A cornerstone of the program is that aggregate data provided to the FAA is kept confidential and the identity of reporting pilots or operators will remain anonymous as allowed by law.

[130] FAA AC 120-90 states that a LOSA is a formal process that requires expert and highly trained observers to ride the flight deck jumpseat during regularly scheduled flights to collect safety-related data on environmental conditions, operational complexity, and flight crew performance. Confidential data collection and non-jeopardy assurance for pilots are fundamental to the process. Similar to a person's annual physical examination, a LOSA provides a diagnostic snapshot of strengths and weaknesses that an airline can use to bolster the "health" of its safety margins and prevent degradation.

[131] According to cast-safety.org, the USCAST is a cooperative government–industry initiative whose mission is to enable a continuous improvement framework built on the proactive identification of current and

PSA's use of safety data is discussed in greater detail in section 1.14, Flight Safety Data.

1.13.4 Army Safety Program

ICAO SMS requirements do not apply to domestic military aircraft operations and Part 5 requirements do not apply to military operations. The military was, therefore, not subject to the same FAA SMS requirements as were PSA or DCA controllers.

Each branch of the military was responsible for developing, resourcing, and managing its own safety program (DOD, 2021). Assistant Secretary of the Army for Installations, Energy, and Environment provided regulations and guidance in this area via Army Regulation AR 385-10, The Army Safety and Occupational Health Program, and Department of the Army Pamphlet (DA PAM) 385-10 (Army, 2023a–b). These materials established risk management as the Army's principal risk reduction methodology and asserted that commanders at every echelon were responsible for the management of their unit's safety program. The documents listed several categories of potential hazards to be managed, including occupational health, tactical safety, aviation safety, off-duty safety, radiation safety, and motor vehicle, pedestrian, and bicycle safety.

DA PAM 385-10 provided guidance on the implementation of Army aviation safety programs. It stated that such programs were to incorporate an occupational hazard reporting and investigation program managed by unit aviation safety officers. Hazards were to be reported using operational hazard reports (OHRs). OHRs were intended to capture potential hazards, including those related to air traffic control, airways and navigation aids, near midair collisions, and aircraft operations, and could not be filed anonymously. OHRs were filed using Department of the Army Form 2696, Operational Hazard Report, and submitted to an Army safety or flight operations office. Reports involving civil aircraft or civil air traffic control were to be mailed to the nearest FAA FSDO and the Department of the Army regional representative for the area.[132]

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future risks, developing mitigations as needed and monitoring the effectiveness of implemented actions. USCAST was integrated into the US Aviation Safety Team (USAST) in August 2025.

[132] DA PAM 385-10 also required the incorporation of a foreign object damage prevention program, a mishap reporting and investigation plan, comprehensive standard operating procedures, and other safety-related programs that could include, but were not limited to fire prevention, hazard communication, hearing conservation, respiratory protection, radiological protection, protective clothing and equipment, hazardous materials handling, aviation maintenance, ammunition/explosives/weapons handling, aviation life support systems, environmental protection, and fighter management.

AR 385-10 required brigade and higher-level units to establish a Safety and Occupational Health Advisory Council (SOHAC). The SOHAC was to meet biannually to review items completed on the commander's safety plan, workplace safety hazard logs, safety assessments and inspections completed, mishap data, work-related illnesses and injuries, civilian case incidence, workers compensation costs, safety services completed, installation hazard abatement, workplace inspections completed, accidents investigated, and employee training.

DOD Instruction 6055.19, "Aviation Hazard Identification and Risk Assessment Programs (AHIRAPs)," issued by the Office of the Under Secretary of Defense for Personnel and Readiness in 2017 and revised in 2019, established a requirement to use a risk management approach to identify hazards, quantify risks, and mitigate hazards associated with flight operations. Per this instruction, DOD component heads (including of the military services) were required to establish AHIRAPs, including military MFOQA programs, ASAPs, and LOSA programs to allow "commanders and aircrew to identify and quantify risks and threats to flight operations that were previously unrecognized." This instruction required Army aviation organizations to incorporate the needs of these programs into budgets and planning; train aircrew, maintenance personnel, leaders, and safety professionals; and promote a nonpunitive reporting culture.

The instruction specifically allowed for excluding MFOQA implementation if a cost-benefit analysis determined that the program was not cost effective. The director of the Data Analysis and Prevention Directorate at the US Army Combat Readiness Center testified during the NTSB investigative hearing that MFOQA was an "unfunded requirement." He further stated, "We had gone back to [the Office of the Secretary of Defense] and…asked if they could support with resources and they said that they could not."

The Secretary of the Army issued Army Directive 2024-09 on August 7, 2024. This formal, servicewide order directed the adoption and implementation of an Army Safety and Occupational Health Management System (ASOHMS), the Army's first official SMS framework. The directive stated that an effective ASOHMS should:

1. Effectively identify, mitigate, and manage internal and external risks to the mission at all appropriate levels of echelon.

2. Ensure two-way communication to solicit soldier and employee input and provide leadership feedback to SOH [safety and occupational health]-related activities and improvement opportunities.

3. Use data, trends, and analysis to manage SOH strategically and proactively within the organization.

4. Transition the culture to approach SOH activities as a seamless decision making process used in all mission tasks and activities to properly mitigate risk before loss occurs.

Army Directive 2024-09 required the Assistant Secretary of the Army for Installations, Energy, and the Environment to incorporate ASOHMS into the Army safety program regulations by September 2026, and it required Army commands and organizations to be fully compliant by the end of calendar year 2030. Review of AR 385-10 and DA PAM 385-10 dated July 24, 2023, revealed that these materials already included extensive reference to ASOHMS that addressed major aspects of SMS, including ensuring leadership and resources, developing safety policy and goals, performing risk management, performing safety assurance activities, and engaging in safety promotion. Army representatives confirmed that there was no additional aviation-specific guidance on ASOHMS or SMS implementation.

The US Army Combat Readiness Center provided an enterprise IT system called the Army Safety Management Information System (ASMIS) to support organizations like TAAB and its battalions. The three modules of this system that were functional at the time of the accident were: 1) a module for hazard identification and tracking (risk assessment), 2) a module for compiling workplace inspection (safety assurance), and 3) a module for mishap and near miss reporting (safety assurance). In addition, the US Army Aviation Center of Excellence provided a computerized preflight risk assessment tool for pilots (the Risk Common Operating Picture, or RCOP) that was customizable to reflect hazards most relevant to a unit’s operations.

The RCOP, developed by the US Army Aviation Center of Excellence, was the principal risk management tool for TAAB flight operations. The worksheet contained three main sections: crew, mission and environment, and weather. The user populated the spreadsheet with information about a proposed mission, and the sheet calculated an initial risk score for each of these categories. Risk scores were classified as “low,” “medium,” “high,” or “extremely high.”

The worksheet automatically populated risk scores for selected mission characteristics such as mission type, crew experience, and weather conditions, eliminating the need for the pilot to rate the risk themselves. The pilot-in-command completed the RCOP and presented it to a mission briefing officer, who reviewed it with the pilot. The pilot then presented the reviewed RCOP to an officer who served as the final mission approval authority. The worksheet included a final “residual risk” sign-off section, where the mission briefing officer and the final mission approval authority recorded and approved the final risk level after reviewing the mission and any mitigations with the pilot or air mission commander.

1.13.4.1 TAAB Safety Program Structure and Administration

TAAB's commander, who had occupied that position since August 2024, said that, per Army Regulation 600-20, commanders were responsible for everything their unit achieved or failed to achieve, and per Army Regulation AR 385-10, commanders at every echelon were responsible for the Army safety program. He said it encompassed diverse activities, most of which involved occupational health and ground safety issues. He had published a safety policy as required, and TAAB had a brigade-level aviation and ground safety SOP that described procedures for risk assessment and risk management, reporting mishaps, and safety education, along with occupational health and personal injury prevention functions (Army, 2024a). The commander convened biannual SOHAC meetings.

TAAB's commander, who had assumed command in August 2024, said he had relied on subordinate battalion safety officers to administer the safety program and he worked closely with a full-time civilian brigade safety manager. A second civilian safety manager was hired shortly before the accident to help reduce workload and allow more emphasis on aviation safety. The commander said he relied on the brigade's standardization pilots for aviation safety and risk management and would shift to the safety team's involvement in the event of an accident.

TAAB's safety manager, a retired Army helicopter pilot who had been the brigade's safety manager since August 2009, stated that he advised, assisted, and oversaw implementation of the brigade's safety program. He said that aviation was one of 14 required safety program areas under AR 385-10 and that the absence of dedicated specialists in industrial hygiene and ground safety required him to devote significant time to those areas. He estimated that "well over 50 percent" of his time was spent on aviation safety, although attention was divided among multiple aircraft types operated by the brigade.

TAAB's safety manager confirmed that the brigade held semiannual SOHAC meetings attended by commanders and safety officers to discuss occupational, ground, and aviation safety issues. He explained that the brigade commander issued follow-up guidance or taskings based on issues identified during these meetings.

TAAB's safety manager stated that the brigade had begun incorporating ASOHMS in September 2021. The program followed a three-stage process: 1) documentation, 2) implementation and execution, and 3) sustainment and continuous improvement. By the time of the accident, TAAB had completed Stage 1 and was transitioning to Stage 2. The safety manager said the brigade's implementation effort included the development of written policies, procedures, and risk management documents in accordance with the guidance contained in AR 385-10 and DA PAM 385-10.

The 12th Aviation Battalion safety officer had completed the US Army Safety Officer Course in 2021 and served in safety officer positions since that time. He had joined the 12th Aviation Battalion as a safety officer in August 2024. He estimated that about 75% of his work hours were devoted to occupational safety and 25% to aviation safety. He described his job as "managing the individual flight companies' safety officer programs." He coordinated quarterly battalion safety standards meetings, which involved discussion of safety issues brought forward by operational personnel. He gave briefings at aircrew meetings organized by standardization pilots. The most recent had addressed winter safety topics such as avoiding slips, trips, and falls; using a buddy system in cold temperatures; powerline safety; and information on wildlife strikes.

The battalion safety officer also participated in SOHAC meetings twice per year and facilitated an employee safety committee chaired by civilian employees from D Company (the maintenance company). He reported a good working relationship with TAAB's safety manager and stated that whenever he encountered an issue he could not resolve at his level, the TAAB safety manager was willing to elevate the matter to obtain a resolution. When asked whether any flight safety related concerns had been reported to him by 12th Aviation Battalion pilots, he said that he had not received reports of issues involving the Washington, DC, helicopter routes, except for one laser incident.

The B company safety officer, who had held that position since April 2024, reported spending about 80% of his work hours on occupational health matters and 20% on aviation safety. He said that if a pilot experienced a hazard or near miss in flight, they would normally communicate it verbally to him and he would file it in the ASMIS reporting module. He said that he had filed only one such report since joining the company, and it had involved a bird strike. He stated, "Usually I've had a pretty easy job here. I haven't had to do too much with the safety side on reporting near misses or accidents."

1.13.4.2 Safety Risk Management

TAAB Safety SOP defined risk management as minimization of "the potential effects of hazards that could cause loss of personnel, equipment, or impact mission success" (Army, 2024a, 7-1-5). TAAB's safety manager stated that the ASMIS hazard management module allowed hazards identified to be tracked. The TAAB Safety SOP described a risk assessment protocol for use in evaluating and addressing such hazards and provided job aids. The steps in the protocol involved identifying the hazard, assessing the hazard to determine its effect on a mission, developing control measures, making decisions, implementing controls, supervising implementation, and evaluating the effect. The SOP defined command levels that were authorized to accept different levels of risk as determined by a formal risk assessment.

In addition, TAAB pilots confirmed that they performed preflight risk assessments for all flight operations and that the primary tool for performing a preflight risk assessment was the RCOP. Pilots from the 12th Aviation Battalion stated that they used the RCOP before every flight and that it had been customized to assess hazards relevant to the operations they performed.

The RCOP for PAT25 initially rated the risk for all three crewmembers as "medium." Mitigations included allowances for experience flying in the local area, review of the hazards along the route of flight, discussion of low illumination conditions and turbulence, and maintaining a minimum altitude of 500 ft agl, except on published helicopter routes that specified a different altitude. The final RCOP rating was "low" in all categories; this was signed by the mission briefing officer and by the company commander, who held final mission approval authority.

1.13.4.3 Safety Assurance

ICAO (2018) defined safety assurance as:

> …processes and activities undertaken to determine whether the SMS is operating according to expectations and requirements. This involves continuously monitoring its processes as well as its operating environment to detect changes or deviations that may introduce emerging safety risks or the degradation of existing safety risk controls. Such changes or deviations may then be addressed through the SRM process.

Although not specifically described as safety assurance processes in DA PAM 385-10 or the TAAB SOP, TAAB relied on several tools and processes for aviation-related safety assurance. These are summarized in table 14 and discussed in more detail in the next section.

Table 14. US Army aviation-related safety assurance tools and processes supporting TAAB.

Name	Managing organization	Primary sources	Data collection method	Repository	Scope
Operational Hazard Report (OHR)	Deputy Assistant Secretary for Environment, Safety and Occupational Health (provides pdf form)	Any Army personnel or DOD civilian employees	Voluntary report, submitted to pilot's mission briefing or safety officer, possibly forwarded to battalion, brigade, or FAA through Army regional representative; no option for anonymous reporting	No central repository	"Any condition, action, or set of circumstances that compromise[s] the safety of Army aircraft, associated personnel, airfields, or equipment" (Army, 2023b)
Mishap and Near Miss Report	US Army Combat Readiness Center	Any Army personnel or civilian employees	Voluntary report, submitted electronically to ASMIS, anonymous option	ASMIS mishap and near miss reporting module	Mishap: "An unplanned event or series of events that results in damage to DOD property; occupational illness to DOD personnel; injury to on- or off-duty DOD military personnel; injury to on-duty DOD civilian personnel; or damage to public or private property, or injury or illness to non-DOD personnel, caused by DOD activities" (DOD, 2019a) Near miss: "A "potentially serious accident or incident that could have resulted in personal injury, death, or property damage, damage to the environment and/or illness but did not occur due to one or more factors." (Army, 2023a)

Name	Managing organization	Primary sources	Data collection method	Repository	Scope
Army Readiness Assessment Program (ARAP)	US Army Combat Readiness Center	Army personnel in battalion-sized units	Survey administered every 24–36 months; follow-up survey at 12–18 months; responses are anonymous	ARAP database maintained by US Army Combat Readiness Center. Commanders briefed at conclusion of the survey.	Safety climate and safety culture
Aviation Resource Management Survey (ARMS)	US Army Forces Command	Army personnel in aviation units	Survey administered every 24–36 months	Records maintained by Army major commands	Range of topics including safety, maintenance, standardization

1.13.4.3.1 Safety Reporting

The brigade safety SOP stated that supervisors and individuals should report all safety hazards to the chain of command, safety officer, or safety non-commissioned officer, and report all injuries, incidents, and equipment damage immediately.[133] The TAAB commander and subordinate safety officers stated that air crews relied primarily on in-person communication for reporting hazards or safety issues. When aircrews encountered a hazard in flight, they would typically discuss it with a mission briefing officer after landing. That information would be elevated through the chain of command and, if significant, the hazard might be risk-assessed and discussed at a SOHAC meeting.

Pilots had the option of submitting an OHR to a safety officer; however, this approach was uncommon. No pilots interviewed by the NTSB recalled submitting an OHR, and the TAAB safety manager said he had not received an OHR "in a while."

The ASMIS mishap and near miss reporting module allowed personnel to submit near miss reports for review by safety officers. No pilots interviewed by the NTSB reported that they had submitted an ASMIS mishap or near miss report. The TAAB manager said that in the year before the accident he had received five near miss reports from the 12th Aviation Battalion. These included reports of three wildlife strikes, an on-ground event where some drive shaft covers had been left open, and one off-duty event. The TAAB safety manager stated that, although one of TAAB's fixed-wing units had been utilizing the system, the other battalions had been "slow to adopt the practice." To encourage greater use of the ASMIS mishap and near miss reporting system, he began having units present near miss reports at SOHAC meetings.

When asked how the safety program could detect or mitigate risk of near midair collisions between military and civilian aircraft in the DCA terminal area, the TAAB safety manager stated, "If people had been filing near-miss reports, it would've helped us gather that there were areas of concern or loss of separation."

1.13.4.3.2 Safety Surveys

The commander and safety officers said the Army also administered an annual Army Readiness Assessment Program (ARAP) survey, which provided feedback on unit safety culture. The most recent survey, completed in fall 2024, identified concerns among 12th Aviation Battalion personnel about maintaining older

[133] The ASMIS hazard reporting system was not limited to aviation and included off-duty events as well as those that occurred on duty.

helicopters to perform "no-fail" missions while also meeting training hour requirements.

An ARAP survey instrument from 2021 reviewed by the investigation consisted of a set of 25 common core items that all respondents ranked on a Likert scale (1 = strongly disagree, 2 = disagree, 3 = agree, and 4 = strongly agree), an open-ended write-in section consisting of five prompts, and between 6–18 additional items tailored to respondents' occupational area (i.e., civilian, ground maintenance, ground operator, ground support/administration, aviation maintenance, aviation operator, aviation support/administration) that respondents again ranked according to Likert scale options. Focus areas consisted of organizational climate, organizational processes, resources, safety programs, and supervision.

Examples of common core questions included:

- My organization adequately trains our personnel to safely conduct their jobs.
- Safety policies are clearly defined in my organization.
- My organization's members incorporate risk management into daily activities.
- My organization has a reputation for high-quality performance.
- Violations of SOPs and safety rules are rare in my organization.
- Individuals in my organization are comfortable reporting safety violations, unsafe behaviors, or hazardous conditions.
- My organization's members avoid cutting corners to accomplish their job/mission.
- Morale and motivation in my organization are high.
- My organization effectively communicates safety information updates and changes.
- Our leadership ensures that personnel in my work area are knowledgeable of all safety policies and procedures.

The five write-in items were:

- The next mishap / near-miss in my organization will be caused by…
- The most hazardous activity I perform is…
- The most significant action(s) my organization can take to improve safety is/are…
- What is your organization doing "right" and why?

- Use this space to provide any feedback you would like to bring to the attention of your command.

Examples of occupationally specific items for aviation operators asked respondents to indicate their level of agreement or disagreement with the following statements:

- Additional duties have not adversely affected my performance in the organization.
- My command is receptive to my safety-related concerns.
- I am aware of my organization's mishap reporting process.
- My organization's safety officers/NCOs [non-commissioned officers]/representatives visit my work location on a periodic basis.
- Crew rest policies are enforced in my organization.
- All of the equipment provided to me is serviceable.
- My organization adequately reviews and updates publications, safety standards, and operating procedures.
- The safety officer/NCO/representative is effective at promoting safety in my organization.
- Safety decisions are made at the appropriate level in accordance with established guidance.

According to an interview with TAAB's commander, ARAP results, including respondents' write-in comments, are reported "at a minimum" to the battalion safety officer and battalion commander; the brigade commander would see all of the battalions' ARAP results in aggregate form, but could not view results "broken out into which organization." Battalion commanders would be able to view their own organization's results, and would receive recommendations from the Army's Combat Readiness Center about which to take action and brief the brigade commander. Staff would use results of the ARAP, along with the ARMS, to conduct assistance visits in areas that warranted further development.

TAAB's commander recalled that ARAP results consistently indicated that respondents reported, in his paraphrasing, "old equipment with a no-fail mission," "the challenge is keeping those aircraft up to meet both your training demand, but also your mission requirement demand," that "the margin is very thin for maintenance challenges," and that this entailed "less aircraft resource available for maintaining proficiency or currency."

Every three years, the brigade also participated in an Aviation Resource Management Survey (ARMS) conducted by US Army Forces Command. The ARMS is a structured compliance inspection/audit instrument used to evaluate whether an Army aviation unit has the required programs, procedures, documentation, and oversight mechanisms in place to manage operational risk and prevent mishaps.

The ARMS checklist is organized into program areas and scored on whether the unit meets stated standards (typically rated Satisfactory/Unsatisfactory/ N/E). For example, it evaluates whether the unit has compliant policies and records for flight operations, SOPs, pre-mishap planning, and individual flight records, and whether the unit has standardized processes for mission approval and standardization/program management.

The most recent ARMS inspection in November 2024 rated the 12th Aviation Battalion's safety management as 94% compliant ("green"). Information was not available to the investigation as to how ARMS scores were derived.

The TAAB safety manager stated that, about 6 months before the accident, TAAB began using the ASMIS hazard module to track hazards identified through ARAP, ARMS, and other assessments. He said few actionable safety items had been identified in recent inspections.

He further stated that updated Army guidance issued in 2023 removed the previous requirement to perform an Aviation Accident Prevention Survey (AAPS) using ARMS checklists. The brigade subsequently eliminated the AAPS from its SOP, but the safety officer said he believed the survey had value for identifying safety gaps and that the commander intended to reinstate it in the next SOP revision. An Army representative stated that the AAPS requirement was added back to the TAAB SOP in June 2025.

1.13.4.3.3 Other Safety Assurance Tools and Processes

TAAB did not have an MFOQA program, ASAP, or LOSA program as required by DOD Instruction 6055.19 at the time of the accident.

The TAAB commander stated that the brigade lacked the technical capability to detect or monitor flight parameter exceedances, such as altitude deviations on the DC helicopter routes, and that such events would only come to the Army's attention if reported by the FAA or self-disclosed by a crew. At the NTSB investigative hearing, Army personnel confirmed that TAAB did not have a flight data monitoring program capable of identifying exceedances of published helicopter route altitudes, or any system to automatically identify near midair collisions or deviations.

The TAAB did not have a reporting system that matched all characteristics of an ASAP program. OHR and ASMIS near miss reports could be submitted for non-aviation near misses. Although ASMIS near miss reports could be submitted anonymously, the program did not incorporate a report acceptance process that granted reporters immunity from adverse action—a distinguishing feature of ASAP programs. TAAB did not have a LOSA program and there was no evidence that the brigade had pursued the development of one.

1.13.4.4 Safety Promotion

TAAB's safety manager said that TAAB presented safety impact awards during brigade safety "stand down" events. In addition, the US Army Combat Readiness Center published a monthly safety newsletter, Flightfax, dedicated to Army aircraft mishap prevention. These newsletters were distributed electronically to all pilots in the TAAB. TAAB's commander reviewed these newsletters. They were discussed in monthly air crew academics sessions at the battalion level and below. The TAAB commander said that this publication was informed by mishap and near miss reports submitted to ASMIS.

1.13.4.5 Government Accountability Office Review

A 2023 GAO report noted deficiencies in Army aviation safety management, including the absence of a system for tracking the status of accident investigation recommendations and a lack of continuous and systematic evaluation and updating of risk management worksheets (GAO, 2023). The report noted deficiencies in Army National Guard safety management, including high workload that degraded Army National Guard safety officer efforts and National Guard pilots' challenges meeting flight hour goals. Army aviation subsequently conducted a safety "stand down" in late 2023, during which units paused missions and training flights to discuss safety issues.

By March 31, 2024, the Army experienced twice the usual number of serious mishaps and fatalities in the first half of the fiscal year. In April 2024, the Army ordered a "safety stand up," during which units received additional training on safety-related procedures and protocols.

1.13.4.6 Army Review of 2024 Mishap Data

According to the January 2025 issue of Flightfax, Army aviation had experienced 15 class A flight mishaps and two class A aircraft ground mishaps in fiscal year 2024 (Army, 2025).[134] The publication stated that this was the highest number of class A mishaps the Army had experienced since fiscal year 2014 and, at 1.90 class A mishaps per 100,000 flight hours, the highest rate the Army had experienced since fiscal year 2007. Fiscal year 2024 mishaps predominantly involved AH-64 and UH-72 helicopters (nine mishaps and three mishaps, respectively);

[134] The Army categorizes a class A mishap as accidents that are fatal or cause permanent disability or more than $2.5 million in damage.

however, a single accident each involved the UH-60, CH-47 helicopter and C-12 airplane. Nine soldiers, one contractor, and one civilian were fatally injured. Nine were attributed to "human error," two to "maintenance error," and one to a bird strike. The publication also analyzed trends in aviator flight experience and found that flight hours per aviator had decreased by an average of 300 hours between 2013 and 2023.

1.13.5 Federal Aviation Administration SMS

FAA Order 8000.369C, "Safety Management System," contains the requirements for the various FAA organization SMSs, which together form the overall FAA SMS. The FAA lines of business covered under the order include the ATO and AVS.[135] The order describes safety assurance as a systematic process that includes the acquisition and monitoring of safety data and information—such as employee reporting systems and process audits—followed by analysis and system assessments to identify new hazards, emerging risks, or ineffective controls.

When safety assurance activities identify deficiencies, organizations are expected to implement corrective actions to mitigate or eliminate safety issues; to conduct periodic management reviews to verify the continued effectiveness of mitigations; and to ensure that SMS processes and controls remain responsive to changes in the operational environment.

The order states that each organization must meet the requirements outlined in chapter 3, SMS Components, and establish and maintain safety policy, safety risk management functions, safety assurance policies, and safety promotion actions. The FAA further established the AOV (see also section 1.12.3) within the AVS as "the safety oversight authority to ensure effective and independent safety oversight, to include establishing the requirements for the ATO's Safety Management System (SMS) in accordance with FAA Order 8000.369, 'Safety Management System,' and in alignment with all applicable International Civil Aviation Organization's (ICAO) Annexes and guidance materials" with dual direct reporting to the FAA Administrator and the Associate Administrator for Aviation Safety (FAA, 2024a).

1.13.5.1 FAA ATO SMS Overview

FAA Order JO 1000.37C, Air Traffic Organization Safety Management System, establishes the ATO's SMS policies. ATO safety policy responsibilities included complying with FAA policy, requirements, and guidance; meeting NAS safety

[135] Other FAA lines of business also have safety management systems, including commercial space (AST SMS Manual 68006), airports (Order 5200.11A), Next Generation Air Transportation System, and Security and Hazardous Materials Safety.

management requirements; adhering to the basic principles and elements of safety management established by the *ATO SMS Manual*; and maintaining required NAS service-level availability.

The ATO's SRM responsibilities include conducting SRM on ATO-provided NAS changes and improvements, as well as on existing safety issues with ATO operations, facilities, equipment, and systems; and accepting safety risk into the NAS per the requirements established in the *ATO SMS Manual* (FAA, 2022b).

ATO safety assurance responsibilities include maintaining and verifying the safety performance of the organization and assessing the effectiveness of safety risk control strategies by measuring the current/residual risk and examining indicators of potential safety risk. This includes the following:

- determining whether NAS safety performance targets are met;
- monitoring the ATO's safety performance indicators and assessing the maturity of the SMS and compliance with safety policy;
- providing data-driven safety information to decision-makers to prioritize and focus resources according to areas of highest safety risk or safety concern; supporting improvements to the SMS through continual verification of safety data and follow-up actions; and
- implementing mitigations to manage safety risk when NAS operations, facilities, equipment, and systems do not perform as designed or expected.

Additionally, the ATO is required to perform SRM on mitigation plans before their implementation, and accounting for human factors after operations, facilities, equipment, and systems are fielded.

ATO's safety promotion responsibilities include:

- promoting a positive safety culture within the organization by complying with ATO SMS requirements;
- allocating sufficient resources, funding, and personnel to operate and maintain the ATO SMS;
- promoting ATO SMS policy and awareness within the ATO and across the FAA via training, conferences/workshops, and other communications efforts; and
- fostering a voluntary, cooperative, non-punitive environment for the open reporting of safety concerns.

1.13.5.1.1 FAA ATO Safety Assurance Activities

FAA ATO Order JO 7210.3DD, "Facility Operation and Administration," required ATMs to coordinate with local airport operators to "increase awareness and understanding of local operations and safety challenges." The order also stated that ATMs must "convene conferences, as often as important local problems warrant, for discussing and clarifying facility operational matters."

Order JO 7210.3DD further required ATMs to establish a task force of local air traffic, FAA, military, and law enforcement operators to aid in the development of helicopter routes, and stated that routes should be reviewed annually; however, guidance for the ATO's internal SMS did not include similarly specific expectations that external stakeholders and local operators be included in data sharing, safety assurance, and safety risk management activities.

Before the accident, the FAA ATO and the Aviation Safety Information Analysis and Sharing program (ASIAS) were monitoring facility performance and collision risk indicators across the NAS.[136] The FAA AVS oversees the ASIAS program, which works with a third party, the MITRE Corporation, to gather, aggregate, and analyze data from multiple stakeholders and provide safety information to participants, including the ATO.

According to the acting deputy COO of the ATO, those analyses did not identify DCA as an outlier for collision risk. Those analyses, however, aggregated all airport traffic and did not include specific analyses or details of the local helicopter traffic that could have identified unique risks at DCA or other airports with extensive helicopter traffic. In testimony provided at the NTSB investigative hearing, the acting deputy COO of the ATO acknowledged that the pre-accident compliance monitoring missed risks associated with the complexity of the DCA airspace, including a dependence on the use of visual separation between helicopters and IFR traffic.

Testimony also indicated that the ATO and local operators did not have a formal process for sharing information about helicopter route traffic, TCAS RAs, or potential traffic conflicts. For example, representatives from the Army and civilian helicopter operators reported that they were not routinely informed when they were involved in TCAS RA events for fixed-wing aircraft, and that this information would have been valuable to have.

[136] ASIAS was launched in 2007 as a collaborative government–industry effort to collect, analyze, and share safety data. It is designed to allow for the identification of safety issues before accidents or incidents occur. Stakeholders, including airlines or other commercial aviation operators, aircraft manufacturers, government, and universities, voluntarily submit proprietary data to ASIAS.

The 2021 GAO study of helicopter noise in the Washington, DC, area cited similar concerns regarding the sharing of noise data, and concluded that "FAA and operators lack complete information about helicopters in the DC area because there is no mechanism to exchange information between these parties or expectation that such information will be regularly shared" (GAO, 2021). The GAO recommended that the FAA develop such a mechanism to exchange helicopter noise information with operators in the DC area, and the DOT agreed with the recommendation.

The FAA ATO's Confidential Information Share Program (CISP) allowed for sharing and analysis of information collected through the Air Traffic Safety Action Program (ATSAP) and participating airlines' ASAP reporting systems.[137] However, civilian helicopter and military operators in the DCA area were not contributing to or receiving information from the CISP.

FAA Order JO 7200.21A defined an FAA ATO Partnership for Safety program with a mission to "facilitate the identification and mitigation of hazards at the local level" through support of collaborative local safety councils. Membership in those local safety councils is described as including local bargaining unit representatives and management at FAA air traffic facilities, but external stakeholder involvement is not required. DCA had a highly active local safety council.

1.13.5.1.2 FAA ATO Safety Culture

FAA AC 120-92D—though directed to entities required to implement an SMS under 14 *CFR* Part 5 and not binding on the ATO—offers a detailed explanation of how the agency conceptualizes a positive safety culture. The circular stated that:

> The culture of an organization is demonstrated through the organization's values, traits, and behaviors. The term "safety culture" is used to describe those aspects of the organization's culture relating to its safety performance. An organization that has a positive safety culture embraces open communication and continuous improvement. Management's consistent attention, commitment, involvement, and visible leadership are essential in guiding an organization toward a positive safety culture. A positive safety culture matures as safety management skills are learned, practiced, and become second nature across the entire organization. (FAA, 2024b)

The AC then described the following practices and characteristics that fostered a positive safety culture within an organization:

[137] ATSAP is a voluntary reporting system for air traffic control personnel. See section 1.14.1.2 for additional information.

Open reporting: An organization's policies and processes should foster open reporting, encourage the disclosure of error without fear of reprisal (as long as the reported issue was not the result of intentional misconduct or gross negligence), and demand accountability on the part of both employees and management.

Just culture: A just culture can be defined as a values-centered model of shared accountability that involves personnel at all levels of an organization, the effective use of relevant information to inform decision making, vigilance in identifying risks, flexibility in making changes necessary to reduce risk, learning from failures and process and performance data, and a code of ethics that requires honesty, integrity, and safety at the core of all decisions.

Management involvement: Effective safety management is accomplished by individuals who "own" the processes in which risk resides. Safety cultures cannot be "created" or "implemented" by management decree, no matter how sincere their intentions. An organization's safety culture is embodied in the way the organization and its members approach safety in their jobs. If positive aspects of culture are to emerge, the organization's senior management must set up the policies and processes that create a working environment that fosters safe behavior, and they should lead by example.

FAA Order 8000.369C, which provided guidance regarding the FAA's internal SMSs, stated:

> All levels of management must actively promote and provide leadership to foster a positive safety culture. A safety culture consists of the shared values, actions, and behaviors that demonstrate a commitment to safety over competing goals and demands. In the desired safety culture, people acknowledge their accountability and act on their individual responsibility for safety. They trust, use, and rely on the organization's processes for managing safety. Individuals report/raise safety issues without fear of reprisal, supporting the implementation of a non-punitive safety reporting system. Decision makers promote continual safety improvement through timely action, when appropriate, and provide feedback to the reporters. There is good communication in the organization, and personnel continue to learn and develop through training and coaching. The ways in which an organization works to improve its safety culture are best determined by the organization's management.

During the NTSB's investigative hearing, the FAA ATO's acting deputy COO was asked to describe a positive safety culture. He stated that:

> A positive safety culture would be non-punitive, educational, continuous learning from systemic issues. When a safety event occurs, we should learn from it as a whole national aerospace system…But ultimately, a healthy safety culture is one where employees don't feel like there's punitive measures, that they can feel free to come up and report safety issues to management…and then collectively, we work on improving safety system together as safety professionals.

When asked how expectations for safety management were communicated throughout the ATO, the acting deputy COO stated that they conducted training, had SMS facilitators, and "build it into our processes." He stated that air traffic personnel did not receive training "specifically on what SMS is, they get training on specific principles they should follow."

When asked to describe the safety culture at the facility before the accident, the DCA ATCT OM stated that he believed it was "robust." Since the external compliance verification (ECV, see section 1.7.7) that had identified multiple safety issues, subsequent ECVs had shown "great improvement across the board." He stated that the safety culture was improving and continuing to improve and things were done in a collaborative manner with good communication between management, the union, and the workforce.

He stated that, following the accident, "the safety culture had shifted from the facility driving safety to outside the facility was driving safety," and that rather than changes being made through discussions or collaborative processes, "directives or rules of that nature were just handed to the facility," circumventing facility management and workforce personnel in their development. This included significant changes being made to the DCA ATCT SOP without any input from DCA ATCT management or workforce personnel.

A former quality control support specialist at DCA ATCT contacted the NTSB following her retirement from the FAA in June 2025. She had worked at the DCA ATCT between fall 2018 and January 2022, when she accepted a detail in the FAA's Office of International Affairs. Her primary duties were collecting and analyzing data to identify potential safety issues or trends at the facility, and to assist in implementing corrective actions.

She stated that some of the most concerning safety issues that she identified during her time at the facility were improper phraseology and radio communications, the absence of traffic advisories or improper phraseology when issuing them, the improper application of pilot-applied visual separation, and the improper application of same-runway separation. Loss of separation events, such as improper spacing between arrival and departure aircraft, were common; however, they largely went unreported, and management often discouraged filing reports because it made the facility "look bad." Controllers often relied on pilot-applied visual separation as their only form of separating aircraft and did not issue the phraseology required by FAA Order JO 7110.65AA.

She reported that she repeatedly raised concerns regarding these systemic safety issues to facility management and subsequently experienced retaliation. She ultimately took another position within the FAA after staying at DCA ATCT became intolerable. She could not recall any training provided to the workforce on SMS or safety risk management, and she did not believe that the facility even knew what SMS was.

A 2023 literature review published by the FAA's Office of Aerospace Medicine sought to support FAA efforts to promote a positive safety culture (Key et. al 2023). The review concluded:

> A key theme identified in this report is that the nature of safety culture is multi-dimensional and dynamic—requiring routine assessment, dedicated promotion, and continuous vigilance. Leadership, employees, and other stakeholders (e.g., regulators) have shared responsibility for creating and maintaining safety culture; everyone must do their part, or the safety promotion efforts will falter.
>
> Safety culture promotion leans on the effectiveness of formalized safety systems and policies, risk management processes, and organizational decision-making that prioritizes safety over competing demands. This requires open communication and information sharing, so that pertinent safety-related information gets to the right decision-makers on time. There must also be an emphasis on organizational learning coupled with an understanding that no organization has a flawless safety culture, and that the quality of the culture is subject to change over time.
>
> Leadership commitment plays a key role in setting the overall tone, policies, and operational environment of the organization. However, stating safety policies is not enough; leadership must demonstrate their commitment and accountability for safety in their actions (i.e., they must "walk the talk"). This includes providing adequate resources for ensuring safety, rewarding and reinforcing safe behavior, and promoting a just culture (i.e., where there is a fair, just, and consistent response to safety concerns). Other important leadership actions are asking questions, ensuring open safety communication and information sharing. Finally, leaders should foster a respectful work environment where diverse professional voices are heard and trust is mutual. This environment is foundational for efforts to improve safety culture.

Employees play a complementary role. They must be committed, held accountable, and involved in safety. Their behaviors should include ensuring compliance with work procedures, processes, and standards; holding themselves and each other responsible for safe behavior, coaching others when needed; and remaining vigilant for unsafe conditions and speaking up so that safety issues can be resolved in a timely manner. Of course, it is only fair to expect safe performance when employees are competent and provided with the necessary work training, procedures, rules, and other resources necessary for safe completion of work tasks. Ensuring that employees are equipped with the right training and resources for the job is an important part of safety management.

1.14 Flight Safety Data

In the days and weeks after the midair collision, the ASIAS program provided the NTSB with data concerning "close proximity events" between helicopters and commercial aircraft near DCA. They reported that, between October 2021 and December 2024, there were 15,214 occurrences between commercial airplanes and helicopters in which there was a lateral separation distance of less than 1 nm and vertical separation of less than 400 ft, and 85 occurrences that involved a lateral separation less than 1,500 ft and vertical separation less than 200 ft. The ASIAS program also shared summary data from pilot and air traffic controller reporting systems and from systems that can track TCAS activations.

Subsequent inquiries about how the FAA defined close proximity events and how aircraft proximity data and other data sources were tracked as a part of the FAA's safety assurance processes revealed that the FAA lacked a standardized approach to defining and tracking data that might be used to assess midair collision risk. As a result, the NTSB formed a Safety Data group with the goals of documenting these and additional safety data sources that could have provided indicators of midair collision risk before the accident, whether those data were available to stakeholders, and how they were used in the context of SMS processes.[138]

The ASIAS program has access to numerous sources of aviation-related data, including hundreds of thousands of safety reports from pilots and air traffic controllers, FAA radar data from more than 120 million flights, and digital aircraft

[138] ICAO defines safety data as "a defined set of facts or set of safety values collected from various aviation-related sources, which is used to maintain or improve safety." Safety data may come from accident/incident investigations, safety reporting, operational performance monitoring, inspections, or other sources. Safety information is defined as "safety data processed, organized, or analyzed in a given context so as to make it useful for safety management purposes."

data from more than 32 million flights. Some data sources analyzed by ASIAS are publicly available and others are considered proprietary and may only be used by participants (such as operators and manufacturers) that contribute data to the program. The NTSB was given limited access to aggregated proprietary data in support of the investigation.[139] Other sources of data included publicly available databases, FAA NAS performance analyses, and data collected by the Army and PSA.

The sources of safety data that could be used to evaluate midair collision risk were grouped into two main types: safety occurrence reports and aircraft position data. Safety occurrence reports refer to reports submitted about observed safety concerns. Reporting may be required if certain criteria are met (such as occurrence types, damage, or injury levels). In other cases, reporting is voluntary. For voluntary systems, reporting may be encouraged by removing identifying information and protecting those who report from punishment or enforcement actions.

Aircraft position data refer to data collected through aircraft avionics or from radar to indicate the relative proximity of aircraft. Reports may be shared with committees composed of various parties to review reports and, as appropriate, develop plans to mitigate hazards. Reports may also be deidentified and combined to facilitate detection and review of safety issues.

1.14.1 FAA Safety Occurrence Reporting Programs

1.14.1.1 Aviation Safety Action Program

The ASAP is defined by the FAA as a voluntary reporting program designed to encourage employees of air carriers, repair stations, or other entities to voluntarily report safety information that may be critical to identifying potential precursors to accidents (FAA, 2020a). An event review committee (ERC) consisting of management, union, and safety oversight representatives ensures that reports meet program criteria, and if so, reviews them to identify potential safety issues and take corrective actions. Accepted ASAP reports are protected from public disclosure under 14 *CFR* Part 193 and cannot be used as the basis for disciplinary actions.[140]

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[139] A 2012 memorandum of understanding between the NTSB and the ASIAS Executive Board states that NTSB may only request information related to specific US air carrier accidents, that all requests from NTSB are subject to approval by the ASIAS Executive Board, and that NTSB will not publicly disclose information provided by ASIAS without review and approval by the ASIAS Executive Board.

[140] ASAP and ATSAP submissions are reviewed by an ERC to determine acceptance eligibility. Reports must be timely and contain sufficiently detailed information about a safety problem or safety-related event to be evaluated by a third party. Any possible noncompliance disclosed in the report must be inadvertent and not involve gross negligence; and the reported event must not appear to involve criminal activity, substance abuse, controlled substances, alcohol, or intentional falsification (FAA, 2021a).

This program was in place at PSA Airlines at the time of the accident. The ASIAS program has access to ASAP data from all ASIAS participants and participants can request aggregated data from the program. The NTSB has limited access to aggregate ASAP data consistent with its memorandum of understanding with the ASIAS Executive Board.

1.14.1.2 Air Traffic Safety Action Program

The ATSAP is a voluntary reporting program for air traffic control personnel based on the ASAP model (FAA, 2021a). Like ASAP, ATSAP reports are reviewed by an ERC for acceptance and follow-up actions. Accepted ATSAP reports cannot be used as the basis for disciplinary actions. ATSAP allows for data sharing to facilitate stakeholder awareness of safety data while protecting the confidentiality of the reporter. The CISP connects ASAP and ATSAP reports about the same event. ATSAP data are available to the FAA ATO and the ASIAS program. The NTSB has limited access, consistent with its memorandum of understanding with the ASIAS Executive Board.

1.14.1.3 Mandatory Occurrence Reports

Air traffic occurrences that meet certain criteria as described in FAA Order JO 7210.632A, "Air Traffic Organization Occurrence Reporting," including "airborne loss of separation," must be reported by controllers using an MOR.[141] Reports are to be made as soon as practical or by the end of a duty shift. The FAA requires that the ATO Office of Safety and Technical Training (AJI) retain data collected through the MOR process and has specific retention requirements for occurrences involving near midair collisions and certain other events. MOR data are available to the FAA ATO and the ASIAS program. The NTSB has access to MORs upon request to the FAA ATO.

1.14.1.4 Near Midair Collision System

The FAA defines an NMAC as "an incident associated with the operation of an aircraft in which a possibility of a collision occurs as a result of proximity of less than 500 feet to another aircraft, or a report is received from a pilot or flight crew member stating that a collision hazard existed between two or more aircraft" (FAA, 2018a). The

[141] Airborne loss of separation is defined in FAA Order JO 7210.632A as:

a) Any suspected loss of radar separation involving instrument flight rules (IFR) aircraft other than as a result of compression on final approach,
b) Any suspected loss of separation involving visual flight rules (VFR) aircraft in Class B and C airspace, Terminal Radar Service Area (TRSA), or practice VFR approaches,
c) Any suspected loss of separation involving formation flights,
d) Any suspected loss of separation involving non-radar standards.

FAA's *Aeronautical Information Manual* advises pilots or flight crew to report NMACs immediately by radio or telephone to their nearest ATC facility, flight service station, or FSDO; however, there is no regulatory requirement to do so.[142] When an NMAC involves a 14 *CFR* Part 121 or Part 135 operation, the Certificate Management Office/FSDO conducts an investigation. Inspectors document the event and rate the risk of collision on a scale from "A" (critical) to "E" (unknown potential).

Originally part of the FAA's Incident Data System, the Near Midair Collision System (NMACS) became a separate reporting system in the mid-1980s. The NMACS database is publicly available and searchable; however, due to a software transition, the FAA stopped populating the database in 2021.[143] Data from the NMACS reports since then are maintained as part of the FAA Flight Standards Safety Assurance System (FAA, 2024d).

1.14.1.5 Aviation Safety Reporting System

ASRS is a voluntary, confidential, and non-punitive incident reporting system that can be used by pilots, air traffic controllers, flight attendants, maintenance personnel, ground personnel, and others (FAA, 2021b; NASA, 2021). The ASRS program was established by the FAA and the National Aeronautics and Space Administration (NASA) in 1976, and is administered by NASA to protect reporter confidentiality. Reports can be submitted directly to ASRS or through the ASAP and ATSAP systems. 14 *CFR* Part 91.25 prohibits the FAA from using ASRS reports in enforcement actions.

After reports are submitted, a team of subject matter experts screen them to identify hazards and vulnerabilities. At this stage, stakeholders are alerted of any critical safety issues. Analysts subsequently combine records describing the same event, deidentify the records, and apply a coding taxonomy to allow for retrieval from the publicly-available ASRS database. The database houses reports from 1988 to the present, and database report sets are available on multiple topics, including near-midair collisions. The ASRS program also issues bulletins and notices to relevant authorities to investigate safety issues, holds monthly safety teleconferences with stakeholders, issues newsletters that are used for industry training, and conducts studies as requested on special topics.

[142] See *Aeronautical Information Manual*, section 7-7-3, Near Midair Collision Reporting.

[143] NMACS Search Form

1.14.2 US Army Mishap and Near Miss Reports

The Army requires mishap reports for certain types of events and tracks those reports in a database. Mishaps are classified by severity from class A (most severe) to class E (least severe) (DOD, 2019a). Reporting is required for all class A, B, and C mishaps and for work-related class D mishaps. Since 2020, the Army has also employed a near-miss reporting and tracking tool as part of ASMIS. Personnel are encouraged, but not required, to report safety events that do not rise to the level of a mishap report. ASMIS data are only accessible by the Army.

1.14.3 Aircraft Position Data

Aircraft position or proximity data could also potentially be used to examine the risk of midair collisions. Such data may be collected through aircraft avionics or from ADS-B/radar data. Aircraft position or proximity data from these sources does not indicate whether involved aircraft were operating under visual separation.

1.14.3.1 Traffic Alert and Collision Avoidance System II

For some aircraft, TCAS II TA and RA information is captured on FDRs and may then be processed as part of an operator's FOQA program. FOQA data from multiple operators are collected and analyzed as part of the FAA's ASIAS program.[144] TCAS II RA report information may also be detected from the surface via Mode S datalink and ADS-B RA broadcasts.[145] FOQA data are only available to operators and the ASIAS program. ASIAS participants may request aggregated FOQA data from ASIAS. ADS-B data are available for a fee through commercial sources or on request from government sources.

1.14.3.2 Aviation Risk Identification and Assessment

According to FAA Order JO 7210.633A, the ARIA automated system is designed to "employ risk-based, data-driven decision-making facilitating better insight into potential risk in the National Airspace System (NAS)." The FAA worked with the MITRE Corporation to develop ARIA to prioritize aircraft encounters for review by the ATO's Office of Safety and Technical Training quality assurance teams based on potential risk. ARIA processes radar data from FAA ATC systems.

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[144] The ASIAS program reported that RA data are captured on nearly 100% of flights; however, only about 42% of flights record TAs.

[145] A subset of RAs are also documented through safety occurrence reporting systems. For example, if a pilot reports an RA encounter to ATC, controllers are required to file an MOR to document it. Operators are also required to notify NTSB about RAs that meet certain criteria described in 49 *CFR* Part 830.5.

The system scans for airborne encounters with less than 8.33 nm horizontal separation, regardless of vertical separation. For encounters that meet that criterion, ARIA continuously calculates a value based on current proximity, projected closest proximity, and rate of closure. An algorithm analyzes these values to yield a numeric index, from zero to infinity, to classify these events based on risk. Lower index values are considered potentially higher risk events.

Events that meet a certain threshold on the index are classified as PARs and are transmitted to a quality assurance team for review. ARIA users can also look at PARs in aggregate and query or analyze the data using a dashboard interface. Additionally, the ASIAS program also has access to ARIA data and can use it to analyze aircraft proximities in a given airspace. The NTSB does not have access to aggregate ARIA proximity data except under the auspices of its memorandum of understanding with the ASIAS Executive Board.

1.14.3.3 Performance Data Analysis and Reporting System

The Performance Data Analysis and Reporting System (PDARS) incorporates surveillance data from ATC center and terminal radar approach control facilities, including radar and weather data. The raw data are cleaned, matched, and merged to create end-to-end trajectories depicting aircraft flight paths. PDARS data are primarily used to assess operational efficiency, including airspace optimization and impact analysis of temporary airspace modifications, but can also be used for incident analysis and safety assurance, tracking events such as go-arounds, runway excursions, or aircraft that come within certain proximities of each other. Neither PDARS nor ARIA proximity data were routinely aggregated for analysis.

1.14.4 Review of Available Safety Data Sources

1.14.4.1 Occurrence Reports

Table 15 presents an overview of occurrence reporting systems.

Table 15. Overview of occurrence reporting systems.

Name	Managing organization	Primary sources	Reporting policies	Availability
Aviation Safety Action Program (ASAP)	Operators, FAA AVS	Pilots	Voluntary, deidentified, non-punitive	Operators, ASIAS
Air Traffic Safety Action Program (ATSAP)	FAA ATO	Controllers	Voluntary, deidentified, non-punitive	FAA ATO, ASIAS
Mandatory Occurrence Reports (MORs)	FAA ATO	Controllers	Required	FAA ATO, ASIAS

Name	Managing organization	Primary sources	Reporting policies	Availability
Near Midair Collision System (NMACS)	FAA AVS	Pilots and Controllers	Required	Public (until 2021), FAA AVS
Aviation Safety Reporting System (ASRS)	NASA, sponsored by FAA AVS	All aviation stakeholders	Voluntary, deidentified, non-punitive	Public
Army Safety Management Information System (ASMIS)	US Army	All Army personnel	Mishaps required; near-misses voluntary	Army

ASIAS Program. The ASIAS program provided information from ASAP reports, ATSAP reports, and MORs concerning close calls between helicopters and fixed-wing traffic near DCA; however, because ASAP and ATSAP programs are part of the protected proprietary data managed by ASIAS, only high-level, deidentified summaries were available.[146]

From February 2020 through October 2024, a total of 16,116 ASAP reports were filed related to DCA. Of those, 85 reports (17.9 reports per year) were filed by pilots concerning close calls between airplanes and helicopters.

From January 2011 through August 2023, a total of 520 ATSAP reports were filed related to DCA; of those, 26 reports (2.1 reports per year) contained information on close calls between airplanes and helicopters.

From March 2013 through March 2024, a total of 172,518 MORs were filed by controllers related to DCA airspace. Of those, 90 MORs (8.2 MORs per year) contained information on close calls between helicopters and airplanes near DCA. About two thirds of those events occurred between 1900 and 0500 local time. The following is a list of summarized findings provided by ASIAS from the reports based on an FAA automated analysis using an artificial intelligence categorization model:

Immediate corrective actions by pilots: Several reports detail incidents where aircraft received TCAS RAs, prompting pilots to take corrective actions such as climbing, descending, or leveling off to avoid potential collisions.

Complexity of airspace: Reports mention helicopter operations in designated zones and routes around DCA, emphasizing the complexity

[146] The varying time periods for each of the reports described in the following paragraphs are based on data provided by the FAA.

of managing helicopter traffic alongside fixed-wing aircraft in a busy airspace.

Communication and coordination issues: Reports mention instances of communication lapses, such as delayed or missed traffic advisories, lack of coordination between controllers, and instances where pilots were not informed of nearby traffic until after a conflict was averted.

Go-arounds and missed approaches: Several reports identified aircraft executing go-arounds or missed approaches in response to TCAS RAs or perceived conflicts with other aircraft, indicating the impact of these advisories on flight operations.

Runway 33: Multiple reports contained information about approaches to runway 33, resulting in evasive maneuvers.

The FAA's NMACS database contained a total of 8,781 records for the period January 1987 through March 2021, 30 of which (0.9 records per year) were identified as occurring near DCA.[147] Within that set, 3 events were rated as "critical," 24 as "potential," 1 as "no hazard," and 2 were not rated. Of the 60 involved aircraft, 29 were airplanes, 5 were helicopters, and 26 were unknown or blank.

The ASRS system was queried to identify reports that involved "close call" airborne encounters between airplanes and helicopters near DCA. The search yielded 33 reports (0.9 reports per year) between 1988 and 2024. The most recent report, dated April 2024, read as follows:

> While we were flying the river visual to Runway 19 into DCA we received a TCAS alert. We were around SETOC or just past it and fully configured to land. There was, what I could only guess as I never saw it, a helicopter about 300ft below us. The TCAS showed it climbing but at a very very slow rate as it never showed closer than 300ft to us. When we flew over top of it, we got a "monitor vertical speed alert from TCAS which we then pitched into the green arc on the [vertical speed indicator] which was -300fpm or greater. After we received the "clear of conflict" the FO corrected and got back on glidepath. I assessed that we were still within stable approach criteria and we continued the approach and landed in DCA without further issue. We never received a warning of the traffic from ATC so we were unaware it was there. Suggestion: Need to have better separation for DCA traffic on the river visual to the helicopter

[147] January 1987 through March 2021 comprises the entire period for which the NMACS database has reports available.

> traffic that is flying up and down the river. Maybe by timing the separation of when we began the approach to where that traffic will be when we cross overhead.

Thirteen ASRS reports within the queried set submitted between 2010 and 2024 were reviewed individually. Based on an NTSB review, the following topics were described in more than one report during that period:

Communication with air traffic controllers: Pilots mentioned instances in which ATC did not alert them to the presence of helicopter traffic, or instances in which ATC communications were incomplete or hindered by considerable "radio chatter." A controller mentioned a helicopter transmission that was "garbled and at times unreadable," and another noted that a helicopter climbed and circled after "reporting landing assured," followed by an airplane on final approach experiencing a TCAS RA due to the helicopter.

TCAS notifications: Pilots described how responses to TCAS TAs and RAs prevented near-collisions with helicopters. In another report, a pilot mentioned a very close call between an airplane and a helicopter in which the TCAS system did not detect the helicopter.

Combined helicopter and local control positions: Controllers referred to events occurring when one controller was performing the duties of both local control and helicopter control and the challenges associated with working both positions simultaneously.

Runway 33: One pilot described a course correction taken around 400 ft above the ground to avoid a helicopter. The pilot noted, "This may have happened…because of an unclear idea of where aircraft should be located during Runway 33 circle to land operations." Another pilot arriving to land on Runway 33 noted that a helicopter affirmed that they had the airplane in sight but then appeared to make a right turn directly into their flight path.

Helicopters flying above prescribed altitudes: After experiencing a TCAS alert on approach about a helicopter below his airplane, one pilot described learning from the controller that the helicopter was about 300 ft higher than normal. In another report, a tower supervisor reported that a helicopter that triggered a TCAS RA was at 800 ft msl in an area where helicopters should remain below 200 ft msl.

An Army review of near-miss reports in the ASMIS for the period of October 2019 through February 2025 identified 24 events; none of which occurred near DCA.

Additionally, during the investigative hearing, the brigade safety manager stated that no OHRs had been submitted by brigade pilots for any reason in the year preceding the accident.

1.14.4.2 Aircraft Position Data

Table 16 presents an overview of aircraft position data systems.

Table 16. Overview of aircraft position data systems.

Name	Managing organization	Primary sources	Position data	Availability
Flight Operations and Quality Assurance (FOQA)	Operators	Aircraft data recorders	TCAS RAs and limited TCAS TAs	Operators, ASIAS
Automatic Dependent Surveillance–Broadcast (ADS-B)	FAA ATO	ADS-B squitter	TCAS RAs	FAA ATO, public
Aviation Risk Identification and Assessment (ARIA)	FAA ATO and ASIAS with contractor support	National Offload Program,[148] radar, ADS-B	Aircraft proximities	FAA ATO, ASIAS, publicly available via open source software
Performance Data Analysis and Reporting System (PDARS)	FAA ATO with contractor support	National Offload Program, radar, ADS-B	Aircraft proximities	FAA ATO

The FAA provided TCAS II TA and RA data for the area near DCA from summary-level FOQA data processed through ASIAS (which included TAs and RAs), and TCAS RA data from ADS-B.

The FOQA data revealed that, from 2021 through 2024, there were 5,328 commercial airline TA events (111 per month) resulting from proximity to a helicopter. For the same period, there were 78 TCAS RAs (1.6 TCAS RAs per month) resulting from proximity to a helicopter. In over half of these instances, the helicopter may have been above the route altitude restriction. Two-thirds of the events occurred at night.

From February 2020 through February 2025, there were 13.9 TCAS RAs per 10,000 flights near DCA, which was lower than the nationwide average of 21.7 TCAS RAs per 10,000 flights. The rate of TCAS RAs at DCA ranked 114 out of 257 tracked airports.

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[148] The National Offload Program is operated by the FAA and collects NAS operational data such as flight track information.

ADS-B–captured TCAS RA data for the period April 2023 through March 2025 revealed 366 RAs (15.3 TCAS RAs per month) within 10 nm of DCA. The RAs were analyzed by a team at MIT-LL and divided into groups depending on their level of confidence in identifying the intruding aircraft.[149]

In 123 of the 366 RAs, 1 or more intruding aircraft tracks were confidently identified and, within that set, 56 of the identified intruding aircraft were helicopters, nearly all of which were owned by law enforcement or medical transport operators.

Summaries of ARIA separation data were provided by the FAA. From June 2022 through May 2025, there were 874 PARs (24.3 PARs per month) for the area surrounding DCA. Additionally, ASIAS analysts reviewed commercial operations at DCA between October 2021 and December 2024, a total of 944,179 operations. Table 17 depicts the number of events during that period in which commercial airplanes and helicopters did not maintain certain separation thresholds, the percentage of all operations represented by those events, and the percentage that occurred when the airplane was on arrival. These counts are based on radar data and do not include operational context such as the application of visual separation.

Table 17. Events involving commercial airplanes and helicopters near DCA between October 2021 and December 2024, according to ASIAS data.

Lateral separation	Vertical separation	Total # of events	Average # per month	% of all operations	% on arrival
<1 nm	<400 ft	15,214	390.1	1.6%	96%
<600 ft	<400 ft	210[a]	5.4	0.02%	99.5%
<1,500 ft	<200 ft	85[a]	2.2	0.004%	100.0%

[a] These events are a subset of the events with < 1 nm lateral and < 400 ft vertical separation and are included in that total.

PDARS was also used to examine encounters at various proximities between fixed-wing airplanes and helicopters. For arriving and departing airplanes and helicopters flying on Routes 1 or 4 over the period January 2018 to February 2025, there were 4,067 encounters (65.6 encounters per month) in which separation was less than or equal to 1,000 ft and 348 encounters (5.6 encounters per month) in which separation was less than or equal to 500 ft. Figure 70 shows a heat map produced

[149] MIT-LL classified the RAs into three groups: 1) 123 RAs in which the threat aircraft was confidently identified by either matching the Mode-S address indicated in the RA or by matching the range/altitude of a track in their database with the range/altitude indicated by the RA, 2) 115 RAs in which one or more intruding aircraft tracks were identified with low confidence as approximately consistent with the range/altitude information in the RA downlink, and 3) 128 RAs in which no intruding aircraft tracks in their database were identified as matching the range/altitude indicated in the RA downlink, or the RA downlink indicated a Mode-S address without a corresponding track in the database.

using PDARS data that depicts the locations of encounters between fixed-wing traffic arriving and departing DCA and helicopters operating on Routes 1 and 4.

A separate PDARS analysis for the 13-month period of January 1, 2024, through January 30, 2025, identified 13,866 helicopter flights on the DC helicopter routes within 5 nm of DCA, of which 10,990 helicopter flights (79.2%) were military flights. "Track points" and flights that flew above route altitudes were calculated for 13 segments on four helicopter routes.[150] The percentage of track points estimated to be above published route altitudes ranged from 0% to 44% for the 13 segments, as shown in figure 71. For the northern segment of Route 4, which included the area of the collision, 17% of all track points exceeded altitude limits. Further analysis found that of the 523 flights that transited this route segment, 260 flights (49%) had at least 1 track point within this segment above route altitude limitations.

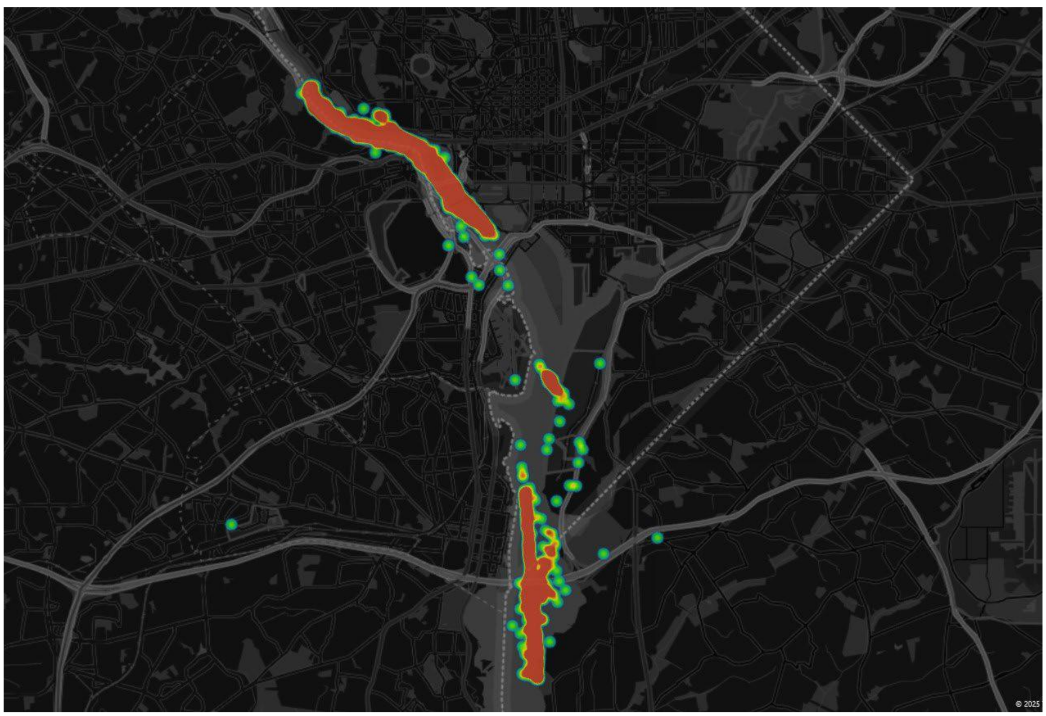

Figure 70. Heat map produced using PDARS data depicting frequency of encounters between arriving and departing airplanes and helicopters flying on Routes 1 or 4 at altitudes from 500–1000 ft, from January 2018 to February 2025. (Source: FAA)

Note: Red denotes areas with the greatest frequency of encounters, and green indicates areas where encounters occur relatively less frequently.

[150] "Track points" were defined as aircraft location estimates that were joined to form a flight path in the data.

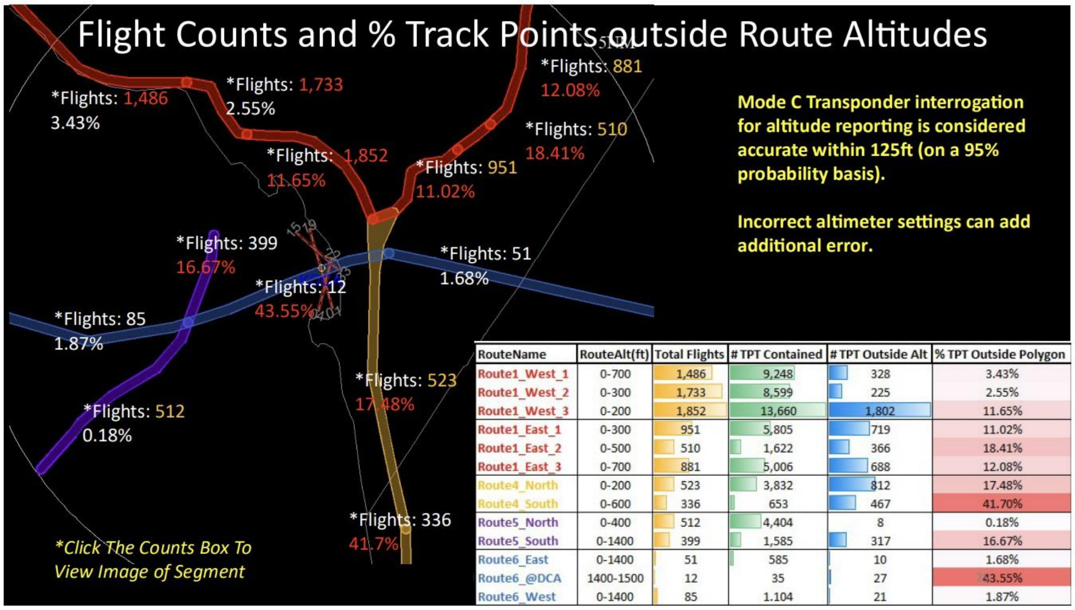

Figure 71. Results of analysis of Potomac TRACON data processed by PDARS for various segments of the Washington, DC, area helicopter routes. (Source: FAA)

Note: The number of helicopter track points within and outside of published route altitudes are shown.

PDARS data also showed the following distribution of flights offloaded to runway 33 when runway 1 was in use (table 18):

Table 18. Percent of flights offloaded per year to runway 33 when landing in a north configuration. (Source: FAA)

Landing runway	2018	2019	2023	2024	2025[a]	Total
1	92.56	91.98	92.89	93.43	94.41	92.84
33	7.44	8.02	7.11	6.57	5.59	7.16
Total (%)	100.0	100.0	100.0	100.0	100.0	100.0

[a]Data as of April 2025.

1.14.5 Stakeholder Use of Safety Data

The Army, PSA Airlines, Air Line Pilots Association (ALPA), FAA, and NATCA were asked to provide additional information regarding their organizations' use of safety data, including what safety data were available to identify midair collision risk, what criteria triggered safety data-based reviews, any data gathered from external sources to supplement internal flight safety data, and whether their organization had identified the risk of a midair collision at DCA before this accident occurred.

1.14.5.1 US Army

The Army reported that, in 2025, ASMIS was updated to route every report to the reporting individual's unit safety officer, who was required to respond to the report in some way, such as filing an OHR or raising the issue at a safety standards council meeting.

An OHR was defined as "any condition, action, or set of circumstances that compromise the safety of Army aircraft, associated personnel, airfields, or equipment."[151] OHRs may pertain to air traffic control, aircraft operations, maintenance, airfields, or near-midair collisions. Hazards were to be corrected at the lowest level possible, and when FAA air traffic facilities or operations were involved, the OHR was sent to the nearest FSDO and to the Department of the Army regional representative for that area. There was no Army-wide repository of OHRs.

The Army did not collect and aggregate safety data from aircraft. Review of external data, such as FAA data, was employed as necessary, but was the exception rather than the rule. As previously stated, an Army review of ASMIS found no reports of mishaps or near-misses for the DCA area. As of the date of this accident, the 12th Aviation Battalion, which is the only Army unit that routinely flies in the Washington, DC, area, had no documented OHRs on file referencing the DC helicopter routes or for other hazards in the area.

The NTSB asked the Army's Chief Engineer for the UH-60 during the investigative hearing whether the Army had considered standing up a FOQA program for its helicopters. The chief engineer stated that the Army had begun an "aviation data exploitation capability program" in the mid-2010s, but the program "had not come to fruition." He did not know why the program was halted, only that the program had not "made it past certain checkpoints during the acquisition program." A TAAB safety officer also did not know why the Army did not have a program to monitor operational flight data from UH-60 helicopters.

During the investigative hearing, the director of the Data Analysis and Prevention Directorate at the US Army Combat Readiness Center said DOD policy required the Army to have a military FOQA program, but that it was an unfunded requirement (DOD, 2019b). He asserted that the Office of the Secretary of Defense had declined to fund that program despite Army requests for funding. As a result, the Army only monitored UH-60 operational data for maintenance-related purposes.

[151] See DA PAM 385-10, "Army Safety and Occupational Health Program Procedures," Chapter 6, July 24, 2023.

1.14.5.2 PSA Airlines

The data captured by PSA's voluntary reporting and flight data analysis systems were reviewed by various working groups within the company and compiled collectively for analysis and internal review. The FAA certificate management office was invited to participate in all periodic SMS meetings. Included in these meetings was a review of safety performance indicators the safety assurance dashboard, open SRM documents, flight safety index injuries, and any other open safety topics. PSA had a flight safety index, which is an internal safety performance indicator for elevated risk items that included, but was not limited to, data from confirmed pilot deviations, emergency declarations, high-speed rejected takeoffs, NTSB reportable events, and runway incursions.

Safety data were reported as a "rate per 10,000 flights" for more precise measurement and comparison of data over time. SRM reviews were applied when new systems were implemented, when revisions to existing systems were implemented, during development of operational procedures, and when new hazards or ineffective risk controls were identified through safety assurance activities.

Pilot reporting was captured through operations reports and ASAP reports. ASAP reports were reviewed by the ERC, which included representatives from the FAA, PSA, and ALPA. PSA's participation in CISP allowed for collaborative evaluation of PSA ASAP reports and air traffic controller-provided ATSAP reports. Pilot-submitted operations reports were rated for risk level, then reviewed by a workgroup that comprised safety and flight operations personnel. The workgroup created SRMPs and escalated elevated risk items or reports that were trending adversely.

Traffic conflict events were captured via ASAP reports, operations reports, and FOQA. The PSA Flight Operations Manual defined situations that required pilots to submit an operations report, which included TCAS RAs; however, TCAS TAs were not included. Because RAs were inhibited below 900 ft, traffic conflict events that occurred below this altitude were not required to be reported, although pilots could do so voluntarily. ASAP reports were submitted at pilots' discretion, and were generally not a source of traffic conflict reports. PSA's FOQA program tracked RAs and input that information into the flight safety index.

Representatives from PSA stated that the company participates in InfoShare, an invitation-only conference that facilitates the sharing of aviation safety information. PSA also transmitted flight safety data to ASIAS and examined how the company's safety data compared among other carriers. PSA conducted monthly reviews of ASIAS data, though they reported a lag of 3 to 6 months between data submission and that data being available to view within the ASIAS dashboards.

PSA had not identified any indicators that warranted an SRM review of runway 33 operations, nor had they identified a heightened risk of midair collision with helicopters at DCA; however, DCA was one of their most complex airports and was "on their radar" for other reasons, including ground deviations and runway incursions. The company had identified hotspots at various locations on the ground at DCA and had distributed that information to flight crews.

1.14.5.3 Air Line Pilots Association

ALPA was the labor union that represented PSA pilots.[152] ALPA representatives stated that the organization itself did not collect voluntary safety data; however, they did participate in ERCs designed to address issues raised by member airlines' voluntary safety reporting systems. ALPA stated that they did not have any knowledge, based on safety data, of an increased risk of midair collisions between airplanes and helicopters at DCA before this accident. ALPA was unaware of any member airlines that distributed information regarding the Washington, DC, helicopter routes to its pilots. If there was pilot knowledge about the helicopter routes, it would have been based on an individual pilot's previous flight experience in the DCA airspace.

1.14.5.4 National Air Traffic Controllers Association

Representatives of NATCA, the labor union that represents a majority of the FAA air traffic controller workforce, reported that the union did not collect or track any safety data. Along with ATO and other FAA personnel, NATCA participated in ERCs designed to address safety issues raised by voluntary safety reports, such as ATSAP reports. NATCA had agreements in place with 35 partner airlines that facilitated the sharing of ASAP and ATSAP reports to identify potential hazards. They had no such agreements in place with any military operators. In collaboration with the FAA (under the auspices of the CISP) they reviewed safety trends across their partner airlines. According to NATCA representatives, review of ATSAP and ASAP reports did not identify an increased midair collision risk at DCA.

1.14.5.5 Federal Aviation Administration

The FAA managed regulatory safety data through its AVS and air traffic control safety data through the ATO AJI.

The AVS is responsible for certification, production approval, and continued airworthiness of aircraft, as well as certification of pilots, mechanics, and others in safety-related positions. AVS is also responsible for safety oversight and includes

[152] According to alpa.org, ALPA is the world's largest airline pilot union, representing pilots at 43 airlines in the United States and Canada.

offices of Air Traffic Oversight Service, which provides independent oversight of the ATO, and Accident Investigation and Prevention, whose purpose is to prevent accidents through data collection, risk analysis, and information sharing. AVS is responsible for the FAA's participation and support of the ASIAS program.

A third party, the MITRE Corporation, supports the ASIAS program. They deidentify the proprietary data received from stakeholders, then aggregate and analyze those data and provide safety intelligence and dashboards to participating stakeholders. The program also analyzes data gathered from nonproprietary sources, such as radar, airport, and weather data. The number of participants in the ASIAS program increased from 42 participants in 2012 to more than 250 participants in 2024, including 45 airlines, 15 rotorcraft organizations, and more than 150 general aviation organizations.

ASIAS does not evaluate individual events, though stakeholders may make requests to ASIAS for aggregate analyses based on individual events. With respect to the risk of midair collisions between airplanes and helicopters at DCA, ASIAS had identified some risk based on TCAS RAs near the Georgetown/Memorial Bridge and Wilson Bridge areas. Because of the inhibit altitudes for TCAS RAs, such events were not perceptible closer to DCA, and although TCAS TAs are provided at lower altitudes, about half of commercial aircraft operating to and from DCA were not configured to record TCAS TA events to their FOQA systems.

The FAA ATO AJI continuously collects, analyzes, and assesses safety data to determine the effectiveness of safety risk controls with respect to its safety objectives. Its main sources of safety data are voluntary reports, mandatory reports, and equipment outage reports.

Voluntary reports, including ATSAP reports from controllers and their corresponding ASAP reports from pilots, if available through CISP, are used to identify leading indicators and significant safety concerns or issues, operational deficiencies, non-compliance with regulations, deviations from agency policies and procedures, and actual or potential safety events.[153] ERCs comprising management, union, and safety oversight representatives analyzed reports to identify safety concerns and used the data to issue information requests or corrective action requests to the organization of primary responsibility.

Events that meet certain criteria—including loss-of-separation events, pilot deviations, pilot-reported NMACs, unauthorized or unsafe activity by unmanned

[153] The ATO AJI's voluntary safety reporting program also included voluntary reports from Technical Operations personnel (Technical Operations Safety Action Program [T-SAP]), engineers (Air Traffic Safety Action Program - Region X [ATSAP-X]), and Federal Contract Tower Controllers (Safety Actions from Event Reporting – Federal Contract Towers [SAFER-FCT]).

aircraft systems, and inflight emergencies—are required to be reported via the MOR program. AJI uses MORs, along with supporting information like voice recordings, to analyze system trends and risks and evaluate potential risk mitigations.

The ATO AJI uses ARIA to continuously and automatically assess potential risk in the NAS and reviews prioritized encounters to verify if adequate procedures or processes are in place to mitigate risk. Potential issues, trends, or operations of interest for further analysis, whether identified by quality assurance or other stakeholders, can also undergo a barrier analysis review (BAR) process. Through the review of individual encounters and aggregate analysis of data, the BAR process informs a facility or facilities about where possible risk or potential safety issues are prevalent and identifies causal and contributory factors that exacerbate or mitigate the possible risk or potential safety issue.

Although an initial version of the BAR process was implemented in 2022, the FAA discontinued the process after 3 months for revision based on initial experiences. As of the writing of this report, the revised SOPs for the BAR process had not been implemented NAS-wide, and there is no current timeline for NAS-wide implementation; however, the FAA stated that the BAR process "continues to be initiated in limited areas across the NAS to refine and review the SOP."

Representatives from the ATO AJI stated that its safety risk management processes are triggered by changes to the NAS or by existing safety issues.[154]

1.15 Previous Related Safety Recommendations

1.15.1 Washington, DC, Area Helicopter Routes

On March 11, 2025, based on preliminary investigative findings for this accident, the NTSB issued an urgent safety recommendation report titled *Deconflict Airplane and Helicopter Traffic in the Vicinity of Ronald Reagan Washington National Airport,* which addressed the potential for midair collisions between helicopters operating on Route 4 and airplanes landing on runway 33 or departing from runway 15 at DCA (NTSB, 2025).

Early in the investigation of this accident, NTSB investigators spoke with FAA aeronautical information specialists who confirmed that helicopter routes have no defined lateral boundaries and are drawn to depict linear paths along defined surface

[154] The *ATO SMS Manual*, section 3, The Safety Risk Management Process, stated that existing safety issues are existing contributing factors or findings that led to, or could lead to, an unsafe outcome (FAA, 2022b). Requests for actions to address such issues may be proposed or initiated as part of a Safety Assurance function, which is usually the result of quality assurance audits or assessments.

features in a manner legible to flight crews. Any applicable altitude and lateral distance restrictions are documented in the chart specifications or in warning boxes displayed on the chart. The lateral guidance provided to pilots flying on Route 4 included, "via east bank of Potomac River"; a specific distance from the river bank was not defined.

Figure 72 presents a cross section of the airspace that extends from the runway 33 centerline, spanning the Potomac River from the runway 33 threshold markings to the river's east bank. The figure shows the separation distance that would exist between a helicopter on Route 4 and an airplane descending on a 3° visual glidepath (the angle provided by runway 33's PAPI system).

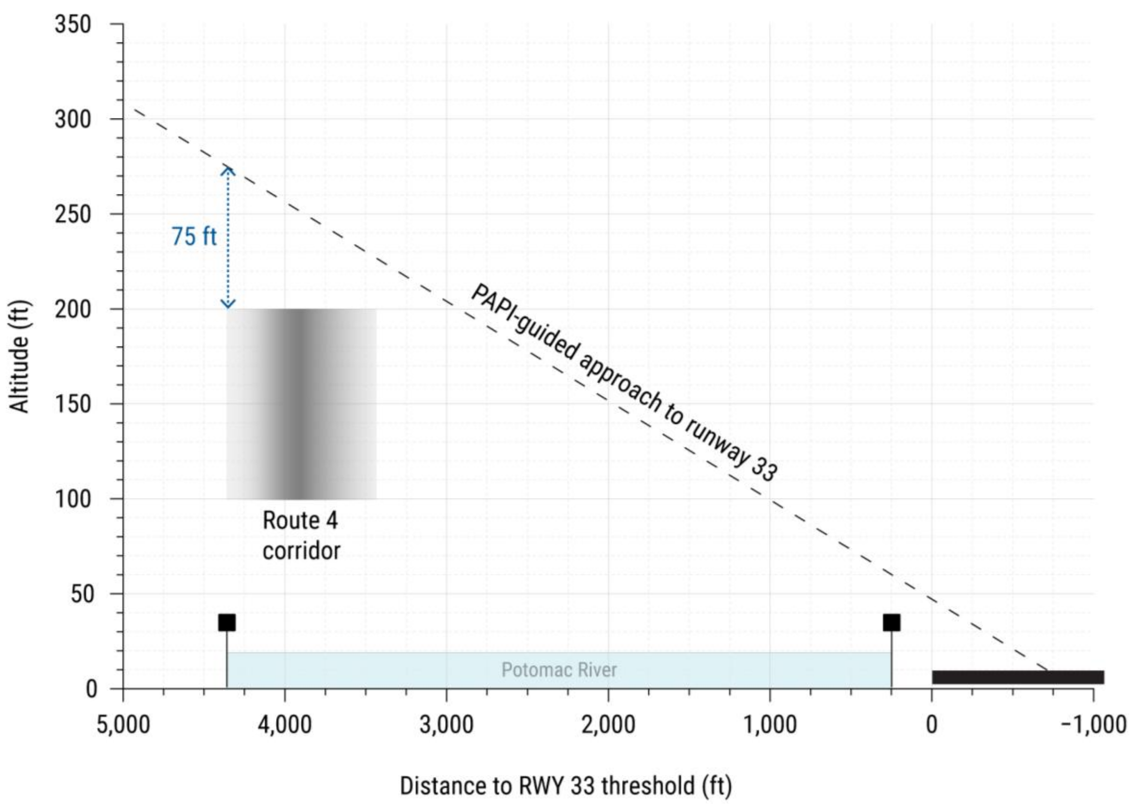

Figure 72. Cross section showing the notional separation between Route 4 and a PAPI-guided visual approach to runway 33, according to FAA charts and aerial photogrammetry analysis.

Because helicopter routes established by the FAA have no lateral boundaries and the Baltimore-Washington Helicopter Route Chart includes no warning for helicopters to operate a defined distance from the shoreline, the shaded region represents an approximation of the area in which helicopters could be flown. At an altitude of 200 ft, a helicopter operating over the eastern shoreline of the Potomac River would have about 75 ft of vertical separation from an airplane approaching runway 33, and this distance decreases the further from (west of) the shoreline the helicopter is flown.

The vertical separation also decreases if an airplane is operating below the 3° visual glidepath provided by the runway 33 PAPI. Additionally, these separation distances do not consider the structure of the aircraft above and below their reported altitudes.

The NTSB's review of data provided by the FAA regarding close-call encounters between helicopters and commercial aircraft near DCA from 2011 through 2024 indicated that a vast majority of the reported events occurred on approach to landing.[155] At least one TCAS RA was triggered per month due to commercial aircraft proximity to a helicopter. In over half of these instances, the helicopter may have been above the published route altitude. Two-thirds of these events occurred at night.

In the urgent safety recommendation report, the NTSB concluded that the separation distances between helicopter traffic operating on Route 4 and aircraft landing on runway 33 as they existed at the time of the accident were insufficient and posed an intolerable risk to aviation safety by increasing the chances of a midair collision. Safety Recommendation A-25-1 asked the FAA to prohibit operations on Helicopter Route 4 between Hains Point and the Wilson Bridge when runways 15 and 33 were being used for departures and arrivals, respectively, at DCA.

The NTSB also concluded that it was critical for public safety helicopter operators to have an alternate route available for operating in and around Washington, DC, without increasing controller workload, and in Safety Recommendation A-25-2 asked the FAA to designate an alternative helicopter route that could be used to facilitate travel between Hains Point and the Wilson Bridge when that segment of Route 4 was closed.

Immediately following the accident, the FAA implemented temporary airspace restrictions around DCA. On March 14, 2025, the FAA removed from helicopter route charts the section of Helicopter Route 4 between Hains Point and the Woodrow Wilson Bridge. Additionally, the FAA prohibited use of runways 15/33 and 4/22 at DCA during "specific, limited helicopter operations" in the vicinity of DCA. On May 2, 2025, the NTSB responded that these actions exceeded the intent of Safety Recommendation A-25-1 and classified it Closed—Exceeds Recommended Action.

In correspondence dated March 26, 2025, the FAA stated that it would collaborate with stakeholders to develop a new helicopter route connecting the

[155] The term "close calls" is defined in footnote 73.

Wilson Bridge to the Anacostia River and would provide updates on the alternate route designation process as it progresses. On May 2, 2025, the NTSB stated that this planned work was responsive to Safety Recommendation A-25-2 and, pending its completion, the recommendation was classified Open—Acceptable Response.

On January 16, 2026, the NTSB received correspondence from the FAA regarding additional actions it had taken to address Safety Recommendation A-25-2, and noted that its final response to the recommendation was forthcoming. In the correspondence, the FAA listed the following actions:

> **Collaborative Work Group:** The FAA established a group consisting of various aviation stakeholders to address and implement the recommendations provided by the NTSB.
>
> **Review of Helicopter Operations:** An in-depth analysis of the helicopter operations within DCA's airspace, including the SFRA and the FRZ, was conducted.
>
> **Removal of Routes:** The decision was made to remove Routes 4 and 6 from helicopter charts to improve safety and efficiency.
>
> **DCA Helicopter Supplement Notices:** The creation of Special DCA Helicopter Supplement Notices that highlight cautionary areas within the airspace.
>
> **New Transition and Waypoints:** A new Broad Creek transition was established, which includes new waypoints and a defined route width.
>
> **Zone Adjustments:** Adjustments were made to police boundaries in Zones 3 and 4, ensuring lateral and vertical separation from DCA traffic, including additional notes for clarity.
>
> **Modification of Helicopter Zones:** Zones 1, 2, and 5 were modified to maintain lateral separation from DCA traffic.
>
> **Route Adjustments:** Routes 7 and 12 were adjusted to ensure both lateral and vertical separation from traffic at IAD and Baltimore/Washington International Thurgood Marshall Airport (BWI), with updated notes for better clarity and operational guidance.

1.15.2 Threat and Error Management Training

In July 2015, a Cessna 150M and a Lockheed Martin F-16CM, operated by the US Air Force, collided in flight near Moncks Corner, South Carolina, under visual meteorological conditions.[156] The private pilot and passenger onboard the Cessna were fatally injured. The F-16 pilot incurred minor injuries after ejecting from the airplane and landing under parachute. The F-16 was operating on an IFR flight plan and was in contact with ATC, who was providing the pilot with radar vectors for a practice instrument approach to Charleston Air Force Base/International Airport (CHS), Charleston, South Carolina. The Cessna had departed from a nearby airport under VFR. The pilot was not in contact with ATC, nor was he required to be.

As the Cessna continued its departure climb, the airplanes converged, triggering a conflict alert on the controller's radar display. The controller issued a traffic advisory three seconds later, notifying the F-16 pilot of the Cessna's position, distance, and indicated altitude. When the F-16 pilot responded that he was looking for the traffic, the controller issued a conditional instruction to the F-16 pilot to turn left if he did not see the airplane.

The F-16 pilot did not see the airplane, and asked the controller to confirm the distance between the two aircraft. The controller subsequently issued the instruction, "If you don't have that traffic in sight turn left heading 180 immediately." The F-16 pilot initiated an approximately standard-rate turn using the airplane's autopilot so that he could continue visually searching for the traffic. The airplanes continued to converge and eventually collided about 40 seconds after the controller's initial advisory.

The NTSB determined that the probable cause of the accident was the approach controller's failure to provide an appropriate resolution to the conflict between the two aircraft. Contributing to the accident were the inherent limitations of the see-and-avoid concept, resulting in both pilots' inability to take evasive action in time to avert the collision.

In August 2015, a Cessna 172M and an experimental North American Rockwell NA265-60SC Sabreliner, callsign Eagle1, collided midair about 1 mile northeast of Brown Field Municipal Airport (SDM), San Diego, California, in visual meteorological conditions.[157] The pilot onboard the Cessna and two pilots and two mission specialists onboard the Sabreliner were fatally injured. About 1 minute before the collision, the Eagle1 crew reported to the tower controller that they were on the downwind leg of the airport traffic pattern for landing and had traffic to the left and right in sight.

[156] More information about this accident, NTSB case number ERA15MA259, is available by using the NTSB's CAROL Query Tool.

[157] More information about this accident, NTSB case number WPR15MA243, is available by using the NTSB's CAROL Query Tool.

At this time, the Cessna was to Eagle1's right, between it and the tower, about 500 ft below Eagle1's altitude, on approach to the same runway. A third airplane (N6ZP) was about 1 mile ahead and to the left of Eagle1 and was departing the airport area. The controller mistakenly identified the Cessna to the right of Eagle1 as N6ZP (another Cessna) and instructed the pilot of N6ZP to perform a right 360° turn to rejoin the downwind leg. The pilot complied; meanwhile, the accident Cessna continued its approach to the runway, and the controller did not visually confirm that the accident Cessna had begun the instructed turn.

Ten seconds later, the controller instructed Eagle1 to turn onto the base leg of the traffic pattern, which put it on a collision course with the accident Cessna. The controller recognized the conflict, still believing that the Cessna involved was N6PZ. He called the pilot of N6PZ, who confirmed that he was turning. The controller then called the accident Cessna's callsign and the pilot responded; however, the collision occurred while the controller was attempting to verify the airplane's position.

The NTSB determined that the probable cause of the accident was the local controller's failure to properly identify the aircraft in the airport traffic pattern and to ensure control instructions provided to the intended Cessna on downwind were performed before turning Eagle1 into its path. Contributing to the controller's actions was his incomplete situation awareness when he took over communications from the local control trainee due to high workload at the time of the accident. Also contributing to the accident were the inherent limitations of the see-and-avoid concept, resulting in the inability of the pilots to take evasive action in time to avert the collision.

Following these two accidents, the NTSB issued Safety Recommendation A-16-51 on November 15, 2016 (NTSB, 2017). The recommendation asked the FAA, Midwest Air Traffic Control Service, Robinson Aviation, and Serco to do the following:

> Include the July 7, 2015, and August 16, 2015, midair collisions as examples in your instructor-led initial and recurrent training for air traffic controllers on controller judgment, vigilance, and/or safety awareness.[158]

In 2018, the recommendation was classified Closed—Acceptable Action to Midwest Air Traffic Control and Serco, and in 2019, the recommendation was classified Closed—Acceptable Action to Robinson Aviation, after all three

[158] Midwest Air Traffic Control, Robinson Aviation, and Serco are companies that operate federal contract air traffic control towers.

organizations provided information regarding their responses to the recommendation.

Serco responded that it had required all air traffic control personnel to view the video and slide presentations from the NTSB's board meeting about the two accidents and amended training programs to require all newly hired controllers to do so as part of initial certification training. These requirements were added as a special emphasis item on facility external compliance verification audit checklists until February 2019 to ensure compliance. Serco also took additional steps to address causal factors cited in the two accident reports.

Midwest Air Traffic Control Service responded that initial training for controllers included a face-to-face briefing for all new hires on the Moncks Corner and San Diego midair collisions, and that the examples had been implemented into Midwest's annual recurrent training and January monthly training curriculum.

Robinson Aviation responded that it had created training around the Moncks Corner and San Diego collisions and incorporated the training into its yearly refresher training schedule as of December 2018. The training emphasized proper phraseology, the need for controllers to remain vigilant when aircraft are in close proximity, and covered priority of duties, with separation of aircraft and safety alerts being the highest priority.

On February 23, 2018, the FAA responded that, in January 2017, they provided controllers with instructor-led training on the components of a healthy occupational safety culture and discussed the indicators, risks, and hazards associated with an unhealthy safety culture. In July 2017, they provided controllers with instructor-led TEM training (which the FAA described as the practice of applying controller judgment, vigilance, and safety awareness). This material was incorporated into a training session titled, "Integrated Safety Training Workshop."

The FAA stated that, as of December 31, 2017, all current controllers had completed the training, and that all future controllers would be required to complete it. The FAA also stated that it delivered the "Emergencies" web-based training in July 2017, dedicated to emergencies identified in events similar to the Moncks Corner and San Diego midair collisions.

On March 9, 2018, the NTSB requested additional details on the Integrated Safety Workshop and Emergencies training to determine whether this training represented an acceptable response to our recommendations. FAA staff replied that, although they believed that the training modules covered incidents similar to the Moncks Corner and San Diego events, they were not able to share any further details nor provide us with access to the web-based training.

On March 31, 2020, the FAA provided the NTSB with a copy of the "Emergencies" web-based training, which included real-life scenarios for some common emergency situations; however, it did not highlight the safety issues identified in the Moncks Corner and San Diego accidents, nor did it discuss those or similar events as case studies.

On September 13, 2022, the FAA submitted the instructor-led threat and error training to the NTSB for review. The FAA further stated, "We believe that there is a greater benefit in reinforcing best practices via instructor-led training for air traffic control specialists and do not intend to include examples from the midair events contained in the accident reports."

On May 24, 2023, the NTSB responded that, upon review of the training material, we did not believe that the Integrated Safety Training Workshop or the Emergencies training highlighted the safety issues identified in the Moncks Corner and San Diego midair collision accidents, nor did the training discuss those or similar accidents. The NTSB stated that it continued to believe that including these accidents as case studies in existing initial and recurrent air traffic controller training would raise controllers' awareness about the safety issues that led to these accidents and help prevent similar accidents in the future. However, because the FAA stated that its actions were complete and that it did not intend to take the recommended actions, Safety Recommendation A-16-51 was classified Closed—Unacceptable Action.

In its response to our recommendation, the FAA stated that they provided "threat and error management" training to controllers. TEM is a process for identifying safety risks in the environment and minimizing or mitigating those risks (Marcil and Vincent, 2000). The concept of TEM originated in the human factors literature on CRM and was later applied to the training of air traffic controllers (Helmreich, Merritt, and Wilhelm, 1999). It refers to the process of identifying safety risks in the environment and minimizing or mitigating those risks (ICAO 2005). There are three basic components of TEM: threats, errors, and hazardous states.

Threats in ATC include many of the complexities faced by controllers, such as airspace congestion, pilot errors, terrain or obstacles near the airport, and adverse weather conditions. Some of these threats can be anticipated while others occur unexpectedly. It is through adequate knowledge and skills that controllers are able to effectively identify and manage these threats every day.

Errors are those actions or inactions by the controller that result in a deviation from the controller's intention or expectation, such as taxiing an aircraft across an occupied runway, not detecting a pilot readback error, or providing an incorrect clearance, heading, or altitude. Undesired states are the operational conditions where the margin of safety is reduced. An undesired state often results from mismanaged or missed threats and errors and is often considered the "last stage" before an accident or incident. It is up to the controller to take action to mitigate the risk by addressing the undesired state rather than the error to restore the margin of safety.

In postaccident interviews, none of the DCA ATCT controllers were familiar with the term "threat and error management," nor were they familiar with the concepts that would typically be included in TEM training. When asked how they were taught to identify and mitigate risk, they cited on-the-job training as the primary means. The investigation found no evidence that TEM training is provided at the FAA Academy in Oklahoma City, where prospective air traffic controllers are trained.

As we cited in our safety recommendation, the controllers in both the Moncks Corner and San Diego accidents were experienced; however, they made assumptions and judgment errors that, if resolved early in the accident sequence when the conflicts were detected, could have prevented the accidents.

FAA Order 7110.65, Air Traffic Control, paragraph 2-1-2, "Duty Priority," states, in part, that controllers should "give first priority to separating aircraft and issuing safety alerts as required in this order. Good judgment must be used in prioritizing all other provisions of this order based on the requirements of the situation at hand." We noted that because there are many variables involved, it is virtually impossible to develop a standard list of duty priorities that would apply uniformly to every conceivable situation. Each set of circumstances must be evaluated on its own merit, and when more than one action is required, controllers must exercise their best judgement based on the facts and circumstances known to them. According to FAA Order 7110.65, "That action which is most critical from a safety standpoint is performed first."

Our recommendation highlighted that the guidance provided in Order 7110.65 is too general and that scenario-based training can provide controllers with specific examples to help them identify situations where good judgment is critical. We found that the foundation for good judgment can be developed in trainees and reinforced in experienced controllers using methods that include, but are not limited to, review of specific events and situations where controller judgment was exemplary or could be improved.

We concluded that the information provided by the developing chain of events in the Moncks Corner and San Diego accidents contained lessons on controller judgment. Further, these lessons presented a learning opportunity for the controller workforce without exposing participants to potential adverse safety outcomes resulting from a poor decision in real-world, on-the-job training, which the FAA often relies on for controller training.

1.15.3 ADS-B

The NTSB also has a long history of supporting the use of technologies, such as ADS-B, that provide identification and location information for aircraft due to the ability of these technologies to improve safety. Between 2006 and 2007, we recommended requirements for equipment that could provide increased aircraft identification, location, and communication capabilities for aircraft operations in the Gulf of America and remote areas of Hawaii and Alaska, with the intent of enhancing flight location, collision avoidance, and weather information services for these operations (see Safety Recommendations A-06-21 and -22, and A-07-025 and -26; NTSB, 2006; NTSB, 2007a).

Following the 2006 midair collision involving a business jet and a transport-category airplane over Brazil that claimed 154 lives, we recommended requirements for equipment that could provide pilots with enhanced alerts regarding the status of transponder and traffic collision avoidance capabilities (Safety Recommendations A-07-35 through -37; NTSB, 2007b). Following the 2007 fatal midair collision of two news-gathering helicopters over Phoenix, Arizona, the NTSB sought to enhance the traffic-avoidance logic for helicopters' onboard equipment by recommending the development of standards and requirements for the incorporation of specific criteria for the types of maneuvers and environments unique to helicopters (Safety Recommendations A-09-4 and -5, superseded by Safety Recommendations A-10-127 and -128; NTSB 2009; NTSB, 2010).

In an October 2007 notice of proposed rulemaking to require ADS-B Out, the FAA stated that it did not plan to also require ADS-B In capability because ADS-B In "has not been identified as a requirement for maintaining the safety and efficiency of NAS operations." In a letter dated February 14, 2008, in response to this notice of proposed rulemaking, the NTSB expressed our belief that this assessment was incorrect and stated that equipping aircraft with ADS-B In capability would "provide an immediate and substantial contribution to safety," especially near airports. The NTSB further stated in our response to the FAA's proposed rule that "the FAA's failure to expedite the adoption of full ADS-B capability (both ADS-B In and ADS-B Out) would be unfortunate and would result in missing or unnecessarily delaying an opportunity to remedy a serious and notorious safety issue" (NTSB, 2008).

The FAA Modernization and Reform Act of 2012 required the FAA to identify the type of avionics required for all classes of airspace. It also specifically required the FAA to initiate rulemaking to require aircraft operating in capacity-constrained airspace, at capacity-constrained airports, or in "any other airspace deemed appropriate by the administrator" be equipped with ADS-B In technology by 2020. An aviation rulemaking committee chartered in April 2012 recommended that the FAA focus on the development of key ADS-B In applications, including airborne traffic awareness systems, that would provide benefits to operators. In 2014, the FAA developed a rulemaking action plan to issue a notice of proposed rulemaking by 2018 and a final rule in 2022.

In 2014, an RTCA committee chartered by the FAA completed the development of standards for ADS-B-supported aircraft surveillance applications, DO-317B (RTCA, 2014). However, the FAA Reauthorization Act of 2018 repealed the requirement that the FAA initiate rulemaking to require ADS-B In technology and instead directed the FAA to ensure that any regulations resulting from that rulemaking had no effect. Because the FAA had not yet issued any regulations, no action was required to change any regulations.

In May 2021, the NTSB issued several safety recommendations (A-21-15 through -17) regarding ADS-B following the investigation into a midair collision between two air tour airplanes in Ketchikan, Alaska, in 2019 (NTSB, 2021a). Safety Recommendation A-21-15 asked the FAA to identify areas with a high concentration of air tour traffic and to require that 14 *CFR* Parts 91 and 135 air tour operators who operate within those areas be equipped with an ADS-B Out- and In-supported traffic advisory system that includes visual and aural alerts.

Safety Recommendation A-21-16 asked that the FAA require that all non-air tour aircraft operating within the airspace identified as a high-traffic tour area in Safety Recommendation A-21-15 be equipped with ADS-B Out. Safety Recommendation A-21-17 asked that the FAA require the installation of ADS-B Out and In supported airborne traffic advisory systems that include aural alerting functions in all aircraft conducting operations under 14 *CFR* Part 135.

In a July 2021 response, the FAA requested a meeting with NTSB staff to further clarify the intent of the recommendations. However, as noted in NTSB correspondence dated February 4, 2022, when the NTSB attempted to schedule this meeting, FAA staff stated that a meeting was no longer necessary. In May 2022, the NTSB reiterated Safety Recommendation A-21-15 in our report on the fatal helicopter air tour accident that occurred in Kekaha, Hawaii, in December 2019 (NTSB, 2022).

In correspondence dated June 26, 2023, the FAA stated that its Air Traffic and Aviation Safety Organizations met to discuss the NTSB recommendations and determined that the agency's current ADS-B requirements adequately addressed the needs of aviation safety and it would not pursue additional requirements. The FAA stated that its current guidance and requirements were sufficient to meet the intent of the recommendations. In addition, the FAA stated that the previously requested meeting with NTSB staff was no longer needed.

In an October 24, 2023, follow-up letter regarding Safety Recommendation A-21-17, the NTSB emphasized that the absence of an ADS-B In requirement for Part 135 passenger-carrying operations fails to take advantage of the demonstrated safety benefit of ADS-B In traffic awareness and alerting and is inconsistent with the "appropriate level of public safety" the FAA itself expects for operations in which passengers bear no responsibility for the aircraft's operation (NTSB, 2023).

In its most recent response to Recommendation A-21-15, on November 6, 2024, the FAA repeated that current ADS-B requirements continue to adequately address the needs of aviation safety and that it would not pursue additional ADS-B operator requirements at this time (FAA, 2024f). During the investigative hearing for the DCA midair collision, however, the FAA ATO's acting deputy COO stated that the agency supported requiring newly manufactured aircraft in the United States be equipped with ADS-B In. He also stated that the agency supported requiring the installation and operation of ADS-B In for aircraft operating in airspace where they are required to transmit ADS-B Out.

1.16 Postaccident Safety Actions

1.16.1 Federal Aviation Administration

In April 2025, the FAA published a NAS Helicopter Operations Helicopter Route Analysis, which summarized the ATO's safety analysis of domestic airports with charted helicopter routes. Using PDARS, TCAS events, and NMAC data, the FAA reviewed charted routes and high-traffic-volume areas for possible conflicts with traffic patterns and reviewed the descriptions for charted and agreement-established routes. The analysis identified hazards in the airspace encompassing the routes and proposed actions to address priority concerns. This analysis, however, did not include DCA. The FAA stated that the DCA airspace and helicopter routes would undergo a separate review and analysis, which to the NTSB's knowledge has not been completed as of the date of this report.

The FAA listed several additional areas of future analysis, including Class C and D airports in the vicinity of charted helicopter routes, determining the effectiveness of air traffic control facility corrective action plans, and assessing staffing and utilization of stand-alone control positions during high-volume helicopter operations.

An investigative memorandum dated January 18, 2026, from the FAA ATO's COO and provided to the NTSB summarized the FAA's postaccident safety actions. The memorandum noted that the FAA completed an internal audit of all helicopter charts nationwide in November 2025, adding that "facilities are now being formally notified of required updates," and that local task forces consisting of ATO, FSDOs, military, law enforcement, and helicopter operators "will be established to review and implement changes."

The FAA's investigative memorandum also noted that:

> Based on the audit results, the FAA developed a national prioritization for helicopter chart updates, with work progressing across major metro areas including Los Angeles, Dallas–Fort Worth, New York, Boston, Chicago, Detroit, Houston, Baltimore–Washington, the Grand Canyon, the US Gulf Coast, and Las Vegas. While sequencing may adjust, the objective remains to complete all required helicopter chart updates no later than October 29, 2026.

The FAA's January 18, 2026, memorandum further stated that the FAA intends to update FAA Order 7210.3 "to strengthen governance and standardization for helicopter route development and modification" by introducing clearer requirements, checklists, and standardized processes "to reinforce disciplined collaboration with stakeholders and reduce future risk." The FAA plans to publish the revisions to FAA Order 7210.3 in December 2026, according to the memorandum.

The memorandum also noted changes made to the Baltimore-Washington Helicopter Chart that included elimination of Helicopter Routes 4 and 6 (which previously overflew DCA's runways), as well as the addition of cautionary areas highlighting high-density helicopter and fixed-wing traffic; these changes are described previously in section 1.15.1.

1.16.2 US Army

Following the accident, the US Army Combat Readiness Center added functionality to the ASMIS database allowing the attachments of OHR reports to near miss reports filed in the system. The system was also modified so that reporters could check a box indicating whether near miss reports were aviation-related or not. The center continued development of two additional ASMIS modules (safety program management and safety training) that it planned to release in 2026.

In July and September 2025, the Army updated the software for their UH-60 simulator (BAT). The terrain database supports virtual orientation training in the National Capital Region with extruded buildings throughout the area, and increased fidelity at geo-specific locations/airfields outside the National Capital Region as selected by the unit.

On April 25, 2025, US Army Aviation and Missile Command released Aviation Safety Action Messages for both fixed and rotary wing aircraft requiring operational checks of their transponders, to include ADS-B Out functionality (if equipped), and verification of the assigned aircraft address. As of the date of this report, the NTSB is evaluating information it has received from the Army regarding an Aviation Maintenance Action Message (AMAM) that it issued and subsequently updated regarding recurrent maintenance actions that have been established for transponders.

1.16.3 PSA Airlines

Following the accident, PSA Airlines published Flight Ops Alert 25-01 to provide additional guidance on the DCA helicopter temporary flight restriction and to provide awareness of the helicopter routes in proximity to DCA. PSA also participated in the FAA's DCA SRM panel and published an article about their participation in the company's pilot newsletter.

1.16.4 Sikorsky Aircraft

On November 12, 2025, Sikorsky issued an all operators letter that informed all UH-60A and UH-60L operators about the potential for a difference between displayed altitude when operating with the ESSS installed. The letter specifically described the distinction between static position error and barometric altimeter instrument error, and how the ESSS and other modifications to the external aircraft configuration could impact static pressure sensed by the helicopter's static ports. The letter showed an altitude correction chart to show the correction that would need to be applied on the displayed altitude based on airspeed and both with and without the ESSS installed.

2. Analysis

2.1 Introduction

The accident occurred when PAT25, which was transiting southbound on Helicopter Route 4, impacted flight 5342, which had just turned onto final approach for runway 33 at DCA. At the time of the accident, the DCA LC controller was working both the LC and HC control positions. About 5 minutes before the collision, the FO of flight 5342 contacted the tower while inbound on approach for landing on runway 1. The LC controller asked if they could switch to runway 33. After deliberation, the crew determined that they could accept the runway change and the FO informed the controller, who then instructed the flight crew to circle to runway 33 and issued a landing clearance.

About 2 minutes before the collision, when the aircraft were about 6.5 nm apart, the LC controller issued a traffic advisory to PAT25, informing them of a "C-R-J just south of the Wilson Bridge circling to runway three three"; however, the helicopter's CVR captured this transmission as, "PAT two five traffic just south of Wilson Bridge is a C-R-J at one thousand two hundred feet for runway three three," indicating that the PAT25 crew did not receive the word "circling" as part of the advisory due to degraded radio reception. At this time, PAT25 was crossing the Tidal Basin, and flight 5342 was one of five airplanes approaching DCA in darkness from the south. The PAT25 IP stated to the controller that they had the traffic in sight and requested visual separation, which the controller approved.

The LC controller contacted the helicopter crew again about 20 seconds before the collision and asked the crew if they had the CRJ in sight, followed by instructions to "pass behind that C-R-J"; however, the helicopter CVR indicated that the "pass behind that" portion of the transmission was blocked by a 0.8-second mic key from within the helicopter. The IP indicated that they had the airplane in sight and requested visual separation, which the controller again approved. About 6 seconds before the collision, the IP stated to the pilot, "alright kinda come left for me ma'am, I think that's why he's asking…we're kinda…out towards the middle." The pilot acknowledged and the helicopter subsequently started to move left. The aircraft collided at an altitude of about 278 ft msl and about 2,500 ft from the runway 33 threshold.

The analysis discusses the accident sequence and evaluates the following safety issues:

- the extensive use of pilot-applied visual separation and the inherent limitations of the see-and-avoid collision avoidance concept;
- controller workload, position combining, and communications practices;

- the design of the Washington, DC, area helicopter routes and operators' awareness and interpretations of route structure and limitations;
- the limitations of the traffic awareness and alerting systems on both aircraft;
- shortcomings in FAA and US Army safety assurance and risk management processes, including lack of proactive data sharing and analysis to identify and mitigate midair collision risk; and
- deficiencies in FAA safety culture and postaccident drug and alcohol testing procedures.

The NTSB investigation's comprehensive review of the accident circumstances determined that the following factors did not contribute to the cause of the accident:

Flight 5342 crew qualifications. The pilots of flight 5342 were certificated and qualified in accordance with federal regulations.

Flight 5342 crew medical factors. The pilots of flight 5342 were medically qualified for duty, and available evidence does not indicate that they were impaired by effects of medical conditions or substances at the time of the accident.

Flight 5342 crew fatigue.[159] Review of the flight 5342 pilots' time since waking and sleep opportunities in the days before the accident indicated that the pilots were unlikely to have been experiencing fatigue.

PAT25 crew qualifications. The pilot, IP, and crew chief onboard PAT25 were qualified and current in their positions as designated by the unit commander in accordance with Army regulations.

PAT25 crew medical factors. The pilot, IP, and crew chief of PAT25 were medically qualified for duty, and available evidence does not indicate that they were impaired by effects of medical conditions or substances at the time of the accident.

PAT25 crew fatigue. Review of the three PAT25 crewmembers' time since waking and sleep opportunities in the days before the accident indicated that the crew were unlikely to have been experiencing fatigue.

Airplane mechanical factors. The airplane was properly certificated, equipped, and maintained in accordance with 14 *CFR* Part 121. The airplane was operated

[159] In this report, "fatigue" is used consistent with human performance science to describe performance impairment associated with insufficient sleep, circadian disruption, and/or extended time awake. Operational factors such as high workload, sustained attention demands, stress, and task saturation can also degrade vigilance and situational awareness, but these effects are analytically distinct from fatigue and are addressed separately in the report.

within its weight and balance limitations throughout the flight. Examination of the airplane revealed damage consistent with an in-flight collision and subsequent impact with water, and there was no evidence of any structural, system, or powerplant failures or anomalies. Review of surveillance videos indicated that the airplane's wing navigation, landing/taxi, and anti-collision strobe lights were operating at the time of the collision.

Helicopter flight controls, rotor system, and powerplants. The helicopter was properly certificated, equipped, and maintained in accordance with US Army regulations. Review of helicopter maintenance records did not reveal any open discrepancies or anomalous trends that contributed to the accident. The helicopter was operated within its weight and balance limitations throughout the flight. Examination of the helicopter revealed damage consistent with an in-flight collision and subsequent impact with water, and there was no evidence of any structural, main or tail rotor system, flight control system, or powerplant failures or anomalies. Review of surveillance videos indicated that the helicopter's right and tail position lights, the landing light, as well as both upper and lower anti-collision lights, were operating at the time of the collision.

Air traffic controller qualifications and tower staffing. The OS and four controllers who were working in the DCA ATCT cab at the time of the accident were properly certified, qualified in accordance with federal regulations and facility directives, and current. Although the DCA ATCT facility was not staffed to its target level at the time of the accident, the number of staff in the tower at the time of the accident was adequate and in accordance with FAA directives. Therefore, the NTSB concludes that the decision to combine the HC and LC controller positions was not the result of insufficient staffing, and personnel were available to staff the HC and LC controller positions separately had the OS chosen to do so.

Controller medical factors. The LC controller, ALC controller, and OS were medically qualified for duty, and available evidence does not indicate they were impaired by effects of medical conditions at the time of the accident.

Controller fatigue. Review of the LC and ALC controllers' and OS's time since waking and sleep opportunities in the days before the accident indicated that the controllers, including the OS, were unlikely to have been experiencing fatigue.

Weather conditions. Visual meteorological conditions prevailed in the area at the time of the accident. A review of observations recorded throughout the night of the accident revealed no evidence of any local atmospheric pressure anomalies that would have impacted barometric altimeter readings.

Airport response. MWAA ARFF and airport operations staff responded immediately and in accordance with applicable emergency plans and regulatory requirements, deploying land- and water-based resources, and coordinating mutual aid under complex nighttime and on water conditions.

2.2 Accident Sequence

2.2.1 Controller Performance

2.2.1.1 Workload and Resource Management

Because the LC and HC positions were combined on the night of the accident, the LC controller was not only responsible for providing services to the arriving and departing fixed-wing aircraft, but had the added responsibility of providing services to numerous helicopters that were transitioning the airspace. In the 20 minutes before the accident, the total number of aircraft that the LC controller was handling fluctuated between 7 and 12 aircraft.

In a postaccident interview, the LC stated that he felt “a little overwhelmed” about 10 to 15 minutes before the accident, and that he felt the volume was manageable when “one or two helicopters” left the airspace. This statement was consistent with a peak in observed traffic volume of 10 aircraft around this time (5 helicopters and 5 airplanes); 1 helicopter subsequently departed the airspace at 2040:28, or 7:31 before the collision. The LC controller reported that he would have asked to have the HC and LC positions staffed separately if he received two more helicopters.

In the 2 minutes before the accident, there were a total of 29 transmissions between the LC controller and airplanes/helicopters on his frequency, and about 90 seconds before the collision, the number of aircraft on the LC controller’s frequency increased to 12. During that time, the controller spoke to or received communications from six of those aircraft: three inflight helicopters, one inflight airplane, and two airplanes on the ground. The other six aircraft, with which the controller did not directly communicate during the 2 minutes before the accident, but which he was still responsible for maintaining awareness of, included two inflight helicopters, two inflight airplanes, and two airplanes on the ground.

Human factors research has consistently shown that in ATC operations, voice communications reliably capture and direct controller attention toward the aircraft involved. Several studies have shown that auditory communication events—including issuing clearances and receiving pilot readbacks—function as attentional anchors that trigger cognitive focus and updates to the controller’s mental representation of that aircraft’s trajectory and status (Endsley and Rogers, 1997; McGee, Mavor, and Wickens, 1997). Therefore, the LC controller’s moment-to-moment subject attention allocation can reasonably be inferred from the aircraft he was communicating with at any given point.

The complexity of the airspace and limited airfield surface area at DCA require controllers to carefully coordinate the flight paths and timing of aircraft taking off, landing, and transitioning through the airspace and to issue instructions and clearances as necessary to efficiently facilitate these various flight operations. The LC controller's communications in the 2 minutes before the accident were consistent with his continuous shifting of priorities between airborne, ground, and transitioning aircraft.

After initially approving PAT25's request to maintain visual separation from flight 5342, he turned his attention to an airplane waiting to depart, informing them about traffic 3 miles out circling to runway 33 (flight 5342) and additional traffic on a 6-mile final approach for runway 1, and instructing them to line up and wait on the runway. At 2046:29.1 (about 1:30 before the collision), an Air Force helicopter checked in on the frequency, along with a simultaneous transmission from an inbound American Airlines airplane. The LC controller instructed the Air Force helicopter to standby then instructed a landing airplane to continue their landing roll to "taxiway November." A medical transport helicopter then contacted the tower. The LC controller cleared the airplane waiting to depart runway 1 for an "immediate takeoff," as the airplane needed to be clear of the intersection of runways 1 and 33 before flight 5342 crossed the runway 33 threshold for landing.

About 2046:58, the LC controller replied to the Air Force helicopter, which was west-southwest of the airport, and approved its requested route of flight. About 45 seconds before the collision, the American Airlines airplane that had attempted to contact the tower at the same time as the Air Force helicopter transmitted its location on the runway 1 approach; however, that transmission was stepped on by the medical transport helicopter's second transmission to the tower. The LC controller then approved the medical transport helicopter's request to transition through the Class B airspace.

A conflict alert was audible during two brief mic keys from the controller at 2047:37.8, and would have been visible on the controller's CTRD. Less than 2 seconds later, about 20 seconds before the collision, the LC controller asked PAT25 if they had the CRJ in sight. Three seconds later, the LC controller instructed PAT25 to pass behind the CRJ. PAT25 said it had the aircraft in sight and requested visual separation; the LC controller stated, "vis separation." The American Airlines airplane inbound on the runway 1 approach then contacted the tower a third time, and the LC controller was communicating with that airplane when the collision occurred.

Given the LC controller's statement that he felt "a little overwhelmed" with a traffic volume of ten aircraft, it is likely he began to feel overwhelmed again in the

2 minutes before the accident when traffic volume increased. A review of the DCA ATCT SOPs and training documents did not indicate any guidance specifically related to controller workload and how and when controllers should ask for relief.

Where a controller's attention is focused can influence the amount of time it takes to recognize and respond to an unexpected event. A study that evaluated scanning patterns and detection times of expert tower controllers to abnormal events found that the controllers' average detection times, beginning from the onset of the abnormal event, ranged from 14 seconds to 204 seconds (Crutchfield et al., 2021), which could lead to adverse outcomes for time-critical safety events.

The conflict alert system acts as a safety net to assist controllers in responding to traffic conflicts in a timely manner. During the 2 minutes before the accident, the LC controller was communicating with aircraft located primarily south and west-southwest of the airport; therefore, his attention would have been focused in that direction. Just before the conflict alert activated, the LC controller was communicating with a medical transport helicopter located about 16 miles west of the airport. The LC controller likely would have looked at the CTRD to confirm that helicopter's location. The LC controller recalled that he noticed the conflict between PAT25 and flight 5342 during his scan and queried PAT25 to ensure that they still had the airplane in sight, which PAT25 confirmed.

Situation awareness forms a basis for decision-making and is defined as the "perception of the elements in the environment within a volume of time and space [Level 1], the comprehension of their meaning [Level 2], and the projection of their status in the near future [Level 3]" (Endsley, 1988).[160] Figure 73 presents an illustration of the situation awareness concept. Situation awareness is not only what the controller is perceiving in the current air traffic situation (level 1) but how they interpret that information (level 2) and use it to project the future state of air traffic (level 3) moving in their airspace. Levels 2 and 3 are especially critical in the air traffic environment because it is dynamic and constantly changing.

[160] These three levels of situation awareness, which are sequential, are followed by decisions and performance of actions.

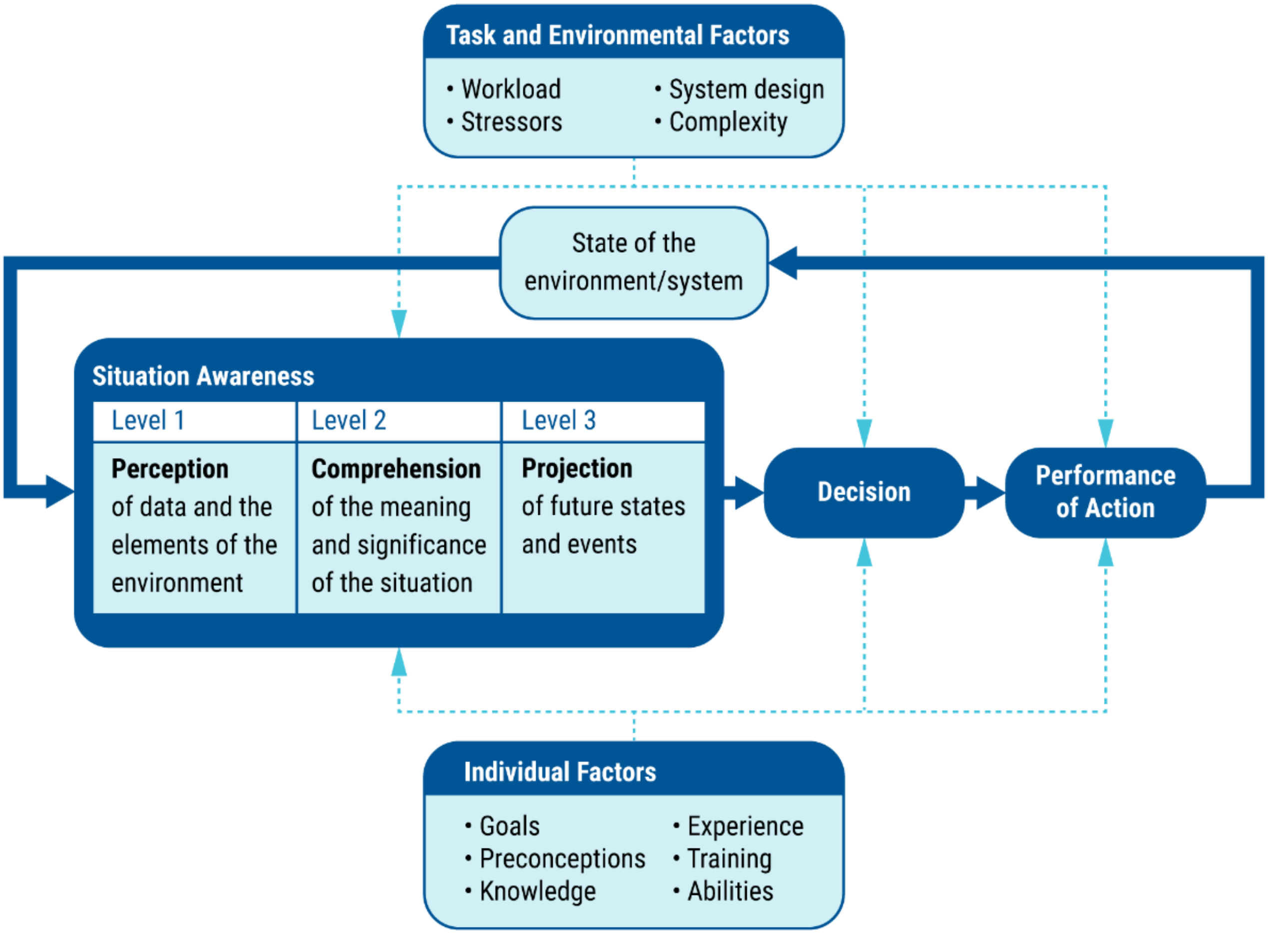

Figure 73. Diagram of the situation awareness concept.

Recognizing an impending collision requires information to be perceived from the environment, stored in working memory, and interpreted against knowledge stored in long-term memory, allowing controllers to identify familiar situations, predict future events, and determine an appropriate response (McGee, Mavor, and Wickens, 1997). Controllers must routinely monitor the current state of an aircraft and predict its future location in relation to other aircraft (Endsley, 1995). Conflicts that develop slowly, particularly at night, are inherently difficult for people to recognize due to reduced visual cues and the fact that gradual change can reduce situation awareness and delay recognition.

Controllers must maintain awareness of each aircraft they are managing (to include, for example, location, altitude, and airspeed) and anticipate where that aircraft will be in the seconds and minutes to follow. A controller's ability to maintain situation awareness is impacted by their workload and divided attention. As remaining cognitive resources are reduced with increasing workload (such as increasing traffic complexity, traffic volume, and/or radio communications), a controller's ability to maintain situation awareness is reduced. Because the LC controller was working the combined LC and HC positions, he was required to manage and maintain awareness of fixed-wing aircraft arrivals and departures as well as the movements of helicopters in the airspace, which required dividing his attention between airborne, ground, and transiting traffic. The NTSB concludes that keeping the HC and LC positions continuously combined on the night of the accident increased the LC controller's workload and negatively impacted his performance and situation awareness.

It is also likely that the controller was using expectation-driven processing, which directs a person's attentional focus. When events occur as expected or are routine, such as a pilot correctly reading back a clearance or adhering to a published flight path, information processing occurs rapidly with minimal effort. This expectation can lead to errors if a pilot or aircraft does not behave as expected. In this case, the controller expected that PAT25 would remain clear of flight 5342 because the PAT25 IP stated that they had the airplane in sight and would maintain visual separation.

The frequent use of pilot-applied visual separation reinforces the expectation that the pilot of one aircraft will maintain separation from another aircraft, and because it has repeatedly worked as expected, it can be more difficult for a controller to notice deviations, especially when workload is high. It is likely that the controller did not expect the conflict between PAT25 and flight 5342 to occur, and felt comfortable dividing his attention between the accident aircraft and the numerous other aircraft under his control at the time of the accident.

The primary duties of the ALC position were to alert the LC controller of any unusual situations or traffic conflicts, maintain surveillance of the local traffic pattern and landing area, and assist the LC controller with monitoring of aircraft on final via the CTRD. These duties would be accomplished by scanning the airspace as well as the tower displays. When the HC and LC positions were combined, the ALC position had the additional duty of monitoring the helicopter and airplane frequencies.

In a postaccident interview, the ALC controller recalled that she was "writing down what the different helicopters were doing" when she heard the conflict alert and the LC controller asking PAT25 if they had the CRJ in sight, then instructing PAT25 to pass behind the CRJ.[161] Monitoring traffic is a workload-intensive task, and,

[161] Note taking and recording aircraft information are routine components of local and assistant local controller duties, along with radio communications, coordination, and traffic sequencing. Such tasks require temporary shifts of attention between displays, communications, and the out-the-window visual scan.

like the LC controller, the ALC controller was also subject to high workload in the minutes before the accident. If the LC and HC positions had been staffed separately, the LC controller and ALC controller would have only been working fixed-wing traffic, and another controller would have been working helicopter traffic.

This staffing would have reduced the number of aircraft the LC controller and ALC controller were controlling and monitoring—for example, about 90 seconds before the accident, the LC/ALC controller would have been handling seven airplanes while a separate helicopter controller handled the five helicopters on frequency at the time. This would have reduced cognitive loading and enabled the HC controller to more easily keep track of the movement of the helicopters and their potential conflicts with arriving airplanes.

It is possible that if the positions had been staffed separately, a standalone HC controller could have detected the potential conflict between PAT25 and flight 5342 earlier, enabling an earlier and more effective traffic advisory to PAT25. The NTSB concludes that had the HC and LC positions been staffed separately, PAT25 might have received a more timely and effective traffic advisory. The NTSB further concludes that the LC and HC positions should have been separated at the time of the accident given traffic volume and complexity.

The NTSB also concludes that in the 2 minutes before the accident when traffic volume was increasing, the ALC should have prioritized surveillance of aircraft in the air in order to assist the local controller, rather than diverting her attention to the lower priority task of documenting helicopter information, which could have been completed when traffic volume and complexity had subsided.

The primary duties and responsibilities of the OS included providing operational supervision, directing the tower operation to ensure efficiency, and determining when the HC and LC positions should be combined or separately staffed. The DCA ATCT SOP stated that the OS, as the watch supervisor, must maintain situation awareness of traffic activity and operational conditions to provide timely assistance to controllers and ensure that available resources are deployed for optimal efficiency. To do this, the OS must not only maintain a general awareness of traffic volume and complexity within the airspace, but also continuously assess the risk of the operation to determine when a controller needs assistance and when the HC/LC positions should be separately staffed. The OS should also scan the airspace and CTRD to identify any potential conflicts.

The HC and LC positions were combined when the OS came on duty earlier on the day of the accident. Why the positions were combined earlier that day was not determined, as facility SOP had been revised in June 2024 to remove the requirement for documentation of the reason for combining. Some controllers interviewed felt that combining the HC and LC positions resulted in better situation awareness and reduced workload because they did not have to coordinate with another controller the way they did when the positions were separately staffed.

Controllers stated that the benefits of staffing the positions separately were having another set of eyes scanning traffic, less frequency congestion, and a controller dedicated to helicopters only. In other words, duties and responsibilities would be divided between two controllers, allowing for more focused attention to aircraft on their respective frequencies to recognize the development of a potential conflict. Although the DCA ATCT SOP specified hours during which the HC position "should normally be de-combined," the SOP allowed the OS to combine or separately staff the position at their discretion after considering factors such as staffing, weather conditions, and traffic volume.

The LC controller stated he was feeling a little overwhelmed about 10 to 15 minutes before the accident and had thought about asking for the HC/LC positions to be staffed separately, but did not because a helicopter left the airspace. Helicopter and airplane traffic volume subsequently increased again in the 2 minutes before the accident; however, the OS stated in a postaccident interview that there was no need to staff the positions separately in the hour before the accident, as they only had one helicopter at a time.

The OS had been working multiple control positions for over 4 hours and had been working the OS position for over 2 hours at the time of the accident. From the OS position in the tower, he was listening to the LC controller's transmissions, which were broadcast on a speaker in the tower cab, and "look[ing] out the window." He could not recall the specifics of the traffic situation at the time of the accident, and did not recall the conflict alert activating, but witnessed the collision.

To provide timely assistance to controllers and ensure that available resources are deployed for optimal efficiency, the OS should continuously assess the risk of ongoing factors in the operation, including traffic volume and complexity, controller experience, time on position, nighttime conditions, and any other factors deemed relevant. However, given his extended time on position, it is likely that the OS was experiencing reduced alertness at the time of the accident, which decreased his ability to effectively assess operational risks. Research in a simulated air traffic control room showed that extended time on task (over 90 minutes) increased detection latency for complex events such as two aircraft at the same altitude on the same flight path (Thackray and Touchstone, 1989).

The OS's reduced alertness and attentiveness would be consistent with his extended time on position at the time of the accident and his not recognizing the increases in traffic volume that occurred 10 to 15 minutes before the accident and again in the 2 minutes before the accident. In addition, he did not recognize the developing traffic conflict as PAT25 continued toward flight 5342. The NTSB concludes that due to extended time on position at the time of the collision and his complacency, the OS was likely experiencing reduced alertness and vigilance, which decreased his awareness of the operational environment and reduced his ability to proactively assess the risks posed by the traffic and environmental conditions at the time of the accident.

FAA Order 7210.3DD, "Facility Operations and Administration"; the collective bargaining agreement (CBA) between NATCA and the FAA; and DCA ATCT SOPs outline the duties and responsibilities of supervisors, including the requirement to ensure that adequate relief opportunities are provided to all operational staff. However, none of these documents detail how a supervisor is expected to manage the supervisor's own relief periods throughout the duty day or shift. The CBA states that employees should not be required to spend more than 2 consecutive hours performing operational duties without a break from operational areas.[162] While breaks for controllers in accordance with the CBA are closely monitored and strictly enforced, the CBA does not cover supervisory personnel such as operations supervisors and controllers-in-charge; therefore, individuals performing these duties are not subject to the same break requirements.

A supervisor's duties are extensive, and providing oversight in an operational environment can be as mentally taxing as working a control position. Under current rules, supervisors are often conducting supervisory duties for hours, and in some cases, entire shifts, but are not provided the same relief periods as operational personnel. The NTSB concludes that the lack of mandatory relief periods for supervisory air traffic control personnel is contrary to human factors research that shows clear performance deterioration in situations of prolonged time on task. Therefore, the NTSB recommends that the FAA develop and implement time-on-position limitations for supervisory air traffic control personnel, including guidance for district and facility level management to adapt these limitations to account for their own staffing and local standard operating procedures.

2.2.1.2 Traffic Advisories

The LC controller's first advisory to PAT25 regarding flight 5342 occurred about 2 minutes before the collision. This advisory was consistent with air traffic policy. In response to the controller's traffic advisory, the PAT25 IP stated that they had the traffic in sight and requested visual separation. The controller did not issue a corresponding traffic advisory to the crew of flight 5342.

[162] A break is defined in the CBA as "a period of time during which no duties are assigned and offer employees opportunities to attend to personal needs or rejuvenate their mental acuity."

The controller later stated that he had other priority duties at the time he issued the initial advisory to PAT25 and that he intended to go back and issue an advisory to flight 5342. However, because he was attending to other priority tasks, he did not return to the airplane before the conflict alert activated about 1 1/2 minutes later. Although the crew of flight 5342 had other contextual clues about the presence of PAT25 (see discussion in section 2.2.3), they never received an advisory from the controller about the helicopter, which would have increased their situation awareness. The NTSB concludes that, although the LC controller provided an initial traffic advisory to the crew of PAT25 in accordance with FAA Order JO 7110.65, he did not provide a corresponding advisory to the crew of flight 5342 regarding PAT25's location and intention, which could have increased situation awareness for the crew of flight 5342.

FAA Order JO 3120.4, "Air Traffic Technical Training," conveys instructions, standards, and guidance for the administration of air traffic technical training (FAA, 2024c). The order lists "positive control" as a job subtask, which it defined, in part, as taking command of control situations and not acting in a hesitant or unsure manner. The LC controller reported that, after the conflict alert activated, he noted that the helicopter was "way closer" to the airplane than it was supposed to be. In response, the controller contacted the crew of PAT25 and stated, "PAT two five do you have that C-R-J in sight?" The controller then instructed PAT25 to "pass behind that C-R-J." The PAT25 IP replied that they had "a- aircraft" in sight and again requested visual separation, which the controller approved.

FAA Order JO 7110.65AA, "Air Traffic Control," paragraph 5-1-4, Merging Target Procedures, stated that controllers must provide traffic information to any turbojet aircraft whose target appears likely to merge with another aircraft, unless those aircraft are separated by more than the appropriate vertical separation minima. Safety alert procedures and phraseology requirements, contained in paragraph 2-1-6, stated that controllers should immediately issue a safety alert to an aircraft that is in unsafe proximity to another aircraft, and to offer the pilot an alternative course of action if feasible, ending the transmission with the word "immediately."

When the LC controller recognized that the two aircraft were in unsafe proximity, the most appropriate action would have been to issue safety alerts to both aircraft regarding the other aircraft's position and distance and to issue positive control instructions to the pilots that would have prevented their courses from converging, such as climb, descend, or turn, as appropriate. However, the controller's traffic call to PAT25 at this time provided no information that could have assisted the crew in visually locating and positively identifying the airplane nor did it contain positive control instructions that the crew could have taken to resolve the conflict.

Additionally, the controller did not issue a safety alert to flight 5342, contrary to merging target procedures. Timely issuance of positive control instructions by the controller and subsequent compliance with those instructions by the flight crew(s) could have averted the impending collision. The NTSB concludes that if the LC controller had issued a standard safety alert to the flight crews of either aircraft as prescribed in FAA Order JO 7110.65, providing the conflicting aircraft's position and positive control instructions, the crew of either aircraft could have taken immediate action to avert the impending collision.

2.2.1.3 Threat and Error Management

The primary purposes of the ATC system are to prevent a collision between aircraft operating in the system and to provide a safe, orderly, and expeditious flow of traffic. FAA Order 7110.65AA, Air Traffic Control, paragraph 2-1-2, "Duty Priority," states that controllers should "give first priority to separating aircraft and issuing safety alerts as required in this order. Good judgment must be used in prioritizing all other provisions of this order based on the requirements of the situation at hand."

Because there are many variables involved, it is virtually impossible to develop a standard list of duty priorities that would apply uniformly to every conceivable situation. Controllers must evaluate each on its own merit, and when more than one action is required, exercise their best judgment based on the facts and circumstances known to them. According to FAA Order JO 7110.65AA, "That action which is most critical from a safety standpoint is performed first." One way that controllers may do this is to use recognition primed decision making, which allows for quick and effective decision making in complex situations. Recognition primed decision making relies on pattern matching of the current situation with past experiences to identify a course (or courses) of action, and mental simulation of how the course(s) of action will play out (Klein, 1998).

In this accident, when the LC controller recognized that PAT25 and flight 5342 were converging after the conflict alert activated, he should have issued a safety alert to both aircraft; however, the LC controller asked PAT25 if they had the airplane in sight. Under high workload and time pressure, controllers have reduced cognitive capacity for responding to unusual situations (Damos, 1988). The LC controller knew he had to resolve the conflict, but had limited time and capacity to do so. Asking if PAT25 still had the CRJ in sight, then instructing PAT25 to pass behind the CRJ, required less processing load than issuing a safety alert, which should include a clock position or location of the traffic, distance, and an action for the pilot to take.

In November 2016, the NTSB issued Safety Recommendation A-16-51, asking the FAA to provide initial and recurrent training for air traffic controllers on controller judgment, vigilance, and/or safety awareness with specific reference to two midair collisions that occurred in 2015 to be used as case studies.[163] The FAA responded that, in July 2017, it delivered instruction to controllers on TEM (which the FAA described as the practice of applying controller judgment, vigilance, and safety awareness) as part of instructor-led recurrent training and stated that the training would also be required training for future controllers. The FAA also stated that they delivered a web-based "Emergencies" training in July 2017 to highlight accidents similar to the two midair collisions cited in the recommendation.

After reviewing this training, the NTSB determined that the materials did not highlight the safety issues identified in the 2015 midair accidents, nor did the training provided discuss those or similar accidents as recommended. When the FAA indicated that it did not plan to take further action, Safety Recommendation A-16-51 was classified Closed—Unacceptable Action in 2023.

A vast majority of the time, controllers perform very effectively and reliably; however, human vulnerabilities such as fatigue, increased workload, time pressure, and biases can increase errors. A controller's ability to anticipate, detect, and mitigate risks is essential. TEM provides a strategy to combat these vulnerabilities. TEM is a process for identifying safety risks—threats, errors, and undesired states—in the environment and mitigating those risks.

In the context of air traffic control, threats include many of the complexities faced by controllers, such as airspace congestion, pilot errors, terrain or obstacles near the airport, and adverse weather conditions. Some threats can be anticipated, while others occur unexpectedly. Errors are actions or inactions by the controller that result in a deviation from the controller's intention or expectation, such as instructing an aircraft to taxi across an occupied runway, not detecting a pilot readback error, or providing an incorrect clearance, heading, or altitude.

Undesired states are operational conditions where the margin of safety is reduced. An undesired state often results from mismanaged or missed threats and errors and is often considered the "last stage" before an accident or incident. To restore the margin of safety, a controller must act to mitigate the risk by addressing the undesired state rather than the error (ICAO 2005).

In an observational study performed by the FAA at two air traffic control centers, they found that communication was the most frequent threat identified, resulting primarily from frequency congestion, simultaneous transmissions, incorrect pilot readback, or failure of a pilot to respond. On average, 15% of threats led to an

[163] Additional information about the two accidents and the findings that led to our recommendations may be found, respectively, in the reports of the investigations (ERA15MA259A/B and WPR15MA243A/B) and the safety recommendation report (ASR-16-6).

error and 13% of errors led to an undesirable state (Eurocontrol, 2011). A review of United Kingdom incident data identified controller scanning patterns of radar and flight strips to be a primary contributor.

None of the controllers involved in this accident were familiar with the term "threat and error management" during postaccident interviews, nor were they familiar with the concepts that would be included in such training, suggesting that they did not receive training on this method of safety management. The NTSB requested and received controller training materials related to identifying and mitigating risk. Review of this material did not reveal any formal TEM training other than the 2017 workshop, and there was no evidence to indicate that the workshop or the subject matter it contained had been offered in any training since 2017.

Adequate training on the use of TEM can strengthen situation awareness by teaching controllers to continuously monitor their environment to more quickly identify threats; promote team communication to ensure that communications are clear, timely, and assertive; emphasize effective scanning habits; recognize patterns in the development of adverse events; and enhance decision making under stress by developing habits that balance procedural compliance with problem solving to mitigate the risks of threats and errors. TEM would have likely improved the situation awareness of all controllers in this event, which may have allowed for earlier conflict recognition or encouraged the OS to conduct a risk assessment of the steady helicopter traffic and its resulting workload on the LC and ALC controllers.

The NTSB continues to believe that including case studies in initial and annual air traffic controller training and highlighting situations in which controller judgment, vigilance, and safety awareness could be improved would enhance controllers' ability to identify and manage threats and errors. FAA guidance on the use of good judgment is vague, and case studies provide the opportunity to examine a real chain of events that had resulted in an accident, imparting valuable lessons without exposing participants to the potential risk of adverse outcomes inherent to on-the-job training, which the FAA often relies upon for controller training.

The NTSB also believes that providing controllers the opportunity to discuss and practice applying TEM using scenario-based training is critical, as repetition of skills through training leads to automaticity of behaviors (Wickens et al., 2004), thus freeing up working memory.[164] Automaticity has been demonstrated to improve speed and accuracy (Wickens et al., 2004), situation awareness (Endsley, 2018), and decision making (Haith and Krakauer, 2018).

[164] "Automaticity" refers to highly learned skill performance driven by schemas that does not require much controlled attention.

Therefore, the NTSB concludes that initial and recurrent scenario-based training in threat and error management would help controllers identify and mitigate risks and strengthen situation awareness. Therefore, the NTSB recommends that the FAA develop instructor-led, scenario-based training on threat and error management that trains controllers to continuously monitor their environment to more quickly and accurately identify threats; promote team communication to ensure that communications are clear, timely, and assertive; emphasize effective scanning habits; recognize patterns in the development of adverse events; and enhance decision-making under stress by developing habits that balance procedural compliance with problem solving to mitigate the risks of threats and errors, and provide this training to all air traffic controllers annually.

TEM training would also benefit controllers performing supervisory duties, who are responsible for overseeing facility operations and making operational decisions, such as when to combine or de-combine control positions, provide additional monitoring of a position or frequency, or rotate controller positions to allow for adequate break opportunities. When making these decisions, OSs must balance safety and risk management with the operational demands of the facility, which are continually changing based on factors such as traffic flow and weather conditions.

Other than the list of factors that the accident OS was to consider when combining the HC and LC positions, there was no guidance or tool available in the DCA ATCT SOP to support supervisors in identifying risk, analyzing the potential impact of that risk on individual controllers or the overall operation, prioritizing risks based on likelihood and impact, or developing strategies to reduce or eliminate the identified risks. Additionally, no such tool or guidance was available in the *ATO SMS Manual* or in FAA Order 7110.65, which prescribes air traffic control procedures.

There were several factors that increased risk to DCA ATCT operations on the night of the accident, including nighttime conditions, the steady volume of helicopter traffic, and the lack of requested miles-in-trail spacing from Potomac TRACON that resulted in offloading airplanes to runway 33. The NTSB concludes that a risk assessment or decision making tool would likely have benefited the accident OS in identifying and mitigating the operational risk factors that were present on the night of the accident.

A risk assessment tool that could be tailored to the operational needs of each facility would benefit supervisory air traffic control personnel throughout the NAS. Therefore, the NTSB recommends that the FAA ATO develop and implement a risk assessment tool for supervisors that incorporates the principles of threat and error management to assist in risk identification, mitigation, and operational decision making.

2.2.2 PAT25 Operations

2.2.2.1 Helicopter Radio Quality

Review of recorded ATC communications on the night of the accident revealed that the transmissions made by PAT25 were accompanied by static interference, which likely made intelligibility of their transmissions difficult for both ATC and other aircraft. The helicopter's CVR also captured a conversation between the pilots earlier in the flight regarding the poor quality of the transmissions received from the controller, many of which were incomplete or broken.

Most critically, the portion of the controller's initial traffic advisory regarding flight 5342, in which he stated that the airplane would be "circling runway 33," was not received in its entirety by the PAT25 crew. Radio interference characteristic of that experienced by the helicopter crew throughout the flight caused the transmission to sound like, "for runway 33" inside the helicopter, omitting the word "circling."[165]

If the PAT25 crew had heard the word "circling," it possibly would have served as a salient cue alerting the crew to the airplane's intended flight path and allowed the IP to better anticipate its subsequent movement. Without hearing the word "circling," the IP had to infer the circling pattern from the airplane's stated destination of runway 33. Interviews with other TAAB pilots indicated that they were not very familiar with fixed-wing approaches to runway 33.

Although the IP likely knew that airplanes landing on runway 33 approached from the southeast due to the runway's orientation, and although this implied that traffic landing on runway 33 had to cross over Route 4, anticipating this would have required the IP's deliberate thought and attention. The NTSB concludes that, due to degraded radio reception, the crew of PAT25 did not receive salient information regarding flight 5342's circling approach to runway 33.

Clear and effective communication is essential for safe ATC operations and pilot situation awareness. When radio quality is degraded, pilots and controllers can miss important information, and having to repeat control instructions can result in time lost for other safety-critical tasks. Given the importance of clear radio communications and the evidence presented in this accident, in which poor radio reception quality may have affected the PAT25 crew's awareness of flight 5342's position and intentions, the NTSB recommends that the Department of War (DOW) Policy Board on Federal Aviation (PBFA) conduct a study to evaluate the quality of radio transmissions and reception for those aircraft operated within the NAS to

[165] This instance of interference was different from the subsequent 0.8 second mic key that resulted in the PAT25 flight crew not hearing "two five pass behind that."

identify factors that degrade communications equipment performance and adversely affect the safety of civilian and military flight operations.

The NTSB further recommends the DOW implement appropriate enhancements, based on the findings of the study recommended in Safety Recommendation A-26-49, to remediate identified deficiencies in air–ground radio communications performance.

2.2.2.2 Flight Crew Performance

Visual meteorological conditions prevailed in the DCA area on the night of the accident, and the recorded wind about the time of the accident was from 300° at 14 kts with gusts to 23 kts, with the wind direction varying between 270° and 330°. These wind conditions would constitute a right quartering tailwind for the accident helicopter, which was traveling on a southerly course at the time of the collision. The helicopter's CVR captured several comments between the pilots throughout the accident flight regarding the wind and turbulence. The comments suggested that maintaining helicopter trim, altitude, and heading required the flying pilot's close attention.

During a postaccident simulator observation, investigators asked a current and qualified Army pilot with over 600 hours of flight experience in the UH-60L to retrace the accident helicopter's flight path in conditions programmed to simulate those present on the night of the accident. When asked to rate the workload, he reported that he had insufficient capacity for "easy attention" to additional tasks due to the conditions.

It is likely that the accident pilot, as the pilot flying, was experiencing similar workload during the accident flight and was relying on the IP, as the pilot monitoring, to respond to the controller and look for traffic. The IP's prompt reply to the controller that he had the aircraft in sight likely further reassured the pilot that he had visually acquired the airplane, although there was no discussion between the crew to confirm this.

At the time of the controller's initial traffic advisory to PAT25, four other airplanes were approaching runway 1 for landing, and flight 5342 would have appeared among them when viewed from the helicopter. None of these airplanes would have been discernable from PAT25's position at the time of the initial traffic advisory as anything other than a point of light in the distance. These airplanes were about 3, 7.5 (flight 5342), 11, 15, and 20 statute miles from PAT25.

During the investigative hearing, an Army standardization instructor pilot stated that, when he was flying over Cabin John, Maryland, at night when wearing NVGs, he was able to see airplanes "lined up" at the Wilson Bridge, a distance of about 14 miles. He also stated that it was difficult to discern any individual aircraft's sequence in a group of airplanes because the brightest landing or position light did not necessarily correspond to the closest aircraft.

NTSB observations of airplane traffic at DCA from the roof of a building on the southwest Washington, DC, waterfront (near the location where PAT25 received the first traffic advisory) confirmed that investigators were able to see airplanes over 16 miles away when using NVGs. It is likely that the accident IP was able to see at least four, and possibly five, airborne targets on the horizon in the direction of the Wilson Bridge when the controller issued the initial traffic advisory. The NTSB visibility study determined that these targets would have appeared as lights in a tight cluster near the horizon south of the airport.

During the NTSB NVG observation, investigators found it difficult to determine which of several tightly spaced approaching airplanes was closest to the Wilson Bridge; thus, the IP's task of identifying the "CRJ just south of the Wilson Bridge" would have been challenging. However, despite the ambiguous visual scene at the time, the IP responded almost immediately that he had the traffic in sight and requested visual separation.

The speed of the accident IP's reply suggests a rote response that occurred without positively identifying flight 5342. This also seems likely because the IP never pointed out or discussed the traffic with the pilot, despite extensive discussions of other nearby targets earlier in the flight (this issue will be discussed further in section 2.4). The NTSB concludes that the PAT25 IP did not positively identify flight 5342 at the time of the initial traffic advisory despite his statement that he had the traffic in sight and his request for visual separation. The NTSB further concludes that, with several other targets located directly in front of the helicopter represented by points of light with no other features by which to identify aircraft type, and without additional position information from the controller, the IP likely identified the wrong target.

Several other reasons support the plausibility that the IP's response to the initial traffic advisory was automatic and that he likely did not fully realize the implications of the controller's message. First, the IP was busy. In the 47 seconds before the controller's transmission, the IP made a position report to the controller, instructed the pilot to apply additional right pedal, advised the pilot to begin a turn, corrected the pilot's altitude, and called out a nearby obstacle (a crane). Second, at the time of the initial traffic advisory, the IP knew that the airplane was at the Wilson Bridge, a distance that did not pose an immediate conflict. Finally, the IP understood that accepting visual separation was the most efficient means of transitioning the DCA Class B airspace. This factor will be discussed in additional detail in section 2.4.

The NTSB visibility study indicated that, from the IP's point of view, the airplane would have been visible in the right windshield for most of the 2 minutes before the collision, except for brief periods when it was obscured by aircraft structure, and would have appeared as a small dot of light low on the horizon among an area of bright cultural lighting. As the helicopter neared the approach path of runway 33, the lights of flight 5342 would have appeared in the helicopter's center windshield, outside the IP's NVG field of view when looking straight ahead.

Spotting the airplane in the 30 seconds before the collision would have required the IP to turn his head to the left and perform a focused visual search of the sky in the approach area for runway 33. That he did not see the airplane at that time suggests that he did not scan the area in the center windshield, which in turn indicates that it did not occur to him that the airplane might be to his left. In the absence of a focused search in the proper area, it is unlikely that the PAT25 pilots would have spontaneously noticed the airplane because it was outside the NVG field of view in an area of very low visual acuity and would have appeared against a complex background of ground lighting. Further, because the airplane was on a collision course with the helicopter, it would have exhibited little relative motion.

The IP's visual search for traffic was likely hindered by the informational content of the LC controller's second traffic callout. If the controller had provided information about the location of the airplane in relation to the helicopter (for example, "ten o'clock"), the IP would have known where to look; however, the controller merely asked if the PAT25 crew had the "C-R-J in sight."

Review of the helicopter's CVR indicated that the IP did not verbally discuss with the pilot the location of flight 5342 after the controller's initial advisory about 2 minutes before the collision nor after the second call from the controller about 20 seconds before the collision. The helicopter CVR recording suggests that his attention was subsequently focused on coaching the pilot on the use of the rudder pedals to compensate for a quartering tailwind and on monitoring radio conversations between the local controller and two other helicopters.

His instruction to the pilot to "kinda come left" following his final interaction with the controller just before the collision occurred reinforces the idea that he believed the "CRJ" referenced by the controller was among the airplanes approaching runway 1; however, he was likely unsure which of those airplanes was the airplane in question. Thus, the IP did not positively identify the location of the airplane and he did not communicate his uncertainty about its location to the pilot.

Information provided by the Army indicated that the accident IP and pilot received aircrew coordination training during Army Helicopter Flight School in 2019 and 2021, respectively. The crew also received annual aircrew coordination training. A TAAB standardization pilot stated that the 2024 aircrew coordination training involved the discussion of several class A mishaps (as defined by the Army, occurrences that are fatal or cause permanent disability or more than $2.5 million in damage) and what each accident crew could have done to improve the situation. Additionally, the accident IP was an aircrew coordination instructor and, according to the B Company safety officer, had provided aircrew coordination training 5 days before the accident.

The Army's *Aircrew Training Manual, Utility Helicopter, H-60 Series*, chapter 7, Aircrew Coordination Training, stated that crews "must use clear, concise terms that can be easily understood and complied with in an environment full of distractions," and further defined preferred terms for communicating about traffic. Terms included, "visual" to indicate that a target, traffic, or obstacle was seen or identified; "traffic," indicating an aircraft that presented a collision hazard, followed by clock position, distance, and reference to altitude; and "no joy," indicating that a target, traffic, or obstacle was not positively seen or identified. As an aircrew coordination training instructor, the accident IP would have been familiar with these terms.

Additional guidance was available in chapter 4, H-60 Crewmember Tasks, which stated that aircrews should "immediately inform other crewmembers of all air traffic or obstacles that pose a threat to the aircraft" using the "clock, altitude, and distance method." Although the IP could have used other methods to point out the airplane to the pilot, he most likely did not do so because he was uncertain about the airplane's position and assumed that it was one of the airplanes in front of the helicopter on approach to runway 1, as evidenced by his lack of a verbal affirmation to the pilot that he had located the airplane.

Another factor that contributed to the PAT25 crew not positively identifying flight 5342 was the lack of an integrated traffic awareness and alerting system in the helicopter that could have provided aural alerts to the crew's headsets and depicted traffic information on an instrument panel display in the pilots' primary field of view as part of their normal instrument scan. Although the crew had the capability to display ADS-B In traffic information on a moving map display on portable tablets using the ForeFlight application, TAAB pilots told investigators that they did not typically monitor their tablets during low-level operations on the DC helicopter routes because the flying task was too demanding. They also stated that any aural alerts from the device could not be heard because of the high level of ambient noise in the helicopter and because their helmets were not equipped to receive audio from the tablets.

In the absence of an accurate mental model of the airplane's expected flight path to runway 33, the lack of instruction from the controller to direct his visual scan, and without an integrated traffic awareness system, the IP's baseline expectations about traffic flow in the DCA area likely drove his visual search. Aggregated flight tracking data from the FAA showed that, in the year before the accident, only 5–7% of northbound arrivals at DCA had landed on runway 33. Anecdotal statements from other TAAB pilots indicated that some had never encountered an airplane landing on runway 33 while traveling on Route 4.

Thus, the more common flight path for airplanes during a north operation at DCA was, by far, a straight-in approach to runway 1, and the IP's baseline expectation would have been for conflicting traffic to approach from the south for runway 1 (to the right of the helicopter) rather than from the southeast (to the left of the helicopter) for runway 33. The numerous airplanes on approach for runway 1 likely reinforced this expectation, making it likely that the IP considered one of them as the conflicting traffic. This scenario would be consistent with his statement to the pilot just before the collision, "alright kinda come left for me…I think that's why he's asking," because moving left would have increased the helicopter's separation from traffic approaching runway 1.

Expectations drive attention, and people sometimes have difficulty noticing a variance between what they usually see and the actual state of things. When expectations are strong, people tend to seek out and attend to confirmatory visual information while overlooking indications that the current situation is different. This phenomenon, known as expectation bias, not only influences perception in the present, but it also influences perception of past events by promoting recollections that conform more closely to typical patterns.

Expectation bias is a well-known vulnerability in human performance. In this case, expectation bias likely played a role in the IP's ineffective scan following the controller's traffic callouts. The NTSB concludes that interference that obscured the controller's "circling to" call, the microphone keying that blocked the PAT25 crew from receiving the instruction to "pass behind," ambiguous visual cues, and the lack of an integrated traffic awareness and alerting system likely reinforced the PAT25 crew's expectation bias that the airplane was among the traffic approaching runway 1 and did not pose a conflict.

It could not be determined whether the PAT25 pilots received specific training addressing DCA runway use and traffic patterns, including fixed-wing approach and departure procedures. However, given the proximity and routine interaction of published helicopter routes with DCA fixed-wing traffic flows, additional airspace-specific training on DCA arrival and departure corridors and runway configurations would likely have improved the PAT25 crew's understanding of the risks inherent in the Army's routine mission-related operations in this environment.

Therefore, the NTSB concludes that the absence of documented training on DCA fixed-wing procedures and the mixed-traffic operating environment represented a safety vulnerability for Army flight crews operating in the DCA Class B airspace. As a result, the NTSB recommends that the US Army revise training procedures for flight crews assigned to operate in the Washington, DC, area to ensure that they receive initial and recurrent training on fixed-wing operations at DCA, including approach and departure paths, runway configurations, and the interaction of those traffic flows with published helicopter routes.

2.2.2.3 Helicopter Altimetry

Aircraft pitot-static systems and barometric altimeters have defined performance specifications. These include allowable instrument errors, which are tolerances for allowable errors after manufacture and during operation. They also include tolerances for position errors, which are errors caused by external aerodynamic effects from the airflow over the aircraft and (on helicopters) the main rotor downwash.

Although cockpit instruments are designed to be accurate, in general, it is not feasible to design barometric altimeters to be perfectly accurate in all flight conditions or throughout their entire service life. Older design mechanical barometric altimeters, such as those on the accident helicopter, have multiple types of allowable errors that can accumulate while still remaining within design and performance criteria. Additionally, changes to the aerodynamic shape of the aircraft, such as adding ESSS tanks, change the pressure effects on the pitot-static system and can increase the position error.

Altimeter testing showed that the 100-ft pressure altitude discrepancy seen in the FDR data for the accident flight was observed on three other UH-60L helicopters operated by the 12th Aviation Battalion. These altimeter testing results also showed that the pressure altitude data recorded by the helicopters' FDRs, when corrected for local conditions, was representative of what was indicated on the right side altimeter. Therefore, the FDR pressure altitude data for the accident helicopter, when corrected for local conditions, was likely representative of what was indicated on the IP's barometric altimeter during the accident flight.

The allowable tolerances are additive, with the total error having the potential of exceeding 100 ft. These tolerances are not unique to military aircraft; they apply to civil aircraft as well. While a difference of 100 ft would have little consequence at higher altitudes, given the low altitudes prescribed along portions of the DC helicopter routes and Army procedures that stated that flight should be conducted no lower than 100 ft agl, such a discrepancy resulted in the increased likelihood of altitude exceedances along these routes.

Although the instrument error specific to the accident helicopter could not be determined, disassembly and examination of the internal components did not reveal any anomalous wear that would have prevented normal operation. Additionally, the CVR recording did not capture any conversations between the flight crew regarding any malfunction of the barometric altimeters during the accident flight. It is likely that the behavior of the accident helicopter's static system position error and barometric altimeter instrument error were similar to that observed on other 12th Aviation Battalion UH-60L helicopters. The NTSB concludes that, due to additive allowable tolerances of the helicopter's pitot-static/altimeter system, it is likely that the crew of PAT25 observed a barometric altimeter altitude about 100 ft lower than the helicopter's true altitude, resulting in the crew erroneously believing that they were under the published maximum altitude for Route 4.

The accident helicopter's FDR should have contained a radio keying parameter; however, these data were not present on the accident helicopter's recorder. The radio keying parameter is needed to synchronize timing between the FDR and CVR, and accurate parametric data from the FDR is crucial for accident investigation purposes as well as for FOQA programs used to support an SMS. The investigation found that after the initial installation of the helicopter's FDR, there was no scheduled recurrent task to verify the continued accuracy of the recorded data.

FAA AC 20-141B recommends that operators of aircraft equipped with a digital FDR perform a "reasonableness check" at an interval not to exceed 18 months (FAA, 2010). The NTSB concludes that a recurrent task to verify the continued accuracy of recorded flight data for US Army aircraft would help ensure the data integrity needed to support quality assurance and safety programs and accident investigations. Therefore, the NTSB recommends that the US Army develop and implement a recurring procedure, at an interval not to exceed 18 months, to verify the continued accuracy of recorded flight data.

The Washington, DC, helicopter route altitudes, particularly the low altitudes specified for Routes 1 and 4 in the vicinity of DCA, did not account for the errors inherent to barometric altimeters, nor did they account for human error tolerances—both Army standards and FAA commercial pilot standards require pilots to maintain altitude within ±100 ft while in flight. Review of aggregated aircraft flight track information for helicopters on the DC helicopter routes from January 1, 2024, through January 30, 2025, indicated that helicopters regularly exceeded published maximum route altitudes.

For the northern segment of Route 4, which included the area of the collision, of the 523 flights analyzed, 260 flights (49%) were identified as exceeding route altitude limitations at some point during the flight. Had the error tolerances of barometric altimeters been considered during design of the helicopter route maximum altitudes, the incompatibility of a 200-ft ceiling and barometric altimeter errors may have been identified.

Although the data did not attribute an exact number or rate of altitude exceedances specifically to Army helicopters, the data indicated that military users comprised about 79% of the helicopter flight track data; therefore, it is reasonable to assume that at least some Army helicopters were exceeding maximum route altitudes. The NTSB concludes that the FAA and the Army failed to identify the incompatibility between the helicopter routes' low maximum altitudes and the error tolerances of barometric altimeters, which contributed to helicopters regularly flying higher than published maximum altitudes and potentially crossing into the runway 33 glidepath.

Despite helicopter manufacturer flight testing that showed increased barometric altimeter position errors with the ESSS installed, the Army's UH-60L operator's manual did not contain an altimeter correction chart for the ESSS configuration. The lack of this information in the operator's manual would result in UH-60L pilots being unaware that the ESSS could result in a greater-than-anticipated position error in flight. Neither maintenance checks nor the pilot's preflight check against local field elevation would detect this error, as these checks are not performed with the helicopter's main rotor turning.

The US Army issued Standardization Communication message 25-02 to inform pilots of the potential for increased position error in UH-60 helicopters equipped with ESSS.[166] This message included instructions to maintain a minus 50-ft margin when flying with a clearance with a maximum altitude to ensure the maximum altitude is not exceeded. However, at the time of this report, the US Army has not incorporated information into the UH-60 series operator's manuals to inform pilots of the increased position error with the ESSS configuration.

The NTSB concludes that pilots need all available information on the potential total error, allowed by design, that could occur in flight on an airworthy barometric altimeter. Therefore, the NTSB recommends that the US Army incorporate information within the appropriate operator's manual for all applicable aircraft on the potential total error allowed by design that could occur in flight on an otherwise airworthy barometric altimeter, including the increased position error associated with the ESSS configuration.

2.2.2.4 Helicopter Transponder

Postaccident examination of the helicopter's transponder revealed that it was transmitting the incorrect aircraft address during the accident flight due to a broken solder connection, which was the result of an incomplete bond at the time of the unit's manufacture. This incorrect address was not a factor in the accident flight because no other aircraft in the geographic area was transmitting an identical

[166] The message was signed by the Director of the US Army Aviation Center of Excellence's Evaluation and Standardization Directorate on August 5, 2025.

address, but it could pose a safety risk if two aircraft in the same vicinity were to broadcast the same address.[167]

The examination also revealed that the transponder ADS-B squitter was off and the time source was incorrectly set, which prevented the transponder from broadcasting ADS-B Out. Given that there was no historical ADS-B data for the accident helicopter following the installation of the transponder in April 2023, it is likely that either the squitter or time source setting, or both, was incorrectly set at the time of installation. A functional check of the transponder that was required after its installation should have detected that ADS-B Out was not broadcasting. Therefore, the NTSB concludes that the Army's post-installation functional check of the transponder on the accident helicopter was insufficient to detect that it was not broadcasting ADS-B Out.

Inspection of other helicopters from the 12th Aviation Battalion found incorrect time source settings on several aircraft equipped with APX-123A transponders, resulting in the Army directing a one-time inspection of transponders to verify ADS-B Out functionality. It could not be determined how or why the time source setting was changed following installation of the transponders. At the time of the accident, the Army had no established recurrent procedure for verifying transponder ADS-B functionality or confirming that it was transmitting the correct address. The NTSB concludes that the Army's lack of a recurrent transponder inspection procedure resulted in the incorrect aircraft address being transmitted by the accident helicopter's transponder, and the incorrect ADS-B settings on several other helicopters being undetected.

As of the date of this report, the Army has not yet developed a recurring procedure for this task, and it is possible that future ADS-B Out or aircraft address issues could go undetected. Therefore, the NTSB recommends that the US Army develop and implement a transponder inspection procedure on all aircraft with transponders capable of transmitting Mode S and ADS-B and operated in the NAS, at least annually and upon each aircraft's entry into service in the NAS, that ensures 1) the transponder ADS-B settings are correct, 2) the transponder is transmitting ADS-B, and 3) the transponder is transmitting the correctly assigned address.

Additionally, the NTSB concludes that, because the APX-123A transponder is designed for use on multiple aircraft platforms, it is possible that incorrect settings may be present on other aircraft used throughout the DOW armed services. Therefore, the NTSB recommends that the DOW PBFA require the DOW to verify on all aircraft with transponders capable of transmitting Mode S and ADS-B and

[167] Although there is a very low probability that two aircraft in the same geographical vicinity and covered by the same radar may broadcast the same aircraft address, the scenario is not impossible.

operated in the NAS, at least annually and upon each aircraft's entry into service in the NAS, that 1) the transponder ADS-B settings are correct, 2) the transponder is transmitting ADS-B, and 3) the transponder is transmitting the correctly assigned address.

2.2.3 Flight 5342 Operations

FDR and CVR information from the airplane indicated that the airplane's control columns rapidly moved aft and the crew indicated surprise and alarm about 1 second before the impact; these actions are consistent with the crew of flight 5342 not detecting the helicopter until it was too late to avoid a collision. The limitations of see-and-avoid, discussed in section 2.3.2, likely explain the crew's late detection.

Factors particularly relevant in this case include a complex background of dense cultural lighting behind the helicopter until about 10 seconds before impact, which would have made the helicopter's external lighting inconspicuous, and the helicopter's minimal relative motion in the flight 5342 crew's field of view, which also would have made it difficult to spot. The crew's moderate to high workload during the final stage of the circling approach, as shown in simulator studies conducted as part of this investigation, likely also reduced the odds of the flight crew detecting the helicopter.

The CVR recording indicated that the crew did not verbally communicate about the TCAS TA they received 19.2 seconds before the collision. Guidance provided by PSA Airlines did not specify standard callouts pilots were required to make in response to a TA. PSA's Flight Operations Manual stated that, upon receiving a TA, a crew should "attempt to see the reported traffic" and "should not maneuver based on a TA alone." The manual referred to FAA AC 120-55, which contained guidance indicating that crews should "respond to TAs by attempting to establish visual contact with the intruder aircraft and other aircraft which may be in the vicinity."

The AC also included the statement, "Coordinate to the degree possible with other crewmembers to assist in searching for traffic. Do not deviate from an assigned clearance based only on TA information." Thus, crew members were advised to search for the conflicting traffic and coordinate with each other as workload allowed, but were not permitted to maneuver in response to a TA without seeing a target that posed a collision risk.

The TA aural alert activated when the airplane was 1.05 nm from the helicopter and as the captain was turning the airplane left to align it with the runway 33 final approach path at about 450 ft radio altitude. Simulator observations with current and qualified PSA CRJ pilots indicated that this was a visually demanding task that required the captain to control the airplane's lateral path, thrust, airspeed, and glidepath (as indicated by the PAPI). It is unlikely that he had spare capacity to perform an extensive visual search for traffic at this time.

The FO was also performing visually demanding tasks, such as monitoring the airplane's lateral alignment, glidepath, and energy state to ensure that the approach remained stable, and monitoring the position of an airplane that had been cleared for takeoff on runway 1 to ensure that it would not pose a conflict. That airplane was still on or near the surface of the runway at the time the TA occurred, and it did not cross the centerline of runway 33 (thus no longer posing a conflict) until 4 seconds after the TA. The FO also would have been required to adjust the airspeed indicator bug for the airplane's final approach speed as soon as the captain had aligned the airplane with the runway. Thus, both pilots were busy and had limited opportunity to search for traffic in response to the TA.

If, despite this workload, the FO had promptly reacted to the TA, it is likely that he would have glanced at the multifunction display (which was set to show traffic within a 5 nm radius) to determine the traffic's location. This would have revealed a traffic icon 1 nm in front of the airplane at a relative altitude of -200 feet. He would then have looked directly in front of the airplane. For 9 seconds after the TA occurred, the helicopter was surrounded by, and likely indistinguishable from, a dense array of both steady and flashing lights that stretched along the horizon to the right of the airport.

Given the complexity of this background and the helicopter's lack of apparent motion when viewed from the airplane, it is likely that the FO would have been unable to spot it during a brief search. Even if the crew was unsuccessful in visually locating the helicopter, they were trained not to maneuver unless they received an RA. Many of the PSA pilots interviewed were unaware of the altitude below which RAs were inhibited.

It is also possible that the radio transmissions audible to the flight crew reduced the extent of their visual search for the helicopter. Although the crew could not hear PAT25's transmissions to the controller, they could hear the controller's transmissions to the helicopter. These transmissions would have been reassuring if the crew heard them and recognized their airplane as the "CRJ" being referenced.

One second before they received the TA aural alert, they would have heard the LC controller transmit, "PAT two five you got the C-R-J in sight?" followed by, "PAT two five pass behind the C-R-J." A few seconds later, they would have heard the LC controller transmit "vis sep." The crew of flight 5342 undoubtedly understood the terminology associated with approving visual separation. Thus, these transmissions (if listened to) would have indicated to the crew that the helicopter had their airplane in sight and intended to avoid them.

The fact that the controller did not issue them any advisories or instructions would also have been reassuring because it would have indicated that the responsibility for deconfliction had been assigned to the helicopter. If heard and attended to, the radio communications audible to the flight 5342 crew could have reassured them that the helicopter was not a significant threat and that they could focus their attention on completing their approach and landing. However, because the CVR did not contain any discussions between the crew about these transmissions or the potential of a conflict with the helicopter, their level of awareness of the transmissions and their involvement in the traffic conflict could not be determined.

The NTSB concludes that the crew of flight 5342 did not see the helicopter until it was too late to avoid a collision because of the high workload imposed during the final phase of their approach, and due to the helicopter's low conspicuity and lack of apparent motion.

2.3 DCA Air Traffic Control Tower Facility

2.3.1 Traffic Management, Volume, and Flow

Postaccident interviews and investigative hearing testimony provided by DCA ATCT and Potomac TRACON personnel, as well as FAA ATO leadership, indicated that managing the flow of traffic at DCA had been a longstanding challenge that could be attributed to several factors, one of which was DCA's AAR.

Potomac TRACON and DCA ATCT personnel stated in interviews and investigative hearing testimony that managing the rate of arrivals into DCA while providing adequate MIT spacing between arriving aircraft was a continual issue. Potomac TRACON and DCA ATCT had agreed that aircraft would arrive at the runway threshold at DCA with a spacing of 4 MIT; however, the FAA found through a systematic review conducted after the accident that DCA ATCT controllers were provided with less than 4 MIT about 40% of the time. This spacing was critical because it allowed adequate time for departures to take place between arriving aircraft, thereby reducing backups on DCA's limited taxiway surface area.

In 2023, Potomac TRACON requested a decrease to the existing AARs due to changes to the mix of aircraft types serving DCA over the previous decade, flight schedule increases that did not allow for use of reduced separation of aircraft on final approach, airspace and weather constraints, and an inability to regulate traffic flow based on time, also referred to as "metering." The Potomac TRACON ATM stated in postaccident interviews that the request to reduce DCA's AARs was not forwarded to higher levels because it was "too political." The FAA's denial of the documented request to change the AAR at DCA without feedback to the requester effectively eliminated what could have been an important operational safety improvement and violated their established review process.

Another factor that DCA ATCT controllers cited as contributing to traffic complexity was that airlines often grouped their allotted departures or arrivals for a given 2-hour period into the last 30 minutes of the first hour and the first 30 minutes of the second hour rather than spreading them evenly throughout the hour, which resulted in times of “compacted demand” on controllers to accommodate traffic surges. The NTSB concludes that times of compacted demand as a result of air carrier scheduling practices increased operational complexity and required mitigations by controllers to maintain spacing and surface movement.

Other airports, including New York’s LaGuardia Airport, have mitigations in place to prevent this practice through federal regulations contained in 14 *CFR* Part 93 Subpart K, which prescribes air traffic rules for aircraft operating to and from high density traffic airports. The regulation specifies the number of operations that can occur during any 30-minute period or any two consecutive 30-minute periods. To alleviate the effects of compacted demand at DCA, the NTSB recommends that the FAA initiate rulemaking in 14 *CFR* Part 93 Subpart K, High Density Traffic Airports, that prescribes air carrier operation limitations at DCA in 30-minute periods, similar to those imposed at LaGuardia Airport, to ensure that the airport does not exceed capacity and to mitigate inconsistent air carrier scheduling practices.

A TBFM (see section 1.7.6.6), or metering, system had been in place at Potomac TRACON for at least 10 years before the accident and controllers had been trained in its use; however, the system was never activated. The core function of TBFM is the ability to schedule aircraft to reach a defined point at a specified time, creating a time-ordered sequence of traffic.

According to testimony provided in the investigative hearing by the FAA’s Washington District traffic management officer, TBFM would allow for better management of the compacted demand at DCA. A representative of American Airlines testified that TBFM was in use at several of the airline’s other hub airports and that it “smooths out the volume” of traffic while providing more accurate MIT. Information provided by the FAA indicated that, as of February 2025, the TBFM project at Potomac TRACON was on hold until further notice due to budget constraints. A manager at Potomac TRACON testified that they had “not seen it yet, and it is supposed to come in March of [20]26.”

In interviews with DCA ATCT personnel, as well as review of ATC audio and personal observation by investigators, “offloading” arrivals to another runway was common practice at DCA to build spacing between aircraft, particularly during times of heavier traffic flow and when the airport was in a north configuration (airplanes landing on runway 1).

The DCA ATCT operations manager at the time of the accident stated that controllers routinely offloaded traffic on approach to runway 1 by having them circle to runway 33. Although other methods were available to DCA controllers to build additional spacing between aircraft, the operations manager stated that offloading traffic to runway 33 was a preferred mitigation at DCA ATCT because it continued the flow of arrivals and departures during compacted demand times.[168] In contrast, having an airplane decrease airspeed on final approach to increase separation would cause traffic buildup behind that aircraft that would also affect Potomac TRACON.

Many of the factors that contributed to DCA's uniquely complex traffic situation were present on the night of the accident and contributed to high controller workload. The LC controller stated in a postaccident interview that a traffic "push," or compacted demand, had begun about 2000 that night, but he believed that traffic was decreasing around the time of the accident. He also stated that the tower "wasn't getting spacing on final" at the time of the accident, referring to the 4 MIT agreement with Potomac TRACON.

Further, he had traffic on the ground waiting to depart. As a result, he was asking pilots of aircraft inbound for landing whether they could switch to runway 33 as a means of increasing space between arrivals to allow for departures. The NTSB concludes that DCA ATCT routinely received less than the requested MIT spacing from Potomac TRACON, which increased controller workload by requiring them to generate additional spacing to prevent delays or gridlock.

The NTSB also concludes that the practice of "offloading" arrival traffic on approach to runway 1 by asking pilots if they could accept a circling approach to runway 33 was a routine mitigation strategy for DCA controllers to generate spacing that was not provided by Potomac TRACON. The NTSB further concludes that TBFM, or metering, would provide Potomac TRACON and DCA ATCT with a consistent flow of traffic with more accurate spacing and greater predictability, thereby reducing controller workload.

The NTSB recognizes that, according to the FAA, Potomac TRACON began limited operational use of TBFM in October 2025; however, TBFM had not yet been implemented at the Potomac TRACON or the DCA ATCT at the time of the accident, and full implementation and operational use of TBFM in both facilities is expected by March 2026. Therefore, the NTSB recommends that the FAA fully implement

[168] During the NTSB's investigative hearing, the ATO's acting deputy COO testified that other methods included slowing aircraft after check-in on final approach, instructing aircraft to perform S-turns on final approach, and "demand[]" that Potomac TRACON provide a certain MIT interval between aircraft, if needed.

operational use of the TBFM system at Potomac TRACON and its associated air traffic control towers.

The NTSB also recognizes that the FAA also made a temporary adjustment to the AAR following this accident, which remains in effect as of the date of this report. In order to fully address the traffic management, volume, and flow issues in the DCA airspace, the NTSB recommends that the FAA reassess the DCA AAR with special consideration to its airspace complexity, airfield limitations, mixed-fleet operations, and traffic volume.

The NTSB is concerned also that the spacing issue observed in this accident may exist elsewhere in the NAS. Therefore, the NTSB also recommends the FAA require each Class B or Class C ATCT facility to evaluate its existing MIT procedures or agreements to ensure that the spacing provided is appropriate for operational safety, and make the results publicly available.

During the course of the investigation, the NTSB learned that the DCA ATCT had been downgraded from a level 10 facility to a level 9 facility in 2018. Facility level is a factor that determines controller compensation, and controllers stated that the downgrade at DCA ATCT impacted employee morale and resulted in the loss of experienced controllers, who left for higher paying facilities. Despite several requests from the NTSB during this investigation, the FAA did not provide documentation of the criteria or formula it used in its determination to downgrade DCA ATCT's facility level.

The NTSB is concerned about the impacts of the downgrade on the DCA ATCT's long-term facility health and by the FAA's lack of transparency regarding the metrics used to define facility levels throughout the NAS. Although the DCA ATCT's facility level downgrade could not be directly correlated to the circumstances of this accident, the NTSB concludes that DCA ATCT has significant airspace, airfield, mixed fleet, and operations complexities that appear to be inconsistent with its current facility level classification.

Therefore, the NTSB recommends that the FAA define objective criteria for the determination of air traffic facility levels considering traffic and airspace volume, operational factors unique to each facility, and cost of living. Using this criteria, determine whether the classification of the DCA ATCT as a level 9 facility appropriately reflects the complexity of its operations.

2.3.2 Visual Separation

The FAA's Pilot-Controller Glossary states that visual separation is a means employed by ATC to separate aircraft in terminal areas and enroute airspace in the NAS. In the terminal, or airport, area, visual separation can be either tower-applied, in which the tower controller sees the aircraft involved and issues instructions to effect separation; or pilot-applied, in which a pilot sees the other aircraft involved and provides their own separation by maneuvering as necessary to avoid it.

Visual separation does not require a certain minimum separation distance between aircraft; therefore, pilots are permitted to determine their own spacing. In the absence of visual separation at DCA, Class B radar separation minimums would apply, which require 1 1/2 miles lateral or 500 ft vertical distance between IFR (airplane) and VFR (helicopter) traffic.

Postaccident interviews with controllers and testimony provided in the NTSB investigative hearing revealed that visual separation was the primary means of separating helicopter and fixed-wing traffic in the DCA area when weather conditions permitted. One controller testified that the use of visual separation was "paramount" to efficient operations at DCA given the volume of traffic and the complexity of the airspace.

Due to the proximity of the helicopter routes and zones to the approach and departure corridors for fixed-wing traffic, applying standard Class B separation minimums at all times would likely require controllers to frequently issue holds to helicopter traffic and, depending on traffic priority, could also result in controllers frequently issuing go-around instructions to fixed-wing traffic, all of which would increase controller workload and contribute to additional airspace congestion and traffic complexity. To avoid these difficulties, controllers were motivated to provide a traffic advisory and authorize visual separation for helicopters transiting DC airspace as early as possible, and interviews with controllers indicated that this practice had become the norm.

Previous ECVs at the DCA ATCT identified issues such as shortcutting standard phraseology, instances in which the HC position was combined or de-combined without required documentation in the facility logs, and occurrences in which helicopters flew in close proximity to arriving fixed-wing aircraft and traffic information was not issued to either aircraft. The team also observed occasions where fixed-wing traffic was not advised regarding helicopters operating in close proximity to the final approach course.

During a November 2024 ECV, the ECV team noted "a few occurrences" in which the LC controller advised aircraft on final approach that helicopters operating near the final approach course had them in sight and were maintaining visual separation. However, at the time these transmissions were made, the helicopter had not reported the traffic in sight and had not been advised to maintain visual separation. The LC controller appeared to be anticipating that the helicopters would visually acquire the arrival traffic, report traffic in sight, and then be instructed to maintain visual separation.

A retired FAA air traffic specialist who was subsequently employed as a contractor to perform ECVs at DCA ATCT stated that, during his 9 months at the facility, he had concerns about potential conflicts with the helicopter routes, which he raised to the ATM at the time.

In the NTSB's investigative hearing, the DCA ATCT OM at the time of the accident stated that the controllers at DCA would "just make it work" by utilizing all available tools to compensate for the traffic volume. Because DCA was a high volume, complex airport with "not a lot of real estate," controllers had to "keep things moving" to provide safe and efficient service. He stated that this "make it work" mentality had become normalized at DCA ATCT before the accident and that:

> …it can be taxing on a person…constantly having to give, give, or push, push, push in order to efficiently move traffic…Whenever the controllers at DCA just make it work, they are going above and beyond to approach the limit of the rules and regulations. They're pushing the limits of what can be done to safely and efficiently move the aircraft and/or helicopters at DCA…you're pushing the line.

The issues identified by previous ECVs at DCA should have served as symptoms of a controller workforce under constant pressure to "make it work." Controllers relied on the use of pilot-applied visual separation in order to accommodate helicopters operating on the routes and zones while moving a high volume of aircraft through complex airspace into and out of an airport with limited surface area. The NTSB concludes that the FAA ATO failed to recognize ECV results as indicators of systemic traffic management, volume, and flow issues at DCA for which controllers were required to compensate.

Interviews and testimony from helicopter operators in the DCA area indicated widespread understanding that visual separation allowed more efficient traffic flow and that requesting and receiving approval for visual separation was normal practice. Helicopter operators reported receiving traffic advisories at distances that made it difficult to identify specific targets. Nevertheless, they were generally comfortable using pilot-applied visual separation, particularly on clear nights and when using NVGs, which allowed aircraft lights to be seen from long distances.

The expectation that helicopter crews would maximize use of visual separation to facilitate traffic flow likely promoted a pattern of automatic responses when flight crews received traffic advisories. An Army standardization instructor pilot stated in a postaccident interview that he sometimes responded to traffic advisories before visually acquiring the traffic if he knew that it was far away and was not an imminent threat. The accident IP's significant experience flying on the DC helicopter routes and the speed of his reply to the controller's traffic advisory support the likelihood that he had also developed this habit. This practice was contrary to FAA requirements that a crew should visually identify aircraft before requesting visual separation.

The acceptance of a gap between typical operating practices and formal operating requirements has been described as normalization of deviance. Coined after the Space Shuttle Challenger disaster in 1986, "normalization of deviance" refers to the gradual shift away from standards or acceptable practices (Vaughan, 1996). Such deviations originate from frontline personnel trying to manage conflicting goals, such as maximizing production and protection, and minimizing workload (Rasmussen, 1997). When such gaps develop, they can become incrementally larger if they persist without negative consequences, and this can lead to systemic safety vulnerabilities.

In this case, controller expectations that a helicopter crew would have a specific aircraft in sight before requesting and receiving approval for visual separation were not necessarily valid. As a result, there was potential for controllers to overestimate the level of traffic awareness a helicopter crew had, following a traffic advisory, and to underestimate the level of information and assistance they might subsequently require to ensure collision avoidance.

The NTSB concludes that the longstanding practice of relying on pilot-applied visual separation (see-and-avoid) as the principal means of separating helicopter and fixed-wing traffic in the Washington, DC, area by DCA ATCT, the Army, and other helicopter operators led to a drift in operating practices among controllers and helicopter crews that increased the likelihood of a midair collision.

There are inherent limitations to seeing and avoiding other airborne traffic. These include the limited field of view from the cockpit, including the obscuring effects of aircraft structures or, in this accident, the limited field of view provided by NVGs. Even the positioning of aircraft in a pilot's field of view near the cockpit structure reduces the odds of detection due to the effect of nearby objects on visual accommodation (Chong and Triggs, 1989).

In this accident, both aircraft were located adjacent to or within a field of background lights when viewed from the other's perspective. Aircraft superimposed on or adjacent to complex backgrounds are more difficult to detect (Steedman and Baker, 1960). Although aircraft lighting may improve the conspicuity of aircraft flying at night, the effect of a complex background of ground lighting may offset the advantages of such lighting.

An Army standardization instructor pilot testified during the investigative hearing that, although it was easy to identify airplanes on approach to runway 1, it would be much more difficult to maintain visual contact with an airplane circling for runway 33, particularly as the helicopter descended to 200 ft. He also testified to the challenges inherent to NVG use, including the limited field of view and the difficulty in identifying aircraft operating near or below the horizon against dense cultural lighting.

Attentional limitations also play a role. Research indicates that fixed-wing pilots spend, on average, 30% to 35% of their time scanning outside, and even less time when engaged in tasks that demand their attention inside the cockpit (Wickens et al., 2001). When pilots do scan outside for traffic, they are biased toward the area directly in front of them, or toward outside features most pertinent to their current task (Colvin et al. 2005). Aircraft on a collision course lack relative motion in a pilot's field of view, which makes them less likely to attract visual attention because peripheral vision is more sensitive to motion than fine detail (Gibb et al., 2010).

These and other factors contribute to delays in detection that can lead to a midair collision when crews are visually self-separating. Research involving actual test flights indicates that most unalerted visual acquisitions of conflicting aircraft occur after two aircraft have closed to within 1 to 2 nm of each other. Mathematical modeling of the probability of visual acquisition based on these studies has indicated that, for a closure rate of 120 kts, the probability of detecting an intruder aircraft in the daytime does not reach 85% until 12 seconds before a collision (Andrews, 1991). In this accident, CVR and FDR data indicate that the crew of flight 5342 detected the helicopter about 1 second before the collision, and that the crew of PAT25 had no awareness of the impending collision.

The NTSB has highlighted the limitations of see-and-avoid in previous investigations and argued that these limitations cannot be overcome by recommending greater pilot diligence and scanning for traffic. Traffic awareness and alerting technologies with aural alerts, however, can significantly improve detection and reaction times (Andrews, 1991). This underscores the importance of such technology in airspace with a high concentration of commercial air traffic.

This accident, in which neither the crew of PAT25 nor the crew of flight 5342 detected each other in time to avoid a collision, amplifies the serious inherent limitations of the see-and-avoid concept, a primary means of separation between helicopters and commercial airplanes at DCA. The NTSB concludes that reliance on pilot-applied visual separation (see-and-avoid) as a primary means of separating mixed traffic introduced unacceptable risk to the DCA Class B airspace.

Although this accident occurred in the uniquely complex DCA Class B airspace, the underlying limitations of pilot-applied visual separation are inherent to human performance and are present wherever see-and-avoid is used as a means of aircraft separation in the NAS. Because controllers nationwide routinely apply visual separation in mixed-traffic environments, mitigating this risk requires consistent, systemwide training that emphasizes the limitations of see-and-avoid and the conditions under which its use may introduce unacceptable risk.

Therefore, the NTSB recommends the FAA develop a new and comprehensive instructor-led, scenario-based training on the proper use of visual separation, both tower- and pilot-applied. This training should include information on the inherent limitations of see and avoid, responsibilities when applying visual separation, and guidance for controllers on factors, such as current traffic volume, workload, weather or environmental factors, experience, and staffing, that should be considered when applying visual separation. Require this training for all controllers and include on a recurrent basis thereafter in annual simulator refresher training.

2.3.3 Radio Frequency Management

The DCA air traffic control tower utilized a discrete frequency for communicating with helicopters to avoid interference and frequency congestion. When the HC and LC positions were combined, it was normal practice to keep helicopters on their own frequency rather than directing all traffic to use the same frequency. This also made the process of de-combining the HC and LC positions easier. When the HC and LC positions were combined, all pilots could hear all transmissions made by the controller; however, the use of separate frequencies meant that transmissions made from helicopters were not audible to airplanes and transmissions made from airplanes were not audible to helicopters.

Pilots indicated that there were advantages and disadvantages to this practice. The advantages included reducing non-pertinent transmissions that could impede communication between crewmembers and alleviating frequency congestion; however, pilots reported that being able to hear transmissions from all other aircraft would be an asset to flight crew situation awareness. Had the accident crews been able to hear each other's transmissions to the controller, PAT25 would have heard flight 5342's acceptance of the runway 33 circling approach and their subsequent readback of the landing clearance. Flight 5342 would have heard PAT25's position report at the Memorial Bridge.

These transmissions contained additional salient information regarding each aircraft's position and intentions, which may have increased the crews' awareness of the potential for a traffic conflict. The NTSB concludes that DCA ATCT's procedure of maintaining a discrete helicopter frequency when the local and helicopter control positions were combined decreased overall situation awareness for pilots operating in the area. Therefore, the NTSB recommends the FAA conduct a comprehensive evaluation, in conjunction with local operators, to determine the overall safety benefits and risks to requiring all aircraft to use the same frequency when the helicopter and local positions are combined in the DCA ATCT.

The very high frequency (VHF) radio communications used by air traffic control do not allow for simultaneous transmissions. If a pilot or controller attempts to broadcast on the same frequency at the same time as another pilot, one or both transmissions may be garbled, incomplete, or blocked from reception entirely. This leads to missed control instructions, lack of clarity, loss of situation awareness, or readback errors; however, there is currently no system in use that allows controllers to know when a simultaneous broadcast has occurred.

Review of the helicopter's CVR indicated that the controller's instruction 17 seconds before the collision, which stated, "PAT two five pass behind that C-R-J," was interrupted by a 0.8-second microphone key from one of the helicopter crewmembers, which resulted in much of the transmission being interrupted, and the crew did not receive the instruction to "pass behind."

In 1984, the FAA was petitioned to enact rulemaking requiring two-way radio communication systems employing anti-blocking and stuck microphone protection circuitry. In response, the FAA issued TSO C128, which provided standards for preventing blocked channels used in two-way radio communications due to unintentional transmissions, and TSO C122, which provides standards for equipment designed to prevent blocked channels in two-way radio communications caused by simultaneous transmissions. TSO C128 and its subsequent revision have proven effective and popular with VHF radio manufacturers; however, only one manufacturer had been issued a letter of TSO design approval under TSO C122 since its original issuance in 1994.

In June 2012, the FAA issued a notice of intent to cancel C122a, the current revision, citing the lack of design approvals and "the eventual obsolescence of TSO C122a equipment"; however, the FAA has not finalized the cancellation of the TSO. In July 2025, citing the circumstances of this accident, the FAA announced that it was withdrawing its previous intent to cancel TSO C122a and was reopening the associated comment period. The FAA stated that it welcomed comments on whether TSO C122a and the standard it references, RTCA/DO-209, are obsolete, as well as input to identify current technologies that may have replaced these standards.

The NTSB recognizes that implementing same-frequency communications for airplanes and helicopters in a high traffic volume area such as DCA increases the risk of simultaneous radio transmissions that prevent critical information from being transmitted or received by both pilots and controllers. Therefore, the NTSB recommends that the FAA implement anti-blocking technology that will alert controllers and/or flight crews to potentially blocked transmissions when simultaneous broadcasting occurs.

2.3.4 Conflict Alert System

The CA system is designed to draw the controller's attention to a potential conflict and is presented in three ways: an aural alert, a flashing "CA" on the display, and a conflict list on the display, which indicates in red the aircraft involved. The activation criteria comprise three algorithms that each detect conflicts independently, sensing potential linear, maneuver, and proximity conflicts. Some of these logics predict where the aircraft is going, while others consider where the aircraft is located at that time; however, the CA presented to the controller is the same regardless of which algorithm is activated. This requires the controller to identify and interpret the severity of the conflict and evaluate the action they should take based on other available information.

Interviews with DCA ATCT personnel indicated that CAs were heard "often" and were "pretty common" at DCA. In the 30 minutes before the accident occurred, the conflict alert could be heard in the background during 18 controller transmissions.[169] Controllers reported that they often received CAs for non-conflicts, such as when aircraft were on diverging paths, or that the CA would continue to activate even after the controller had taken action to mitigate the conflict. In this accident, the controller responded about 6 seconds after the alert activated. There was a slight delay in the LC controller's response, as he was completing a transmission with another helicopter when the CA activated, and he did not query PAT25 until after the other helicopter had responded.

Allendoerfer et al. (2007) analyzed 607 CAs from 5 enroute and 17 terminal ATC facilities and categorized controller responses to the alerts and the timing of the responses. This research indicated that the majority of CAs (44% in the terminal area) received no response from controllers; many are so brief that controllers have resolved the situation before the alert activated, or that the situation resolved itself without any controller input. The research noted that no operational errors or deviations occurred in these instances. Alerts that activate and require no controller action may increase workload, as the alert directs the controller's attention away from their current tasks and toward the aircraft involved in the alerting event.

Of the alert situations where controllers acted, they most often acted before the alert activated (67% of the time). This suggests that, while many alerts are valid according to the alert algorithms, they do not provide useful information to controllers, nuisance alerts are common (81–87% of CAs are estimated to be nuisance

[169] As previously noted in section 1.7.8.4, these instances did not necessarily represent 18 distinct CA activations. Review of available radar display replay data for the final 18 minutes before the accident identified five separate CA activations, several of which persisted long enough to be audible across multiple transmissions.

alerts), and high nuisance alert rates may desensitize controllers and lead to poor responses to critical alerts.

The current system displays all CAs in the same manner regardless of the algorithm that triggered the alert. In the absence of any salient information conveying the severity of the conflict, controllers must make their own determination regarding whether the conflict alert requires immediate action, thus increasing cognitive load. The FAA's Human-Systems Integration Branch manager stated during the NTSB's investigative hearing that available improvements to the CA software could provide color coding or various aural alerts depending on which of the three conflict alert algorithms was activated.

The NTSB concludes that providing controllers with additional salient cues regarding the perceived severity of a potential conflict would reduce controller cognitive load and would likely improve reaction time to the most critical conflict alerts. Therefore, the NTSB recommends that the FAA develop and implement improvements to the conflict alert system to provide more salient and meaningful alerts to controllers based on the severity of the conflict triggering the alert. Once the improvements to the conflict alert system discussed in Safety Recommendation A-26-20 are implemented, provide training to controllers on its use.

2.3.5 Postaccident Drug and Alcohol Testing

The LC controller, ALC controller, and OS underwent DOT workplace postaccident drug testing about 18 hours, 20 hours, and 18 hours after the accident, respectively. This testing did not detect any tested-for substances indicative of prohibited drug use. They did not undergo alcohol testing.

The 14 tested-for substances on the DOT workplace drug testing panel in effect at the time of the accident may be detectable in urine for a day or more after last drug use. As such, the testing was worthwhile, although it was less sensitive for identifying pre-accident prohibited drug use than it would have been if it was conducted sooner after the accident.

There was no evidence to indicate that any of the controllers were under the influence of alcohol at the time of the accident; however, had timely postaccident alcohol testing been conducted, controller alcohol use might have been definitively excluded as a factor in the accident. Unfortunately, postaccident alcohol testing was not conducted, so there was no toxicological evidence available to support such a determination.

The NTSB concludes that there was no evidence that the LC controller, ALC controller, or OS were under the influence of alcohol or prohibited drugs at the time of the accident; however, evidence was substantially limited by the lack of postaccident alcohol testing, and evidence was of somewhat lower quality than it would have been if drug testing had been conducted sooner following the accident.

DOT Order 3910.1D, "Drug and Alcohol-Free Departmental Workplace Program," stated that air traffic controllers must undergo postaccident drug and alcohol testing as soon as possible after a fatal accident, any accident that involved a need for medical treatment away from the accident site, or following an accident that resulted in substantial damage to aircraft or other vehicles or property. The order also required that, whenever possible, alcohol testing must take place within 2 hours after the accident and drug testing within 4 hours after the accident.

Review of documentation provided by the FAA indicated that the drug and alcohol testing determination was not made until almost 3 1/2 hours after this accident, when the FAA ATO determined that there was a requirement to test the LC controller, ALC controller, and OS. By that time, the controllers had left the facility. Although DOT Order 3910.1D permitted alcohol testing for another 4 1/2 hours after the determination was made and stated that controllers must remain readily available for testing, the ATO decided to test for drugs only, and the testing was scheduled for late the following afternoon. Thus, the NTSB concludes that the FAA ATO's drug and alcohol testing determination did not meet DOT timeliness requirements; furthermore, the ATO's decision to not conduct drug testing as soon as possible after the testing determination, and to not conduct alcohol testing at all, violated DOT requirements.

FAA Order JO 1030.3B, "Initial Event Response," outlines ATO procedures following an accident, to include the postaccident/incident drug and alcohol testing determination being made concurrently with the ATO's SRT, which is a management review to assess air traffic services associated with an event (FAA, 2014a). However, initiating an SRT requires multiple initial notifications and preliminary review of the event, to include preparing audio and radar display recordings of the event for playback. These administrative and investigative actions take time.

When possible, SRTs are convened the administrative day following the accident to allow time for such actions to be completed, though major air carrier accidents or fatal accidents involving air traffic control services require an SRT to be convened no later than 3 hours following initial notification. However, an SRT conducted 3 hours after an accident is already outside the 2-hour postaccident alcohol testing window outlined by the DOT, and an SRT conducted the next administrative day is likely to fall outside both the 4-hour postaccident drug testing window and the 8-hour maximum time for alcohol testing.

Additionally, there was evidence that ATO staff lacked a complete understanding of DOT postaccident drug and alcohol testing requirements. First, the testing determination itself violated DOT requirements. Also, a DOT-required memorandum addressing why testing was not performed in a timely manner was not prepared, which an ATO representative attributed to staff's lack of awareness of this requirement.[170]

The NTSB concludes that the delayed and inappropriate drug and alcohol testing determination was due in part to the ATO's determination process being inadequately designed to routinely meet DOT requirements for timely testing, and in part to ATO staff's incomplete understanding of those requirements.

A primary intended purpose of DOT workplace drug and alcohol testing is to deter and identify abuse of alcohol and use of certain illegal drugs by individuals performing security- and safety-sensitive duties, with the recognition that those substances may have impairing effects on the performance of those duties (US Congress, 1991). Systemic obstacles to accomplishing timely and appropriate postaccident and postincident testing weaken the ability of such testing to serve its intended safety purpose. Accordingly, the ATO's inadequately designed determination process presents a public safety risk that extends beyond any single accident investigation.

The ATO representative testified at the NTSB's investigative hearing that the FAA had begun efforts to revise the initial event response procedures outlined by FAA Order JO 1030.3B. As of the date of this report, those initial event response procedures have not been revised. In this process, the FAA could consider the example of drug and alcohol testing requirements for FAA-regulated employers such as airlines, which are closely related to the requirements for FAA-employed air traffic control specialists.

The DOT requires the FAA to conduct postaccident testing of FAA-employed controllers whose performance is thought to have contributed to an accident or cannot be completely discounted as a contributing factor, and the FAA imposes similar requirements on its regulated employers. FAA regulations contain language clarifying the permissive intent of the requirement imposed by the FAA on regulated employers, stating that the employer's decision not to administer a test must be based on a determination, using the best information available at the time of the

[170] This accident was not the only recent NTSB investigation to identify delayed drug testing and missed alcohol testing of an air traffic controller who was providing services during a serious safety event. The NTSB's investigation of a 2023 runway incursion involving a Southwest Airlines passenger airplane and a FedEx cargo airplane identified that the controller who had been communicating with both airplanes had not undergone postincident alcohol testing, and did not undergo postincident drug testing until the day after the event. In response to NTSB queries about the drug testing determination in that event, the FAA provided a copy of an FAA email request to "please test" the controller that had been sent more than 8 hours after the event, by which time the window for alcohol testing had closed.

determination, that the employee's performance could not have contributed to the accident.[171]

There is no requirement in the DOT's workplace drug and alcohol testing program, or in DOT/FAA regulations for regulated employers, for each drug and alcohol testing determination to be based on upper managerial consensus after investigation. DOT's own workplace drug and alcohol testing guidance states, "The decision to subject an employee to a postaccident test shall be made using the best information that is reasonably available to management at or about the time of the accident." DOT's guidance to DOT/FAA-regulated employers is more explicit:

> The supervisor at the scene of the accident/event should know the testing criteria and make a **good-faith effort decision** to test or not test based on the **information available at the time** [emphasis in original]. The supervisor may consult with others, but the supervisor is the person who has to make the decision.

If the FAA were to adopt a process whereby on-site supervisors are empowered to make postaccident/incident testing determinations using available information independently from SRTs, not only would many of the barriers to timely decision-making be removed, but also parity with DOT's guidance on best practices for DOT/FAA-regulated employers would be achieved. Any such process change would need to be effectively communicated throughout the ATO, including by revising FAA Order JO 1030.3B, leveraging existing training procedures, and possibly developing new tools, to ensure that ATO staff possess a strong understanding of associated requirements. This institutional understanding would need to be resilient to workforce turnover and to the relative infrequency of events triggering postaccident and incident testing.

Therefore, the NTSB recommends that the FAA revise the ATO's initial event response procedures so that an appropriate on-site supervisor makes each postaccident and postincident drug and alcohol testing determination, based on their assessment of whether the event meets testing criteria and which controllers had duties pertaining to the involved aircraft, without needing to wait for investigation or approval.

The NTSB additionally recommends that the FAA at least annually, provide training on the revised postaccident and postincident drug and alcohol testing determination procedure discussed in Safety Recommendation A-26-22 to all staff

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[171] For corresponding DOT/FAA workplace testing language, see DOT Order 3910.1D, Chapter III, paragraph 6.i(2). For corresponding language pertaining to safety-sensitive employees of FAA-regulated employers, see 14 *CFR* 120.109(c) and 14 *CFR* 120.217(b)(1).

who have responsibilities under that procedure; this training should include a post-learning knowledge assessment.

FAA ATO procedures that limit the timeliness of postaccident/incident testing determinations also limit opportunities to evaluate potential downstream barriers to timely testing. It is possible that successful revision of ATO procedures might expose other weaknesses—for example, in contractor availability to conduct timely testing once a timely drug and alcohol testing determination is made. The DOT, including the Assistant Secretary for Administration and the Departmental Drug Office, has the responsibility to oversee FAA adherence to DOT workplace drug and alcohol testing requirements and associated required training of supervisors.

To enforce its workplace drug testing requirements effectively, the DOT should ensure that the FAA systematically identifies and addresses barriers to timely postaccident and postincident drug and alcohol testing at its facilities. Importantly, addressing these barriers likely would require administrative support from the DOT Departmental Drug Office, not just oversight.

Accordingly, the NTSB recommends that the DOT require the FAA to demonstrate at least annually that each air traffic control facility it operates has the routine capability to accomplish required postaccident and postincident drug and alcohol testing within the US DOT's specified timeframes of 2 hours for alcohol and 4 hours for drugs, and implement a process to ensure that any facility without such capability will demonstrate timely remediation.

2.4 Helicopter Route Design and Information

Preliminary investigative findings of this accident revealed that, when flown at the recommended maximum altitude of 200 ft, a helicopter operating over the eastern shoreline of the Potomac River on Helicopter Route 4 would have about 75 ft of vertical separation from an airplane approaching runway 33. This vertical separation decreases the farther west of the shoreline the helicopter is flown, or if the airplane is operating below the 3° visual glidepath provided by the runway 33 PAPI.

In an urgent safety recommendation report published on March 11, 2025, the NTSB concluded that the separation distances between helicopter traffic operating on Route 4 and aircraft landing on runway 33 that existed at the time of the accident were insufficient and posed an intolerable risk to aviation safety by increasing the chances of a midair collision. The NTSB also concluded that it was critical for public safety helicopter operators to have an alternate route available for operating in and around Washington, DC, without increasing controller workload.

As a result of our findings, we issued two urgent safety recommendations to the FAA. Urgent Safety Recommendation A-25-1 asked the FAA to prohibit operations on Helicopter Route 4 between Hains Point and the Wilson Bridge when runways 15 and 33 were being used for departures and arrivals, respectively, at DCA. Urgent Safety Recommendation A-25-2 asked the FAA to designate an alternative helicopter route that could be used to facilitate travel between Hains Point and the Wilson Bridge when that segment of Route 4 was closed.

Immediately following the accident, the FAA implemented temporary airspace restrictions around DCA. On March 14, 2025, the FAA removed from helicopter route charts the section of Helicopter Route 4 between Hains Point and the Wilson Bridge. Additionally, the FAA prohibited use of runways 15/33 and 4/22 at DCA during "specific, limited helicopter operations" in the vicinity of DCA. The NTSB responded that these actions exceeded the intent of Safety Recommendation A-25-1 and classified it Closed—Exceeds Recommended Action.

In correspondence dated March 26, 2025, the FAA stated that it would collaborate with stakeholders to develop a new helicopter route connecting the Wilson Bridge to the Anacostia River and would provide updates on the alternative route designation process as it progresses. The NTSB stated that this planned work was responsive to Safety Recommendation A-25-2 and, pending its completion, the recommendation was classified Open—Acceptable Response.

FAA Order JO 7210.3DD listed criteria and procedures for the development and modification of helicopter route charts. One of the listed criteria was, "Care should be exercised to avoid recommending altitudes or flight ceilings/floors which would cause helicopters operating on a designated route to encounter inflight wake turbulence generated by large, fixed-wing traffic." The order stated that Terminal Operations Service Area Directors were responsible for reviewing and approving new or revised helicopter route chart proposals and assuring that they complied with all prescribed criteria. These directors were also responsible for conducting annual reviews of existing VFR helicopter route charts to determine their accuracy and continued utility; however, the FAA was unable to provide documentation of the required annual reviews for the Baltimore-Washington Helicopter Route Chart.

As of the date of this report, no information has been provided regarding annual reviews conducted, including criteria used if such reviews were conducted. The NTSB concludes that annual reviews of helicopter route charts as required by FAA Order 7210.3DD would have provided an opportunity to identify the risk posed by the proximity of Route 4 to the runway 33 approach path, but there is no evidence to support that these reviews were being performed at DCA. The NTSB is concerned that the lack of documentation of annual reviews for the Baltimore-Washington Helicopter Route Chart may be an indication that these annual reviews are not occurring at other locations throughout the NAS. Therefore, the NTSB recommends that the FAA ensure that annual reviews of helicopter route charts are being conducted throughout the NAS as required by FAA Order.

Although the FAA took immediate action following this accident to remove the portion of Route 4 between Hains Point and the Wilson Bridge, the NTSB remains concerned about the potential for other areas of conflict within this airspace. Following the accident, the FAA published a NAS Helicopter Operations Helicopter Route Analysis, which summarized the ATO's safety analysis of domestic airports with charted helicopter routes. Using PDARS, TCAS events, and NMAC data, the FAA reviewed charted routes and high-traffic-volume areas for possible conflicts with traffic patterns and reviewed the descriptions for charted and agreement-established routes. The analysis identified hazards in the airspace encompassing the routes and proposed actions to address priority concerns. This analysis, however, did not include DCA.

The NTSB reviewed PDARS data provided by the FAA regarding encounters between fixed-wing airplanes and helicopters operating on Routes 1 or 4 from January 2018 to February 2025. During this time, there were 4,067 encounters (65.6 encounters per month) in which separation was less than or equal to 1,000 ft and 348 encounters (5.6 encounters per month) in which separation was less than or equal to 500 ft. A heat map depicting the frequency of these events showed several areas where encounters between helicopters and fixed-wing aircraft were concentrated, including the area of the accident site, as well as north of DCA, consistent with encounters with aircraft on approach to runway 19, and south of DCA, consistent with encounters with aircraft on approach to runway 1.

In unofficial correspondence dated January 16, 2026, the FAA reported that it had conducted an in-depth analysis of the helicopter operations within DCA's airspace and made additional changes to the Baltimore-Washington Helicopter Route Chart. As of the date of this report, that analysis has not been provided to the NTSB. Therefore, the NTSB recommends that the FAA conduct an SRM process to evaluate whether modifications to the remaining helicopter route structure in the vicinity of DCA are necessary to safely deconflict helicopter and fixed-wing traffic and provide the results to the NTSB.

In addition, the NTSB recommends that the FAA amend their helicopter route design criteria and approval process to ensure that current and future route designs or design changes provide vertical separation from airport approach and departure paths. Once the criteria and approval process referenced in Safety Recommendation A-26-26 are developed and implemented, review all existing helicopter routes to ensure alignment with these updated criteria.

According to testimony provided by personnel from the FAA's Aeronautical Information Services office during the NTSB's investigative hearing, the routes depicted on a helicopter chart do not have lateral limitations unless explicitly outlined on the chart's route description. The routes were described as "recommended paths" that served to streamline traffic flow and facilitate easier communication between pilots and controllers regarding expected flight paths, reporting points, and area ingress and egress locations. According to the FAA, helicopter routes were not specifically designed to provide separation between helicopters and fixed-wing traffic.

The Baltimore-Washington Helicopter Route Chart included depictions of each helicopter route and associated altitudes; however, it provided inconsistent guidance on route altitudes, showing the depicted altitudes as both “maximum” and “recommended” in the chart legend, textual route description, and additional information sections. The chart did not describe any lateral boundaries associated with the helicopter routes nor were the visual depictions of each route on the chart associated with any specific measurement or scale. The description of Route 4 stated that pilots should fly “via east bank of Potomac River” between the Anacostia River north of DCA and the Wilson Bridge south of DCA. The version of the Baltimore-Washington Helicopter Route Chart effective October 2, 2025, removed language in the route descriptions that stated “All Route Altitudes are Maximum.”

Three pilots from the 12th Aviation Battalion stated in postaccident interviews that they assumed that the published helicopter route altitudes provided separation from the flow of fixed-wing aircraft, and, as long as they remained at or below the published altitude, they would be deconflicted from fixed-wing traffic. In testimony provided at the NTSB investigative hearing, a standardization instructor pilot stated that the battalion did not have written guidance regarding the proximity to the east bank that they were required to maintain, but that “tribal knowledge” was to “hug the shoreline” along this portion of the route unless it was necessary to deviate for traffic avoidance.

Given the low altitudes of the routes, the fact that these route altitudes decreased nearer to DCA, and that the battalion’s LOA with the DCA ATCT required adherence to the published route altitudes, it is understandable that helicopter pilots would conclude that the purpose of the route altitudes was to separate fixed-wing and helicopter traffic; and the FAA provided no warnings or advisories on the helicopter route chart to ensure that they understood this was not the case. The NTSB concludes that the information published by the FAA regarding Washington, DC, area helicopter routes was insufficient to provide helicopter and fixed-wing operators with a complete understanding of the helicopter route structure and its lack of procedural separation from fixed-wing traffic.

Interviews with four DCA-based PSA pilots revealed that only one of the pilots, who was previously a military pilot in the area, had specific knowledge of the helicopter routes, locations, and altitudes. Another pilot was aware that there were helicopter routes but was not aware of their associated lateral or altitude limitations. The other two pilots had no knowledge of the helicopter routes. FAA-published terminal procedures did not contain any information to inform fixed-wing pilots operating at DCA about the presence or location of the helicopter routes, and DCA-specific airport and approach information published by PSA also did not include information about the helicopter routes.

Without this information, fixed-wing pilots were left uninformed of the potential that they may come in close proximity to or conflict with helicopters utilizing visual separation on published helicopter routes underlying the DCA approach and departure corridors. The NTSB concludes that current aeronautical charting does not provide information on VFR helicopter routes that may conflict or come in close proximity to approach and departure corridors, which reduces pilot situation awareness.

Although the flight 5342 crew's awareness of the helicopter routes could not be determined, other PSA pilots interviewed displayed a varying level of knowledge about the routes. Including helicopter route information on approach procedure charts would increase pilot situation awareness of the operating environment and potential risk. Therefore, the NTSB recommends that the FAA incorporate the lateral location and published altitudes of helicopter routes onto all instrument and visual approach and departure procedures to provide necessary situation awareness to fixed-wing operators of the risk of helicopter traffic operating in their vicinity.

2.5 ADS-B and Collision Avoidance Technologies

The accident helicopter was equipped with a transponder that could transmit ADS-B Out information. This capability was tied to the Mode S function of the transponder such that, when Mode S was selected, the helicopter should have broadcasted ADS-B Out information. As of January 1, 2020, all aircraft operating above 10,000 ft msl or in Class B and C airspace are required to transmit ADS-B Out; however, federal regulations exempt DOW aircraft from broadcasting ADS-B Out when performing sensitive government missions.

Due to the routes and landing sites used during the accident flight, the DOW considered PAT25's flight path sensitive and, therefore, the helicopter was not required to be broadcasting ADS-B Out at the time of the accident. Radar data indicated that the helicopter's transponder switched from Mode 3/A and C to Mode S near Cabin John, Maryland, before it proceeded south along the Potomac River about 8 minutes before the accident, but the helicopter was not broadcasting ADS-B Out despite the crew's selection of the Mode S function.

Although the helicopter's CVR did not capture any crew conversation about activating Mode S, it is likely that the crew turned on the transponder's Mode S function before flying south on Helicopter Route 1 toward the high-traffic airspace near DCA in order to provide ADS-B Out data to air traffic control and other aircraft;

however, the crew's activation of Mode S during the flight was contrary to Army SOP, which stated that flight crews should not change transponder modes during flight.

The TAAB commander testified during the NTSB's investigative hearing that the reason for the prohibition on changing transponder modes during flight was due to the amount of "heads down" time required to change the transponder mode; however, the UH-60L operator's manual, as well as testimony by a former TAAB standardization pilot at the NTSB's investigative hearing, indicated that activating Mode S required just two button pushes.

Although the helicopter was not transmitting ADS-B Out, its position and speed were available to the DCA local controller because its transponder was responding to Mode S interrogations, and ADS-B Out information would not have appreciably changed the timing of the conflict alert the controller received before the collision. Flight 5342 was not equipped with ADS-B In, nor was its TCAS II system capable of receiving ADS-B In information as part of its activation algorithm. The NTSB concludes that the lack of ADS-B Out from the accident helicopter did not contribute to this accident, as the helicopter was still being tracked by radar, and ADS-B Out would not have provided improved traffic alerting for the DCA controller or the crew of flight 5342, because the airplane was not equipped with ADS-B In.

Although the lack of ADS-B Out information from the accident helicopter did not change the circumstances of this accident, collision avoidance technologies that leverage ADS-B In information are most effective if all aircraft broadcast ADS-B Out at all times. The NTSB concludes that the Army's SOPs that prevent flight crews from enabling ADS-B Out while in flight, when not performing sensitive missions that require ADS-B to be disabled, limit the visibility of military aircraft on collision avoidance technologies that leverage ADS-B information. Therefore, the NTSB recommends that the DOW PBFA require armed services to amend their operational procedures to allow flight crews to enable ADS-B Out while in flight.

The accident airplane was equipped with TCAS II, and information obtained from the airplane's FDR and CVR indicated that the crew received a TA regarding PAT25 about 20 seconds before the collision, which was within TCAS system alerting specifications. This TA remained active until the collision occurred; however, the crew had been trained not to maneuver based solely on a TA, and their workload at the time they received the TA was high, resulting in limited available capacity to look for and visually acquire the traffic. The TCAS system did not generate a subsequent RA even though the two aircraft continued to converge because TCAS II inhibit logic was designed to suppress RAs below 900 ft agl during descent.

A known limitation of TCAS II is that it often issues RAs during some normal and routine operations, including when visual separation is being applied. The TCAS II RA inhibit altitude threshold was established based on the technological limitations available at the time it was developed to maximize effective alerting while minimizing these types of nuisance alerts.[172]

PSA crews were trained to respond promptly to RAs and maneuver as indicated by the advisory, even if such a maneuver conflicted with ATC instructions. Therefore, it is probable that the crew of flight 5342 would have maneuvered in accordance with the instructions provided by the RA had they received one, which may have prevented the collision. The NTSB concludes that, although the airplane's TCAS operated as designed, it was ineffective in preventing the collision because of current activation criteria and resolution advisory inhibit altitudes.

The NTSB has previously advocated for the FAA to require ADS-B In technology on the basis that equipping aircraft with ADS-B In capability would provide an immediate and substantial contribution to safety, especially near airports. Simulations using the circumstances of this accident reaffirm this conclusion and demonstrate the value of ADS-B In-derived traffic information in improving pilots' situation awareness and supporting earlier identification of potential traffic conflicts.

ATAS is an ADS-B application intended to reduce the number of midair collisions and near midair collisions involving general aviation aircraft. ATAS utilizes ADS-B information to generate verbal alerts indicating the clock position, relative altitude, range, and vertical tendency of proximate traffic.

In this accident, the TA that the flight 5342 crew received consisted simply of the annunciation, "Traffic, traffic." No information about the location of the traffic threat relative to the airplane was annunciated, and the crew would have had to refer to the TCAS display to determine the relative position of the threat before directing their visual scan in the appropriate area. Given the crew's high workload at the time they received the TA, it is unlikely that they performed a focused visual search for the helicopter at this time.

The NTSB performed a simulation to determine how an ADS-B based system capable of providing ATAS-style alerts would have performed in the accident scenario. The simulation indicated that the crew of flight 5342 would have received two alerts concerning PAT25 had it been equipped with such a system. The first aural and visual alert would have occurred 59 seconds before the collision, annunciating, "Traffic, 12 o'clock, low, three miles, descending." A second aural alert would have occurred 35 seconds before the collision, annunciating, "Traffic, 12 o'clock, low, two miles." These two alerts would have occurred 40 and 16 seconds, respectively, before

[172] For more information, see section 1.4.2.1 and footnote 41.

the TCAS TA that the crew received before the collision, providing the crew with additional awareness of the helicopter.

While TCAS TAs provide a verbal annunciation that a potential traffic conflict exists, the annunciations do not include the position and range of the target, requiring the pilot to first refer to the TCAS display inside the cockpit to determine the direction in which they need to direct their visual search. An ATAS-style TA indicating the clock position, relative altitude, range, and vertical tendency of nearby traffic would allow pilots to immediately direct their visual search in the proper direction outside the aircraft. The NTSB concludes that TA aural alerts that include additional information about the location of traffic could reduce the time pilots need to visually acquire target aircraft. The NTSB recommends that the FAA modify ACAS TA aural alerts to include clock position, relative altitude, range, and vertical tendency.

The crew of flight 5342 could have intervened in the accident sequence if they had more knowledge about the level of the threat posed by the traffic that triggered the TCAS TA. While a TCAS display does depict traffic targets, a pilot must monitor the display over time to determine in what direction the target is moving. By leveraging ADS-B In traffic information, an ACAS display can depict the ground track of traffic targets, increasing pilots' awareness of the movements of nearby traffic and providing more timely information to help a pilot determine whether that target may become a collision threat.

The NTSB concludes that had the airplane been equipped with an ACAS that used ADS-B In information to show directional traffic symbols, the crew of flight 5342 would have received enhanced information about the risk posed by the helicopter, which could have enabled them to take earlier action to avert the collision. Therefore, the NTSB recommends that the FAA require existing and new TCAS I, TCAS II, and ACAS X installations to integrate directional traffic symbols.

The helicopter was not equipped with an integrated CDTI, nor was it required to be under current regulations. As previously discussed, the pilot and IP onboard PAT25 had tablets that were capable of displaying ADS-B traffic information from other aircraft and providing visual and aural alerts.[173] A simulation of the ForeFlight CDTI display available on the tablets indicated that the application would have generated a visual and aural alert concerning the airplane at 2047:11, or 48 seconds before the collision. The tablets, which would likely have been strapped to the pilots' thighs, were normally referenced in flight by the pilot monitoring (in this accident, the

[173] Although tablets and other portable traffic-display devices can provide helpful supplementary awareness, they are not a functional substitute for an integrated CDTI within the normal instrument scan or for timely ATC traffic advisories and safety alerts—particularly in complex Class B environments.

IP); however, statements from Army helicopter pilots indicated that it was unlikely that the accident crew were referring to the tablets for traffic information at the time of the accident given the demands of visual, low-level flight at night under NVGs.

Simulator testing indicated that, when using a tablet secured to a thigh, a pilot would be required to divert their attention below a normal scan of the cockpit instruments in order to view the tablet screen. Additionally, the aural alerting that could have been provided by the tablets was not integrated into the crew's helmets and would not have been heard by the crew over the ambient noise inside the helicopter, even if the application had been configured to provide aural traffic alerts. At the time of the accident—and still as of the date of this report—the DOW had no requirement for military aircraft to receive ADS-B In, or to be equipped with any integrated cockpit display of traffic information derived from ADS-B In data. The NTSB concludes that, although the pilot and IP onboard PAT25 were equipped with tablets that had the ability to display traffic transmitting ADS-B Out, it is unlikely that the pilots were using the tablets to monitor or identify traffic at the time of the accident due to the workload associated with low-altitude flight.

The NTSB has investigated numerous midair collision accidents that occurred within controlled airspace or in which air traffic control was in contact with at least one of the involved aircraft. In many of these investigations, the NTSB noted that a CDTI with ADS-B In information would enhance pilots' situation awareness by providing information regarding traffic conflicts that may otherwise go undetected due to the numerous documented limitations of see-and-avoid.[174]

Following the investigation into a midair collision between two air tour airplanes in Ketchikan, Alaska, in 2019, the NTSB issued several safety recommendations to the FAA, asking them to identify areas with a high concentration of air tour traffic and to require that 14 *CFR* Parts 91 and 135 air tour operators that operate within those areas be equipped with an ADS-B Out- and In-supported traffic advisory system that includes visual and aural alerts (NTSB, 2021). We also recommended that the FAA require all aircraft operating within those high density traffic areas, not just those conducting air tours, be equipped with ADS-B Out.

In an October 24, 2023, follow-up letter regarding Safety Recommendation A-21-17, the NTSB emphasized that the absence of an ADS-B In requirement for Part 135 passenger-carrying operations fails to take advantage of the demonstrated safety benefit of ADS-B In traffic awareness and alerting and is inconsistent with the "appropriate level of public safety" the FAA itself expects for operations in which passengers bear no responsibility for the aircraft's operation (NTSB, 2023). In a

[174] Examples include ERA09MA447, CEN19MA141AB, ANC20LA074, ERA22FA318, CEN22FA081, and ERA23FA142.

response dated November 2024, the FAA stated that they had determined that "current ADS-B requirements continue to adequately address the needs of aviation safety," and that they would "not pursue additional ADS-B operator requirements at this time" (FAA, 2024f).

During the NTSB's investigative hearing for this accident, the FAA ATO's acting deputy COO stated that the agency supported requiring that newly manufactured aircraft in the United States be equipped with ADS-B In. He also stated that the agency supported requiring that aircraft operating in airspace where they are required to transmit ADS-B Out also be required to install and operate ADS-B In.

The circumstances of this accident illustrate that the additional information provided by an ACAS system supplemented with ADS-B In information, including ATAS alerts and directional traffic displays, further enhance the safety benefit provided by ACAS. For all pilots, ADS-B In information provided on a CDTI with alerting that is audible to the pilot would provide critical situation awareness to help mitigate the risk of midair collisions, even if their aircraft are not equipped with an ACAS.

To take full advantage of the safety benefits provided by ADS-B, the NTSB recommends that the FAA require all aircraft operating in airspace where ADS-B Out is required to also be equipped with ADS-B In with a CDTI that is configured to provide alerting audible to the pilot and/or flight crew. To provide the same situation awareness advantages to military flight crews, the NTSB recommends that the DOW require all military aircraft operating in the NAS be equipped with ADS-B In with a CDTI that is configured to provide alerting audible to the pilot and/or flight crew, and that such requirement apply wherever in the NAS the FAA requires any aircraft to operate with ADS-B Out.

Advances since the development of TCAS II standards allow ACAS X, the next generation of airborne collision avoidance systems, to provide improved alerting. Among other enhancements, ACAS X systems utilize ADS-B In information in addition to transponder interrogations, and include improved algorithms to more accurately reflect actual collision risk.

A series of simulations conducted using the circumstances of this accident showed that the crew of flight 5342 would have received a TA about 8 seconds earlier if the airplane had been equipped with ACAS Xa, an ACAS X variant for airplanes, even though ADS-B information from the helicopter was unavailable. However, although ACAS Xa can deliver earlier and more accurate alerts than TCAS II, the current RA inhibit altitudes under ACAS Xa are the same as those of TCAS II, and would also have prevented ACAS Xa from issuing an RA under the accident circumstances. The results of the simulation indicated that the risk of an NMAC was reduced by more than 90% when the ACAS Xa logic was modified to allow RAs down to 300 ft because it is possible that the crew would have taken the action prescribed by the RA to avoid the collision.

The NTSB concludes that technological advances since the development of TCAS II operating standards may allow ACAS Xa with reduced inhibit altitudes to have an expanded alerting envelope while reducing nuisance alerts. Furthermore, the NTSB believes that ACAS X, as the standard is currently defined, would improve the safety of aircraft that are currently required to be equipped with TCAS. Therefore, the NTSB recommends that the FAA require the use of the appropriate variant of ACAS X on new production aircraft that are subject to TCAS equipage regulations and that the FAA require existing aircraft that are subject to TCAS equipage regulations be retrofitted with the appropriate variant of ACAS X.

Given the results of the TCAS and ACAS X simulation study, which showed a significant reduction in the risk of an NMAC when the RA inhibit altitude was lowered, the NTSB also recommends that the FAA evaluate the feasibility of decreasing the TA and RA inhibit altitudes in ACAS Xa to enable improved alerting throughout more of the flight envelope. If the FAA's evaluation resulting from Safety Recommendation A-26-34 finds that the inhibit altitudes can be safely decreased, the NTSB further recommends that the FAA require retrofitting of the applicable ACAS X variant incorporating the reduced TA and RA inhibit altitudes on all aircraft that are subject to TCAS and equipage regulations.

The ACAS simulations using the circumstances of this accident also showed that, had the helicopter been equipped with ACAS Xr, a version of ACAS X that is still under development and intended specifically for rotorcraft, the risk of an NMAC was reduced by more than 50%, with no changes to the TCAS or ACAS Xa inhibit altitudes. This information would have been provided to the crew via a cockpit display that would have been part of their normal instrument scan and also would have provided aural alerting integrated with the helicopter's internal communications system. Therefore, the NTSB concludes that, although not yet commercially available, had the helicopter been equipped with ACAS Xr with integrated aural alerting, the crew could have received an alert regarding flight 5342 and could have taken action to avert the collision.

Given the significant reduction in the risk of an NMAC as shown in the simulations when the helicopter was equipped with ACAS Xr, the NTSB recommends that the RTCA Program Management Committee finalize and publish the minimum operational performance standards for ACAS Xr for rotorcraft. The NTSB also recommends that the FAA require that all rotorcraft operating in Class B airspace be equipped with ACAS Xr technology once the ACAS Xr standard has been published.

2.6 Safety Management Systems and Safety Data

2.6.1 Indicators of Midair Collision Risk

Multiple safety occurrence reporting systems contained reports from pilots and controllers about close calls between airplanes and helicopters in the vicinity of DCA in the years before the accident, some of which included airplanes on approach to runway 33.[175] Several of those reports described issues similar to those found in this investigation, including airspace complexity, problems with ATC communications, challenges associated with combining helicopter and local control positions, and helicopters flying above recommended altitudes. An ASIAS review of ASAP reports filed by pilots from February 2020 through October 2024 found 85 reports, or about 18 reports per year, that contained information on close calls between helicopters and airplanes near DCA.[176]

Reports of close calls near DCA were also found in other safety occurrence reporting systems, including ATSAP, ASRS, NMACS, and MORs. Although it is possible that some of the reports in these systems described the same events, it is reasonable to conclude that there were more than 18 close calls per year, or more than 1 close call per month on average, reported in the 4 years before the accident.

Safety occurrence reporting systems rely on subjective self-reports with varying submission criteria and are therefore unlikely to capture all safety events (Dy and Mott, 2024).[177] By comparison, objective aircraft position data, such as TCAS RA data captured by ground-based receivers, indicated that there were about 15 TCAS RAs per month, on average, within 10 nm of DCA between April 2023 and March 2025.

ARIA data showed that airplanes and helicopters came within 1 nm laterally and 400 ft vertically 390 times per month, on average, between October 2021 and December 2024. PDARS data identified an average of 5.6 instances per month between 2018 and 2025 in which helicopters flying on Routes 1 or 4 came within 500 ft of airplanes arriving or departing DCA.

[175] These included an NMAC (1070511144 in the NMAC database) for the May 2013 near miss between an airplane and a military helicopter that was the catalyst for the formation of the HWG at DCA ATCT; an ASRS report from July 2015 that involved a near miss between an airplane on a circling approach to runway 33 and a helicopter (ACN 1283693); and an ASRS report from June 2013 in which an airplane on the River Visual approach to runway 19 received a TCAS RA due to a helicopter passing below (ACN 1095485).

[176] The term "close calls" is defined in footnote 73.

[177] Additionally, pilots may not be aware of close proximity events or may have been successfully applying visual separation, which would not result in safety reporting in instances when objective measures indicated close proximities.

Some objective measures of aircraft proximity that were examined after the accident were not used for safety assurance before the accident occurred. For example, postaccident review of PDARS radar-based data identified close encounters between aircraft in the vicinity of airports and revealed instances of helicopters flying above maximum route altitudes; however, the FAA had not previously used those data to track such metrics. Additionally, ARIA proximity data and TCAS RA data from ground-based receivers were available to ASIAS, but those data were also not actively monitored by ASIAS or widely available before the accident.[178]

The Army and PSA had varied knowledge of and limited access to safety data systems. The Army did not participate in ASIAS, did not request FAA data, and did not routinely use information that the FAA made publicly available. The Army did not have a robust safety occurrence reporting system, nor did it collect and aggregate safety data from its helicopters. PSA had an SMS, as required by 14 *CFR* Part 5, and participated in the ASIAS program. Although PSA reported reviewing safety occurrence reports from its pilots and FOQA-based TCAS data provided by the ASIAS program, PSA did not have access to objective proximity data from PDARS or ARIA. As a result, their safety assurance and safety risk management processes did not identify a heightened risk of midair collision at DCA.

The FAA ATO had access to many sources of data, including ASIAS, PDARS, ARIA, ATSAP, MORs, ASRS, and NMACs, as well as limited access to ASAP and TCAS RA information. Although the ATO reported that they reviewed a large number of data sources as part of their safety assurance process, they also did not identify the risk of a midair collision between helicopters and fixed-wing traffic at DCA. In the investigative hearing, FAA officials acknowledged that the ATO had missed these indicators of risk.

The ARIA system was designed specifically to use objective criteria to automatically identify air traffic operations that represented potential safety risks and generate reports known as preliminary ARIA reports, or PARs (discussed previously in section 1.14.3.2). However, ATO's subsequent reviews of PARs were subjective and largely focused on regulatory compliance rather than potential risk. For example, ARIA generated 874 PARs for the area surrounding DCA between June 2022 and May 2025, but ATO classified none of them as NMACs, even though pilots and controllers made multiple reports of close calls during that period.

Additionally, the safety group manager for the FAA's Eastern Service Area noted that their Quality Assurance Office reviewers did not normally search for

[178] TCAS TA and RA data were available through an operator's FOQA and could have provided useful information, but those data are proprietary and only represented information from, and were only available to, operators who participated in ASIAS.

voluntary reports and acknowledged that "from one validator to another, or from somebody that's looking at that report, their perception of what is the possibility of collision may be different." As a result of these subjective reviews, potentially valuable objective risk-based safety data were not tracked. The NTSB concludes that multiple data sources provided evidence of midair collision risk between fixed-wing aircraft and helicopters at DCA, including on approach to runway 33, before this accident; however, the limited access to and use of available objective and subjective proximity data hindered industry and government stakeholders' ability to identify hazards and mitigate risk.

In its Safety Risk Management Policy, the FAA recognized the value of objective data, stating, "While any data is better than no data, when available, analytical data is preferred, followed by empirical, and finally, judgmental. This is due to the margin of error associated with each type of data. Analytical data typically has the lowest margin of error; the margin of error of empirical data can be controlled by sample size; and judgmental data has the largest margin of error due to human biases and subjective experience" (FAA, 2023d).

Since the accident, the FAA ATO has used objective proximity data to identify areas of potential conflict between airplanes and helicopters in the NAS. It conducted a helicopter route analysis using multiple data systems to count "close proximity" events with objective measures based on parameters such as vertical/horizontal proximity, slant range, or time to contact. In addition to identifying near midair collisions, analyses of objective proximity data can identify areas of high traffic density and potential routing conflicts, and depict areas with a high concentration of encounters involving distances less than those provided by standard IFR separation, which could have shown evidence of the dependence on visual separation to manage traffic in the DCA airspace before the accident.[179]

Although there is value in using multiple data sources to understand a problem, the lack of standard proximity metrics or indexes to signify when aircraft are "too close" results in difficulty comparing the risk levels of different locations or tracking the incidence of events over time. The NTSB concludes that improving stakeholder access to standardized and objective information about aircraft close proximity encounters for use in safety assurance processes would increase the likelihood of detecting and mitigating hazards before accidents occur.

Therefore, the NTSB recommends that the FAA create an objective definition of close proximity encounter and a public database of those encounters and their

[179] During the investigative hearing, the FAA ATO acting deputy COO cited the dependence on visual separation between helicopters and IFR traffic at DCA as an example of risk that was missed prior to the accident.

locations that can be used to monitor their prevalence and identify areas of potential traffic conflict for safety assurance and safety risk management.

2.6.2 Safety Information Sharing

Most of the stakeholder groups involved in the investigation described internal processes for evaluating and addressing safety occurrence reports. That the midair collision between PAT25 and flight 5342 occurred despite these reported activities raises the question of why they did not lead to more meaningful risk mitigations at DCA. Some evidence suggests that safety occurrence reports were used at DCA tower to identify hotspots, including a hotspot in the same location as the midair collision, and propose changes to helicopter route charting through the SRMP process; however, these efforts met with resistance from the ATO, yielding little success.

The investigation also revealed that, although helicopters routinely triggered TCAS RAs for airplanes on approach to DCA and were the subject of many voluntary pilot reports, helicopter operators were largely unaware of their involvement in these events. Upon learning of its involvement in TCAS RA events involving airplanes on approach to DCA, one helicopter operator made changes to its SOPs to help mitigate such events. Additionally, an Army representative stated in the investigative hearing that learning of Army helicopter involvement in TCAS RAs would be valuable for risk mitigation.

FAA regulations (see 14 *CFR* Part 5.57) state that, if a hazard is identified through an operator's SMS, that operator must provide notice to anyone involved that could address the hazard or mitigate the risk. Additional guidance in FAA Order JO 1000.37C states that safety promotion activities include actively sharing safety-related information with other external parties, such as industry stakeholders, air navigation service providers, and other federal agencies.

Despite this guidance, this investigation revealed that reviews of close proximity events around DCA appeared to have occurred in isolation rather than involving all relevant parties. For example, preliminary ARIA reports were only reviewed by FAA ATO Quality Assurance Office staff and did not incorporate the operators involved in the events. PSA Airlines reported reviewing TCAS RAs involving its aircraft, but noted that there was often a delay of several months between the occurrence and the review. Additionally, PSA relied on CISP or the FAA to identify other aircraft that triggered TCAS RA activations on PSA aircraft.

When two TCAS-equipped aircraft come into conflict, both aircraft receive RAs that alert the pilots and are captured on flight data recorders. However, when a TCAS RA is triggered by an aircraft without TCAS, the pilot of the unequipped aircraft may never become aware of the event. If timely steps are taken to identify the threat aircraft, the pilots or operators can be notified of their involvement in the event. However, as this investigation showed, it may be difficult to identify aircraft that triggered TCAS RAs if not attempted until months or years after the event, particularly if they are not broadcasting ADS-B Out.

The NTSB concludes that the FAA's lack of an established process to inform parties about their involvement in events such as NMACs or TCAS RAs reduces the likelihood of fully understanding and mitigating future midair collision risk. Therefore, the NTSB recommends that the FAA develop and implement a process that will, in a timely manner, notify involved parties after events such as NMACs or TCAS RA activations, such that notification occurs while relevant data remain available and before meaningful safety analysis, reporting, or corrective action is no longer practicable.

2.6.3 FAA Air Traffic Organization Safety Management System

2.6.3.1 Safety Risk Management and Safety Assurance

At the time of the accident, the FAA had an established SMS for several of its organizations, including the ATO and ATO facilities (such as DCA ATCT). FAA policy required that each organization establish and maintain each of the four components of SMS—safety policy, safety risk management, safety assurance, and safety promotion. However, despite the ATO's established and well documented safety policy, this investigation indicated significant gaps in its safety risk management, safety assurance, and safety promotion processes and procedures.

FAA guidance for SMS implementation clearly establishes responsibility and requirements for operators and external service providers to coordinate safety risk management and safety assurance activities with external parties to collect and share safety hazard information and monitor safety risk controls. For example, the FAA stated that airport operators, tenants, and users should coordinate SMS efforts to the fullest extent possible, and that a method of data sharing and reporting among the separate SMSs be included in the safety risk management process. The FAA also required that ATMs coordinate with local airport operators to increase awareness and understanding of local operations and safety challenges, including convening conferences to discuss and clarify operations.

By contrast, the FAA ATO Order on identification and mitigation of hazards at the local level does not require external stakeholder involvement. Participation is limited to bargaining unit representatives and management at FAA air traffic facilities (FAA, 2020b). Although the 2021 GAO report called on the FAA to develop a mechanism to exchange information with operators in the DC area, there was no formal process in place at DCA for operators and the FAA to share information about helicopter route traffic, TCAS RAs, or potential traffic conflicts.

In the absence of a formal process, formation of HWGs in the Washington, DC, area demonstrated recognition by local controllers and operators of safety risks and attempted coordination of the diverse helicopter operations in the DCA Class B airspace. However, these groups were described as informal, did not include a mission statement or statement of work, and their attempts to recommend changes were met with resistance from, and little action by, the ATO.

As an example of informal collaboration, the DCA ATCT HWG identified areas of increased collision risk between airplanes and helicopters, and proposed changes to the charted helicopter route and zone altitudes to mitigate those risks. One of the proposed changes included relocating or eliminating the section of Route 4 adjacent to DCA due to the risk posed by the proximity of that route to fixed-wing approach and departure paths. A near midair collision between a military helicopter and a regional jet in 2013 (which occurred in the same vicinity as this accident) was the catalyst for this initial proposal, and the DCA ATCT HWG (see section 1.6.3.1) made additional recommendations to move Route 4 in the years after; however, members of the group recalled a lack of feedback from management at higher levels within the ATO regarding why their suggestions to move or eliminate Route 4 were not adopted.

The group also proposed the addition of "hotspots" to the Baltimore-Washington Helicopter Route Chart to highlight areas that posed an increased risk of potential conflicts between airplanes and helicopters to increase pilot and controller vigilance in those areas. However, the FAA also rejected the proposal to chart these hotspots because "hotspots are associated with ground or surface movement and are not within the VFR aeronautical chart specification."

The HWG comprised DCA ATCT controllers—the individuals most familiar with the flow and separation of helicopter and fixed-wing traffic around DCA and with the greatest insight into its vulnerabilities and areas of highest risk; however, the FAA repeatedly failed to act on proposals provided by the group and rejected changes that would have raised pilot awareness of areas of increased midair collision risk and increased separation between Helicopter Route 4 and fixed-wing approach and departure paths.

In addition, the investigation did not identify evidence showing that the ATO conducted annual, documented reviews of helicopter route charts in the Washington, DC, area as required by FAA Order JO 7210.3DD. Further, review of FAA data programs did not indicate that the ATO routinely used available data to evaluate separation risk between fixed-wing traffic and helicopter operations at congested airports, including DCA.

The NTSB concludes that, given their access to a wide range of data sources and information, the FAA ATO was made aware of, and had multiple opportunities to identify, the risk of a midair collision between airplanes and helicopters at DCA; however, their data analysis, safety assurance, and risk assessment processes failed to recognize and mitigate that risk. The NTSB further concludes that the FAA ATO's application of its safety management system did not effectively coordinate safety assurance and safety risk management activities with external stakeholders in the DCA Class B airspace.

The FAA established the AOV (see section 1.12.3) in 2004 as the safety oversight authority to ensure effective and independent safety oversight of ATO and to enforce safety regulations related to air navigation services, including ATO SMS functions (FAA, 2024a). However, in December 2025, the FAA Administrator announced that the FAA was implementing a single, agencywide SMS, stating in testimony before the House Committee on Transportation and Infrastructure's Subcommittee on Aviation, "This unified approach will help the FAA detect, analyze, and mitigate risk more consistently and ensure that lessons from accidents, incidents, and near misses are acted upon quickly across the agency" (FAA, 2025f). Additionally, in a document titled "FAA Flight Plan 2026" the agency stated its intent, as part of creating one FAA SMS, to establish a Safety Integration Office and implement an FAA-wide safety risk management process (FAA, 2026).

Therefore, the NTSB recommends that the US DOT Office of Inspector General complete an audit of the FAA ATO's SMS functions and data sharing activities at all air traffic control facilities and determine whether these activities are conducted in collaboration with all relevant external stakeholders, ensuring that the audit's results are documented, reported to the Secretary of Transportation and the FAA Administrator, and made available to the public. Additionally, the NTSB recommends that the FAA, based on results of the audit, ensure that all SMS functions and data sharing activities at all air traffic control facilities are conducted in collaboration with all relevant external stakeholders.

At the NTSB's investigative hearing, the DCA ATCT OM at the time of the accident testified that controllers would routinely compensate for the conditions provided by reduced MIT spacing and compacted demand times by "making it work," and using "all available tools." The "make it work" mindset had become normalized and "routine" at DCA ATCT.

Although processes were in place to conduct risk assessments of hazards at the facility level, existing procedures did not provide robust guidance to assist controller and supervisor risk assessment and decision making in real-time, day-to-day operations. For example, the DCA ATCT SOP contained a list of seven factors that an OS should consider when deciding to combine or de-combine the HC position but did not provide additional information on how to effectively evaluate the impact of those factors on the control position(s).

Changes to the DCA ATCT SOP in 2023 removed the requirement for the OS to document the time and reason for combining or de-combining the HC position in the facility log. Requiring this information to be recorded made it more likely that the OS would consider and evaluate the risks associated with combining or de-combining the position under the existing operational and environmental conditions, and it is likely that the removal of this requirement normalized combining the positions without a thorough evaluation of the associated risk factors. Maintaining this record could also provide background information for safety assurance processes to determine whether the positions were being combined and de-combined appropriately.

The NTSB concludes that changes to DCA ATCT's SOPs prior to the accident removing the requirement for the OS to document the time and reason for combining or de-combining the HC position in the facility log made it less likely that the OS would consider and evaluate the risks associated with combining or de-combining the position.

Because operational position-combining decisions are made routinely at towers throughout the NAS under time pressure and with similarly limited documentation requirements, establishing a standardized, nationwide requirement to record the time and rationale for combining or de-combining positions would strengthen real-time risk-based decision making and provide consistent safety assurance inputs across facilities. Therefore, the NTSB recommends that the FAA establish a requirement across all ATCT SOPs that the OS or CIC document in the daily facility log when any control position is combined with the LC position, or when the OS/CIC position is combined with a control position, along with a rationale for doing so.

A number of hazards existed within the DCA ATCT at the time of the accident. Nighttime operations reduced visibility and made identification of aircraft more difficult; traffic volume was increasing with reduced MIT, which increased controller workload and required the use of runway 33 to build additional spacing; helicopter traffic was present; and the HC and LC positions were combined, which increased workload for the LC and ALC controllers.

The DCA ATCT SOP stated that the OS was responsible for maintaining situation awareness of the operation, providing assistance to controllers, and deploying available resources for optimal efficiency; however, there was no guidance provided by the ATO or the ATCT SOP that would have assisted the OS in assessing, anticipating, or alleviating controller workload. Because concerns about potential conflicts between airplanes and helicopters had been identified in previous ECVs at the tower facility, the night conditions, helicopter traffic on Route 4, and use of runway 33 at the time of the accident should have raised an additional level of awareness and vigilance, particularly on the part of the OS, as all of those factors increased the likelihood that an airplane and helicopter may come in close proximity. However, the guidance available to the OS was insufficient to help him evaluate these factors and apply operational risk management in a manner that could have more effectively mitigated these hazards.

It is apparent that controllers in the DCA area were under pressure to accommodate more traffic volume and, in response, developed their own methods of traffic management in order to maintain operational efficiency. A functional SMS should have identified and addressed these locally accepted operational practices, the “make it work” mentality described by controllers, and the lack of a robust process for day-to-day risk assessment and mitigation. The NTSB concludes that safety risk management practices were not fully integrated into DCA ATCT operations and did not identify or mitigate the operational challenges faced by controllers or the lack of guidance regarding operational risk assessments for controllers and supervisors.

2.6.3.2 Safety Promotion and Positive Safety Culture

According to ICAO, safety promotion is how an organization builds and sustains a positive safety culture and the foundation for an effective SMS. It does this by actively communicating safety information, policies, priorities, and lessons learned. The goal is to ensure that everyone understands their shared responsibility for safety, feels supported by leadership, and has the awareness, tools, and motivation to manage safety risks effectively. During the investigative hearing, the ATO acting deputy COO stated that there was no formal SMS training for controllers, though he believed that facility management would be familiar with the *ATO SMS Manual*.

Ensuring that every employee is familiar with their organization’s SMS through training and consistent, transparent communication is essential for building trust and collaboration. FAA AC 120-92D stated that organizations are required to provide initial safety training for employees so that they can perform their SMS-related duties, and that recurrent training may be necessary to maintain employee competencies. The FAA’s previously discussed failure to deliver recurrent TEM training highlights a missed opportunity to reinforce controllers’ abilities to recognize and mitigate hazards, which are critical skills that they can apply not only in their day-to-day duties of managing air traffic, but also in providing feedback through established safety reporting systems to foster continuous improvement of the SMS.

At the facility level, ATO utilized and encouraged use of formal safety reporting systems, such as ATSAP, to collect safety concerns from tower personnel without fear of punishment. However, the practice of a just culture was not consistently followed by ATO management. Interviews with some ATO staff indicated that there was a fear of retaliation for raising safety issues, and some individuals would only speak to investigators because they were close to retirement or had retired. An air traffic safety specialist, who would not speak to investigators until after her retirement was finalized, discussed multiple occasions where mandatory reporting events went unreported as well as harassment for pushing back on unsafe practices.

Following this accident, DCA ATCT management personnel were reassigned, an action that appeared inconsistent with the characteristics of a positive safety culture defined by the ATO acting deputy COO. During the NTSB's investigative hearing, ATO management witnesses had to be separated from subordinate witnesses due to concern that answers were being influenced due to their close proximity. Organizations involved in the investigative hearing were asked to confirm that there would not be any retaliation against the witnesses participating in the hearing, and all affirmed this commitment. Additionally, interviews with current and former DCA ATCT personnel indicated that morale had been low for years before the accident due to the 2018 facility level downgrade and the FAA's lack of transparency regarding the metrics used to support that decision.

DCA ATCT controllers were familiar with the ATSAP program for reporting safety concerns. As previously discussed, between January 2011 and August 2023, a total of 520 ATSAP reports (approximately 40 reports per year) were filed related to DCA, supporting controller statements that they felt comfortable reporting safety concerns through the system. If a safety concern did not warrant filing an ATSAP report, controllers stated they also felt comfortable expressing their concerns to facility management.

Although there were multiple indicators of the risk of a midair collision in the DCA airspace from numerous objective and subjective data sources, such as ATSAP, ASRS, MORs, ARIA, and NMACs, these risks were not identified by ATO safety assurance processes. The FAA also lacked an established process for informing parties about their involvement in NMACs and TCAS RAs. Without adequate awareness that such risks exist, ATO and parties were unable to take adequate mitigations and the DCA airspace remained vulnerable to the risk of a midair collision.

Although traffic flow volume and management issues had been longstanding challenges at DCA, ATO management did not adequately respond to concerns expressed by frontline personnel. For example, suggestions from personnel who were involved in efforts to reduce DCA's AAR were often met with resistance and a lack of communication from ATO management. Instead, controllers were required to adopt a "make it work" mindset and compensated for these conditions by relying on mitigations such as extensive use of pilot-applied visual separation and offloading arrivals to runway 33. Potomac TRACON personnel stated that they also employed workarounds for dealing with the high volume of traffic in the DCA airspace. Proposals from the DCA ATCT HWG to move Route 4 and add “hotspots” to the helicopter route chart were rejected despite their identification of risks in these areas.

Finally, on numerous occasions during the course of this investigation, the FAA failed to provide the NTSB with requested investigative information, even after agreeing to do so, or provided incomplete responses to information requests.

The lack of flexibility in adapting procedures to changes in air traffic, the dismissal of safety improvements suggested by frontline personnel, the fear of retaliation expressed by some former employees, and the ATO’s actions following this accident all suggest an organization that does not embrace the principles of open communication, just culture, and continuous improvement inherent to a positive safety culture. The NTSB concludes that FAA ATO management did not follow the tenets of SMS to support its workforce, encourage open communication, identify and mitigate risks, or foster a just culture, which eroded the overall safety culture within the ATO.

The NTSB recognizes that the FAA’s postaccident initiative to introduce a single, agencywide SMS presents an opportunity to identify and correct inconsistencies between ATO SMS guidance and its other SMS policies and guidance. Therefore, the NTSB recommends that the Secretary of Transportation work with the FAA Administrator to convene an independent panel to conduct a comprehensive review of the safety culture within the FAA’s ATO, and use the findings to enhance the ATO’s existing SMS and integrate it into all levels of the organization.

2.6.4 US Army Safety Assurance

Although helicopters and airplanes had routinely experienced close encounters in the DCA area, the organizations involved appeared to lack awareness of how common such encounters were, or the safety-related implications. Aside from the DCA ATCT controllers who recommended the relocation of Helicopter Route 4 away from the runway 33 approach path, neither the FAA nor the Army was effectively monitoring the risk of a midair collision between military helicopters and civilian fixed-wing aircraft in the area.

The NTSB’s review of the Army’s safety management processes revealed deficiencies in safety assurance that were not in compliance with DOW requirements and that left the Army unaware of the potential for a midair collision in the DCA area (DOD, 2019b). For example, the Army lacked a flight data monitoring program that could have detected deviations above the published altitudes on Route 4. Flight data monitoring programs have been used by commercial operators, manufacturers, and the FAA to identify, evaluate, and monitor the risks of specific categories of accidents and to design and implement safety enhancements to mitigate such risks; however, these programs depend on the collection of relevant operational data, which the Army was not collecting.

Flight data monitoring programs analyze data from a variety of sources, such as flight recorders, dedicated quick access recorders, and ADS-B. If Army safety professionals had been analyzing operational data from its helicopters, it is likely they would have identified altitude exceedances on the helicopter routes adjacent to DCA and would have taken steps to understand why the exceedances were occurring at such a high rate. This may have also raised their awareness about cumulative errors in the UH-60's barometric altimetry system, and the lack of compatibility between the narrow acceptable range of operating altitudes on Route 4 and the acceptable range of error in the barometric altimeters.

The NTSB concludes that the Army did not have a flight safety data monitoring program for helicopters, and as a result, was unaware of routine altitude exceedances and related risks in the DCA terminal area. Given the density of civil air traffic in close proximity to the helicopter routes, this was an unacceptable oversight. Class B airspace surrounds the busiest airports in the country used by passenger-carrying airlines. The Army must take extraordinary care that it does not routinely introduce unacceptable risk to civil aircraft operations in such areas.

A 2020 report from the National Commission on Military Aviation Safety found that, if all military services fully employed FOQA, LOSA, and ASAP programs, "the DOD and services would have an invaluable collection of data that would support the development of predictive analysis safety programs" (National Commission on Military Aviation Safety, 2020). Therefore, the NTSB recommends that the Secretary of the Army establish a flight data monitoring program for rotary-wing aircraft the US Army operates in the NAS.

Another limitation in the Army's safety assurance capability was the absence of a mature, front-ine incident reporting program capable of capturing first-hand accounts of close encounters between aircraft. The Army's framework for hazard identification, reporting, and analysis consisted of OHRs and the ASMIS "mishap and near miss reporting" module; however, participation in these programs was limited, and they had not yet matured into full operational use.

The TAAB safety manager stated that ASMIS 2.0 was being used to record monthly inspection results, mishaps, and near-misses, but described these as company-level safety inputs rather than individual pilot submissions. TAAB pilots similarly described company safety officers as responsible for most safety paperwork and data entry. Pilot interviews gave no indication of flight crew-initiated OHRs, and no interviewee described pilots directly logging events in ASMIS.

According to the brigade safety manager, no ASMIS near-miss reports or OHRs related to NMACs between aircraft had been filed, and no OHRs had been filed about NMACs in the DCA area. The brigade safety manager stated that no OHRs had been submitted by brigade pilots for any reason in the year preceding the accident. This low utilization could explain, in part, the Army's lack of awareness about the prevalence of close proximity events in the DCA area. The NTSB concludes that the Army's safety reporting systems for pilots were not well utilized and did not provide the organization with information about close encounters between Army helicopters and other aircraft that were later found to have occurred frequently.

Given the number of close encounters between helicopters and fixed-wing aircraft in the DCA area revealed by postaccident analysis of safety data, the NTSB believes that it is important for the Army to improve its capability in this area. Interviewed pilots did not offer reasons for their lack of utilization of the safety reporting systems. Research literature suggests that common reasons for underreporting cited by pilots include the effort required to file a safety report, concern over negative consequences, and disbelief that safety reporting will lead to safety improvements (Haslbeck, Schmidt-Moll, and Schubert, 2015, 596-601).

Such barriers might be addressed by reducing the effort required to file a report, cultivating a supportive ("just") culture, or providing feedback to pilots about changes resulting from safety reports. The first step in addressing this issue would be for the Army to identify the specific reasons for the low utilization of safety reporting systems among its pilots. Therefore, the NTSB recommends that the Secretary of the Army survey US Army helicopter pilots to identify barriers to the utilization of flight safety reporting systems, develop a plan to address the identified barriers, and implement that plan across Army aviation units.

The deficiencies noted above likely existed because the Army had yet to fully implement best practices for safety management. Based on testimony from the TAAB commander during the investigative hearing, TAAB was in the beginning stages of implementing the Army's version of SMS (ASOHMS) and had not yet reached the point where it was focused on the development of effective safety assurance capabilities.

The Army's slow progress in implementing ASOHMS could stem from several causes. First, responsibility for different aspects of safety management was widely distributed across various Army organizations. Second, the program was designed to address the full range of safety issues that a commander might seek to manage, both on- and off-duty, not only safety of flight operations. Third, the Army encountered resource issues, as evidenced by comments made at the NTSB's investigative hearing by the director of the Data Analysis and Prevention Directorate that the military flight operations quality assurance mandate was unfunded. Fourth, TAAB safety personnel indicated that staffing was an issue.

Until shortly before this accident, TAAB had only one full-time safety manager, who was responsible for five battalions and a variety of different functions. Due to his broad range of responsibilities, only half of his time was available for working on flight safety issues, and only a portion of that time was spent specifically on helicopter safety. The 12th Aviation Battalion safety officer, who was also a pilot, spent about 75% of his time on ground safety and occupational health matters and 25% on aviation safety. B Company's safety officer, also a pilot, estimated that 80% of his time was spent on occupational health and safety matters. By comparison, a Part 121 airline typically employs several individuals working full-time on flight safety management-related functions.

A 2023 GAO study of Army National Guard helicopter units found that workload and staffing imbalances hindered the scope of safety officer efforts in the Guard's aviation units. Safety officers interviewed by the GAO described struggling to address the broad scope of their ground and flight safety responsibilities and their roles as pilots. This impeded their ability to do such things as "coordinating with other safety organizations; using data systems to perform hazard analysis; communicating with unit personnel for aircraft-specific insights; and overseeing the quality of hazard and accident reporting processes." Evidence from this investigation suggests that TAAB and the 12th Aviation Battalion faced similar challenges with safety-related staffing and workload allocations.

At the NTSB's investigative hearing, the director of safety and occupational health for the US Army Secretariat acknowledged the existence of these challenges and said that the Army was updating its "manpower evaluation" model to address the issue. Although updating the manpower evaluation model was an annual requirement, past updates did not result in adequate safety staffing. The NTSB concludes that the Army's process for allocating resources to aviation safety management did not ensure the development of a robust SMS for helicopter operations in the Washington, DC, area.

This accident demonstrates the importance of having the capability for, at a minimum, implementing safety assurance processes to monitor the safety of Army aviation operations in densely utilized airspace with a high concentration of commercial air traffic. Therefore, the NTSB recommends that the Secretary of the Army revise the method for allocating resources to ensure the development of a robust SMS that will, at a minimum, identify and monitor the potential for midair collisions between Army aircraft and civil air traffic operating in the NAS.

2.6.5 US Army Safety Culture

Our investigation identified several characteristics of the Army's safety culture relevant to this accident.

Just culture: At the operational unit level (brigade and battalion), investigators found evidence of a generally non-punitive and non-repressive safety climate. Frontline personnel reported feeling comfortable expressing safety-related concerns to safety officers and to their chain of command. The absence of a repressive climate did not appear to be a limiting factor in safety information flow.

Reporting culture: Although formal safety reporting systems existed, including OHRs and ASMIS near-miss reports, their utilization by flight crews was low. As a result, the organization had limited visibility into emerging operational risks, including the frequent close proximity of helicopters to jet aircraft arriving at DCA. This gap reflects a reporting culture that was formally established but not functionally embedded in routine operations.

Informed culture: The Army's ability to maintain an informed understanding of operational risk was constrained by organizational structure and priorities. Safety professionals who might otherwise analyze safety reports and operational data were largely consumed by ground safety and occupational health responsibilities mandated at the Army level. In combination with the low volume of flight safety reports and the absence of flight data monitoring capability, these constraints limited the organization's capacity to synthesize available information and maintain awareness of hazards, such as routine altitude exceedances on Washington, DC, helicopter routes.

Flexible culture: The Army's safety system lacked the structural flexibility and analytical capability necessary to adapt its safety focus in response to changes in the operational environment. Consequently, safety oversight did not adjust to the increasing density of aircraft arrivals at DCA, the reliance on visual separation to maintain traffic flow, or the infrequent use of runway 33, which made encounters between helicopters on Route 4 and low-flying airplanes approaching from the southeast atypical and less anticipated.

Learning culture: Organizational learning within the Army was primarily reactive, occurring in response to mishaps rather than through anticipatory identification of weak signals and emerging trends. The Secretary of the Army had mandated adoption of the ASOHMS in 2024, and the Army Combat Readiness Center had developed tools to support hazard tracking and analysis; however, these capabilities were not effectively utilized due to the structural and cultural limitations described above.

Although Army leadership had recently initiated policy changes intended to shift aviation safety management in a more proactive direction, these efforts were constrained by limitations in organizational capacity and safety culture. Specifically, Army aviation exhibited an underdeveloped reporting culture, limited informed awareness of operational hazards, insufficient flexibility to adapt safety oversight to changing risk, and a learning culture oriented toward reactive rather than anticipatory risk management.

The NTSB concludes that the Army's aviation safety system failed to consistently detect, interpret, and act on signals of latent hazards, resulting in degraded safety assurance, organizational learning, and safety culture.

The NTSB believes that addressing the identified safety culture limitations described above would require the Army to take several interrelated, system-level steps. First, the Army would need to ensure that flight safety management functions are adequately staffed and resourced, including the assignment of competent safety professionals with the expertise and time necessary to cultivate a robust reporting culture and to identify weak signals of risk through effective analysis.

Second, the Army would need to structurally protect these personnel from collateral duties unrelated to aviation safety that dilute their capacity to perform proactive safety oversight.

Third, the Army would need to provide flight safety personnel with objective data collection and analysis tools, such as a funded and institutionalized MFOQA capability, to support the detection of emerging risk trends during normal operations.

Finally, the Army would need to ensure that flight safety personnel are empowered, through organizational authority and access to leadership, to effectively advocate for safety-related changes based on the risks they identify.

As a result, the NTSB recommends that the US Army develop and maintain a flight safety management capability that is independently resourced and functionally separate from its occupational and environmental health management system, and ensure that this capability is both culturally and functionally integrated with units conducting sustained flight operations in the NAS.

3. Conclusions

3.1 Findings

1. The pilots of flight 5342 were certificated and qualified in accordance with federal regulations.

2. The pilots of flight 5342 were medically qualified for duty, and available evidence does not indicate that they were impaired by effects of medical conditions or substances at the time of the accident.

3. Review of the flight 5342 pilots' time since waking and sleep opportunities in the days before the accident indicated that the pilots were unlikely to have been experiencing fatigue.

4. The pilot, instructor pilot, and crew chief onboard PAT25 were qualified and current in their positions as designated by the unit commander in accordance with Army regulations.

5. The pilot, instructor pilot, and crew chief of PAT25 were medically qualified for duty, and available evidence does not indicate that they were impaired by effects of medical conditions or substances at the time of the accident.

6. Review of the three PAT25 crewmembers' time since waking and sleep opportunities in the days before the accident indicated that the crew were unlikely to have been experiencing fatigue.

7. The airplane was properly certificated, equipped, and maintained in accordance with 14 *Code of Federal Regulations* Part 121. The airplane was operated within its weight and balance limitations throughout the flight. Examination of the airplane revealed damage consistent with an in-flight collision and subsequent impact with water, and there was no evidence of any structural, system, or powerplant failures or anomalies. Review of surveillance videos indicated that the airplane's wing navigation, landing/taxi, and anti-collision strobe lights were operating at the time of the collision.

8. The helicopter was properly certificated, equipped, and maintained in accordance with US Army regulations. Review of helicopter maintenance records did not reveal any open discrepancies or anomalous trends that contributed to the accident. The helicopter was operated within its weight and balance limitations throughout the flight. Examination of the helicopter revealed damage consistent with an in-flight collision and subsequent impact with water, and there was no evidence of any structural, main or tail

rotor system, flight control system, or powerplant failures or anomalies. Review of surveillance videos indicated that the helicopter's right and tail position lights, the landing light, as well as both upper and lower anti-collision lights, were operating at the time of the collision.

9. The operations supervisor and four controllers who were working in the Ronald Reagan Washington National Airport air traffic control tower cab at the time of the accident were properly certified, qualified in accordance with federal regulations and facility directives, and current.

10. Although the Ronald Reagan Washington National Airport air traffic control tower facility was not staffed to its target level at the time of the accident, the number of staff in the tower at the time of the accident was adequate and in accordance with Federal Aviation Administration directives.

11. The decision to combine the helicopter control and local control positions was not the result of insufficient staffing, and personnel were available to staff the helicopter control and local control positions separately had the operations supervisor chosen to do so.

12. The local control controller, assistant local controller, and operations supervisor were medically qualified for duty, and available evidence does not indicate they were impaired by effects of medical conditions at the time of the accident.

13. Review of the local control and assistant local control controllers' and operations supervisor's (OS) time since waking and sleep opportunities in the days before the accident indicated that the controllers, including the OS, were unlikely to have been experiencing fatigue.

14. Visual meteorological conditions prevailed in the area at the time of the accident. A review of observations recorded throughout the night of the accident revealed no evidence of any local atmospheric pressure anomalies that would have impacted barometric altimeter readings.

15. Metropolitan Washington Airports Authority aircraft rescue and firefighting and airport operations staff responded immediately and in accordance with applicable emergency plans and regulatory requirements, deploying land- and water-based resources, and coordinating mutual aid under complex nighttime and on water conditions.

16. Keeping the helicopter control and local control positions continuously combined on the night of the accident increased the local control controller's workload and negatively impacted his performance and situation awareness.

17. Had the helicopter and local control positions been staffed separately, PAT25 might have received a more timely and effective traffic advisory.

18. The local control and helicopter control positions should have been separated at the time of the accident given traffic volume and complexity.

19. In the two minutes before the accident when traffic volume was increasing, the assistant local controller should have prioritized surveillance of aircraft in the air in order to assist the local controller, rather than diverting her attention to the lower priority task of documenting helicopter information, which could have been completed when traffic volume and complexity had subsided.

20. Due to extended time on position at the time of the collision and his complacency, the operations supervisor was likely experiencing reduced alertness and vigilance, which decreased his awareness of the operational environment and reduced his ability to proactively assess the risks posed by the traffic and environmental conditions at the time of the accident.

21. The lack of mandatory relief periods for supervisory air traffic control personnel is contrary to human factors research that shows clear performance deterioration in situations of prolonged time on task.

22. Although the local control controller provided an initial traffic advisory to the crew of PAT25 in accordance with Federal Aviation Administration Order Job Order 7110.65, he did not provide a corresponding advisory to the crew of flight 5342 regarding PAT25's location and intention, which could have increased situation awareness for the crew of flight 5342.

23. If the local control controller had issued a standard safety alert to the flight crews of either aircraft as prescribed in Federal Aviation Administration Order Job Order 7110.65, providing the conflicting aircraft's position and positive control instructions, the crew of either aircraft could have taken immediate action to avert the impending collision.

24. Initial and recurrent scenario-based training in threat and error management would help controllers identify and mitigate risks and strengthen situation awareness.

25. A risk assessment or decision making tool would likely have benefited the accident operations supervisor in identifying and mitigating the operational risk factors that were present on the night of the accident.

26. Due to degraded radio reception, the crew of PAT25 did not receive salient information regarding flight 5342's circling approach to runway 33.

27. The PAT25 instructor pilot did not positively identify flight 5342 at the time of the initial traffic advisory despite his statement that he had the traffic in sight and his request for visual separation.

28. With several other targets located directly in front of the helicopter represented by points of light with no other features by which to identify aircraft type, and without additional position information from the controller, the instructor pilot likely identified the wrong target.

29. Interference that obscured the controller's "circling to" call, the microphone keying that blocked the PAT25 crew from receiving the instruction to "pass behind," ambiguous visual cues, and the lack of an integrated traffic awareness and alerting system likely reinforced the PAT25 crew's expectation bias that the airplane was among the traffic approaching runway 1 and did not pose a conflict.

30. The absence of documented training on Ronald Reagan Washington National Airport's fixed-wing procedures and the mixed-traffic operating environment represented a safety vulnerability for Army flight crews operating in the Ronald Reagan Washington National Airport Class B airspace.

31. Due to additive allowable tolerances of the helicopter's pitot-static/altimeter system, it is likely that the crew of PAT25 observed a barometric altimeter altitude about 100 ft lower than the helicopter's true altitude, resulting in the crew erroneously believing that they were under the published maximum altitude for Route 4.

32. A recurrent task to verify the continued accuracy of recorded flight data for US Army aircraft would help ensure the data integrity needed to support quality assurance and safety programs and accident investigations.

33. The Federal Aviation Administration and the Army failed to identify the incompatibility between the helicopter routes' low maximum altitudes and the error tolerances of barometric altimeters, which contributed to helicopters regularly flying higher than published maximum altitudes and potentially crossing into the runway 33 glidepath.

34. Pilots need all available information on the potential total error, allowed by design, that could occur in flight on an airworthy barometric altimeter.

35. The Army's post-installation functional check of the transponder on the accident helicopter was insufficient to detect that it was not broadcasting Automatic Dependent Surveillance–Broadcast Out.

36. The Army's lack of a recurrent transponder inspection procedure resulted in the incorrect aircraft address being transmitted by the accident helicopter's transponder, and the incorrect automatic dependent surveillance–broadcast settings on several other helicopters being undetected.

37. Because the APX-123A transponder is designed for use on multiple aircraft platforms, it is possible that incorrect settings may be present on other aircraft used throughout the Department of War armed services.

38. The crew of flight 5342 did not see the helicopter until it was too late to avoid a collision because of the high workload imposed during the final phase of their approach, and due to the helicopter's low conspicuity and lack of apparent motion.

39. Times of compacted demand as a result of air carrier scheduling practices increased operational complexity and required mitigations by controllers to maintain spacing and surface movement.

40. Ronald Reagan Washington National Airport air traffic control tower routinely received less than the requested miles in trail spacing from Potomac Consolidated Terminal Radar Approach Control, which increased controller workload by requiring them to generate additional spacing to prevent delays or gridlock.

41. The practice of "offloading" arrival traffic on approach to runway 1 by asking pilots if they could accept a circling approach to runway 33 was a routine mitigation strategy for Ronald Reagan Washington National Airport controllers to generate spacing that was not provided by Potomac Consolidated Terminal Radar Approach Control.

42. Time-based flow management, or metering, would provide Potomac Consolidated Terminal Radar Approach Control and Ronald Reagan Washington National Airport air traffic control tower with a consistent flow of traffic with more accurate spacing and greater predictability, thereby reducing controller workload.

43. Ronald Reagan Washington National Airport air traffic control tower has significant airspace, airfield, mixed fleet, and operations complexities that appear to be inconsistent with its current facility level classification.

44. The Federal Aviation Administration Air Traffic Organization failed to recognize external compliance verification results as indicators of systemic traffic management, volume, and flow issues at Ronald Reagan Washington National Airport for which controllers were required to compensate.

45. The longstanding practice of relying on pilot-applied visual separation (see-and-avoid) as the principal means of separating helicopter and fixed-wing traffic in the Washington, DC, area by Ronald Reagan Washington National Airport air traffic control tower, the Army, and other helicopter operators led to a drift in operating practices among controllers and helicopter crews that increased the likelihood of a midair collision.

46. Reliance on pilot-applied visual separation (see-and-avoid) as a primary means of separating mixed traffic introduced unacceptable risk to the Ronald Reagan Washington National Airport Class B airspace.

47. Ronald Reagan Washington National Airport air traffic control tower's procedure of maintaining a discrete helicopter frequency when the local and helicopter control positions were combined decreased overall situation awareness for pilots operating in the area.

48. Providing controllers with additional salient cues regarding the perceived severity of a potential conflict would reduce controller cognitive load and would likely improve reaction time to the most critical conflict alerts.

49. There was no evidence that the local control controller, assistant local control controller, or operations supervisor were under the influence of alcohol or prohibited drugs at the time of the accident; however, evidence was substantially limited by the lack of postaccident alcohol testing, and evidence was of somewhat lower quality than it would have been if drug testing had been conducted sooner following the accident.

50. The Federal Aviation Administration Air Traffic Organization's (ATO) drug and alcohol testing determination did not meet Department of Transportation (DOT) timeliness requirements; furthermore, the ATO's decision to not conduct drug testing as soon as possible after the testing determination, and to not conduct alcohol testing at all, violated DOT requirements.

51. The delayed and inappropriate drug and alcohol testing determination was due in part to the Air Traffic Organization's (ATO) determination process being inadequately designed to routinely meet Department of Transportation requirements for timely testing, and in part to ATO staff's incomplete understanding of those requirements.

52. Annual reviews of helicopter route charts as required by Federal Aviation Administration Order 7210.3DD would have provided an opportunity to identify the risk posed by the proximity of Route 4 to the runway 33

approach path, but there is no evidence to support that these reviews were being performed at Ronald Reagan Washington National Airport.

53. The information published by the Federal Aviation Administration regarding Washington, DC, area helicopter routes was insufficient to provide helicopter and fixed-wing operators with a complete understanding of the helicopter route structure and its lack of procedural separation from fixed-wing traffic.

54. Current aeronautical charting does not provide information on visual flight rules helicopter routes that may conflict or come in close proximity to approach and departure corridors, which reduces pilot situation awareness.

55. The lack of Automatic Dependent Surveillance–Broadcast (ADS-B) Out from the accident helicopter did not contribute to this accident, as the helicopter was still being tracked by radar, and ADS-B Out would not have provided improved traffic alerting for the Ronald Reagan Washington National Airport controller or the crew of flight 5342 because the airplane was not equipped with ADS-B In.

56. The Army's standard operating procedures that prevent flight crews from enabling Automatic Dependent Surveillance–Broadcast (ADS-B) Out while in flight, when not performing sensitive missions that require ADS-B to be disabled, limit the visibility of military aircraft on collision avoidance technologies that leverage ADS-B information.

57. Although the airplane's traffic alert and collision avoidance system operated as designed, it was ineffective in preventing the collision because of current activation criteria and resolution advisory inhibit altitudes.

58. Traffic advisory aural alerts that include additional information about the location of traffic could reduce the time pilots need to visually acquire target aircraft.

59. Had the airplane been equipped with an airborne collision avoidance system that used Automatic Dependent Surveillance–Broadcast In information to show directional traffic symbols, the crew of flight 5342 would have received enhanced information about the risk posed by the helicopter, which could have enabled them to take earlier action to avert the collision.

60. Although the pilot and instructor pilot onboard PAT25 were equipped with tablets that had the ability to display traffic transmitting Automatic Dependent Surveillance–Broadcast Out, it is unlikely that the pilots were using the tablets to monitor or identify traffic at the time of the accident due to the workload associated with low-altitude flight.

61. Technological advances since the development of traffic alert and collision avoidance system II operating standards may allow airborne collision avoidance system Xa with reduced inhibit altitudes to have an expanded alerting envelope while reducing nuisance alerts.

62. Although not yet commercially available, had the helicopter been equipped with airborne collision avoidance system Xr with integrated aural alerting, the crew could have received an alert regarding flight 5342 and could have taken action to avert the collision.

63. Multiple data sources provided evidence of midair collision risk between fixed-wing aircraft and helicopters at Ronald Reagan Washington National Airport, including on approach to runway 33, before this accident; however, the limited access to and use of available objective and subjective proximity data hindered industry and government stakeholders' ability to identify hazards and mitigate risk.

64. Improving stakeholder access to standardized and objective information about aircraft close proximity encounters for use in safety assurance processes would increase the likelihood of detecting and mitigating hazards before accidents occur.

65. The Federal Aviation Administration's lack of an established process to inform parties about their involvement in events such as near midair collisions or traffic alert and collision avoidance system resolution advisories reduces the likelihood of fully understanding and mitigating future midair collision risk.

66. The Federal Aviation Administration Air Traffic Organization was made aware of, and had multiple opportunities to identify, the risk of a midair collision between airplanes and helicopters at Ronald Reagan Washington National Airport; however, their data analysis, safety assurance, and risk assessment processes failed to recognize and mitigate that risk.

67. The Federal Aviation Administration Air Traffic Organization's application of its safety management system did not effectively coordinate safety assurance and safety risk management activities with external stakeholders in the Ronald Reagan Washington National Airport Class B airspace.

68. Changes to Ronald Reagan Washington National Airport air traffic control tower's standard operating procedures prior to the accident removing the requirement for the operations supervisor (OS) to document the time and reason for combining or de-combining the helicopter control position in the

facility log made it less likely that the OS would consider and evaluate the risks associated with combining or de-combining the position.

69. Safety risk management practices were not fully integrated into Ronald Reagan Washington National Airport air traffic control tower operations and did not identify or mitigate the operational challenges faced by controllers or the lack of guidance regarding operational risk assessments for controllers and supervisors.

70. Federal Aviation Administration Air Traffic Organization (ATO) management did not follow the tenets of safety management systems to support its workforce, encourage open communication, identify and mitigate risks, or foster a just culture, which eroded the overall safety culture within the ATO.

71. The Army did not have a flight safety data monitoring program for helicopters, and as a result, was unaware of routine altitude exceedances and related risks in the Ronald Reagan Washington National Airport terminal area.

72. The Army's safety reporting systems for pilots were not well utilized and did not provide the organization with information about close encounters between Army helicopters and other aircraft that were later found to have occurred frequently.

73. The Army's process for allocating resources to aviation safety management did not ensure the development of a robust safety management system for helicopter operations in the Washington, DC, area.

74. The Army's aviation safety system failed to consistently detect, interpret, and act on signals of latent hazards, resulting in degraded safety assurance, organizational learning, and safety culture.

3.2 Previously Issued Findings

75. Separation distances between helicopter traffic operating on Route 4 and aircraft landing on runway 33 as they existed at the time of the accident were insufficient and posed an intolerable risk to aviation safety by increasing the chances of a midair collision.

76. When Route 4 operations are prohibited as recommended in Safety Recommendation A-25-1, it is critical for public safety helicopter operations to have an alternate route for operating in and around Washington, DC, without increasing controller workload.

3.3 Probable Cause

The NTSB determines that the probable cause of this accident was the Federal Aviation Administration's (FAA) placement of a helicopter route in close proximity to a runway approach path; their failure to regularly review and evaluate helicopter routes and available data, and their failure to act on recommendations to mitigate the risk of a midair collision near Ronald Reagan Washington National Airport (DCA); as well as the air traffic system's overreliance on visual separation in order to promote efficient traffic flow without consideration for the limitations of the see-and-avoid concept. Also causal was the lack of effective pilot-applied visual separation by the helicopter crew, which resulted in a midair collision. Additional causal factors were the tower team's loss of situation awareness and degraded performance due to the high workload of the combined helicopter and local control positions and the absence of a risk assessment process to identify and mitigate real-time operational risk factors, which resulted in misprioritization of duties, inadequate traffic advisories, and the lack of safety alerts to both flight crews. Also causal was the Army's failure to ensure pilots were aware of the effects of error tolerances on barometric altimeters in their helicopters, which resulted in the crew flying above the maximum published helicopter route altitude. Contributing factors include:

- the limitations of the traffic awareness and collision alerting systems on both aircraft, which precluded effective alerting of the impending collision to the flight crews;
- an unsustainable airport arrival rate, increasing traffic volume with a changing fleet mix, and airline scheduling practices at DCA, which regularly strained the DCA air traffic control tower workforce and degraded safety over time;
- the Army's lack of a fully implemented safety management system, which should have identified and addressed hazards associated with altitude exceedances on the Washington, DC, helicopter routes;
- the FAA's failure across multiple organizations to implement previous NTSB recommendations, including Automatic Dependent Surveillance–Broadcast In, and to follow and fully integrate its established safety management system, which should have led to several organizational and operational changes based on previously identified risks that were known to management; and
- the absence of effective data sharing and analysis among the FAA, aircraft operators, and other relevant organizations.

4. Recommendations

4.1 New Recommendations

As a result of this investigation, the National Transportation Safety Board makes the following new safety recommendations.

To the Federal Aviation Administration—

Develop and implement time-on-position limitations for supervisory air traffic control personnel, including guidance for district and facility level management to adapt these limitations to account for their own staffing and local standard operating procedures. (A-26-8)

Develop instructor-led, scenario-based training on threat and error management that trains controllers to continuously monitor their environment to more quickly and accurately identify threats; promote team communication to ensure that communications are clear, timely, and assertive; emphasize effective scanning habits; recognize patterns in the development of adverse events; and enhance decision-making under stress by developing habits that balance procedural compliance with problem solving to mitigate the risks of threats and errors, and provide this training to all air traffic controllers annually. (A-26-9)

Develop and implement a risk assessment tool for supervisors that incorporates the principles of threat and error management to assist in risk identification, mitigation, and operational decision making. (A-26-10)

Initiate rulemaking in 14 *Code of Federal Regulations* Part 93 Subpart K, High Density Traffic Airports, that prescribes air carrier operation limitations at Ronald Reagan Washington National Airport in 30-minute periods, similar to those imposed at LaGuardia Airport, to ensure that the airport does not exceed capacity and to mitigate inconsistent air carrier scheduling practices. (A-26-11)

Fully implement operational use of the time-based flow management system at Potomac Consolidated Terminal Radar Approach Control and its associated air traffic control towers. (A-26-12)

Reassess the Ronald Reagan Washington National Airport's airport arrival rate with special consideration to its airspace complexity, airfield limitations, mixed-fleet operations, and traffic volume. (A-26-13)

Require each Class B or Class C air traffic control tower facility to evaluate its existing miles-in-trail procedures or agreements to ensure that the spacing provided is appropriate for operational safety, and make the results publicly available. (A-26-14)

Define objective criteria for the determination of air traffic facility levels considering traffic and airspace volume, operational factors unique to each facility, and cost of living. (A-26-15)

Using the criteria established by Safety Recommendation A-26-15, determine whether the classification of the Ronald Reagan Washington National Airport's air traffic control tower as a level 9 facility appropriately reflects the complexity of its operations. (A-26-16)

Develop a new and comprehensive instructor-led, scenario-based training on the proper use of visual separation, both tower- and pilot-applied. This training should include information on the inherent limitations of see and avoid, responsibilities when applying visual separation, and guidance for controllers on factors, such as current traffic volume, workload, weather or environmental factors, experience, and staffing, that should be considered when applying visual separation. Require this training for all controllers and include on a recurrent basis thereafter in annual simulator refresher training. (A-26-17)

Conduct a comprehensive evaluation, in conjunction with local operators, to determine the overall safety benefits and risks to requiring all aircraft to use the same frequency when the helicopter and local positions are combined in the Ronald Reagan Washington National Airport air traffic control tower. (A-26-18)

Implement anti-blocking technology that will alert controllers and/or flight crews to potentially blocked transmissions when simultaneous broadcasting occurs. (A-26-19)

Develop and implement improvements to the conflict alert system to provide more salient and meaningful alerts to controllers based on the severity of the conflict triggering the alert. (A-26-20)

Once the improvements to the conflict alert system discussed in Safety Recommendation A-26-20 are implemented, provide training to controllers on its use. (A-26-21)

Revise the Air Traffic Organization's initial event response procedures so that an appropriate on-site supervisor makes each postaccident and postincident drug and alcohol testing determination, based on their assessment of whether the event meets testing criteria and which controllers had duties pertaining to the involved aircraft, without needing to wait for investigation or approval. (A-26-22)

At least annually, provide training on the revised postaccident and postincident drug and alcohol testing determination procedure discussed in Safety Recommendation A-26-22 to all staff who have responsibilities under that procedure; this training should include a post-learning knowledge assessment. (A-26-23)

Ensure that annual reviews of helicopter route charts are being conducted throughout the National Airspace System as required by Federal Aviation Administration Order. (A-26-24)

Conduct a safety risk management process to evaluate whether modifications to the remaining helicopter route structure in the vicinity of Ronald Reagan Washington National Airport are necessary to safely deconflict helicopter and fixed-wing traffic and provide the results to the National Transportation Safety Board. (A-26-25)

Amend your helicopter route design criteria and approval process to ensure that current and future route designs or design changes provide vertical separation from airport approach and departure paths. (A-26-26)

Once the criteria and approval process referenced in Safety Recommendation A-26-26, review all existing helicopter routes to ensure alignment with these updated criteria. (A-26-27)

Incorporate the lateral location and published altitudes of helicopter routes onto all instrument and visual approach and departure procedures to provide necessary situation awareness to fixed-wing operators of the risk of helicopter traffic operating in their vicinity. (A-26-28)

Modify airborne collision avoidance system traffic advisory aural alerts to include clock position, relative altitude, range, and vertical tendency. (A-26-29)

Require existing and new traffic alerting and collision avoidance system (TCAS) I, TCAS II, and airborne collision avoidance system X installations to integrate directional traffic symbols. (A-26-30)

Require all aircraft operating in airspace where Automatic Dependent Surveillance–Broadcast (ADS-B) Out is required to also be equipped with ADS-B In with a cockpit display of traffic information that is configured to provide alerting audible to the pilot and/or flight crew. (A-26-31)

Require the use of the appropriate variant of airborne collision avoidance system X on new production aircraft that are subject to traffic alert and collision avoidance system equipage regulations. (A-26-32)

Require existing aircraft that are subject to traffic alert and collision avoidance system equipage regulations be retrofitted with the appropriate variant of airborne collision avoidance system X. (A-26-33)

Evaluate the feasibility of decreasing the traffic advisory and resolution advisory inhibit altitudes in airborne collision avoidance system Xa to enable improved alerting throughout more of the flight envelope. (A-26-34)

If the evaluation resulting from Safety Recommendation A-26-34 finds that the inhibit altitudes can be safely decreased, require retrofitting of the applicable airborne collision avoidance system X variant incorporating the reduced traffic advisory and resolution advisory inhibit altitudes on all aircraft that are subject to traffic alert and collision avoidance system and equipage regulations. (A-26-35)

Require that all rotorcraft operating in Class B airspace be equipped with airborne collision avoidance system (ACAS) Xr technology once the ACAS Xr standard has been published. (A-26-36)

Create an objective definition of close proximity encounter and a public database of those encounters and their locations that can be used to monitor their prevalence and identify areas of potential traffic conflict for safety assurance and safety risk management. (A-26-37)

Develop and implement a process that will, in a timely manner, notify involved parties after events such as near midair collisions or traffic alert and collision avoidance system resolution advisory activations, such that notification occurs while relevant data remain available and before meaningful safety analysis, reporting, or corrective action is no longer practicable. (A-26-38)

Based on the results of the audit completed in accordance with Safety Recommendation A-26-56, ensure that all safety management system functions and data sharing activities at all air traffic control facilities are conducted in collaboration with all relevant external stakeholders. (A-26-39)

Establish a requirement across all air traffic control tower standard operating procedures that the operations supervisor (OS) or controller-in-charge (CIC) document in the daily facility log when any control position is combined with the local control position, or when the OS/CIC position is combined with a control position, along with a rationale for doing so. (A-26-40)

To the US Army—

Revise training procedures for flight crews assigned to operate in the Washington, DC, area to ensure that they receive initial and recurrent training on fixed-wing operations at Ronald Reagan Washington National Airport, including approach and departure paths, runway configurations, and the interaction of those traffic flows with published helicopter routes. (A-26-41)

Develop and implement a recurring procedure, at an interval not to exceed 18 months, to verify the continued accuracy of recorded flight data. (A-26-42)

Incorporate information within the appropriate operator's manual for all applicable aircraft on the potential total error allowed by design that could occur in flight on an otherwise airworthy barometric altimeter, including the increased position error associated with the external stores support system configuration. (A-26-43)

Develop and implement a transponder inspection procedure on all aircraft with transponders capable of transmitting Mode S and Automatic Dependent Surveillance—Broadcast (ADS-B) and operated in the National Airspace System (NAS), at least annually and upon each aircraft's entry into service in the NAS, that ensures 1) the transponder ADS-B settings are correct, 2) the transponder is transmitting ADS-B, and 3) the transponder is transmitting the correctly assigned address. (A-26-44)

Establish a flight data monitoring program for rotary-wing aircraft the US Army operates in the National Airspace System. (A-26-45)

Survey US Army helicopter pilots to identify barriers to the utilization of flight safety reporting systems, develop a plan to address the identified barriers, and implement that plan across Army aviation units. (A-26-46)

Revise the method for allocating resources to ensure the development of a robust safety management system that will, at a minimum, identify and monitor the potential for midair collisions between Army aircraft and civil air traffic operating in the National Airspace System. (A-26-47)

Develop and maintain a flight safety management capability that is independently resourced and functionally separate from its occupational and environmental health management system, and ensure that this capability is both culturally and functionally integrated with units conducting sustained flight operations in the National Airspace System. (A-26-48)

To the Department of War Policy Board on Federal Aviation—

Conduct a study to evaluate the quality of radio transmissions and reception for those aircraft operated within the National Airspace System to identify factors that degrade communications equipment performance and adversely affect the safety of civilian and military flight operations. (A-26-49)

Implement appropriate enhancements, based on the findings of the study recommended in Safety Recommendation A-26-49, to remediate identified deficiencies in air–ground radio communications performance. (A-26-50)

Require the Department of War to verify on all aircraft with transponders capable of transmitting Mode S and Automatic Dependent Surveillance—Broadcast (ADS-B) and operated in the National Airspace System (NAS), at least annually and upon each aircraft's entry into service in the NAS, that 1) the transponder ADS-B settings are correct, 2) the transponder is transmitting ADS-B, and 3) the transponder is transmitting the correctly assigned address. (A-26-51)

Require armed services to amend their operational procedures to allow flight crews to enable Automatic Dependent Surveillance—Broadcast Out while in flight. (A-26-52)

Require all military aircraft operating in the National Airspace System (NAS) be equipped with Automatic Dependent Surveillance—Broadcast (ADS-B) In with a cockpit display of traffic information that is configured to provide alerting audible to the pilot and/or flight crew, and that such requirement apply wherever in the NAS the Federal Aviation Administration requires any aircraft to operate with ADS-B Out. (A-26-53)

To the Department of Transportation—

Require the Federal Aviation Administration to demonstrate at least annually that each air traffic control facility it operates has the routine capability to accomplish required postaccident and postincident drug and alcohol testing within the US Department of Transportation's specified timeframes of 2 hours for alcohol and 4 hours for drugs, and implement a process to ensure that any facility without such capability will demonstrate timely remediation. (A-26-54)

Work with the Federal Aviation Administration (FAA) Administrator to convene an independent panel to conduct a comprehensive review of the safety culture within the FAA's Air Traffic Organization (ATO), and use the findings to enhance the ATO's existing safety management system and integrate it into all levels of the organization. (A-26-55)

To the Department of Transportation Office of Inspector General—

Complete an audit of the Federal Aviation Administration (FAA) Air Traffic Organization's safety management system functions and data sharing activities at all air traffic control facilities and determine whether these activities are conducted in collaboration with all relevant external stakeholders, ensuring that the audit's results are documented, reported to the Secretary of Transportation and the FAA Administrator, and made available to the public. (A-26-56)

To the RTCA Program Management Committee—

Finalize and publish the minimum operational performance standards for airborne collision avoidance system Xr for rotorcraft. (A-26-57)

4.2 Previously Issued Recommendations

On March 11, 2025, the NTSB issued a safety recommendation report titled *Deconflict Airplane and Helicopter Traffic in the Vicinity of Ronald Reagan Washington National Airport,* which issued the following urgent safety recommendations addressing the potential for midair collisions between helicopters operating on Route 4 and airplanes landing on runway 33 or departing from runway 15 at DCA identified during this investigation:

To the Federal Aviation Administration:

Prohibit operations on Helicopter Route 4 between Hains Point and the Wilson Bridge when runways 15 and 33 are being used for departures and arrivals, respectively, at Ronald Reagan Washington National Airport (DCA). (A-25-1) (Urgent)

Designate an alternative helicopter route that can be used to facilitate travel between Hains Point and the Wilson Bridge when that segment of Route 4 is closed. (A-25-2) (Urgent)

BY THE NATIONAL TRANSPORTATION SAFETY BOARD

JENNIFER L. HOMENDY
Chairwoman

MICHAEL GRAHAM
Member

J. TODD INMAN
Member

Report Date: January 27, 2026

Board Member Statements

Chairwoman Jennifer Homendy filed the following concurring statement on February 3, 2026.

The National Transportation Safety Board (NTSB) met on January 27, 2026, to finalize our investigation of the midair collision between a Blackhawk operated by the United States Army under the callsign PAT25 and a CRJ700 operated by PSA Airlines as American Airlines flight 5342. The collision occurred on January 29, 2025, at about 8:48 pm eastern standard time about half a mile southeast of Ronald Reagan Washington National Airport (DCA).

Tragically, there were no survivors. The two pilots, two flight attendants, and 60 passengers aboard the airplane and three crew members aboard the helicopter were fatally injured.

To the families and friends of the 67 loved ones who died that day: We can only imagine all that you've been through over the past year. You are in our prayers and, on behalf of everyone at the NTSB, please accept our heartfelt condolences and our deepest sympathies.

You are, however, an inspiration to so many of us. You have, in the wake of absolute devastation, shown remarkable selflessness, courageously advocating for important reforms to improve aviation safety. I have no doubt the information uncovered by our investigation will support your efforts to make aviation safer, save lives, and work towards a future where no family endures such tremendous loss.

I also want to recognize staff for their incredible work on this investigation, which is undoubtedly one of the most complex in NTSB's history.

If anyone would like a glimpse into what these dedicated safety experts have done over the past year, look no further than the public docket for this investigation; it spans more than 19,000 pages and includes testimony from our investigative hearing last July.

And yet, we can never quantify the time staff dedicated to this investigation over the past year, from their work on scene to the countless hours spent analyzing and distilling the information into a comprehensive report to ensure every lesson is learned from this devastating tragedy. That they did so in less than 12 months' time, while meeting the high bar for quality and impartiality that our agency is known for – at one point working through the longest government shutdown in history with a myriad of other accident investigations underway – is a true testament to their commitment and professionalism. Thank you to the following staff who supported the investigation:

- Jennifer Adler
- Katherine Ambrose
- James Anderson
- Christopher Babcock
- Brandi Baldwin
- Brice Banning
- Daniel Baronofsky
- Leani Benitez-Cardona
- Chris Bjuland
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- Dr. William Bramble
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- Clint Crookshanks
- Jesus Cudemus
- John Curran
- Barbara Czech
- Carolyn Deforge
- Allison Diaz
- Nathan Doble
- Lauren Dudley
- Deidra Esters
- Steve Flores
- John Flynn
- Olivia Fowler
- Marvin Frantz
- Derek Freckleton
- Kim Frierson
- Dr. Brian Fuchs
- Jennifer Gabris
- Rolando Garcia
- Kyle Garner
- Andrew Giacini
- Emily Gibson
- Max Green
- Joseph Gregor
- Eric Gregson
- Dr. Loren Groff
- Erik Grosof
- James Gunter
- David Helson
- Keith Holloway
- Nathan Hoyt
- Scott Hsu
- Adam Huray
- Gerald Kawamoto
- Dr. Turan Kayagil
- Peter Knudson
- Dr. Elias Kontanis
- Dr. Don Kramer
- Timothy LeBaron
- Sarah Lewis
- Olivia Marcus
- Jake Marshall
- Stephanie Matonek
- Van McKenny
- Tom McMurry
- Marie Moler
- Daniel Morgan
- Dr. Erik Mueller
- John O'Callaghan
- Alice Park
- Sean Payne
- Dave Pereira
- Carl Perkins
- Jessica Perlewitz
- Michael Portman
- Dr. Jana Price
- Sarah Quinn
- Mike Richards
- Dr. Carl Schultheisz
- Dr. Dujuan Sevillian
- Chihoon Shin
- Dr. Sathya Silva
- Steven Smith
- Christy Spangler
- Brian Soper
- Robert (Rocky) Stone
- Sarah Sulick
- Caleb Wagner
- Chris Wallace
- Lorenda Ward
- Mark Ward
- Eric Weiss
- Dr. Katherine Wilson
- Dr. Sabrina Woods
- Jonathan Xue
- Stephen Yee

There is a tendency in the immediate aftermath of any accident we investigate to question human error – on the actions or inactions of individuals. However, human error in complex systems, like our modern aviation system and the National Airspace System, isn't a cause; it's a consequence. Many things need to go wrong for an accident to occur.

In any investigation, the NTSB could choose to focus on a simple moment – on what happened immediately prior to the accident – or on the individuals involved. But that's not the whole picture. To quote research from the National Highway Traffic Safety Administration, what we refer to as human error is, in reality, "the last event in the causal chain immediately preceding [a] crash."

Indeed, in Board meetings and reports over the years, in our findings and analyses, across all modes of transportation, we've often referred to the work of leading scholars like Dr. James Reason, Captain Dan Maurino, and Dr. Nancy Leveson to demonstrate that human error is a symptom of deeper, underlying systemic failures. A consequence, not a cause.

These underlying deficiencies, often referred to as latent conditions, or systemic vulnerabilities, are what aligned to allow for the DCA tragedy to occur. It is the worst U.S. aviation disaster – in terms of fatalities – since November 12, 2001, when American Airlines flight 587 crashed into a residential area of Belle Harbor, New York, killing all 260 people aboard the airplane and five on the ground. We also remember on this somber occasion the 50 people who died on February 12, 2009, when Colgan Air flight 3407 crashed into a residence in Clarence Center, New York.

A year before the midair collision at DCA, Alaska Airlines flight 1282 experienced an in-flight separation of the left mid-exit door plug and rapid depressurization during climb after takeoff from Portland International Airport. We were fortunate no one lost their life or was seriously injured in that accident. But, within weeks, there was a lot of focus on human error – on the actions of a team of Boeing manufacturing employees in Renton.

In the final investigation report, we cited Dr. James Reason:

> *[W]ithin a robust system, the introduction of a single error is almost never the only cause of an accident. Rather, several barriers of defense must fail for the error to lead to an accident.*

In other words: there was a long chain of events that led to the door plug departing from the aircraft – just as there is for every accident we investigate.

In preparing for this Board meeting, I reviewed a myriad of midair collisions we've investigated since 1968, when North Central Airlines Flight 261, a Convair 580, collided with a Cessna 150 near General Mitchell Airport in Milwaukee, Wisconsin. That was just one of 38 midair collisions we investigated in 1968.

A year later, we investigated the midair collision of Allegheny Airlines Flight 853 and a small Piper Cherokee outside Shelbyville, Indiana, killing 83 people. Within months, the Board held a hearing on midair collisions in general and issued 14 recommendations aimed at preventing them from reoccurring, including our first recommendation to "expeditiously develop and implement a collision avoidance system in all civil aircraft."

Fast forward 50 years to 2019. I was the Board Member on scene for a midair collision between a de Havilland DHC-2 (Beaver) airplane and a de Havilland DHC-3 (Otter) about 8 miles northeast of Ketchikan, Alaska. Six people died; 10 others were injured. We didn't conclude that the cause was "pilot error," but rather "the inherent limitations of the see-and-avoid concept."

It's notable that we've investigated 163 aviation accidents and 47 incidents resulting from a midair collision, near midair collision, or loss of separation over the last two decades alone. Combined, these events killed 281 people and injured 112 others. We raised concern with the see-and-avoid concept in 45% of those accident and incident investigations.

The similarities among the midair collisions we've investigated are striking, whether the accident occurred more than half a century ago or as recently as the DCA tragedy.

In every case, we could have focused our investigation entirely on the individuals involved: flight crews, pilots, maintenance personnel, or controllers. We didn't because we have long recognized that "human error is a symptom of a system that needs to be redesigned." That's a quote from Dr. Leveson.

When *SpaceshipTwo* broke up during a test flight in 2014, our probable cause didn't cite human error, but Scaled Composites' "failure to consider and protect against the possibility that a single human error could result in a catastrophic hazard."

And in 2022, when an Amtrak train derailed after hitting a dump truck that was blocking a grade crossing in Mendon, Missouri, we didn't limit our investigation to the driver. In so doing, we found the design of the crossing was flawed; it reduced drivers' ability to see approaching trains and made stopping difficult for heavy trucks. That knowledge enabled Governor Parsons to address not only the safety of that grade crossing, but 49 others across Missouri, saving countless lives.

Steve Wallace, the former director of the FAA Office of Accident Investigations, was interviewed in 2023 to mark the 20th anniversary of the Space Shuttle Columbia disaster. After the Columbia disintegrated upon reentry to Earth, killing all seven astronauts on board, the NTSB was heavily involved in the investigation. Steve was a member of the Columbia Accident Investigation Board; in the interview, he cited a lesson he learned from our investigators:

> *NTSB people have a saying that, when you find the human error, that's not the end of the investigation; that's the beginning of the investigation. What is the true root cause? The root cause is the thing that you have to change so it doesn't happen again.*

Commercial aviation embraced the same shift in root cause analysis. And the results were powerful: flying became safer. In fact, the U.S. aviation system had been experiencing a record level of safety before the DCA tragedy occurred. *That* is the power of systems thinking, which is based not on speculation but decades of research, evidence, and our own investigations.

As aviation safety evolves, so do the systems and so do the risks. I'll repeat: "[W]ithin a robust system, the introduction of a single error is almost never the only cause of an accident. Rather, several barriers of defense must fail for the error to lead to an accident." That's precisely what occurred on January 29, 2025.

Our work does not end with the issuance of this final report, which contains 74 findings and 50 recommendations aimed at preventing similar tragedies. It represents the first step toward lasting change.

But our recommendations are voluntary. Unless they're acted on, they're simply words on a page, which is why we now turn to the vital work of advocacy. We must relentlessly, vigorously pursue the implementation of our safety recommendations. We must do everything in our power to ensure the lessons learned from this devastating tragedy are heeded. We must ensure the hard-won knowledge contained in this report translates to lives saved.

I mentioned our investigations of Colgan Air flight 3407 and American Airlines flight 587. Between those two investigations, we issued 40 safety recommendations – every one of them aimed at preventing tragedy from reoccurring. Thirteen of the recommendations issued to the FAA were "closed unacceptable." That means no action was taken.

Sometimes there is progress, but it takes years. Other times, decades. All that's to say: Enduring change can take time. Making the system-wide changes we need doesn't come easy, *but we must make them*.

And we should do so BEFORE people die.

The "tombstone mentality" of transportation safety whereby we pursue safety improvements only after people die is unconscionable. We can do better; we must do better. We must proactively improve safety. That is how we honor the victims.

To all who have lost loved ones in an accident we've investigated, know this: the NTSB will never give up. Until every single one of our safety recommendations is fully implemented. Until there's no longer a need for our recommendations. Until there's no longer a need for the NTSB. Until we have a safe transportation system for all.

Until there are zero grieving families. *Zero*.

In closing, I'd like to thank the first responders on behalf of the Board. Dozens of organizations responded to the scene of this tragedy to support search-and-recovery efforts, establish incident and unified command, and assist in our investigative work. They include the following organizations:

- Alexandria City Fire Department
- Alexandria Police Department
- Ann Arundel Fire Department
- Arlington County Fire & Rescue
- Arlington County Office of Emergency Management
- Arlington Police Department
- Baltimore City Fire Department
- Baltimore Police
- Charles County Fire and Rescue
- DC Fire Department & EMS
- Fairfax City Fire & Rescue
- Fairfax County Fire & Rescue Department
- Federal Aviation Administration
- Federal Bureau of Investigation
- Maryland Natural Resources Police
- Maryland State Police
- Montgomery County Fire and Rescue
- MWAA Fire & Rescue
- MWAA Police
- NCR-Incident Management Team
- Office of Chief Medical Examiner of the District of Columbia
- Prince George's County Fire & Rescue
- Prince William Fire & Rescue
- U.S. Air Force
- U.S. Army
- U.S. Army Corps of Engineers

- U.S. Coast Guard
- U.S. Navy Supervisor of Salvage and Diving
- Virginia Department of Emergency Management
- Virginia State Police

Member J. Todd Inman filed the following concurring statement on February 3, 2026.

As the Board Member on Scene for this accident, I want to thank every person that touched this investigation. Your work has honored the victims of this crash through carefully crafted recommendations that ensure their lives were not lost in vain. We can now say with certainty that this tragedy was not caused by a single person or action but was the result of many failures across multiple systems.

I know that staff worked relentlessly to reach these conclusions, which is especially impressive given the expedited timeline they were told to complete the report in. While our investigation cannot undo the loss suffered by the victims' families, we will continue our work to advocate for the implementation of these recommendations to improve safety for us all.

As with many investigations, the NTSB could not have gotten to these results alone. The first responders, and our partners at the FBI evidence response and dive teams performed admirably to collect and preserve evidence that served to inform our investigators and hopefully provide some manner of solace to the families. These first responders acted swiftly, with the first search and rescue boats being on the water within 4 minutes of the crash. Working in freezing conditions and icy waters, those responders performed with distinction as they searched for the passengers and crew, and their actions should serve as a model for others.

Within the report we highlight systemic failures that led to the local air traffic controller failing to provide required traffic alerts, the PAT 25 crew not knowing or indicating their correct altitude, the FAA not evaluating their own data, and a dangerous route design that left no room for error. These are real, tangible problems that need to be addressed, and I hope the recipients of our recommendations get to work immediately.

While we laude ADS-B systems as an emerging technology in commercial fixed-wing and rotorcraft aviation that could have prevented this accident, it is still exactly that, an emerging technology. There are still technological barriers to implementing ADS-B In into the 5,500 commercial aircraft that are in the skies at any given moment. While some newer aircraft may have been designed to incorporate ADS-B into the flight deck, older models which carry the public for the majority of regional carriers simply do not have the same technology available. This coupled with competing regulations that have not been harmonized internationally add to the complexity of full implementation. To this day, there are validated concerns with ADS-B cyber security that include spoofing and jamming that allow easy access to those that wish to cause harm. Even within this report, we see what can happen when ADS-B transmitters are configured incorrectly across a fleet, rendering them useless.

To be perfectly clear: I want this technology to work, and I want it to be in the aircraft carrying my loved ones, but we cannot expect fast development, certification or implementation of a product that may play a part in preventing a similar accident from ever happening again. It must be done right. Henry Wadsworth Longfellow once stated, “It takes less time to do a thing right than to explain why you did it wrong”.

It is important that the public understands this. In 2012, Congress required the FAA to develop ADS-B In rulemaking, only for the requirement to be repealed in 2018 due to some of the complex system limitations that still exist today. Positive train control, a technology that prevents train-to-train collisions and other unsafe conditions, was mandated by Congress in 2008. The NTSB advocated for its adoption for over 30 years. Although the original deadline for implementation was 2015, rail operators required extensions and full implementation was not completed until 2020. While ADS-B In may be talked about in press conferences, the public deserves to know that critical safety technology cannot be willed into existence. This will be a long road ahead before the right equipment is developed and certified for widespread use.

That does not mean we, meaning everyone involved in aviation safety, should not continue to push for technological advances in commercial operations. The general aviation community has proven the technology exists and is providing a roadmap for further integration. It is now time for the regulator and commercial operators to follow suit.

The FAA needs to get to work immediately to solve its organizational problems that contributed to this accident. This must happen first. I hope that by the time ADS-B In is finally ready for implementation across the national airspace that they have learned from this accident and are up to the challenge. From what I have seen during this investigation, there is substantial opportunity for improvement.

As I stated at the start of our full board meeting to the families impacted by this tragedy, “I am sorry, you should not be here. None of us should be here.”

I am proud of the work demonstrated within this report, and hope that everyone who reads it will see the benefit of the NTSB recommendations included.

Appendixes

Appendix A: Investigation

The National Transportation Safety Board (NTSB) was notified of this accident on January 29, 2025, about 2100 eastern standard time. A Go-Team responded on January 30, 2025. Chairwoman Jennifer Homendy accompanied the team, and Member J. Todd Inman served as the agency spokesperson on-scene.

The following investigative teams were formed: Airplane Operations and Human Performance, Helicopter Operations and Human Performance, Air Traffic Control and Human Performance, Medical, Airplane Systems, Helicopter Airworthiness, Structures, Powerplants, Materials, Survival Factors, Helicopter and Airplane Flight Data Recorders, Helicopter and Airplane Cockpit Voice Recorders, Performance, and Safety Data. Additional specialists were assigned to evaluate meteorology components and security video footage.

Parties to the investigation were Aerosonic, the Air Line Pilots Association (ALPA), the Association of Flight Attendants, BAE Systems, Collins Aerospace, the Federal Aviation Administration (FAA), GE Aerospace, the International Association of Machinists and Aerospace Workers, the Metropolitan Washington Airports Authority, the National Air Traffic Controllers Association (NATCA), PSA Airlines, Sikorsky, and the United States Army. In accordance with the provisions of Annex 13 to the Convention on Civil Aviation, the Transportation Safety Board (TSB) of Canada served as an accredited representative representing the state of manufacture of the airplane and Transport Canada and MHI RJ Aviation participated as technical advisors to the TSB.

Investigative Hearing

An investigative hearing was held from July 30 to August 1, 2025, in Washington, DC. Chairwoman Homendy served as the Chair of the Board of Inquiry for the en banc hearing. The issues discussed at the investigative hearing were the accident helicopter’s air data system and altimeters, the DCA Class B airspace and helicopter routes, DCA air traffic controller training and guidance, collision avoidance technologies, and safety data and safety management systems at the various organizations involved in the accident. Parties to the hearing were the FAA, the US Army, PSA Airlines, ALPA, NATCA, and Sikorsky.

Appendix B: Consolidated Recommendation Information

Title 49 *United States Code* 1117(b) requires the following information on the recommendations in this report.

For each recommendation—

(1) a brief summary of the Board's collection and analysis of the specific accident investigation information most relevant to the recommendation;

(2) a description of the Board's use of external information, including studies, reports, and experts, other than the findings of a specific accident investigation, if any were used to inform or support the recommendation, including a brief summary of the specific safety benefits and other effects identified by each study, report, or expert; and

(3) a brief summary of any examples of actions taken by regulated entities before the publication of the safety recommendation, to the extent such actions are known to the Board, that were consistent with the recommendation.

To the Federal Aviation Administration

A-26-8
Develop and implement time-on-position limitations for supervisory air traffic control personnel, including guidance for district and facility level management to adapt these limitations to account for their own staffing and local standard operating procedures.

Information that addresses the requirements of 49 *USC* 1117(b), as applicable, can be found in sections 1.7.5 Operations Supervisor, 1.7.8.6 Tower Team Position Responsibilities, and 2.2.1.1 Workload and Resource Management. Information supporting (b)(1) can be found on pages 62, 68-69, 89, and 223-230; (b)(2) and (b)(3) are not applicable.

A-26-9
Develop instructor led, scenario-based training on threat and error management that trains controllers to continuously monitor their environment to more quickly and accurately identify threats; promote team communication to ensure that communications are clear, timely, and assertive; emphasize effective scanning habits; recognize patterns in the development of adverse events; and enhance decision-making under stress by developing habits that balance procedural compliance with problem solving to mitigate the risks of threats and errors, and provide this training to all air traffic controllers annually.

Information that addresses the requirements of 49 *USC* 1117(b), as applicable, can be found in sections 1.15.2 Threat and Error Management Training and 2.2.1.3 Threat and Error Management. Information supporting (b)(1) can be found on pages 209-214 and 232-235; (b)(2) is not applicable; and information supporting (b)(3) can be found on pages 232-233.

A-26-10
Develop and implement a risk assessment tool for supervisors that incorporates the principles of threat and error management to assist in risk identification, mitigation, and operational decision making.

Information that addresses the requirements of 49 *USC* 1117(b), as applicable, can be found in sections 1.7.5 Operations Supervisor, 2.2.1.1 Workload and Resource Management, and 2.2.1.3 Threat and Error Management. Information supporting (b)(1) can be found on pages 223-230 and 235; (b)(2) and (b)(3) are not applicable.

A-26-11
Initiate rulemaking in 14 Code of Federal Regulations Part 93 Subpart K, High Density Traffic Airports, that prescribes air carrier operation limitations at Ronald Reagan Washington National Airport in 30-minute periods, similar to those imposed at LaGuardia Airport, to ensure that the airport does not exceed capacity and to mitigate inconsistent air carrier scheduling practices.

Information that addresses the requirements of 49 *USC* 1117(b), as applicable, can be found in sections 1.7.6 DCA Traffic Management, Volume, and Flow, 1.7.6.4 Slot Controls, and 2.3.1 Traffic Management, Volume, and Flow. Information supporting (b)(1) can be found on pages 76-77 and 248-249; (b)(2) and (b)(3) are not applicable.

A-26-12
Fully implement operational use of the time based flow management system at Potomac Consolidated Terminal Radar Approach Control and its associated air traffic control towers.

Information that addresses the requirements of 49 *USC* 1117(b), as applicable, can be found in sections 1.7.6.6 Time-Based Flow Management and 2.3.1 Traffic Management, Volume, and Flow. Information supporting (b)(1) can be found on pages 79, and 248-251; (b)(2) is not applicable; and information supporting (b)(3) can be found on pages 79 and 250.

A-26-13
Reassess the DCA AAR with special consideration to its airspace complexity, airfield limitations, mixed-fleet operations, and traffic volume.

Information that addresses the requirements of 49 *USC* 1117(b), as applicable, can be found in sections 1.7.6.3 Airport Arrival Rate and Miles-in-Trail, 1.7.6.5 Offloading to Runway 33, and 2.3.1 Traffic Management, Volume, and Flow. Information supporting (b)(1) can be found on pages 73-76, 77-78, and 248-251; (b)(2) is not applicable; and information supporting (b)(3) can be found on pages 74 and 251.

A-26-14
Require each Class B or Class C air traffic control tower facility to evaluate its existing miles-in-trail procedures or agreements to ensure that the spacing provided is appropriate for operational safety, and make the results publicly available.

Information that addresses the requirements of 49 *USC* 1117(b), as applicable, can be found in sections 1.7.6.3 Airport Arrival Rate and Miles-in-Trail, 1.7.6.5 Offloading to Runway 33, and 2.3.1 Traffic Management, Volume, and Flow. Information supporting (b)(1) can be found on pages 73-76, 77-78, and 248-251; (b)(2) and (b)(3) are not applicable.

A-26-15
Define objective criteria for the determination of air traffic facility levels considering traffic and airspace volume, operational factors unique to each facility, and cost of living.

Information that addresses the requirements of 49 *USC* 1117(b), as applicable, can be found in sections 1.7.9 Facility Level Classification and 2.3 DCA Air Traffic Control Tower Facility. Information supporting (b)(1) can be found on pages 89-92 and 251; (b)(2) and (b)(3) are not applicable.

A-26-16
Using the criteria established by Safety Recommendation A-26-15, determine whether the classification of the Ronald Reagan Washington National Airport air traffic control tower as a level 9 facility appropriately reflects the complexity of its operations

Information that addresses the requirements of 49 *USC* 1117(b), as applicable, can be found in sections 1.7.9 Facility Level Classification and 2.3 DCA Air Traffic Control Tower Facility. Information supporting (b)(1) can be found on pages 89-92 and 251; (b)(2) and (b)(3) are not applicable.

A-26-17
Develop a new and comprehensive instructor-led, scenario-based training on the proper use of visual separation, both tower- and pilot-applied. This training should include information on the inherent limitations of see and avoid, responsibilities when applying visual separation, and guidance for controllers on factors, such as current traffic volume, workload, weather or environmental factors, experience, and staffing, that should be considered when applying visual separation. Require this training for all controllers and include on a recurrent basis thereafter in annual simulator refresher training.

Information that addresses the requirements of 49 *USC* 1117(b), as applicable, can be found in sections 1.7.6.2 Visual Separation Between Helicopters and Airplanes, 1.11.4 Visibility Studies, 1.11.5 Limitations of See-and-Avoid, and 2.3.2 Visual Separation. Information supporting (b)(1) can be found on pages 71-73, 251-256; information supporting (b)(2) can be found on pages 139-142; (b)(3) is not applicable.

A-26-18
Conduct a comprehensive evaluation, in conjunction with local operators, to determine the overall safety benefits and risks to requiring all aircraft to use the same frequency when the helicopter and local positions are combined in the DCA ATCT.

Information that addresses the requirements of 49 *USC* 1117(b), as applicable, can be found in sections 1.7.6.1 Combined Control Positions, 1.7.8 Air Traffic Control Procedures, and 2.3.3 Radio Frequency Management. Information supporting (b)(1) can be found on pages 2 and 256-257; (b)(2) and (b)(3) are not applicable.

A-26-19
Implement anti-blocking technology that will alert controllers and/or flight crews to potentially blocked transmissions when simultaneous broadcasting occurs.

Information that addresses the requirements of 49 *USC* 1117(b), as applicable, can be found in sections 1.1 History of Flight, 1.7.8 Air Traffic Control Procedures, 2.2.1.2 Traffic Advisories, and 2.3.3 Radio Frequency Management. Information supporting (b)(1) can be found on pages 8 and 256-257; (b)(2) and (b)(3) are not applicable.

A-26-20
Develop and implement improvements to the conflict alert system to provide more salient and meaningful alerts to controllers based on the severity of the conflict triggering the alert.

Information that addresses the requirements of 49 *USC* 1117(b), as applicable, can be found in sections 1.7.8.4 Conflict Alerts and 2.3.4 Conflict Alert System . Information supporting (b)(1) can be found on pages 7, 85-87, and 258-259; information supporting (b)(2) can be found on pages 258; (b)(3) is not applicable.

A-26-21
Once the improvements to the conflict alert system discussed in Safety Recommendation A-26-20 are implemented, provide controllers training on its use.

Information that addresses the requirements of 49 *USC* 1117(b), as applicable, can be found in 1.7.8.4 Conflict Alerts; 2.3.4 Conflict Alert System; 2.2.1 Controller Performance. Information supporting (b)(1) can be found on pages 7, 85-87, and 258-259; information supporting (b)(2) can be found on page 258; (b)(3) is not applicable.

A-26-22
Revise the Air Traffic Organization's initial event response procedures so that an appropriate on-site supervisor makes each postaccident and postincident drug and alcohol testing determination, based on their assessment of whether the event meets testing criteria and which controllers had duties pertaining to the involved aircraft, without needing to wait for investigation or approval.

Information that addresses the requirements of 49 *USC* 1117(b), as applicable, can be found in sections 1.10.4 Controller Postaccident Drug and Alcohol Testing and 2.3.5 Postaccident Drug and Alcohol Testing. Information supporting (b)(1) can be found on pages 106-110, and 259-263; (b)(2) and (b)(3) are not applicable.

A-26-23
At least annually, provide training on the revised postaccident and postincident drug and alcohol testing determination procedure discussed in Safety Recommendation A-26-22 to all staff who have responsibilities under that procedure; this training should include a post-learning knowledge assessment.

Information that addresses the requirements of 49 *USC* 1117(b), as applicable, can be found in sections 1.10.4 Controller Postaccident Drug and Alcohol Testing and 2.3.5 Postaccident Drug and Alcohol Testing. Information supporting (b)(1) can be found on pages 106-110, and 259-263; (b)(2) and (b)(3) are not applicable..

A-26-24
Ensure that annual reviews of helicopter route charts are being conducted throughout the National Airspace System as required by Federal Aviation Administration Order.

Information that addresses the requirements of 49 *USC* 1117(b), as applicable, can be found in sections 1.6 Helicopter Routes, 1.6.2 Helicopter Route Development and Modification, and 2.4 Helicopter Route Design and Information. Information supporting (b)(1) can be found on pages 46-48 and 263-267; (b)(2) is not applicable; and information supporting (b)(3) can be found on pages 208-209.

A-26-25
Conduct a safety risk management process to evaluate whether modifications to the remaining helicopter route structure in the vicinity of Ronald Reagan Washington National Airport are necessary to safely deconflict helicopter and fixed-wing traffic and provide the results to the NTSB.

Information that addresses the requirements of 49 *USC* 1117(b), as applicable, can be found in sections 1.6 Helicopter Routes, 2.4 Helicopter Route Design and Information, and 2.6.3.1, Safety Risk Management and Safety Assurance. Information supporting (b)(1) can be found on pages 46-48, 206-208, and 263-267; (b)(2) is not applicable; and information supporting (b)(3) can be found on pages 208-209.

A-26-26
Amend your helicopter route design criteria and approval process to ensure that current and future route designs or design changes provide vertical separation from airport approach and departure paths.

Information that addresses the requirements of 49 *USC* 1117(b), as applicable, can be found in sections 1.6 Helicopter Routes, and 2.4 Helicopter Route Design and Information. Information supporting (b)(1) can be found on pages 46-48, 206-208, and 263-267; (b)(2) and (b)(3) are not applicable.

A-26-27
Based on the criteria and approval process established by Safety Recommendation A-26-26, review all existing helicopter routes to ensure alignment with these updated criteria.

Information that addresses the requirements of 49 *USC* 1117(b), as applicable, can be found in sections 1.6 Helicopter Routes, and 2.4 Helicopter Route Design and Information. Information supporting (b)(1) can be found on pages 46-48, 206-208, and 263-267; (b)(2) and (b)(3) are not applicable.

A-26-28
Incorporate the lateral location and published altitudes of helicopter routes onto all instrument and visual approach and departure procedures to provide necessary situation awareness to fixed-wing operators of the risk of helicopter traffic operating in their vicinity.

Information that addresses the requirements of 49 *USC* 1117(b), as applicable, can be found in sections 1.6 Helicopter Routes and 2.4 Helicopter Route Design and Information. Information supporting (b)(1) can be found on pages 46-48, 206-208, and 263-267; (b)(2) and (b)(3) are not applicable.

A-26-29
Modify airborne collision avoidance system traffic advisory aural alerts to include clock position, relative altitude, range, and vertical tendency.

Information that addresses the requirements of 49 *USC* 1117(b), as applicable, can be found in sections 1.3.1.1 CRJ Traffic Alert and Collision Avoidance System, 1.4.2, Airborne Collision Avoidance and Traffic Awareness Systems, 1.11.6 ADS-B In and ACAS X Simulations, and 2.5 ADS-B and Collision Avoidance Technologies. Information supporting (b)(1) can be found on pages 28-32, 142-147, and 268-270; (b)(2) and (b)(3) are not applicable.

A-26-30
Require existing and new traffic awareness and collision avoidance system I, traffic awareness and collision avoidance system II, and airborne collision avoidance system X installations to integrate directional traffic symbols.

Information that addresses the requirements of 49 *USC* 1117(b), as applicable, can be found in sections 1.3.1.1 CRJ Traffic Alert and Collision Avoidance System, 1.4.2 Airborne Collision Avoidance and Traffic Awareness Systems, 1.11.6 ADS-B In CDTI and ACAS X Simulations, and 2.5 ADS-B and Collision Avoidance Technologies. Information supporting (b)(1) can be found on pages 36-38, 142-146, and 268-272; (b)(2) and (b)(3) are not applicable.

A-26-31
Require all aircraft operating in airspace where Automatic Dependent Surveillance—Broadcast (ADS-B) Out is required to also be equipped with ADS-B In with a cockpit display of traffic information that is configured to provide audible alerting to the pilot and/or flight crew.

Information that addresses the requirements of 49 *USC* 1117(b), as applicable, can be found in sections 1.3.1.1 CRJ Traffic Alert and Collision Avoidance System, 1.4 Automatic Dependent Surveillance–Broadcast and Collision Avoidance Technologies, 1.11.6 ADS-B In CDTI and ACAS X Simulations, and 2.5 ADS-B and Collision

Avoidance Technologies. Information supporting (b)(1) can be found on pages 25-28, 34-37, 142-149, and 267-273; (b)(2) and (b)(3) are not applicable.

A-26-32
Require the use of the appropriate variant of airborne collision avoidance system X on new production aircraft that are currently subject to traffic alert and collision avoidance system equipage regulations.

Information that addresses the requirements of 49 *USC* 1117(b), as applicable, can be found in sections 1.3.1.1 CRJ Traffic Alert and Collision Avoidance System, 1.4.2 Airborne Collision Avoidance and Traffic Awareness Systems, 1.11.6 ADS-B In CDTI and ACAS X Simulations, and 2.5 ADS-B and Collision Avoidance Technologies. Information supporting (b)(1) can be found on pages 34-37, 147-149, 267-273; (b)(2) and (b)(3) are not applicable.

A-26-33
Require existing aircraft that are subject to traffic alert and collision avoidance system equipage regulations be retrofitted with the appropriate variant of airborne collision avoidance system X.

Information that addresses the requirements of 49 *USC* 1117(b), as applicable, can be found in sections 1.4.2 Airborne Collision Avoidance and Traffic Awareness Systems, 1.11.6 ADS-B In CDTI and ACAS X Simulations, and 2.5 ADS-B and Collision Avoidance Technologies. Information supporting (b)(1) can be found on pages 34-37, 147-149, 267-273; (b)(2) and (b)(3) are not applicable.

A-26-34
Evaluate the feasibility of decreasing the traffic advisory and resolution advisory inhibit altitudes in airborne collision avoidance system Xa to enable improved alerting throughout more of the flight envelope.

Information that addresses the requirements of 49 *USC* 1117(b), as applicable, can be found in sections 1.4.2 Airborne Collision Avoidance and Traffic Awareness Systems, 1.11.6 ADS-B In CDTI and ACAS X Simulations, and 2.5 ADS-B and Collision Avoidance Technologies. Information supporting (b)(1) can be found on pages 34-37, 147-149, 246-248, and 267-273; (b)(2) and (b)(3) are not applicable.

A-26-35
If the evaluation resulting from Safety Recommendation A-26-34 finds that inhibit altitudes can be safely decreased, require retrofitting of the applicable airborne collision avoidance system X variant incorporating the reduced traffic advisory and resolution advisory inhibit altitudes on all aircraft that are subject to traffic alert and collision avoidance system equipage regulations.

Information that addresses the requirements of 49 *USC* 1117(b), as applicable, can be found in sections 1.3.1.1 CRJ Traffic Alert and Collision Avoidance System, 1.4.2 Airborne Collision Avoidance and Traffic Awareness Systems, 1.11.6 ADS-B In CDTI and ACAS X Simulations, and 2.5 ADS-B and Collision Avoidance Technologies. Information supporting (b)(1) can be found on pages 34-37, 147-149, 246-248, and 267-273; (b)(2) and (b)(3) are not applicable.

A-26-36
Require that all rotorcraft operating in Class B airspace be equipped with airborne collision avoidance system (ACAS) Xr technology once the ACAS Xr standard has been published.

Information that addresses the requirements of 49 *USC* 1117(b), as applicable, can be found in sections 1.4.2 Airborne Collision Avoidance and Traffic Awareness Systems, 1.4.4 Accident Aircraft Equipment, 1.11.6 ADS-B In CDTI and ACAS X Simulations, and 2.5 ADS-B and Collision Avoidance Technologies. Information supporting (b)(1) can be found on pages 34-37, 147-149, 240-242, and 270-273; (b)(2) and (b)(3) are not applicable.

A-26-37
Create an objective definition of close proximity encounter and a public database of those encounters and their locations that can be used to monitor their prevalence and identify areas of potential traffic conflict for safety assurance and safety risk management.

Information that addresses the requirements of 49 *USC* 1117(b), as applicable, can be found in sections 1.14 Flight Safety Data and 2.6.1 Indicators of Midair Collision Risk. Information supporting (b)(1) can be found on pages 191-201 and 274-277; (b)(2) and (b)(3) are not applicable.

A-26-38
Develop and implement a process that will, in a timely manner, notify involved parties after events such as near midair collisions or traffic alert and collision avoidance system resolution advisory activations, such that notification occurs while relevant data remain available and before meaningful safety analysis, reporting, or corrective action is no longer practicable.

Information that addresses the requirements of 49 *USC* 1117(b), as applicable, can be found in sections 1.14 Flight Safety Data and 2.6.2 Safety Information Sharing. Information supporting (b)(1) can be found on pages 191-192, 203, and 277-278; (b)(2) and (b)(3) are not applicable.

A-26-39
Based on the results of the audit recommended in Safety Recommendation A-26-56,ensure that all SMS functions and data sharing activities at all air traffic control facilities are conducted in collaboration with all relevant external stakeholders.

Information that addresses the requirements of 49 *USC* 1117(b), as applicable, can be found in sections 1.12.3 Federal Aviation Administration, 1.13.5, Federal Aviation Administration SMS, and 2.6.3 FAA Air Traffic Organization Safety Management System. Information supporting (b)(1) can be found on pages 182-185 and 278-280; (b)(2) and (b)(3) are not applicable.

A-26-40
Establish a requirement across all air traffic control tower standard operating procedures that the operations supervisor (OS) or controller-in-charge (CIC) document in the daily facility log when any control position is combined with the local control position, or when the OS/CIC position is combined with a control position, along with a rationale for doing so.

Information that addresses the requirements of 49 *USC* 1117(b), as applicable, can be found in sections 1.7.6.1, Combined Control Positions, 2.2.1, Controller Performance, and 2.6.3.1, Safety Risk Management and Safety Assurance. Information supporting (b)(1) can be found on pages 69-71, 223-230, and 280-282; (b)(2) and (b)(3) are not applicable.

To the US Army

A-26-41
Revise training procedures for flight crews assigned to operate in the Washington, DC, area to ensure that they receive initial and recurrent training on fixed-wing operations at Ronald Reagan Washington National Airport, including approach and departure paths, runway configurations, and the interaction of those traffic flows with published helicopter routes.

Information that addresses the requirements of 49 *USC* 1117(b), as applicable, can be found in sections 1.6 Helicopter Routes; 1.7 Airport Information; 2.2.2.2 Flight Crew Performance. Information supporting (b)(1) can be found on pages 51-54, 263, 240-242, and 266-267; (b)(2) and (b)(3) are not applicable.

A-26-42
Develop and implement a recurring procedure, at an interval not to exceed 18 months, to verify the continued accuracy of recorded flight data .

Information that addresses the requirements of 49 *USC* 1117(b), as applicable, can be found in sections 1.8 Flight Recorders; 1.11 Tests and Research; 1.14.3 Aircraft Position Data. Information supporting (b)(1) can be found on pages 94 and 149-150 and 242-244; (b)(2) and (b)(3) are not applicable.

A-26-43
Incorporate information within the appropriate operator's manual for all applicable aircraft on the potential total error allowed by design that could occur in flight on an otherwise airworthy barometric altimeter, including the increased position error associated with the ESSS configuration

Information that addresses the requirements of 49 *USC* 1117(b), as applicable, can be found in sections 1.3.2.3 UH-60L Altimeters; 1.9.3.1 Helicopter Altimeters; 1.11.3.1 Altitude Measurements; 2.2.2.3 Helicopter Altimetry. Information supporting (b)(1) can be found on pages 103, 117-121, and 242-244; (b)(2) and (b)(3) are not applicable.

A-26-44
Develop and implement a transponder inspection procedure on all aircraft with transponders capable of transmitting Mode S and Automatic Dependent Surveillance—Broadcast (ADS-B) and operated in the National Airspace System (NAS), at least annually and upon each aircraft's entry into service in the NAS, that ensures 1) the transponder ADS-B settings are correct, 2) the transponder is transmitting ADS-B, and 3) the transponder is transmitting the correctly assigned address.

Information that addresses the requirements of 49 *USC* 1117(b), as applicable, can be found in sections 1.3.2.1 UH-60L Transponder; 1.4.4.1 Accident Helicopter ADS-B History; 1.11.7 ADS-B Out Anomaly with 12th Aviation Battalion Helicopters; 2.2.2.4 Helicopter Transponder. Information supporting (b)(1) can be found on pages 37-39, 149-150, and 244-246; (b)(2) is not applicable; and information supporting (b)(3) can be found on pages 218-219.

A-26-45
Establish a flight data monitoring program for rotary-wing aircraft the US Army operates in the National Airspace System.

Information that addresses the requirements of 49 *USC* 1117(b), as applicable, can be found in sections 1.13.4 Army Safety Program; 1.14 Flight Safety Data; 2.6.4 US Army Safety Assurance. Information supporting (b)(1) can be found on pages 169-170, 180-181, 193, and 284-287; (b)(2) and (b)(3) are not applicable.

A-26-46
Survey US Army helicopter pilots to identify barriers to the utilization of flight safety reporting systems, develop a plan to address the identified barriers, and implement that plan across Army aviation units.

Information that addresses the requirements of 49 *USC* 1117(b), as applicable, can be found in sections 1.14.2 US Army Mishap and Near Miss Reports; 1.13.4 Army Safety Program; 2.6.5 US Army Safety Culture. Information supporting (b)(1) can be found on pages 169-170, 177-180, and 285-286; (b)(2) and (b)(3) are not applicable.

A-26-47
Revise the method for allocating resources to ensure the development of a robust safety management system that will, at a minimum, identify and monitor the potential for midair collisions between Army aircraft and civil air traffic operating in the National Airspace System.

Information that addresses the requirements of 49 *USC* 1117(b), as applicable, can be found in sections 1.13.4 Army Safety Program, 1.14.2 US Army Mishap and Near Miss Reports, and 2.6.5 US Army Safety Culture. Information supporting (b)(1) can be found on pages 286-289; (b)(2) and (b)(3) are not applicable.

A-26-48
Develop and maintain a flight safety management capability that is independently resourced and functionally separate from its occupational and environmental health management system, and ensure that this capability is both culturally and functionally integrated with units conducting sustained flight operations in the National Airspace System.

Information that addresses the requirements of 49 *USC* 1117(b), as applicable, can be found in sections 1.13.4 Army Safety Program, 1.13.4.1 TAAB Safety Program Structure and Administration, 2.6.4 US Army Safety Assurance, and 2.6.5 US Army Safety Culture. Information supporting (b)(1) can be found on pages 172-173, 284-289; (b)(2) and (b)(3) are not applicable.

To the Department of War Policy Board for Federal Aviation

A-26-49
Conduct a study to evaluate the quality of radio transmissions and reception for those aircraft operated within the National Airspace System to identify factors that degrade communications equipment performance and adversely affect the safety of civilian and military flight operations.

Information that addresses the requirements of 49 *USC* 1117(b), as applicable, can be found in sections 1.1 History of Flight and 2.2.2.1 Helicopter Radio Quality. Information supporting (b)(1) can be found on pages 3, and 236-237; (b)(2) and (b)(3) are not applicable.

A-26-50
Implement appropriate enhancements, based on the findings of the study recommended in Safety Recommendation A-26-49 to remediate identified deficiencies in air–ground radio communications performance.

Information that addresses the requirements of 49 *USC* 1117(b), as applicable, can be found in sections 1.1 History of Flight and 2.2.2.1 Helicopter Radio Quality. Information supporting (b)(1) can be found on pages 3, and 236-237; (b)(2) and (b)(3) are not applicable.

A-26-51
Require the Department of War to verify on all aircraft with transponders capable of transmitting Mode S and Automatic Dependent Surveillance—Broadcast (ADS-B) and operated in the National Airspace System (NAS), at least annually and upon each aircraft's entry into service in the NAS, that 1) the transponder ADS-B settings are correct, 2) the transponder is transmitting ADS B, and 3) the transponder is transmitting the correctly assigned address.

Information that addresses the requirements of 49 *USC* 1117(b), as applicable, can be found in sections 1.4.4.1 Accident Helicopter ADS-B History, 1.11.7 ADS-B Out Anomaly with 12th Aviation Battalion Helicopters, and 2.5 ADS-B and Collision Avoidance Technologies. Information supporting (b)(1) can be found on pages 38-39, 149-150, and 244-246; (b)(2) and (b)(3) are not applicable.

A-26-52
Require armed services to amend their operational procedures to allow flight crews to enable Automatic Dependent Surveillance—Broadcast (ADS-B) Out while in flight.

Information that addresses the requirements of 49 *USC* 1117(b), as applicable, can be found in sections 1.1 History of Flight, 1.4.4.1 Accident Helicopter ADS-B History, 1.11.7 ADS-B Out Anomaly with 12th Aviation Battalion Helicopters, and 2.5 ADS-B and Collision Avoidance Technologies. Information supporting (b)(1) can be found on pages 38-39, 149-150, and 244-246; (b)(2) and (b)(3) are not applicable.

A-26-53
Require all military aircraft operating in the National Airspace System (NAS) be equipped with Automatic Dependent Surveillance—Broadcast (ADS-B) In with a cockpit display of traffic information that is configured to provide audible alerting to the pilot and/or flight crew, and that such requirement apply wherever in the NAS the Federal Aviation Administration requires any aircraft to operate with ADS-B Out.

Information that addresses the requirements of 49 *USC* 1117(b), as applicable, can be found in sections 1.4 Automatic Dependent Surveillance–Broadcast and Collision Avoidance Technologies, 1.11.6 ADS-B In CDTI and ACAS X Simulations, and 2.5 ADS-B and Collision Avoidance Technologies. Information supporting (b)(1) can be found on pages 25-28, 37-39, 142-147, 240-242, and 267-273; (b)(2) and (b)(3) are not applicable.

To the Department of Transportation

A-26-54
Require the Federal Aviation Administration to demonstrate at least annually that each air traffic control facility it operates has the routine capability to accomplish required postaccident and postincident drug and alcohol testing within the US Department of Transportation's specified timeframes of 2 hours for alcohol and 4 hours for drugs, and implement a process to ensure that any facility without such capability will demonstrate timely remediation.

Information that addresses the requirements of 49 *USC* 1117(b), as applicable, can be found in sections 1.10.4 Controller Postaccident Drug and Alcohol Testing; 1.16 Postaccident Safety Actions; 1.16.1.1 Federal Aviation Administration; and 2.3.5 Postaccident Drug and Alcohol Testing. Information supporting (b)(1) can be found on pages 106-110 and 259-263; (b)(2) and (b)(3) are not applicable.

A-26-55
Work with the FAA Administrator to convene an independent panel to conduct a comprehensive review of the safety culture within the Federal Aviation Administration's Air Traffic Organization (ATO), and use the findings to enhance the ATO's existing safety management system and integrate it into all levels of the organization.

Information that addresses the requirements of 49 *USC* 1117(b), as applicable, can be found in sections 1.13.5 Federal Aviation Administration SMS, and 2.6.3 FAA Air Traffic Organization Safety Management System. Information supporting (b)(1) can be found on pages 185-189 and 282-284; (b)(2) and (b)(3) are not applicable.

To the Department of Transportation Office of Inspector General

A-26-56
Complete an audit of the Federal Aviation Administration (FAA) Air Traffic Organization's safety management system functions and data sharing activities at all air traffic control facilities and determine whether these activities are conducted in collaboration with all relevant external stakeholders, ensuring that the audit's results are documented, reported to the Secretary of Transportation and FAA Administrator, and made available to the public.

Information that addresses the requirements of 49 *USC* 1117(b), as applicable, can be found in sections 1.12.3 Federal Aviation Administration, 1.13.2 Organizational Safety Theory and Safety Culture; 1.13.5, Federal Aviation Administration SMS, and 2.6.3 FAA Air Traffic Organization Safety Management System. Information supporting (b)(1) can be found on pages 163-164, 182-185, and 278-282; (b)(2) and (b)(3) are not applicable.

To the RTCA Program Management Committee

A-26-57
Finalize and publish the minimum operational performance standards for ACAS Xr for rotorcraft.

Information that addresses the requirements of 49 *USC* 1117(b), as applicable, can be found in sections 1.4.2 Airborne Collision Avoidance and Traffic Awareness Systems, 1.4.4 Accident Aircraft Equipment, 1.11.6 ADS-B In CDTI and ACAS X Simulations, and 2.5 ADS-B and Collision Avoidance Technologies. Information supporting (b)(1) can be found on pages 34-37, 147-149, 240-242, and 270-273; (b)(2) and (b)(3) are not applicable.

Appendix C: Cockpit Voice Recorders and Air Traffic Control Combined Transcript

A partial combined transcript was generated to more clearly show how the three recordings aligned and which radio communications were audible to each crew in the minutes leading up to the collision.

Description of Combined Transcript

The combined transcript from the helicopter and Washington Tower began at 20:30:18 EST when the helicopter attempted to check in with Washington Tower. The transcript from the airplane began at 20:43:06 EST when the airplane crew checked in with Washington Tower.

The transcript is formatted in three columns such that the UH-60L helicopter CVR transcript is on the left (labeled PAT-25 (Helicopter) CVR), the Washington Tower recording transcript is in the center (labeled DCA Tower Recording), and the CRJ airplane CVR transcript is on the right (labeled JIA5342 (Airplane) CVR).

PAT-25 (Helicopter) CVR	DCA Tower Recording	JIA5342 (Airplane) CVR
All radio transmissions and all internal communications and sounds recorded on the CVR.	Radio transmissions sent from and received by the DCA Tower local controller.	All radio transmissions and all internal communications and sounds recorded on the CVR.

The combined transcript illustrates which radio transmissions were audible to each entity. Helicopters and fixed-wing aircraft were communicating with Washington Tower on different frequencies at the time of the accident, so transmissions made from helicopters were not audible to fixed-wing aircraft, and transmissions made from fixed-wing aircraft were not audible to helicopters. However, Washington Tower transmissions were transmitted on both frequencies and were audible to both helicopters and fixed-wing aircraft. Occasionally multiple entities attempted to transmit simultaneously, resulting in interrupted or “stepped on” transmissions.

Common air traffic control transmissions audible to others on frequency are shown on the same line and outlined.

Note, crew internal communications frequently overlapped with radio transmissions, even though they appear on different lines in the transcript.

Transcription Process

A CVR group consists of representatives from parties to the investigation convening at the NTSB Vehicle Recorder laboratory to review the CVR audio and produce a factual transcript of recorded words and sounds. If the group cannot understand or reach a consensus about a word or sound, it is noted as an unintelligible word or a questionable insertion.

The airplane and helicopter CVRs were transcribed by separate, independent NTSB groups. Phrases may differ between transcripts for several reasons, including:

- Transmissions being "stepped on" by other radio traffic.
- Internal conversations between the crew, obscuring radio calls.
- Static or poor-quality sound produced by the radio.
- Alerts or other ambient sounds in the flight deck blocking radio calls.
- Groups interpreting words differently during the transcription process.

Timing and Correlation

The timing on each CVR transcript was established using a combination of FDR data, ADS-B Data, and radio transmissions. For more information on the timing of each transcript see the individual transcript reports in the docket.

The ATC recording file included a time code which was used to align the transcript with the CVR transcripts. Due to the manual transcription process, the beginning time of some transmissions may vary by a few tenths of a second. There are also cases where the first words of a transmission were not audible on the receiving side, leading to a difference in the timing of the transmission.

All times were offset to reflect the local eastern standard time (EST) of the accident. Times are given in EST for the remainder of this report.

The following is a transcript of communications transmitted on the DCA Air Traffic Control Tower frequencies and conversations internal to the aircraft involved in the accident on January 29, 2025, in Washington, DC.

LEGEND	
AAL1630	Radio transmission from American 1630
AAL1733	Radio transmission from American 1733
AAL3130	Radio transmission from American 3130
AAL472	Radio transmission from American 472
ARCR1	Radio transmission from helicopter callsign AirCare 1
ASH6149	Radio transmission from AirShuttle 6149
BLJK1	Radio transmission from helicopter callsign Blackjack 1
CAM	Voice or sound heard on the cockpit area microphone on JIA5342
DAL832	Radio transmission from Delta 832
DCA-LC[180]	Radio transmission from DCA Air Traffic Control Tower Local Control, as captured by ATC recording
EGPWS	Enhanced ground proximity warning system on JIA5342
ENY3771	Radio transmission from Envoy 3771
FPS	Aural alert from the Flight Path Stabilization System on PAT-25
HOT	Flight crew audio panel voice or sound source on JIA5342
INT	Flight crew intercom audio panel voice or sound source on PAT-25
JBU2355	Radio transmission from JetBlue 2355
JIA5025	Radio transmission from Bluestreak 5025
JIA5038	Radio transmission from Bluestreak 5038
JIA5057	Radio transmission from Bluestreak 5057
JIA5125	Radio transmission from Bluestreak 5125
JIA5164	Radio transmission from Bluestreak 5164
JIA5170	Radio transmission from Bluestreak 5170
JIA5247	Radio transmission from Bluestreak 5247
JIA5269	Radio transmission from Bluestreak 5269
JIA5286	Radio transmission from Bluestreak 5286
JIA5305	Radio transmission from Bluestreak 5305
JIA5307	Radio transmission from Bluestreak 5307
JIA5342	Radio transmission from Bluestreak 5342 (accident airplane)
JIA5608	Radio transmission from Bluestreak 5608
JIA5673	Radio transmission from Bluestreak 5673
JZA789	Radio transmission from Jazz 789

[180] DCA-LC and TWR-A attributions refer to the same individual. DCA-LC denotes the phrases as transmitted from the tower. TWR-A denotes the phrases as heard by the CVR on each aircraft.

MUSL12	Radio transmission from helicopter callsign Muscle 12
MUSL13	Radio transmission from helicopter callsign Muscle 13
MUSL7	Radio transmission from helicopter callsign Muscle 7
PAT25	Radio transmission from helicopter callsign PAT-25 (accident helicopter)
RDO	Radio transmission made by flight crew on PAT-25 or JIA5342, as captured by the CVR on each aircraft
RPA5752	Radio transmission from Brickyard 5752
SKW5800	Radio transmission from Skywest 5800
TCAS	Traffic Alert and Collision Avoidance System on JIA5342
TWR-A[181]	Radio transmission from DCA Air Traffic Control Tower Local Controller, as received by PAT-25 and JIA5342
UAL1531	Radio transmission from United 1531
UAL2472	Radio transmission from United 2472
-1	Voice identified as the instructor pilot on PAT-25 or the Captain on JIA5342
-2	Voice identified as the pilot being evaluated on PAT-25 or the First Officer on JIA5342
-3	Voice identified as the helicopter crew chief on PAT-25
*****	Unintelligible word
#	Expletive
@	Non-pertinent word
( )	Questionable insertion
[ ]	Editorial insertion

Note 1: Times are expressed in EST.

Note 2: Words shown with excess vowels, letters, or drawn out syllables are a phonetic representation of the words as spoken.

Note 3: Radio transmissions that are noted as broken have periods of no audio or radio static during the transmission. Unintelligible words in radio transmissions that are not noted as broken are generally due to poor radio reception, crew conversation, or other noise preventing understanding.

181 DCA-LC and TWR-A attributions refer to the same individual. DCA-LC denotes the phrases as transmitted from the tower. TWR-A denotes the phrases as heard by the CVR on each aircraft.

Time and Source	PAT-25 (Helicopter) CVR	Time and Source	DCA Tower Recording	Time and Source	JIA5342 (Airplane) CVR
20:30:18.0 START OF COMBINED TRANSCRIPT					
		20:30:18.0 DCA-LC	thank you Bluestreak fifty six seventy three winds are three two zero at one six gusts two five traffic on runway one will hold short of your intersection runway three three cleared for takeoff.		
20:30:19.1 RDO-2	Washington Tower PAT two five U-H sixty off of Montgomery requesting flight following back to Davison.				
20:30:27.2 INT-2	wow not flight following *.				
		20:30:27.6 JIA5673	cleared for takeoff runway three three Bluestreak fifty six seventy three.		
20:30:28.1 INT-1	ha.				
20:30:33.7 INT-2	hopefully they didn't hear that but they probably did. [sound of quick laugh]				
20:30:41.5 INT-1	they just said uh we'll ignore that.				
20:30:43.7 INT-2	yeah. I don't hear any traffic on there though. we don't need to talk to them yet.				

Time and Source	PAT-25 (Helicopter) CVR	Time and Source	DCA Tower Recording	Time and Source	JIA5342 (Airplane) CVR
20:30:49.4 TWR-A	* in sight departing runway three three maintain-maintain visual separation.	20:30:48.6 DCA-LC	Skywest fifty eight hundred do you have the departed C-R-J in sight runway three three and can main— maintain visual separation.		
20:30:54.7 INT-2	we're below twenty five hundred.				
20:30:55.9 TWR-A	* * *.	20:30:55.5 DCA-LC	actually disregard Skywest fifty eight hundred.		
20:30:56.6 INT-1	yup.				
		20:30:57.4 SKW5800	Skywest fifty eight hundred.		
20:30:58.4 TWR-A	disregard Southwest * * runway runway one.	20:30:58.4 DCA-LC	uh disregard so Southwest fifty eight hundred continue holding position runway— runway one.		
		20:31:02.3 SKW5800	hold position runway one Skywest fifty eight hundred.		
20:31:05.0 TWR-A	Bluestreak fifty six seventy three contact Potomac.	20:31:04.9 DCA-LC	Bluestreak fifty six seventy three contact Potomac Departure.		
		20:31:07.4 JIA5673	(to) departure Bluestreak fifty six seventy three.		

Time and Source	PAT-25 (Helicopter) CVR	Time and Source	DCA Tower Recording	Time and Source	JIA5342 (Airplane) CVR
20:31:08.1 RDO	[sound similar to twelve mic clicks, consistent with operating PCL]				
20:31:10.9 INT-2	more lights.				
20:31:13.5 INT-1	I was trying to find it. this time for real.				
20:31:20.6 INT-2	* at the back right of the aircraft.				
20:31:24.9 INT-1	yeah there it is.				
20:31:25.4 TWR-A	Skywest * traffic on a two mile final for runway three three no delay runway one clear for takeoff.	20:31:25.4 DCA-LC	Skywest fifty eight hundred traffic on a two mile final for runway three three. no delay. runway one cleared for takeoff.		
20:31:28.0 INT-1	there's fifteen hundred feet.				
20:31:30.4 INT-2	okay. * altitude. fifteen hundred's good.				
		20:31:31.1 SKW5800	runway one cleared for takeoff no delay Skywest fifty eight hundred.		
20:31:33.9 TWR-A	Bluestreak fifty two sixty nine Washington Tower runway one line up and wait traffic landing three three.	20:31:33.8 DCA-LC	Bluestreak fifty two sixty nine Washington Tower runway one line up and wait traffic lands runway three three.		

Time and Source	PAT-25 (Helicopter) CVR	Time and Source	DCA Tower Recording	Time and Source	JIA5342 (Airplane) CVR
		20:31:38.2 JIA5269	runway one line up and wait Bluestreak fifty two sixty nine.		
20:31:39.2 INT-2	alright number one needle. I'll try them again.				
20:31:42.2 INT-1	alright coming right on the number one.				
20:32:00.1 RDO-2	National Tower PAT two five requesting Cabin John route one route four Davison.	20:32:00.2 PAT25	National Tower PAT two five requesting Cabin John route one route four Davison. [loud static during transmission]		
20:32:09.2 TWR-A	PAT two five Washington Tower * two niner eight nine say position. [transmission broken]	20:32:09.2 DCA-LC	PAT two five Washington Tower National altimeter two niner eight nine uh say position.		
20:32:13.9 RDO-2	two niner eight nine PAT two five proceed as requested	20:32:14.0 PAT25	two niner eight nine PAT two five proceed as requested. [loud static during transmission]		
20:32:18.2 INT-2	alright. is he pretty muffled?				
20:32:19.0 TWR-A	Skywest fifty eight * contact departure.	20:32:18.9 DCA-LC	Skywest fifty eight hundred contact Potomac Departure.		
		20:32:21.3 SKW5800	over to departure Skywest fifty eight hundred.		

Time and Source	PAT-25 (Helicopter) CVR	Time and Source	DCA Tower Recording	Time and Source	JIA5342 (Airplane) CVR
20:32:23.7 INT-1	yeah. I definitely didn't catch what he said. I'm glad you did.				
20:32:28.8 INT-2	I don't know if that last one * not. * before that though.				
20:32:38.9 INT-2	huh. volume's at eighteen its loud enough.				
20:32:44.4 TWR-A	Bluestreak fifty two sixty nine winds are three one direct one eight gust two six * * takeoff. [transmission broken]	20:32:44.4 DCA-LC	Bluestreak fifty two sixty nine winds are three one zero at one eight gusts two six runway one cleared for takeoff.		
20:32:49.5 INT-1	okay ma'am you can fly. sounds like you've communicated all that needs to be communicated.				
		20:32:50.5 JIA5269	runway one cleared for takeoff Bluestreak fifty two sixty nine.		
20:32:53.0 TWR-A	Bluestreak * *.	20:32:53.0 DCA-LC	Bluestreak fifty thirty eight left turn at sierra or at the end ground point seven.		
20:32:54.0 INT-2	okay sounds good. do you want me to fly?				
20:32:55.9 INT-1	sure.				
20:32:56.5 INT-2	alright I have flight controls.				

Time and Source	PAT-25 (Helicopter) CVR	Time and Source	DCA Tower Recording	Time and Source	JIA5342 (Airplane) CVR
		20:32:57.2 JIA5038	uh left turn at the end and ground point seven Bluestreak fifty thirty eight.		
20:32:57.3 INT-1	you do have flight controls.				
20:32:58.1 INT-2	yup.				
		20:33:00.6 DCA-LC	Bluestreak five zero two five Washington Tower runway one line up and wait traffic lands runway three three.		
		20:33:06.6 JIA5025	* runway one line up and wait Bluestreak five zero two five.		
20:33:09.6 INT-1	right front's inside.				
		20:33:09.9 DCA-LC	Bluestreak fifty two eighty six Washington Tower runway one cleared to land traffic departs prior to your arrival.		
20:33:11.4 INT-2	rog.				
		20:33:14.5 JIA5286	cleared to land one Bluestreak fifty two eighty six.		
20:33:16.6 TWR-A	PAT two five Washington Tower IDENT.	20:33:16.5 DCA-LC	PAT two five Washington Tower IDENT.		

Time and Source	PAT-25 (Helicopter) CVR	Time and Source	DCA Tower Recording	Time and Source	JIA5342 (Airplane) CVR
20:33:19.4 RDO-1	there goes PAT two five.	20:33:19.5 PAT25	there goes PAT two five. [loud static during transmission]		
20:33:21.6 INT-2	IDENT.				
		20:33:21.6 UAL1531	tower United fifteen thirty one's with you just inside KATRN.		
20:33:24.6 TWR-A	* * * squawk * * gust two six runway one. [transmission broken]	20:33:24.6 DCA-LC	United fifteen thirty one Washington Tower winds are three one zero at one niner gusts two six. runway one cleared to land.		
		20:33:31.1 UAL1531	cleared to land runway one United fifteen thirty one.		
20:33:33.4 TWR-A	PAT * * north of the * say your request. [transmission broken]	20:33:33.3 DCA-LC	PAT two five radar contact six miles north of Bethesda at one thousand five hundred feet uh say again your request.		
20:33:41.1 RDO-1	PAT two five is looking for Cabin John route one to route four to Davison.	20:33:41.2 PAT25	PAT two five is looking for Cabin John route one route four to Davison. [loud static during transmission]		
20:33:46.7 TWR-A	PAT two five approved.	20:33:46.6 DCA-LC	PAT two five approved.		

Time and Source	PAT-25 (Helicopter) CVR	Time and Source	DCA Tower Recording	Time and Source	JIA5342 (Airplane) CVR
20:33:48.1 RDO-1	approved two five.	20:33:48.1 DCA-LC	Bluestreak fifty two sixty nine contact Potomac Departure. [transmission made simultaneously to transmission from PAT-25]		
20:33:49.2 TWR-A	* contact departure.				
		20:33:50.9 JIA5269	over to departure see ya Bluestreak fifty two sixty nine.		
20:33:51.0 INT-2	*.				
		20:33:52.8 DCA-LC	see ya.		
20:34:03.6 BLJK1	* * zone two * route one heading boardwalk. [transmission broken]	20:34:02.6 BLJK1	National Tower Blackjack one approaching Woods Corner request zone three zone two split the p's route one Pentagon boardwalk.		
20:34:13.9 TWR-A	Blackjack one Washington Tower standby.	20:34:13.9 DCA-LC	Blackjack one Washington Tower standby.		
20:34:16.6 BLJK1	*.	20:34:16.5 BLJK1	Blackjack one.		
20:34:17.8 INT-1	right front's back outside.				
20:34:18.5 INT-2	com sounds really crappy.				

Time and Source	PAT-25 (Helicopter) CVR	Time and Source	DCA Tower Recording	Time and Source	JIA5342 (Airplane) CVR
20:34:21.0 INT-2	do they have a U-H-F?				
20:34:21.7 TWR-A	* winds are three two * * mile final runway one *. [transmission broken]	20:34:21.3 DCA-LC	Bluestreak fifty twenty five winds are three two zero at one six gusts two six traffic three mile final runway one cleared for takeoff.		
20:34:24.3 INT-2	we got a master caution for the aux fuel.				
20:34:26.2 INT-1	roger. what'd you say right before that?				
		20:34:27.5 JIA5025	runway one cleared for takeoff Bluestreak fifty twenty five.		
20:34:30.0 INT-2	oh I was gonna do they have a U-H-F...or don't they?				
20:34:30.7 TWR-A	Bluestreak fifty * left uh left turn at sierra.	20:34:30.7 DCA-LC	Bluestreak fifty six zero eight left turn at uh left turn at sierra ground point seven.		
20:34:32.3 INT-1	um...				
		20:34:35.7 JIA5608	left sierra ground point seven good night Bluestreak fifty six oh eight.		
20:34:35.9 INT-2	he still sounds really crappy.				
20:34:37.3 INT-1	...they do but uh I don't know if they use it.				

Time and Source	PAT-25 (Helicopter) CVR	Time and Source	DCA Tower Recording	Time and Source	JIA5342 (Airplane) CVR
20:34:37.8 TWR-A	Brickyard * * cross runway three three * *. [transmission broken]	20:34:37.8 DCA-LC	good night. Brickyard forty seven fifty two Washington Tower runway three three line up and wait traffic lands runway one.		
20:34:39.2 INT-2	master caution for the aux fuel.				
20:34:42.8 INT-1	roger.				
		20:34:43.0 RPA5752	runway three three line up and wait Brickyard fifty seven fifty two.		
20:34:45.9 TWR-A	and Blackjack one you said you want to do zone three zone four?	20:34:45.9 DCA-LC	and Blackjack one you said you want to do zone three zone four?		
20:34:50.1 BLJK1	tower for Blackjack one request zone three zone two split the p's followed by route one * *. [transmission broken]	20:34:50.2 BLJK1	tower for Blackjack one request zone three zone two split the p's followed by route one pentagon track boardwalk. [transmission stepped on by simultaneous transmission from airplane frequency]		
		20:34:53.3 UAL1531	United fifteen thirty one we're slowin' to final. [transmission made during previous helicopter transmission]		
		20:35:00.4 UAL2472	tower twenty four seventy two uh Mount Ver—Vernon Visual one.		

Time and Source	PAT-25 (Helicopter) CVR	Time and Source	DCA Tower Recording	Time and Source	JIA5342 (Airplane) CVR
20:35:03.9 TWR-A	Blackjack one approved report landing assured.	20:35:03.9 DCA-LC	Blackjack one approved report landing assured.		
20:35:07.0 BLJK1	Blackjack one approved.	20:35:07.0 BLJK1	Blackjack one approved.		
20:35:08.1 INT-1	split the p's what?				
20:35:09.4 TWR-A	Bluestreak fifty twenty five contact departure.	20:35:09.3 DCA-LC	Bluestreak fifty twenty five contact Potomac Departure.		
20:35:10.4 INT-2	*.				
		20:35:11.3 JIA5025	departure good night Bluestreak fifty twenty five.		
20:35:12.3 INT-2	I thought they didn't want us doing that.				
20:35:13.4 TWR-A	good night. * * *.	20:35:13.4 DCA-LC	good night. * four seventy two Wash Tower you say you're on frequency.		
20:35:13.9 INT-1	Blackjack out here running amok.				
20:35:17.1 INT-2	[sound of laugh]				
20:35:19.3 MUSL12	tower Muscle twelve request zone four.	20:35:19.4 MUSL12	tower Muscle twelve request zone four.		

Time and Source	PAT-25 (Helicopter) CVR	Time and Source	DCA Tower Recording	Time and Source	JIA5342 (Airplane) CVR
		20:35:21.4 UAL2472	tower United twenty four seventy two on visual one.		
20:35:24.0 TWR-A	* Washington Tower winds are three two direct one six gust six traffic * arrival runway one *. [transmission broken]	20:35:23.9 DCA-LC	United twenty four seventy two Washington Tower winds are three two zero at one six gusts two six traffic departs prior to your arrival runway one cleared to land.		
		20:35:32.3 UAL2472	cleared to land United twenty four seventy two.		
20:35:34.3 TWR-A	Muscle twelve you said zone four?	20:35:34.3 DCA-LC	Muscle twelve you said zone four?		
20:35:35.7 MUSL12	a-firm.	20:35:35.8 MUSL12	a-firm.		
20:35:36.8 TWR-A	Muscle twelve zone four approved.	20:35:36.8 DCA-LC	Muscle twelve zone four approved.		
20:35:38.4 MUSL12	* * twelve. [transmission broken]	20:35:38.5 MUSL12	copy. Muscle twelve.		
		20:35:52.1 JIA5247	tower Bluestreak fifty two forty seven is with you M-T-V one.		
		20:36:07.9 JIA5247	tower Bluestreak fifty two forty seven M-T-V one. [transmission broken]		

Time and Source	PAT-25 (Helicopter) CVR	Time and Source	DCA Tower Recording	Time and Source	JIA5342 (Airplane) CVR
20:36:10.8 TWR-A	Bluestreak * forty seven Washington Tower winds are three two * * *. [transmission broken]	20:36:10.8 DCA-LC	Bluestreak fifty two forty seven Washington Tower winds are three two zero at one six gusts two six runway one cleared to land traffic departs prior to you.		
		20:36:18.0 JIA5247	runway one cleared to land Bluestreak fifty two forty seven.		
20:36:22.3 TWR-A	Bluestreak * * turn left *. [transmission broken]	20:36:22.3 DCA-LC	Bluestreak fifty two (eighty) six if able turn left on mike ground point seven.		
		20:36:28.0 JIA5286	alright mike. ground point seven Bluestreak fifty two eighty s—.		
20:36:35.8 TWR-A	Brickyard * * hold position runway three three * one more arrival off runway one. [transmission broken]	20:36:35.8 DCA-LC	Brickyard fifty seven fifty two continue to hold position runway three three there'll be one more arrival off runway one.		
		20:36:41.2 RPA5752	alright we'll continue holding on runway three three Brickyard fifty seven fifty two.		
20:36:41.3 INT-1	just for your awareness I put them in two.				
20:36:44.5 INT-2	okay thanks.				
20:36:46.4 INT-1	see if it'll pick them up a little better.				

Time and Source	PAT-25 (Helicopter) CVR	Time and Source	DCA Tower Recording	Time and Source	JIA5342 (Airplane) CVR
20:36:51.2 INT-1	you are five K from Cabin John I'm sure you have it in sight.				
20:36:56.4 INT-2	I believe that's it that bridge.				
20:36:58.4 INT-1	a-firm.				
20:37:18.9 TWR-A	Blackjack one do you have uh Muscle thirteen just two miles north of you one thousand one hundred feet? [sounds of rapid beeping consistent with conflict alert audible in background while tower is transmitting]	20:37:18.9 DCA-LC	Blackjack one do you have uh Muscle thirteen just two miles north of you one thousand one hundred feet? [sounds of rapid beeping consistent with conflict alert audible in background]		
20:37:26.1 TWR-A	Muscle thirteen traffic just (four) miles south of you Blackjack one. [transmission broken]	20:37:26.1 DCA-LC	Muscle thirteen traffic just * mile south of you is Blackjack one nine hundred feet.		
20:37:29.7 MUSL13	Muscle thirteen searching for traffic.	20:37:29.7 MUSL13	and Muscle thirteen looking for traffic. [loud static heard in background]		
20:37:31.1 BLJK1	visual sep.	20:37:31.4 BLJK1	maintain visual sep.		
20:37:32.2 TWR-A	visual separation approved Blackjack one.	20:37:32.2 DCA-LC	visual separation approved Blackjack one.		

Time and Source	PAT-25 (Helicopter) CVR	Time and Source	DCA Tower Recording	Time and Source	JIA5342 (Airplane) CVR
20:37:34.0 TWR-A	* fifteen thirty one left turn november ground point seven.	20:37:33.9 DCA-LC	United fifteen thirty one left turn november ground point seven.		
		20:37:37.0 UAL1531	left november ground point seven United fifteen thirty one.		
20:37:39.1 TWR-A	Brickyard fifty seven * winds are three two direct one three gust two six traffic on a two mile final for runway one no delay runway three three clear for takeoff.	20:37:39.1 DCA-LC	Brickyard fifty seven fifty two winds are three two zero at one three gusts two six traffic two mile final for runway one. no delay. runway three three cleared for takeoff.		
		20:37:47.2 RPA5752	runway three three and cleared for takeoff Brickyard fifty seven fifty two.		
20:37:50.2 TWR-A	and Muscle thirteen do you (see/have) that Blackjack in sight?	20:37:50.2 DCA-LC	and Muscle thirteen did you have Blackjack in sight?		
20:37:53.2 MUSL13	negative for Muscle thirteen still searching.	20:37:53.3 MUSL13	negative for Muscle thirteen still searching. [loud static in background]		
20:37:55.1 TWR-A	Blackjack correction Muscle thirteen traffic south * four miles south no factor * they're * eight hundred. [transmission broken]	20:37:55.1 DCA-LC	Blackjack correction Muscle thirteen traffic is now just one mile south of you no factor they're at currently at eight hundred feet.		

Time and Source	PAT-25 (Helicopter) CVR	Time and Source	DCA Tower Recording	Time and Source	JIA5342 (Airplane) CVR
20:38:02.1 MUSL13	Muscle thirteen still searching for traffic we'll be heading northbound * *.	20:38:02.1 MUSL13	Muscle thirteen (searching/still looking) for traffic we'll be headed northbound towards College Park. [loud static in background]		
20:38:04.0 INT-1	left seat's inside.				
20:38:05.5 INT-2	say again? you're good I got your scan.				
20:38:05.6 TWR-A	*.	20:38:05.4 DCA-LC	Muscle thirteen roger. [sounds of rapid beeping consistent with conflict alert audible in background]		
		20:38:10.2 JIA5170	tower Bluestreak fifty one seventy visual for runway three three.		
20:38:11.3 INT-2	thirteen at Cabin John.				
20:38:14.6 TWR-A	Bluestreak fifty one seventy Washington Tower winds are three two direct one three gust two six * *. [transmission broken]	20:38:14.6 DCA-LC	Bluestreak fifty one seventy Washington Tower winds are three two zero at one three gusts two six runway three three cleared to land.		
		20:38:20.2 JIA5170	alright three three cleared to land Bluestreak fifty one seventy.		
20:38:27.1 TWR-A	Brickyard fifty seven (fifty/sixty) two contact *.	20:38:27.1 DCA-LC	Brickyard fifty seven fifty two contact Potomac Departure.		

Time and Source	PAT-25 (Helicopter) CVR	Time and Source	DCA Tower Recording	Time and Source	JIA5342 (Airplane) CVR
		20:38:29.8 RPA5752	departure Brickyard fifty seven fifty two see ya.		
20:38:31.8 TWR-A	see ya.	20:38:31.8 DCA-LC	see ya.		
20:38:35.8 INT-1	what's up ma'am where we going?				
20:38:38.1 INT-2	down the river. uh route one to four.				
20:38:42.7 INT-1	uh you just took a right turn which is gonna take us back to Great Falls and *.				
20:38:46.4 TWR-A	Bluestreak fifty one twenty five * aircraft four mile final runway one line up and wait.	20:38:46.4 DCA-LC	Bluestreak fifty one twenty five tower traffic four mile final for runway one line up and wait.		
20:38:47.2 INT-2	oh excuse me. okay * I should be headed...alright. coming to the...left.				
		20:38:50.4 JIA5125	line up and wait runway one Bluestreak fifty one twenty five.		
20:38:57.4 INT-3	clear left.				
20:38:58.2 INT-1	I mean I'm all game for it but we just gotta let the dude know.				
20:39:00.8 INT-2	haha no totally fair.				

Time and Source	PAT-25 (Helicopter) CVR	Time and Source	DCA Tower Recording	Time and Source	JIA5342 (Airplane) CVR
20:39:04.6 INT-1	I am all game for goin to shake up some Great Falls at twenty feet tonight. we didn't brief it so we'll have to make a blood pact.				
20:39:10.5 INT-2	nope. right.				
20:39:11.4 TWR-A	* four seven two left turn at november one *. [transmission broken]	20:39:11.4 DCA-LC	United twenty four seventy two left turn at november one join juliet ground point seven.		
20:39:14.9 INT-1	alright a little right pedal. yeah that'll help it feel smoother.				
		20:39:16.2 UAL2472	* november one juliet ground point uh seven United twenty four seventy two.		
20:39:19.3 INT-2	let's see if it feels smoother.				
20:39:21.8 TWR-A	* keep your speed up * * right behind you. [transmission broken]	20:39:21.8 DCA-LC	if able just keep your speed up exiting the runway for traffic will roll right behind you.		
		20:39:25.4 UAL2472	roger keep speed up United twenty four seventy two.		
		20:39:27.1 DCA-LC	thank you.		
20:39:28.8 INT-2	I'm with it alright. *.				

Time and Source	PAT-25 (Helicopter) CVR	Time and Source	DCA Tower Recording	Time and Source	JIA5342 (Airplane) CVR
20:39:30.3 TWR-A	Bluestreak fifty one seventy two winds are three two direct one two gust two six traffic's on a four mile final without delay runway one clear for takeoff.	20:39:30.3 DCA-LC	Bluestreak fifty one seventy two winds are three two zero at one two gusts two six traffic on a four mile final. without delay runway one cleared for takeoff. [addressing Bluestreak 5125]		
		20:39:38.0 JIA5125	all clear for takeoff Bluestreak fifty one twenty five.		
20:39:45.3 MUSL12	tower Muscle twelve request uh direct back to Andrews.	20:39:45.4 MUSL12	tower Muscle twelve request uh direct back to Andrews. [loud static in background]		
		20:39:49.7 JBU2355	Washington Tower JetBlue twenty three fifty five visual one.		
20:39:53.7 TWR-A	Muscle twelve approved.	20:39:53.5 DCA-LC	Muscle twelve approved.		
20:39:55.4 MUSL12	Muscle twelve. and request freq change.	20:39:55.4 MUSL12	Muscle twelve. and request freq change. [loud static in background]		
20:39:58.2 TWR-A	* stand by for *. [transmission broken]	20:39:58.2 DCA-LC	(you'll have to) standby for handoff.		
20:39:59.9 MUSL12	copy.	20:39:59.9 MUSL12	copy. [loud static in background]		
20:40:06.2 INT-2	okay.				

Time and Source	PAT-25 (Helicopter) CVR	Time and Source	DCA Tower Recording	Time and Source	JIA5342 (Airplane) CVR
20:40:09.0 INT-1	alright down to thirteen hundred feet we're already a little low.				
20:40:11.7 INT-2	alright. oh wow yeah okay.				
20:40:16.8 INT-1	thirteen hundred feet to Chain Bridge at Chain Bridge down to seven hundred of the feets.				
20:40:18.8 INT-2	okay. yeah.				
20:40:21.1 INT-1	so we'll just maintain here we're already at seven.				
		20:40:21.3 JBU2355	Washington Tower JetBlue twenty three fifty five Mount Vernon Visual one.		
20:40:23.6 INT-2	okay.				
20:40:25.1 TWR-A	Muscle twelve contact Andrews Tower one one eight point four.	20:40:25.0 DCA-LC	Muscle twelve contact Andrews Tower one one eight point four.		
20:40:28.1 MUSL12	Muscle twelve switching thank you.	20:40:28.1 MUSL12	Muscle twelve switching thank you. [loud static in background]		

Time and Source	PAT-25 (Helicopter) CVR	Time and Source	DCA Tower Recording	Time and Source	JIA5342 (Airplane) CVR
20:40:29.9 TWR-A	you're welcome. Bluestreak fifty one seventy two contact departure.	20:40:29.9 DCA-LC	you're welcome. Bluestreak fifty one seventy two contact Potomac Departure. [addressing Bluestreak 5125]		
20:40:33.4 TWR-A	correction Bluestreak fifty one twenty five contact departure.	20:40:33.3 DCA-LC	correction Bluestreak fifty one twenty five contact Potomac Departure.		
		20:40:36.0 JIA5125	fifty one twenty five's goin' to departure see ya.		
20:40:38.0 TWR-A	*.	20:40:38.0 DCA-LC	see ya.		
20:40:40.8 TWR-A	Bluestreak fifty one sixty four Washington Tower * circle runway three three * traffic on a eight mile final for runway one line up and wait. [transmission broken]	20:40:40.9 DCA-LC	Bluestreak fifty one sixty four Washington Tower traffic four out circling for runway three three additional traffic on a eight mile final for runway one line up and wait.		
		20:40:48.5 JIA5164	runway one line up and wait Bluestreak fifty one sixty four.		
20:40:50.9 TWR-A	* twenty three fifty five Washington Tower winds are three two direct one four gust two six traffic * * arrivals runway one. [transmission broken]	20:40:50.9 DCA-LC	JetBlue twenty three fifty five Washington Tower winds are three two zero at one four gusts two six traffic departs prior to your arrival. runway one cleared to land.		
		20:40:58.8 JBU2355	cleared to land runway one JetBlue twenty three fifty five.		

Time and Source	PAT-25 (Helicopter) CVR	Time and Source	DCA Tower Recording	Time and Source	JIA5342 (Airplane) CVR
20:41:07.0 TWR-A	Bluestreak fifty two forty seven when able left turn november * three three.	20:41:07.0 DCA-LC	Bluestreak fifty two four seven if able left turn november if not left turn three three.		
		20:41:11.4 JIA5247	uh left on november Bluestreak fifty two forty seven.		
20:41:14.5 TWR-A	Bluestreak * * thank you left turn november ground.	20:41:14.5 DCA-LC	Bluestreak fifty two four seven thank you left turn november ground point seven.		
		20:41:17.5 JIA5247	over to ground fifty two forty seven.		
20:41:19.8 TWR-A	Bluestreak fifty one sixty four winds are three two direct one five gust * traffic * for runway three three runway one clear for takeoff.	20:41:19.8 DCA-LC	Bluestreak fifty one sixty four winds are three two zero at one five gusts two six traffic three out for runway three three runway one cleared for takeoff.		
		20:41:26.9 JIA5164	runway one cleared for takeoff Bluestreak fifty one sixty four.		
20:41:35.1 INT-1	alright Blackjack's already cleared the p's so he's not going to be a factor for us.				
20:41:40.0 INT-2	yeah.				
20:41:42.8 INT-1	and what did we request one to four? so we'll head straight down the river.				
20:41:47.1 INT-2	one for Hains...and...four				

Time and Source	PAT-25 (Helicopter) CVR	Time and Source	DCA Tower Recording	Time and Source	JIA5342 (Airplane) CVR
20:42:03.1 BLJK1	tower Blackjack one Memorial Bridge.	20:42:03.2 BLJK1	tower Blackjack one Memorial Bridge.		
20:42:06.4 INT-1	*.				
20:42:08.7 TWR-A	Blackjack one roger.	20:42:08.7 DCA-LC	Blackjack one roger.		
20:42:12.5 INT-1	I did not hear his route...after...				
20:42:14.5 INT-2	the Memorial.				
20:42:15.4 INT-1	yeah.				
20:42:16.1 INT-2	I don't see him yet.				
20:42:18.0 INT-1	* he's gonna be down in the lights.				
20:42:19.4 TWR-A	Bluestreak fifty one sixty four contact departure.	20:42:19.4 DCA-LC	Bluestreak fifty one sixty four contact Potomac Departure		
		20:42:22.2 JIA5164	departure Bluestreak fifty sixty four.		
		20:42:31.2 JIA5307	tower Bluestreak fifty three zero seven Mount Vernon Visual to one.		

Time and Source	PAT-25 (Helicopter) CVR	Time and Source	DCA Tower Recording	Time and Source	JIA5342 (Airplane) CVR
20:42:35.0 TWR-A	* * hold * * *.	20:42:35.0 DCA-LC	Jazz seven eight nine tower pull to hold short runway one you'll be next for departure.		
20:42:36.5 INT-1	* the Chain Bridge at seven hundred feet. good. next'll be Key Bridge we'll be down to three hundred.				
		20:42:38.3 JZA789	pull up hold short one checker marks Jazz seven eight nine.		
20:42:42.3 TWR-A	Bluestreak fifty three zero seven Washington Tower winds are three two direct one seven gust two five can you take runway three three?	20:42:42.1 DCA-LC	Bluestreak fifty three zero seven Washington Tower winds are three two zero at one seven gusts two five can you take runway three three?		
20:42:43.2 INT-2	I see it. to the left.				
		20:42:48.0 JIA5307	unable tonight.		
20:42:49.3 TWR-A	Bluestreak fifty three zero seven roger runway one cleared to land traffic * prior to arrival.	20:42:49.3 DCA-LC	Bluestreak fifty three zero seven roger runway one cleared to land traffic will depart prior to your arrival.		
		20:42:54.6 JIA5307	cleared to land one Bluestreak fifty three zero seven.		
					The CRJ (JIA5342, callsign Bluestreak 5342) joins the DCA Tower frequency. The CVR transcript from the CRJ is included from this point forward.

Time and Source	PAT-25 (Helicopter) CVR	Time and Source	DCA Tower Recording	Time and Source	JIA5342 (Airplane) CVR
		20:43:06.2 JIA5342	tower Bluestreak fifty three forty two on Mount Vernon Visual runway one.	20:43:06.3 RDO-2	tower Bluestreak fifty three forty two on Mount Vernon Visual runway one.
20:43:09.5 TWR-A	Bluestreak fifty three forty two Washington Tower winds are three two direct one seven gust five can you take runway three three?	20:43:09.5 DCA-LC	Bluestreak fifty three forty two Washington Tower winds are three two zero at one seven gusts two five can you take runway three three?	20:43:09.3 TWR-A	Bluestreak fifty three forty two Washington Tower winds are three two zero at one seven gusts two five can you take runway three three?
				20:43:17.9 HOT-1	do we got the numbers for it?
				20:43:19.5 HOT-2	yeah I think so.
20:43:20.0 TWR-A	Bluestreak fifty one seventy eight left turn at sierra ground point seven.	20:43:20.0 DCA-LC	Bluestreak fifty one seventy eight left turn at sierra ground point seven.[addressing Bluestreak 5170]	20:43:20.1 TWR-A	Bluestreak fifty one seventy eight left turn at sierra ground point seven.
				20:43:23.0 HOT-2	yeah.
				20:43:24.6 HOT-2	it's uh it's the same numbers.
		20:43:25.6 JIA5170	left sierra ground point seven fifty one seventy.	20:43:25.6 JIA5170	* * ground point seven fifty one seventy.
				20:43:29.1 HOT-1	I really don't want to but I guess uhhh tell 'em—.
				20:43:31.4 HOT-2	I mean I can just tell 'em—.

Time and Source	PAT-25 (Helicopter) CVR	Time and Source	DCA Tower Recording	Time and Source	JIA5342 (Airplane) CVR
				20:43:33.2 HOT-1	nah it's fine we got the numbers for it yeah tell 'em we're fine we'll do three three we'll do it.
		20:43:36.8 JIA5342	yeah we can do uh three three for Bluestreak fifty three forty two.	20:43:37.0 RDO-2	yeah we can do uh three three for Bluestreak fifty three forty two.
20:43:39.6 TWR-A	Bluestreak fifty three forty two at the Wilson Bridge change to * change to runway three three runway three three. [transmission broken]	20:43:39.6 DCA-LC	Bluestreak fifty three forty two at the Wilson Bridge change to cir— change to circ(le) runway three three. runway three three cleared to land.	20:43:39.7 TWR-A	Bluestreak fifty three forty two at the Wilson Bridge change to cir— * change to circ— * runway three three. runway three three cleared to land.
20:43:40.0 INT-2	gettin choppy close to the ground.				
20:43:43.5 INT-1	oh yeah down low its definitely gonna get choppy.				
20:43:45.8 INT-2	yeah.				
		20:43:46.8 JIA5342	change to runway three three uh runway three three cleared to land Bluestreak fifty three forty two.	20:43:46.3 RDO-2	change to runway three three uh runway three three cleared to land Bluestreak fifty three forty two.
20:43:47.7 INT-2	we're at three hundred.				
20:43:49.8 INT-1	roger got you at four looking for *.				

Time and Source	PAT-25 (Helicopter) CVR	Time and Source	DCA Tower Recording	Time and Source	JIA5342 (Airplane) CVR
20:43:51.5 TWR-A	Blackjack one landing at boardwalk will be at your own risk when able report landing assured winds are currently three three direct one five gust two five.	20:43:51.4 DCA-LC	Blackjack one landing bal— at the boardwalk will be at your own risk when able report landing assured winds are currently three three zero at one five gusts two five.	20:43:51.6 TWR-A	Blackjack one land * * land at the boardwalk will be at your own risk when able report landing assured winds are currently three three zero at one five gust two five.
				20:43:54.0 HOT-1	three three.
20:43:59.7 BLJK1	landing own risk and wilco for Blackjack one copy the winds thanks.	20:43:59.7 BLJK1	landing own risk and wilco for Blackjack one copy the winds thanks.		
				20:44:07.4 HOT-1	thousand feet at the uh highway. five hundred over the church.
				20:44:08.6 EGPWS	twenty five hundred. [automated voice]
20:44:15.5 TWR-A	* * traffic on * four mile final runway one line up and wait * ready to go.	20:44:15.5 DCA-LC	Jazz seven eight nine traffic on three to four mile final runway one line up and wait be ready to go.	20:44:15.6 TWR-A	Jazz seven eight nine traffic will be on a four mile final runway one lineup and wait be ready to go.
				20:44:16.4 HOT-2	all right yep.
		20:44:19.6 JZA789	line up and wait we'll be ready Jazz seven eight nine.	20:44:19.7 JZA789	line up and wait we'll be ready Jazz seven eight nine.
20:44:27.7 INT-1	alright there's three hundred for two hundred.			20:44:27.3 HOT-1	I'll just disconnect everything and we'll go from there.

Time and Source	PAT-25 (Helicopter) CVR	Time and Source	DCA Tower Recording	Time and Source	JIA5342 (Airplane) CVR
20:44:29.2 TWR-A	Bluestreak fifty three zero five currently number two for departure following an American seven three off your left.	20:44:29.2 DCA-LC	Bluestreak fifty three zero five tower be number two for departure follow that American seven three off your left.	20:44:29.2 TWR-A	Bluestreak fifty three zero five currently number two for departure following an American seven three off your left.
				20:44:31.7 HOT-1	all right.
		20:44:34.1 JIA5305	Bluestreak fifty three zero five.	20:44:34.2 JIA5305	Bluestreak fifty three zero five.
				20:44:35.1 HOT-1	* go gear down flaps thirty.
20:44:35.7 TWR-A	Delta eight thirty two currently number three following an American C-R-J.	20:44:35.6 DCA-LC	Delta eight thirty two tower be number three follow that American C-R-J.	20:44:35.9 TWR-A	Delta eight thirty two currently number three following the American C-R-J.
				20:44:37.2 HOT-2	gear down.
				20:44:37.3 CAM	[increase in ambient noise consistent with gear deployment]
		20:44:39.3 DAL832	number three after the C-R-J Delta eight fi— eight thirty two.	20:44:39.4 DAL832	number three after the C-R-J.
				20:44:39.5 HOT-2	flaps thirty.
				20:44:40.6 HOT-1	flaps forty five before landing checklist.
20:44:41.8 TWR-A	* twenty three fifty five left turn november ground point seven good day.	20:44:41.7 DCA-LC	JetBlue twenty three fifty five left turn november ground point seven good day.	20:44:41.9 TWR-A	JetBlue twenty three fifty five left on november ground point seven have a good day.

Time and Source	PAT-25 (Helicopter) CVR	Time and Source	DCA Tower Recording	Time and Source	JIA5342 (Airplane) CVR
				20:44:43.7 HOT-2	flaps forty five.
				20:44:46.0 HOT-2	thrust reverser armed. landing gear lever verify down three green.
		20:44:46.0 JBU2355	I think we're gonna miss november can we take the runway?	20:44:46.1 JBU2355	* * * november can we take the runway?
20:44:48.4 TWR-A	looks like you have november. let me know if you have it.	20:44:48.3 DCA-LC	looks like you have november let me know if you have it.	20:44:48.4 TWR-A	looks like you have november let me know if you have it.
				20:44:51.9 HOT-1	uh down three green.
				20:44:53.0 HOT-2	slats flaps verify forty five degrees * indicating.
		20:44:54.4 JBU2355	yeah we got november for JetBlue twenty three fifty five.	20:44:54.6 JBU2355	yeah we got november for JetBlue twenty three fifty five.
20:44:55.1 INT-2	two hundred.			20:44:55.3 HOT-1	forty five degrees indicating.
				20:44:56.2 HOT-2	flight spoilers verify stowed.
20:44:56.9 TWR-A	alright. ground point seven good day.	20:44:56.9 DCA-LC	alright. ground point seven good day.	20:44:56.9 TWR-A	* ground point seven have a good day.

Time and Source	PAT-25 (Helicopter) CVR	Time and Source	DCA Tower Recording	Time and Source	JIA5342 (Airplane) CVR
				20:44:57.6 HOT-1	they're stowed.
		20:44:58.3 JBU2355	ground point seven we'll see ya.	20:44:58.5 JBU2355	ground point seven * *.
				20:44:58.5 HOT-2	before landing checklist is complete.
				20:45:00.2 HOT-1	thank you.
20:45:00.2 TWR-A	* seven * winds are three two direct one five gust two five * * no delays runway one.	20:45:00.2 DCA-LC	Jazz seven eight nine winds are three two zero at one five gusts two five traffic two out no delay runway one cleared for takeoff.	20:45:00.3 TWR-A	Jazz seven eight nine winds are three two zero at one five gust two five traffic's two out no delay runway one cleared for takeoff.
		20:45:06.0 JZA789	cleared takeoff runway one no delay Jazz seven eight nine.	20:45:06.2 JZA789	cleared takeoff runway one no delay Jazz seven eight nine.
20:45:09.3 BLJK1	Blackjack one landing assured boardwalk good night.	20:45:09.3 BLJK1	Blackjack one landing assured boardwalk good night.		
				20:45:11.3 HOT-1	lets see... approaches... approaches... I dunno * *.
20:45:11.7 TWR-A	Blackjack one roger freq change approved good night.	20:45:11.7 DCA-LC	Blackjack one roger frequency change approved good night.	20:45:11.7 TWR-A	* * * frequency change approved good night.

Time and Source	PAT-25 (Helicopter) CVR	Time and Source	DCA Tower Recording	Time and Source	JIA5342 (Airplane) CVR
20:45:13.8 RDO-1	PAT two five Memorial.	20:45:14.0 PAT25	PAT two five Memorial. [loud static in background]		
20:45:14.5 INT-2	*.				
20:45:16.1 TWR-A	PAT two five roger.	20:45:16.0 DCA-LC	PAT two five roger.	20:45:16.1 TWR-A	PAT two five roger.
20:45:17.1 INT-2	alright.				
20:45:17.8 INT-1	lots of right pedal ma'am.				
20:45:19.0 INT-2	oh-kay.				
		20:45:19.9 AAL3130	Washington Tower American thirty one thirty with you runway one.	20:45:20.0 AAL3130	Washington Tower American thirty one thirty with you runway one.
20:45:20.0 INT-1	there we go now we can make the turn.				
20:45:21.3 INT-2	okay.				
20:45:22.7 INT-2	* * *.				
20:45:22.7 TWR-A	American thirty one (thirty/thirty one) Washington Tower winds are three one direct one four * runway one clear to land * *.	20:45:22.8 DCA-LC	American thirty one thirty Washington Tower winds are three one zero at one four gusts two five runway one cleared to land traffic will depart— may depart prior to your arrival.	20:45:22.8 TWR-A	American thirty one thirty Washington Tower winds are three one zero at one four gust two five runway one cleared to land traffic will depart— may depart prior to your arrival.

Time and Source	PAT-25 (Helicopter) CVR	Time and Source	DCA Tower Recording	Time and Source	JIA5342 (Airplane) CVR
				20:45:24.1 HOT-1	* * visual three three * *.
20:45:27.6 INT-3	clear left.			20:45:27.5 CAM	[sound of cavalry charge consistent with autopilot disconnect]
20:45:28.8 INT-2	clear left. crane. no factor.				
				20:45:30.6 HOT-1	that's me I got ten plus.
20:45:32.4 INT-1	you're at three hundred feet. come down for me.				
		20:45:32.5 AAL3130	okay cleared to land runway one American thirty one thirty.	20:45:32.6 AAL3130	okay clear to land runway one American thirty one thirty.
20:45:33.9 INT-2	yeah.				
20:45:36.0 INT-2	go down two hundred.			20:45:35.1 HOT-2	all checks.
				20:45:39.4 HOT-1	we're configured.
				20:45:39.9 HOT-2	yep.
				20:45:40.5 CAM	[sound of switch]
				20:45:41.3 HOT-1	what'd ya say?

Time and Source	PAT-25 (Helicopter) CVR	Time and Source	DCA Tower Recording	Time and Source	JIA5342 (Airplane) CVR
				20:45:42.0 HOT-2	yeah we are configured. you want me to uh clear the flight director and everything?
				20:45:44.8 HOT-1	uhhh sure why not.
				20:45:46.4 HOT-2	all right.
20:45:50.6 INT-1	crane out the right. no factor.				
20:45:52.2 INT-2	okay.				
20:45:55.0 TWR-A	* * contact * good day.	20:45:55.0 DCA-LC	Jazz seven eight nine contact Potomac Departure good day.	20:45:55.0 TWR-A	Jazz seven eight nine contact Potomac Departure good day.
		20:45:56.9 JZA789	have a good day.	20:45:57.2 JZA789	have a good day.
20:45:57.9 TWR-A	American seventy one thirty * final.	20:45:57.9 DCA-LC	American thirty one thirty slow to final.	20:45:58.0 TWR-A	American thirty one thirty slow to final.
		20:46:00.1 AAL3130	slowin' American thirty one thirty.	20:46:00.2 AAL3130	slowin' American thirty one thirty.
				20:46:01.7 CAM	[sound of tone consistent with altitude alert]

Time and Source	PAT-25 (Helicopter) CVR	Time and Source	DCA Tower Recording	Time and Source	JIA5342 (Airplane) CVR
20:46:01.6 TWR-A	PAT two five traffic just south of Wilson Bridge is a C-R-J at one thousand two hundred feet for runway three three.	20:46:01.5 DCA-LC	PAT two five traffic just south of the Wilson Bridge is a C-R-J at one thousand two hundred feet circling runway three three.	20:46:01.7 TWR-A	PAT two five traffic just south of Wilson Bridge is a C-R-J at one thousand two hundred feet circling to runway three three.
20:46:07.9 RDO-1	PAT two five has the traffic in sight request visual separation.	20:46:08.0 PAT25	PAT two five has the traffic in sight request visual separation. [loud static during transmission]		
				20:46:09.8 HOT-1	uhhh I gotta level off.
20:46:10.5 TWR-A	separation approved.	20:46:10.5 DCA-LC	vis separation approved.	20:46:10.5 TWR-A	vis separation approved.
20:46:11.6 TWR-A	American sixteen thirty tower runway one line up and wait traffic * runway three three this traffic on a six mile final.	20:46:11.7 DCA-LC	American sixteen thirty tower runway one line up and wait traffic three out circling runway three three additional traffic on six mile final.	20:46:11.7 TWR-A	American sixteen thirty tower runway one lineup and wait traffic is * * circling runway three three additional traffic on a six mile final.
				20:46:13.2 HOT-2	all right.
		20:46:16.8 AAL1630	line up and wait runway one American sixteen thirty.	20:46:16.9 AAL1630	lineup and wait runway one American sixteen thirty.
20:46:19.1 MUSL7	tower Muscle seven approaching Springfield request route three to zone six.	20:46:19.2 MUSL7	tower Muscle seven approaching Springfield request route three to zone six. [loud static during transmission, transmission stepped on by simultaneous transmission from airplane frequency]		

Time and Source	PAT-25 (Helicopter) CVR	Time and Source	DCA Tower Recording	Time and Source	JIA5342 (Airplane) CVR
		20:46:22.1 AAL472	American four seventy two by KATRN runway one. [transmission simultaneous with Muscle 7 transmission]	20:46:22.0 AAL472	American four seventy two by KATRN runway one.
20:46:24.5 TWR-A	seven stand by.	20:46:24.5 DCA-LC	Muscle seven stand by.	20:46:24.6 TWR-A	Muscle seven standby.
20:46:26.4 INT-1	ha ha.				
20:46:27.2 INT-2	ha.				
				20:46:29.9 EGPWS	one thousand. [automated voice]
20:46:29.8 TWR-A	Bluestreak fifty three zero seven keep rolling out to november ground point seven good day.	20:46:29.8 DCA-LC	Bluestreak fifty three zero seven keep rolling out to november ground point seven good day.	20:46:29.9 TWR-A	Bluestreak fifty three zero seven keep rolling out to november ground point seven good day.
				20:46:30.6 CAM	[sound of click consistent with verifying spoilers are stowed]
				20:46:32.1 HOT-2	thousand feet.
				20:46:32.8 HOT-1	stable spoilers stowed confirm missed approach altitude set.
		20:46:33.4 JIA5307	november three zero seven.	20:46:33.5 JIA5307	november fifty three zero seven.
20:46:34.0 INT-1	he's got'em stacked up tonight.				

Time and Source	PAT-25 (Helicopter) CVR	Time and Source	DCA Tower Recording	Time and Source	JIA5342 (Airplane) CVR
20:46:36.0 INT-2	(yeah/kinda) busy.			20:46:35.3 HOT-2	uh two thousand two hundred set.
20:46:40.4 INT-1	alright three three zero so now we've pretty much got a right quartering tailwind going to be pushing you.				
20:46:43.7 INT-2	yeah.				
20:46:45.7 ARCR1	National Tower good eveining AirCare one's with you a single medivac heli— [transmission cut off by next tower transmission]	20:46:45.7 ARCR1	National Tower good evening AirCare one's with you a single medivac— [transmission cut off by next tower transmission]		
20:46:48.0 TWR-A	American sixteen * one * one four gust two five traffic * * runway three three no delay runway one clear for immediate takeoff.	20:46:48.1 DCA-LC	American sixteen thirty winds are three two zero at one four gusts two five traffic two mile left base runway three three no delay runway one cleared for immediate takeoff.	20:46:48.2 TWR-A	American sixteen thirty winds are at three two zero at one four gusting two five traffic is a two mile left base runway three three no delay runway one clear for immediate takeoff. [sound of two beeps audible during transmission]
20:46:48.9 INT-2	* crabbing.				
20:46:50.6 INT-1	yeah.				
20:46:51.8 INT-2	better not to fight the wind.				
		20:46:55.6 AAL1630	number one cleared for takeoff American sixteen thirty.	20:46:55.8 AAL1630	number one cleared for takeoff American sixteen thirty.
20:46:56.6 INT-2	right pedal.				

Time and Source	PAT-25 (Helicopter) CVR	Time and Source	DCA Tower Recording	Time and Source	JIA5342 (Airplane) CVR
20:46:58.7 TWR-A	Muscle seven say request.	20:46:58.6 DCA-LC	Muscle seven say request.	20:46:58.8 TWR-A	Muscle seven say request.
20:47:00.8 MUSL7	and Muscle seven request route three to zone six.	20:47:00.9 MUSL7	yeah Muscle seven request route three to zone six. [loud static during transmission]		
20:47:04.7 TWR-A	Muscle seven you said route three to zone six?	20:47:04.7 DCA-LC	Muscle seven you say route three to zone six?	20:47:04.1 TWR-A	Muscle seven did you say * * zone six?
20:47:06.7 MUSL7	a-firm Muscle seven.	20:47:06.8 MUSL7	a-firm Muscle seven. [loud static during transmission]		
20:47:07.9 TWR-A	Muscle seven approved.	20:47:07.8 DCA-LC	Muscle seven approved.	20:47:07.9 TWR-A	Muscle seven approved.
20:47:09.1 MUSL7	Muscle seven *.	20:47:09.2 MUSL7	Muscle seven. [loud static during transmission]		
		20:47:13.8 AAL472	American four seventy two Mount Vernon Visual one. [transmission stepped on by simultaneous transmission from helicopter frequency]	20:47:13.7 AAL472	American four seventy two Mount Vernon Visual * one.

Time and Source	PAT-25 (Helicopter) CVR	Time and Source	DCA Tower Recording	Time and Source	JIA5342 (Airplane) CVR
20:47:15.0 ARCR1	National Tower good evening AirCare one's with you single medivac helicopter one thousand feet two niner niner one on the altimeter requesting zone six for Fairfax.	20:47:15.1 ARCR1	National Tower good evening AirCare one is with you single medivac helicopter one thousand feet two niner niner one on the altimeter requesting zone six for Fairfax. [transmission made during previous airplane transmission]		
20:47:25.5 TWR-A	medivac AirCare one Washington Tower nearest altimeter two niner niner zero approved through Washington class bravo airspace before landing assured at Fairfax.	20:47:25.5 DCA-LC	medivac AirCare one Washington Tower National altimeter two niner niner zero. approved through Washington class bravo airspace report landing assured at Fairfax.	20:47:25.5 TWR-A	medevac AirCare one Washington Tower * altimeter two niner niner zero * approved bravo airspace * * landing assured *.
				20:47:29.2 EGPWS	five hundred. [automated voice]
				20:47:30.9 HOT-2	five hundred feet on top of the bug sinking seven stable.
20:47:34.0 ARCR1	two niner two niner niner zero for AirCare one copies.	20:47:34.0 ARCR1	two niner— two niner niner zero for AirCare one copies.		
				20:47:34.3 HOT-1	checks.
				20:47:35.5 HOT-2	I got two white two red.
				20:47:37.2 HOT-1	cool.
		20:47:37.8 DCA-LC	[two brief mic keys with rapid beeping audible in background consistent with conflict alert]		

Time and Source	PAT-25 (Helicopter) CVR	Time and Source	DCA Tower Recording	Time and Source	JIA5342 (Airplane) CVR
20:47:39.1 TWR-A	PAT two five you have the C-R-J in sight? [sounds of rapid beeping consistent with conflict alert audible in background while tower is transmitting]	20:47:39.1 DCA-LC	PAT two five do you have that C-R-J in sight? [sounds of rapid beeping consistent with conflict alert audible in background]	20:47:39.1 TWR-A	PAT two five you got the C-R-J in sight? [sounds of rapid beeping consistent with conflict alert audible in background while tower is transmitting]
				20:47:40.3 TCAS	traffic. traffic. [automated voice]
20:47:41.9 TWR-A	PAT [transmission interrupted by 0.8 second mic key from PAT-25] C-R-J.	20:47:41.9 DCA-LC	PAT two five pass behind that C-R-J. [sounds of rapid beeping consistent with conflict alert audible in background]	20:47:42.0 TWR-A	PAT two five pass behind the C-R-J. [sounds of rapid beeping consistent with conflict alert audible in background while tower is transmitting]
20:47:44.1 RDO-1	PAT two five has uh— aircraft in sight request visual separation.	20:47:44.1 PAT25	PAT two five has a— aircraft in sight request visual separation. [loud static in background]		
20:47:47.3 TWR-A	*.	20:47:47.3 DCA-LC	vis separation.	20:47:47.3 TWR-A	vis sep * *.
20:47:47.8 INT-2	(woah/below).				
20:47:52.5 INT-1	alright kinda come left for me ma'am I think that's why he's asking.				
20:47:54.3 INT-2	sure.				

Time and Source	PAT-25 (Helicopter) CVR	Time and Source	DCA Tower Recording	Time and Source	JIA5342 (Airplane) CVR
		20:47:54.7 **AAL472**	American four seventy two by BADDN Mount Vernon Visual.	20:47:54.8 **AAL472**	American four seventy two at BADDN Mount Vernon Visual.
20:47:55.3 **INT-1**	we're kinda...				
20:47:55.4 **INT-2**	oh-kay. fine.			20:47:55.4 **EGPWS**	plus hundred. [automated voice]
20:47:56.4 **INT-1**	...out towards the middle.				
20:47:57.6 **TWR-A**	American four seventy two Washington Tower [transmission cut off by impact]	20:47:57.6 **DCA-LC**	American four seventy two Washington Tower winds are three two zero at one seven— [sounds of rapid beeping audible in background consistent with conflict alert. audible reaction in background before transmission cut off]	20:47:57.7 **TWR-A**	American four seventy ***. [transmission cut off by impact]
20:47:57.7 **INT-2**	[sound similar to mumbling]			20:47:58.1 **CAM**	[sound of click]
				20:47:58.6 **HOT-1**	oh #.
				20:47:58.8 **HOT-2**	ohhhh ohhhh. [louder voice]
20:47:59.2 **RDO**	[sound similar to ELT signal]			20:47:59.5 **CAM**	[sounds consistent with impact]
20:48:00.1 **FPS**	[sound of rapid beeping similar to stabilator auto mode fail master caution, continues to end of recording]				
20:48:00.1					

Time and Source	PAT-25 (Helicopter) CVR	Time and Source	DCA Tower Recording	Time and Source	JIA5342 (Airplane) CVR
END OF COMBINED TRANSCRIPT					

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The NTSB is an independent federal agency charged by Congress with investigating every civil aviation accident in the United States and significant events in the other modes of transportation—railroad, transit, highway, marine, pipeline, and commercial space. We determine the probable causes of the accidents and events we investigate and issue safety recommendations aimed at preventing future occurrences. In addition, we conduct transportation safety research studies and offer information and other assistance to family members and survivors for each accident or event we investigate. We also serve as the appellate authority for enforcement actions involving aviation and mariner certificates issued by the Federal Aviation Administration (FAA) and US Coast Guard, and we adjudicate appeals of civil penalty actions taken by the FAA.

The NTSB does not assign fault or blame for an accident or incident; rather, as specified by NTSB regulation, "accident/incident investigations are fact-finding proceedings with no formal issues and no adverse parties … and are not conducted for the purpose of determining the rights or liabilities of any person" (Title 49 *Code of Federal Regulations* section 831.4). Assignment of fault or legal liability is not relevant to the NTSB's statutory mission to improve transportation safety by investigating accidents and incidents and issuing safety recommendations. In addition, statutory language prohibits the admission into evidence or use of any part of an NTSB report related to an accident in a civil action for damages resulting from a matter mentioned in the report (Title 49 *United States Code* section 1154(b)).

For more detailed background information on this report, visit the NTSB Case Analysis and Reporting Online (CAROL) website and search for NTSB accident ID DCA25MA108. Recent publications are available in their entirety on the NTSB website. Other information about available publications also may be obtained from the website or by contacting –

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