



# Aviation Investigation Final Report

<b>Location:</b>	Hoffman Island, New York	<b>Incident Number:</b>	DCA17IA202
<b>Date &amp; Time:</b>	September 21, 2017, 19:20 Local	<b>Registration:</b>	UNREG
<b>Aircraft:</b>	DJI Phantom	<b>Aircraft Damage:</b>	Destroyed
<b>Defining Event:</b>	Midair collision	<b>Injuries:</b>	1 None
<b>Flight Conducted Under:</b>	Part 107: Small UAS		

## Analysis

The United States Army UH-60M helicopter was operating under visual flight rules within Class G airspace about 300 ft above mean sea level (msl) when it collided with a privately owned and operated DJI Phantom 4 small unmanned aircraft system (sUAS). The helicopter sustained minor damage and landed uneventfully; the sUAS was destroyed. Although the pilot flying the helicopter saw the sUAS before impact and immediately applied flight control inputs, there was insufficient time to avoid the collision.

The sUAS pilot was operating the aircraft recreationally and did not hold a Federal Aviation Administration (FAA) Remote Pilot certificate. Hobby and recreational pilots are expected to operate their aircraft in accordance with Title 14 Code of Federal Regulations Part 101, which includes maintaining visual contact with the aircraft at all times and not interfering with any manned aircraft. There are no training or certification requirements for model aircraft pilots.

During the incident flight, the pilot of the sUAS intentionally flew the aircraft 2.5 miles away, well beyond visual line of sight and was just referencing the map on his tablet; therefore, he was not aware that the helicopter was in close proximity to the sUAS. Although the pilot stated that he knew that the sUAS should be operated at an altitude below 400 ft, flight logs revealed that he had conducted a flight earlier on the evening of the incident, in which he exceeded 547 ft altitude at a distance of 1.8 miles, which was unlikely to be within visual line of sight. In addition, even though the sUAS pilot indicated that he knew there were frequently helicopters in the area, he still elected to fly his sUAS beyond visual line of sight, demonstrating his lack of understanding of the potential hazard of collision with other aircraft. In his interview, the sUAS pilot indicated that he was not concerned with flying beyond visual line of sight, and he expressed only a general cursory awareness of regulations and good operating practices.

A Temporary Flight Restriction (TFR) was in effect for the area of the flight; the helicopter was authorized for flight within this area. The helicopter was operating over water and not in the vicinity of

any vessels; therefore, its operating altitude was in accordance with FAA regulations and Army guidance. The sUAS pilot was unaware of the active TFRs in the area that specifically prohibited both model aircraft and UAS flight. Further, the sUAS pilot relied only on the DJI GO4 app for airspace awareness. Although the TFR airspace awareness functionality in the DJI app (GEO) was not active at the time of the incident, this feature is intended for advisory use only, and sUAS pilots are responsible at all times to comply with FAA airspace restrictions. Sole reliance on advisory functions of a non-certified app is not sufficient to ensure that correct airspace information is obtained. Had the functionality been active, the sUAS pilot would still have needed to connect his tablet to the internet before the flight in order to receive the TFR information. Since the sUAS pilot's tablet did not have cellular connection capability, it is unlikely that he would have been able to obtain TFR information at the time of the flight. Because the pilot solely relied on the app to provide airspace restriction information; he was unaware of other, more reliable methods to maintain awareness.

The collision occurred 2 minutes before the end of civil twilight. Although modeler (recreational) sUAS pilots may fly at night under certain conditions, when asked about night flight, the incident pilot only stated that he had built-in position lights; thus he was likely unaware of any guidelines or practices for night operations.

There was no evidence of any mechanical or software problems with the sUAS relevant to the flight. The pilot did not report any anomalies, and stated the recorded information on the flight logs accurately reflected the incident flight. The sUAS operated as expected at all times. Although the recorded data showed a 9-second gap in telemetry, this was likely due to distance from the remote controller.

## Probable Cause and Findings

The National Transportation Safety Board determines the probable cause(s) of this incident to be:

the failure of the sUAS pilot to see and avoid the helicopter due to his intentional flight beyond visual line of sight. Contributing to the incident was the sUAS pilot's incomplete knowledge of the regulations and safe operating practices.

### Findings

<b>Personnel issues</b>	Monitoring other aircraft - Pilot
<b>Personnel issues</b>	Use of policy/procedure - Pilot
<b>Personnel issues</b>	Knowledge of procedures - Pilot
<b>Personnel issues</b>	Knowledge of regulatory reqs - Pilot

## Factual Information

### History of Flight

Enroute	Midair collision (Defining event)
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On September 21, 2017, at 1920 eastern daylight time, a Sikorsky UH-60M Black Hawk helicopter, R20087, operated by the U.S. Army as CAVM087 ("Caveman 87"), collided with a privately owned and operated Dà-Jiang Innovations (DJI) Phantom 4 small unmanned aircraft system (sUAS). The collision occurred about 300 ft above mean sea level (msl) and 1 mile east of Midland Beach, Staten Island, New York, in the vicinity of Hoffman Island. The helicopter received minor damage, and the sUAS was destroyed. There were no injuries or ground damage.

The incident helicopter was the lead aircraft of a flight of two, and was operating as a local orientation flight for the Hudson Class B Airspace Exclusion and the United Nations General Assembly Temporary Flight Restriction (TFR) operations. The flight had flown south along the Hudson River, then turned east at the Verrazano-Narrows Bridge toward Coney Island, New York. The crew then decided to make a right turn toward the west and return to their base at Linden Airport (LDJ), Linden, New Jersey. Air traffic control (ATC) radar obtained from the Federal Aviation Administration (FAA) showed the flight heading toward LDJ between 200 and 300 ft msl. The crew reported that the flight had just passed Hoffman Island when the lead helicopter made contact with what appeared to be a sUAS. Recorded data from the helicopter indicated that it was flying at an altitude of 274 ft msl at the time of the collision.

The helicopter co-pilot was the pilot flying when the collision occurred. He reported that he immediately and rapidly reduced the collective as the sUAS suddenly came into his view in close proximity to the helicopter. The pilot-in-command took the controls and recommended that they return to LDJ. Radar data indicated that the flight proceeded to LDJ, climbing to about 800 ft as it passed over the shore and overflowed more populated areas. The flight landed uneventfully, and the air mission commander subsequently reported the collision to the air traffic control tower at Newark Liberty International Airport.

The sUAS pilot was unaware that a collision had taken place until he was contacted by the NTSB. The pilot reported that he initiated the pleasure flight from the shore adjacent to Dyker Beach Park, southeast of the Verrazano-Narrows Bridge, in the Fort Hamilton neighborhood of Brooklyn, New York, and that he intended to fly "over the ocean." Data logs from the control tablet provided by the pilot indicated that the sUAS took off at 1911:34 and, after takeoff, climbed to a recorded altitude of 89 meters (292 ft). The sUAS altitude is based on height above the takeoff point ("home point"); the elevation of the park is about 7 ft msl.

The sUAS then proceeded on a straight, southwesterly course toward Hoffman Island, about 2.5 miles from the takeoff location. The data log showed the aircraft briefly paused over the ship channel and completed some yawing turn maneuvers, consistent with the pilot looking through the camera view at points of interest, then resumed the straight course toward the island.

At 1914:30, ATC radar indicated the flight of helicopters was travelling south-southeasterly from the Verrazano-Narrows Bridge toward Coney Island at 400 ft (Figure 1). The helicopters passed the sUAS pilot's position from his right to left about 1 mile from his location. The sUAS was about 1 1/2 miles from the sUAS pilot at that time and along a common line of sight. Shortly afterward, at 1915:30, data logs indicated the sUAS paused and hovered northeast of Hoffman Island for about 2 minutes before resuming a southwesterly track toward the island. During this time, the helicopters were flying east along the Coney Island shoreline about 300 ft msl.

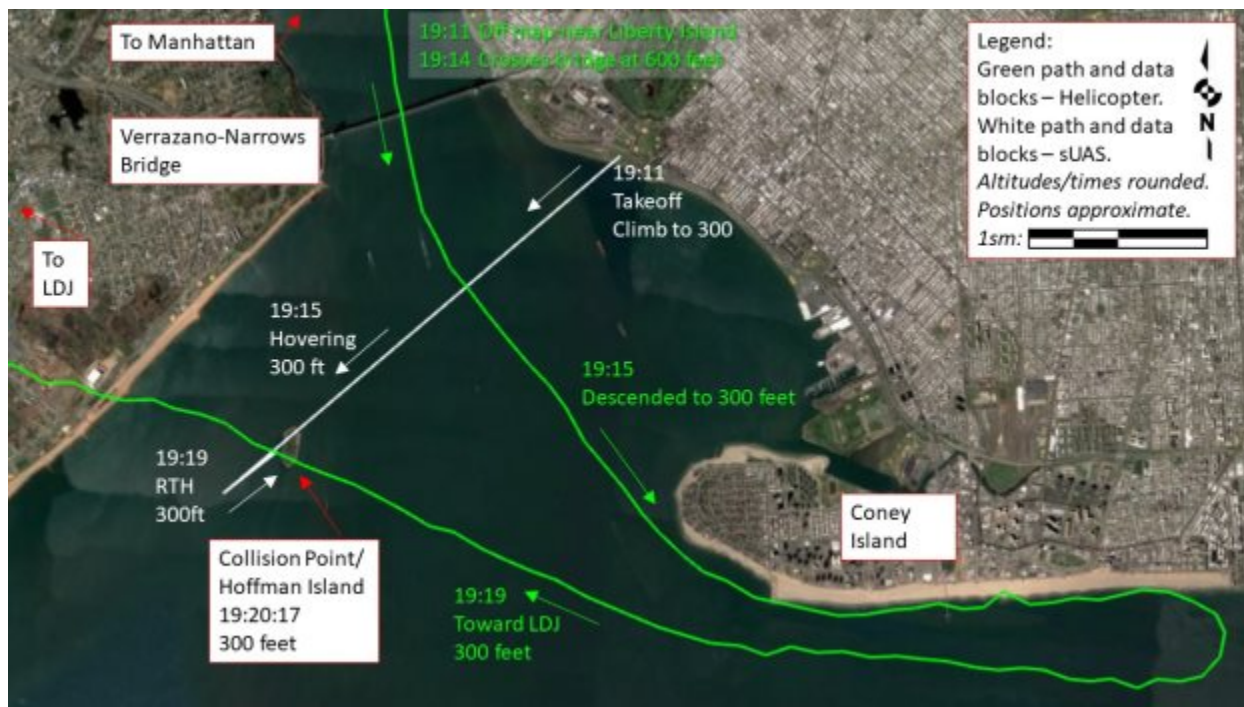


Figure 1: Approximate route of flight of the UH-60 and sUAS

At 1919:15, the sUAS pilot pressed the return-to-home (RTH) button on the control tablet, and the aircraft turned around and began tracking northeast toward the home point. The helicopters had completed a turn toward LDJ, and were just west of Coney Island at 300 ft. At 1919:51, the sUAS battery endurance warning activated, indicating that only enough charge remained to return directly to the home point. The pilot did not have visual contact with the sUAS or the helicopters at that time. As the sUAS was tracking northeast, telemetry data dropped out for about 9 seconds but returned just before the collision. The position of the aircraft was near the maximum range of the remote controller. At 1920:17.6, the data logs ended. The last position and altitude logged correlated with the position and altitude of the incident helicopter's recorded data and ATC radar information; about 300 ft west of Hoffman Island. The sUAS pilot reported that he lost signal with the aircraft and assumed it would return home as programmed. After waiting about 30 minutes, he assumed it had experienced a malfunction and crashed in the water.

The airspace in the area of the flight is Class G, underlying a shelf of the New York Class B airspace. A Notice to Airmen (NOTAM 7/4755), issued by the FAA Flight Data Center, was in effect at the time of the incident flight. The NOTAM established a Temporary Flight Restriction (TFR) due to the United Nations General Assembly meeting. The TFR restricted operations within the lateral limits of the New York Class B airspace from the surface up to 17,999 ft msl, and included a prohibition on model aircraft and unmanned aerial systems (UAS).

Additionally, another NOTAM (7/8423) was in effect establishing a VIP Presidential TFR within 30 nautical miles (nm) of Bedminster, New Jersey, from the surface up to 17,999 ft msl, which also included a prohibition on model aircraft and unmanned aerial systems (UAS). The incident sUAS launch point was 30.35 nm from the center of that TFR; Hoffman Island was 29.22 nm from the center point.

### Pilot Information

<b>Certificate:</b>	None	<b>Age:</b>	58
<b>Airplane Rating(s):</b>	None	<b>Seat Occupied:</b>	None
<b>Other Aircraft Rating(s):</b>	None	<b>Restraint Used:</b>	
<b>Instrument Rating(s):</b>	None	<b>Second Pilot Present:</b>	
<b>Instructor Rating(s):</b>	None	<b>Toxicology Performed:</b>	No
<b>Medical Certification:</b>	None	<b>Last FAA Medical Exam:</b>	
<b>Occupational Pilot:</b>	No	<b>Last Flight Review or Equivalent:</b>	
<b>Flight Time:</b>	(Estimated) 100 hours (Total, all aircraft), 38 hours (Total, this make and model)		

The helicopter flight crew comprised two pilots and two crew chiefs. The pilot-in-command had 1,570 hours of experience in the UH-60, and the co-pilot had 184 hours. The crew reported that they had no previous encounters with sUAS in flight and no outside knowledge or experience with sUAS.

The sUAS pilot stated he was a recreational operator, and that he flew only for enjoyment. He did not hold an FAA Remote Pilot certificate or a manned aircraft pilot certificate. He flew only DJI products, and he did not have experience with conventional radio-control airplanes. He said he had "a lot" of experience with sUAS; the data logs provided by him indicated that he had flown 38 flights in the previous 30 days. He had owned the incident sUAS for about one year and owned a Phantom 3 and another Phantom 4 before purchasing the incident sUAS. Five days after the collision, he purchased a Phantom 4 Pro. He had registered with the FAA as a model aircraft operator during the time period that the registration requirement was in effect. He had taken no specific sUAS training other than the tutorials that are included in the DJI GO4 operating application (app). At the time of the collision, there were no training or certification requirements for hobbyist or modeler pilots.

The pilot said that he was familiar with the area and had flown there many times before. He said that he had flown at night before, and that his sUAS did not have any extra lighting, stating that, "it has four lights."

When asked about specific regulations or guidance for sUAS flights, he stated that he knew to stay away from airports, and was aware there was Class B airspace nearby. He said that he relied on "the app" to tell him if it was OK to fly. He stated he knew that the aircraft should be operated below 400 ft. When asked about TFRs, he said he did not know about them; he would rely on the app, and it did not give any warnings on the evening of the collision. He said he was not familiar with the TFRs for the United Nations meeting and Presidential movement.

When asked, he did not indicate that he was aware of the significance of flying beyond line of sight and again stated that he relied on the app display. He said he did not see or hear the flight of helicopters involved in the collision but said that helicopters fly in the area all the time.

### Aircraft and Owner/Operator Information

<b>Aircraft Make:</b>	DJI	<b>Registration:</b>	UNREG
<b>Model/Series:</b>	Phantom 4	<b>Aircraft Category:</b>	Helicopter
<b>Year of Manufacture:</b>	2016	<b>Amateur Built:</b>	
<b>Airworthiness Certificate:</b>	None	<b>Serial Number:</b>	07DDD640B11457
<b>Landing Gear Type:</b>	Skid	<b>Seats:</b>	0
<b>Date/Type of Last Inspection:</b>		<b>Certified Max Gross Wt.:</b>	4 lbs
<b>Time Since Last Inspection:</b>		<b>Engines:</b>	4 Electric
<b>Airframe Total Time:</b>		<b>Engine Manufacturer:</b>	DJI
<b>ELT:</b>		<b>Engine Model/Series:</b>	
<b>Registered Owner:</b>	On file	<b>Rated Power:</b>	
<b>Operator:</b>	On file	<b>Operating Certificate(s) Held:</b>	None

The UH-60M is a four-bladed, twin-engine, medium utility helicopter manufactured by Sikorsky Aircraft. It is widely used by the US military for many missions.

The Phantom 4 is a small unmanned aircraft system of quadcopter configuration, about 13 inches in diameter. It is powered by four electric, brushless motors and a 4-cell, 15.2-volt lithium-polymer battery. The maximum takeoff weight is 3 pounds; maximum altitude is about 19,685 ft msl. Maximum endurance is 28 minutes. Specified maximum range of the remote controller is 3.1 miles. The aircraft is equipped with a GPS/GLONASS navigation system and a flight controller enabling various automated functions. The aircraft is equipped with a 12-megapixel digital camera capable of still or video recording and first-person view display. Aircraft telemetry and video is transmitted to the remote controller in the 2.4 GHz band and displayed on a smartphone or tablet of the pilot's choice using an app supplied by the manufacturer or various third-party app developers. The pilot used a Samsung tablet with wi-fi but no cellular data capability. He did not use any third-party apps to control the aircraft.

The Phantom 4 includes a feature called Geospatial Environment Online (GEO), which is designed to aid pilots in avoiding certain types of airspace. When available, the pilot receives a message on the control smartphone or tablet advising of the type of airspace and other information. According to DJI:

*"GEO provides pilots with up-to-date guidance on areas where flight may be limited by regulation or raise safety concerns. In addition to airport location information, flyers will have real-time access to live information on temporary flight restrictions [and] locations such as prisons, nuclear power plants and other sensitive areas where flying may raise non-aviation security concerns. The GEO system is advisory only. Each user is responsible for checking official sources and determining what laws or regulations might apply to his or her flight."*

The GEO system categorizes features into one of four zones: Warning, Enhanced Warning, Authorization, and Restricted zones. Temporary Flight Restrictions are typically coded as Authorization Zones, which appear yellow in the DJI GO4 map. Users will be prompted with a warning and flight is limited by default. A user with appropriate authorization may unlock the Authorization Zone by using a DJI-verified account. This is called "self-unlocking" and can be accomplished before the flight via DJI's website for a period of up to three days, or at the time of flight if the user has an internet connection in the field.

The incident pilot's tablet did not have a cellular data connection, so the GEO system information regarding the TFRs would not download in real time at the takeoff location. In order for the system to have warned the pilot, he would have had to connect to the internet at some point while the TFR was active; however, at the time of the incident, the TFR system within DJI GEO and displayed to customers through DJI GO4 was not active. During August 2017, an issue was identified with the GEO function that inadvertently and intermittently rendered the self-unlock feature for certain TFRs ineffective for some users. After a significant number of complaints about the problem, DJI decided to temporarily disable the TFR functionality in GEO until the feature was investigated and confirmed to be working properly. Therefore, at the time of the incident, no TFR information was available in GEO. Since GEO is meant to be an advisory system to pilots, DJI decided it was better to disable this feature until the problem could be corrected to enable authorized users to support recovery efforts and other authorized missions across the country, including firefighting response and demonstrations at air shows. There was no notice or advisory to users that this advisory function had been disabled. The TFR functionality in GEO was restored in October 2017.

## Meteorological Information and Flight Plan

<b>Conditions at Accident Site:</b>	Visual (VMC)	<b>Condition of Light:</b>	Dusk
<b>Observation Facility, Elevation:</b>	KLDJ	<b>Distance from Accident Site:</b>	10 Nautical Miles
<b>Observation Time:</b>	23:15 Local	<b>Direction from Accident Site:</b>	290°
<b>Lowest Cloud Condition:</b>	Clear	<b>Visibility</b>	10 miles
<b>Lowest Ceiling:</b>	None	<b>Visibility (RVR):</b>	
<b>Wind Speed/Gusts:</b>	3 knots / None	<b>Turbulence Type Forecast/Actual:</b>	/ None
<b>Wind Direction:</b>	40°	<b>Turbulence Severity Forecast/Actual:</b>	/
<b>Altimeter Setting:</b>	29.98 inches Hg	<b>Temperature/Dew Point:</b>	-11°C
<b>Precipitation and Obscuration:</b>			
<b>Departure Point:</b>	Brooklyn, NY	<b>Type of Flight Plan Filed:</b>	None
<b>Destination:</b>	Brooklyn, NY	<b>Type of Clearance:</b>	None
<b>Departure Time:</b>	19:11 Local	<b>Type of Airspace:</b>	Class G

The LDJ surface observation at 1915 reported clear skies, 10 miles visibility and light northeasterly winds. Sunset was at 1855 and the end of civil twilight occurred at 1922.

## Wreckage and Impact Information

<b>Crew Injuries:</b>	1 None	<b>Aircraft Damage:</b>	Destroyed
<b>Passenger Injuries:</b>		<b>Aircraft Fire:</b>	Unknown
<b>Ground Injuries:</b>	N/A	<b>Aircraft Explosion:</b>	None
<b>Total Injuries:</b>	1 None	<b>Latitude, Longitude:</b>	40.5,-74(est)

One motor and a portion of an arm of the sUAS was recovered from the helicopter. Debris was found in the engine oil cooler fan by Army maintenance personnel. The components were transferred by the US Army to a representative of the FAA Teterboro, New Jersey, Flight Standards District Office, then to the NTSB. Manufacturing serial number information inscribed on the motor enabled sales records provided by the manufacturer to aid in identifying the pilot, as the sUAS was purchased directly from the manufacturer. The remainder of the sUAS was not recovered.

## Damage to Aircraft

A 1 1/2-inch dent was found on the leading edge of one of the UH-60's main rotor blades, surrounded by various scratches and material transfer. Some cracks were observed in the composite fairing and window frame material.

The Phantom 4 sUAS was destroyed and several components were lodged in the helicopter.

## **Additional Information**

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The investigation reviewed pertinent regulations and guidance regarding helicopter and sUAS operation.

### Helicopter Operating Altitude

14 *Code of Federal Regulations (CFR)* Part 91.119 states in part:

Except when necessary for takeoff or landing, no person may operate an aircraft below the following altitudes:

(c) Over other than congested areas. An altitude of 500 feet above the surface, except over open water or sparsely populated areas. In those cases, the aircraft may not be operated closer than 500 feet to any person, vessel, vehicle, or structure. . . .(d) Helicopters, . . . If the operation is conducted without hazard to persons or property on the surface - (1) A helicopter may be operated at less than the minimums prescribed in paragraph (b) or (c).

### Statutes, Regulations, and Guidelines applicable to sUAS

Public Law 112-95 section 336(c) (Feb. 14, 2012) defines "model aircraft" as an unmanned aircraft that is:

- (1) Capable of sustained flight in the atmosphere;
- (2) Flown within visual line of sight of the person operating the aircraft; and
- (3) Flown for hobby or recreational purposes.

14 *CFR* 1.1 (and 101.1) state in part:

Model aircraft means an unmanned aircraft that is:

- (2) Flown within visual line of sight of the person operating the aircraft; and
- (3) Flown for hobby or recreational purposes.

14 *CFR* 101.41 states in part:

Applicability.

This subpart prescribes rules governing the operation of a model aircraft that meets all of the following conditions ...

- (a) The aircraft is flown strictly for hobby or recreational use;
- (b) The aircraft is operated in accordance with a community-based set of safety guidelines;...
- (d) The aircraft is operated in a manner that does not interfere with and gives way to any manned aircraft...

The Academy of Model Aeronautics (AMA) publishes such safety guidelines. The AMA Safety Code states in part:

9. The pilot of an RC model aircraft shall:

- (a) Maintain control during the entire flight, maintaining visual contact without enhancement other than by corrective lenses prescribed for the pilot.

Temporary Flight Restrictions

According to the FAA, TFRs are tools used by the FAA to restrict aircraft operations within designated areas. [In recent] years, TFRs, along with Air Defense Identification Zones and Flight Restriction Zones, have been widely used to restrict overflights through certain airspace for reasons of national security. Two TFRs were in effect in the area and time of the incident, as noted in the History of Flight section above.

## Administrative Information

**Investigator In Charge (IIC):** English, William

**Additional Participating Persons:**

**Original Publish Date:** December 14, 2017

**Last Revision Date:**

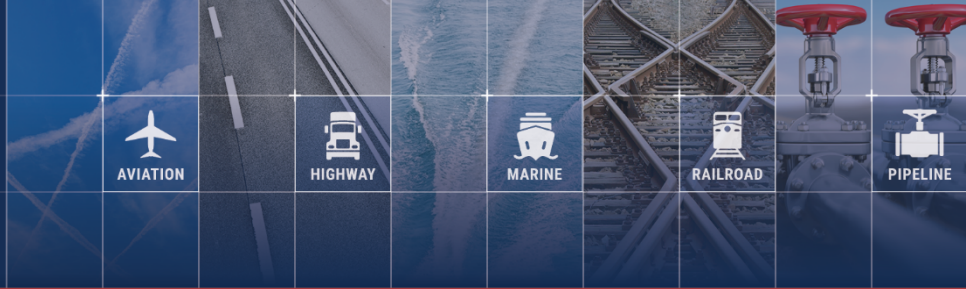
**Investigation Class:** [Class](#)

**Note:** The NTSB did not travel to the scene of this incident.

**Investigation Docket:** <https://data.ntsb.gov/Docket?ProjectID=96058>

The National Transportation Safety Board (NTSB) is an independent federal agency charged by Congress with investigating every civil aviation accident in the United States and significant events in 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)). A factual report that may be admissible under 49 *United States Code* section 1154(b) is available [here](#).



# Aviation Investigation Final Report

<b>Location:</b>	Hoffman Island, New York	<b>Incident Number:</b>	DCA17IA202
<b>Date &amp; Time:</b>	September 21, 2017, 19:20 Local	<b>Registration:</b>	R20087
<b>Aircraft:</b>	Sikorsky UH60	<b>Aircraft Damage:</b>	Minor
<b>Defining Event:</b>	Midair collision	<b>Injuries:</b>	4 None
<b>Flight Conducted Under:</b>	Armed Forces		

## Analysis

The United States Army UH-60M helicopter was operating under visual flight rules within Class G airspace about 300 ft above mean sea level (msl) when it collided with a privately owned and operated DJI Phantom 4 small unmanned aircraft system (sUAS). The helicopter sustained minor damage and landed uneventfully; the sUAS was destroyed. Although the pilot flying the helicopter saw the sUAS before impact and immediately applied flight control inputs, there was insufficient time to avoid the collision.

The sUAS pilot was operating the aircraft recreationally and did not hold a Federal Aviation Administration (FAA) Remote Pilot certificate. Hobby and recreational pilots are expected to operate their aircraft in accordance with Title 14 Code of Federal Regulations Part 101, which includes maintaining visual contact with the aircraft at all times and not interfering with any manned aircraft. There are no training or certification requirements for model aircraft pilots.

During the incident flight, the pilot of the sUAS intentionally flew the aircraft 2.5 miles away, well beyond visual line of sight and was just referencing the map on his tablet; therefore, he was not aware that the helicopter was in close proximity to the sUAS. Although the pilot stated that he knew that the sUAS should be operated at an altitude below 400 ft, flight logs revealed that he had conducted a flight earlier on the evening of the incident, in which he exceeded 547 ft altitude at a distance of 1.8 miles, which was unlikely to be within visual line of sight. In addition, even though the sUAS pilot indicated that he knew there were frequently helicopters in the area, he still elected to fly his sUAS beyond visual line of sight, demonstrating his lack of understanding of the potential hazard of collision with other aircraft. In his interview, the sUAS pilot indicated that he was not concerned with flying beyond visual line of sight, and he expressed only a general cursory awareness of regulations and good operating practices.

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The collision occurred 2 minutes before the end of civil twilight. Although modeler (recreational) sUAS pilots may fly at night under certain conditions, when asked about night flight, the incident pilot only stated that he had built-in position lights; thus he was likely unaware of any guidelines or practices for night operations.

There was no evidence of any mechanical or software problems with the sUAS relevant to the flight. The pilot did not report any anomalies, and stated the recorded information on the flight logs accurately reflected the incident flight. The sUAS operated as expected at all times. Although the recorded data showed a 9-second gap in telemetry, this was likely due to distance from the remote controller.

## Probable Cause and Findings

The National Transportation Safety Board determines the probable cause(s) of this incident to be:

the failure of the sUAS pilot to see and avoid the helicopter due to his intentional flight beyond visual line of sight. Contributing to the incident was the sUAS pilot's incomplete knowledge of the regulations and safe operating practices.

### Findings

<b>Personnel issues</b>	Incorrect action performance - Pilot of other aircraft
<b>Environmental issues</b>	Aircraft - Effect on equipment

## Factual Information

### History of Flight

#### Enroute

#### Midair collision

On September 21, 2017, at 1920 eastern daylight time, a Sikorsky UH-60M Black Hawk helicopter, R20087, operated by the U.S. Army as CAVM087 ("Caveman 87"), collided with a privately owned and operated Dà-Jiang Innovations (DJI) Phantom 4 small unmanned aircraft system (sUAS). The collision occurred about 300 ft above mean sea level (msl) and 1 mile east of Midland Beach, Staten Island, New York, in the vicinity of Hoffman Island. The helicopter received minor damage, and the sUAS was destroyed. There were no injuries or ground damage.

The incident helicopter was the lead aircraft of a flight of two, and was operating as a local orientation flight for the Hudson Class B Airspace Exclusion and the United Nations General Assembly Temporary Flight Restriction (TFR) operations. The flight had flown south along the Hudson River, then turned east at the Verrazano-Narrows Bridge toward Coney Island, New York. The crew then decided to make a right turn toward the west and return to their base at Linden Airport (LDJ), Linden, New Jersey. Air traffic control (ATC) radar obtained from the Federal Aviation Administration (FAA) showed the flight heading toward LDJ between 200 and 300 ft msl. The crew reported that the flight had just passed Hoffman Island when the lead helicopter made contact with what appeared to be a sUAS. Recorded data from the helicopter indicated that it was flying at an altitude of 274 ft msl at the time of the collision.

The helicopter co-pilot was the pilot flying when the collision occurred. He reported that he immediately and rapidly reduced the collective as the sUAS suddenly came into his view in close proximity to the helicopter. The pilot-in-command took the controls and recommended that they return to LDJ. Radar data indicated that the flight proceeded to LDJ, climbing to about 800 ft as it passed over the shore and overflowed more populated areas. The flight landed uneventfully, and the air mission commander subsequently reported the collision to the air traffic control tower at Newark Liberty International Airport.

The sUAS pilot was unaware that a collision had taken place until he was contacted by the NTSB. The pilot reported that he initiated the pleasure flight from the shore adjacent to Dyker Beach Park, southeast of the Verrazano-Narrows Bridge, in the Fort Hamilton neighborhood of Brooklyn, New York, and that he intended to fly "over the ocean." Data logs from the control tablet provided by the pilot indicated that the sUAS took off at 1911:34 and, after takeoff, climbed to a recorded altitude of 89 meters (292 ft). The sUAS altitude is based on height above the takeoff point ("home point"); the elevation of the park is about 7 ft msl.

The sUAS then proceeded on a straight, southwesterly course toward Hoffman Island, about 2.5 miles from the takeoff location. The data log showed the aircraft briefly paused over the ship channel and completed some yawing turn maneuvers, consistent with the pilot looking through the camera view at points of interest, then resumed the straight course toward the island.

At 1914:30, ATC radar indicated the flight of helicopters was travelling south-southeasterly from the Verrazano-Narrows Bridge toward Coney Island at 400 ft (Figure 1). The helicopters passed the sUAS pilot's position from his right to left about 1 mile from his location. The sUAS was about 1 1/2 miles from the sUAS pilot at that time and along a common line of sight. Shortly afterward, at 1915:30, data logs indicated the sUAS paused and hovered northeast of Hoffman Island for about 2 minutes before resuming a southwesterly track toward the island. During this time, the helicopters were flying east along the Coney Island shoreline about 300 ft msl.

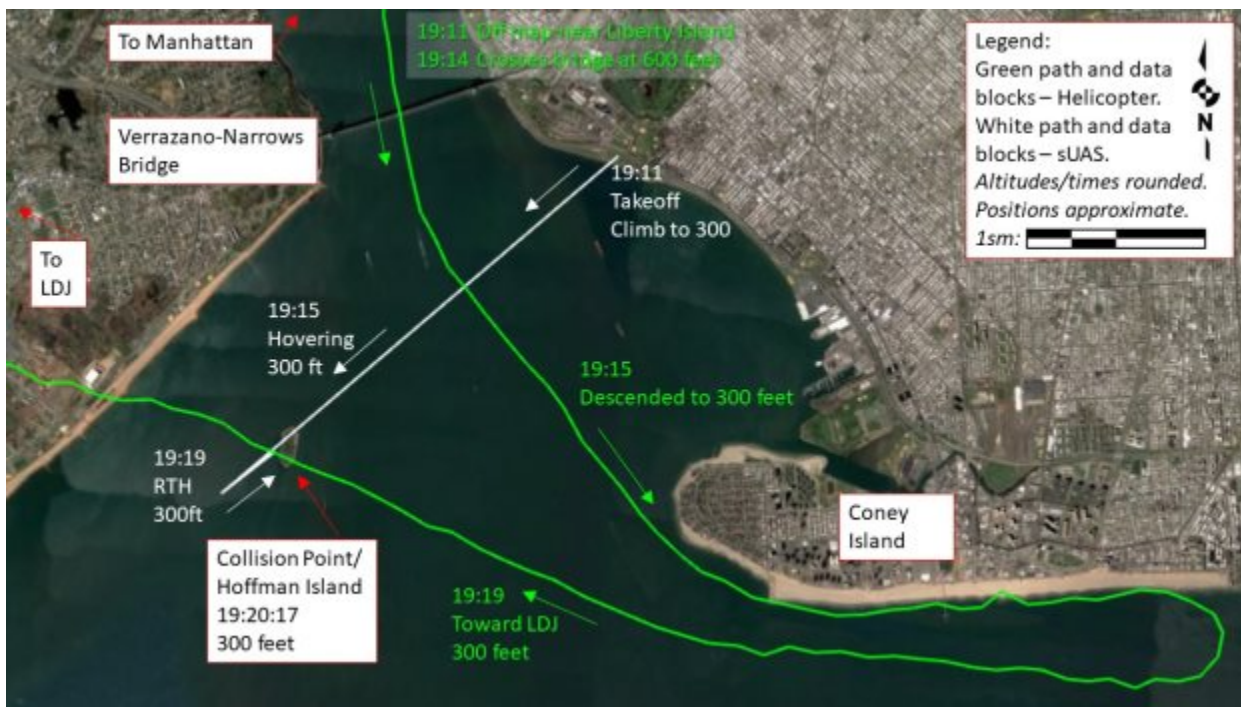


Figure 1: Approximate route of flight of the UH-60 and sUAS

At 1919:15, the sUAS pilot pressed the return-to-home (RTH) button on the control tablet, and the aircraft turned around and began tracking northeast toward the home point. The helicopters had completed a turn toward LDJ, and were just west of Coney Island at 300 ft. At 1919:51, the sUAS battery endurance warning activated, indicating that only enough charge remained to return directly to the home point. The pilot did not have visual contact with the sUAS or the helicopters at that time. As the sUAS was tracking northeast, telemetry data dropped out for about 9 seconds but returned just before the collision. The position of the aircraft was near the maximum range of the remote controller. At 1920:17.6, the data logs ended. The last position and altitude logged correlated with the position and altitude of the incident helicopter's recorded data and ATC radar information; about 300 ft west of Hoffman Island. The sUAS pilot reported that he lost signal with the aircraft and assumed it would return home as programmed. After waiting about 30 minutes, he assumed it had experienced a malfunction and crashed in the water.

The airspace in the area of the flight is Class G, underlying a shelf of the New York Class B airspace. A Notice to Airmen (NOTAM 7/4755), issued by the FAA Flight Data Center, was in effect at the time of the incident flight. The NOTAM established a Temporary Flight Restriction (TFR) due to the United Nations General Assembly meeting. The TFR restricted operations within the lateral limits of the New York Class B airspace from the surface up to 17,999 ft msl, and included a prohibition on model aircraft and unmanned aerial systems (UAS).

Additionally, another NOTAM (7/8423) was in effect establishing a VIP Presidential TFR within 30 nautical miles (nm) of Bedminster, New Jersey, from the surface up to 17,999 ft msl, which also included a prohibition on model aircraft and unmanned aerial systems (UAS). The incident sUAS launch point was 30.35 nm from the center of that TFR; Hoffman Island was 29.22 nm from the center point.

## Information

<b>Certificate:</b>	<b>Age:</b>
<b>Airplane Rating(s):</b>	<b>Seat Occupied:</b>
<b>Other Aircraft Rating(s):</b>	<b>Restraint Used:</b>
<b>Instrument Rating(s):</b>	<b>Second Pilot Present:</b>
<b>Instructor Rating(s):</b>	<b>Toxicology Performed:</b>
<b>Medical Certification:</b>	<b>Last FAA Medical Exam:</b>
<b>Occupational Pilot:</b>	<b>Last Flight Review or Equivalent:</b>
<b>Flight Time:</b>	

The helicopter flight crew comprised two pilots and two crew chiefs. The pilot-in-command had 1,570 hours of experience in the UH-60, and the co-pilot had 184 hours. The crew reported that they had no previous encounters with sUAS in flight and no outside knowledge or experience with sUAS.

The sUAS pilot stated he was a recreational operator, and that he flew only for enjoyment. He did not hold an FAA Remote Pilot certificate or a manned aircraft pilot certificate. He flew only DJI products, and he did not have experience with conventional radio-control airplanes. He said he had "a lot" of experience with sUAS; the data logs provided by him indicated that he had flown 38 flights in the previous 30 days. He had owned the incident sUAS for about one year and owned a Phantom 3 and another Phantom 4 before purchasing the incident sUAS. Five days after the collision, he purchased a Phantom 4 Pro. He had registered with the FAA as a model aircraft operator during the time period that the registration requirement was in effect. He had taken no specific sUAS training other than the tutorials that are included in the DJI GO4 operating application (app). At the time of the collision, there were no training or certification requirements for hobbyist or modeler pilots.

The pilot said that he was familiar with the area and had flown there many times before. He said that he had flown at night before, and that his sUAS did not have any extra lighting, stating that, "it has four lights."

When asked about specific regulations or guidance for sUAS flights, he stated that he knew to stay away from airports, and was aware there was Class B airspace nearby. He said that he relied on "the app" to tell him if it was OK to fly. He stated he knew that the aircraft should be operated below 400 ft. When asked about TFRs, he said he did not know about them; he would rely on the app, and it did not give any warnings on the evening of the collision. He said he was not familiar with the TFRs for the United Nations meeting and Presidential movement.

When asked, he did not indicate that he was aware of the significance of flying beyond line of sight and again stated that he relied on the app display. He said he did not see or hear the flight of helicopters involved in the collision but said that helicopters fly in the area all the time.

### Aircraft and Owner/Operator Information

<b>Aircraft Make:</b>	Sikorsky	<b>Registration:</b>	R20087
<b>Model/Series:</b>	UH60	<b>Aircraft Category:</b>	Helicopter
<b>Year of Manufacture:</b>		<b>Amateur Built:</b>	
<b>Airworthiness Certificate:</b>	Unknown	<b>Serial Number:</b>	Unknown
<b>Landing Gear Type:</b>		<b>Seats:</b>	
<b>Date/Type of Last Inspection:</b>		<b>Certified Max Gross Wt.:</b>	
<b>Time Since Last Inspection:</b>		<b>Engines:</b>	
<b>Airframe Total Time:</b>		<b>Engine Manufacturer:</b>	
<b>ELT:</b>		<b>Engine Model/Series:</b>	
<b>Registered Owner:</b>	US Army	<b>Rated Power:</b>	
<b>Operator:</b>	US Army	<b>Operating Certificate(s) Held:</b>	None

The UH-60M is a four-bladed, twin-engine, medium utility helicopter manufactured by Sikorsky Aircraft. It is widely used by the US military for many missions.

The Phantom 4 is a small unmanned aircraft system of quadcopter configuration, about 13 inches in diameter. It is powered by four electric, brushless motors and a 4-cell, 15.2-volt lithium-polymer battery. The maximum takeoff weight is 3 pounds; maximum altitude is about 19,685 ft msl. Maximum endurance is 28 minutes. Specified maximum range of the remote controller is 3.1 miles. The aircraft is equipped with a GPS/GLONASS navigation system and a flight controller enabling various automated functions. The aircraft is equipped with a 12-megapixel digital camera capable of still or video recording and first-person view display. Aircraft telemetry and video is transmitted to the remote controller in the 2.4 GHz band and displayed on a smartphone or tablet of the pilot's choice using an app supplied by the manufacturer or various third-party app developers. The pilot used a Samsung tablet with wi-fi but no cellular data capability. He did not use any third-party apps to control the aircraft.

The Phantom 4 includes a feature called Geospatial Environment Online (GEO), which is designed to aid pilots in avoiding certain types of airspace. When available, the pilot receives a message on the control smartphone or tablet advising of the type of airspace and other information. According to DJI:

*"GEO provides pilots with up-to-date guidance on areas where flight may be limited by regulation or raise safety concerns. In addition to airport location information, flyers will have real-time access to live information on temporary flight restrictions [and] locations such as prisons, nuclear power plants and other sensitive areas where flying may raise non-aviation security concerns. The GEO system is advisory only. Each user is responsible for checking official sources and determining what laws or regulations might apply to his or her flight."*

The GEO system categorizes features into one of four zones: Warning, Enhanced Warning, Authorization, and Restricted zones. Temporary Flight Restrictions are typically coded as Authorization Zones, which appear yellow in the DJI GO4 map. Users will be prompted with a warning and flight is limited by default. A user with appropriate authorization may unlock the Authorization Zone by using a DJI-verified account. This is called "self-unlocking" and can be accomplished before the flight via DJI's website for a period of up to three days, or at the time of flight if the user has an internet connection in the field.

The incident pilot's tablet did not have a cellular data connection, so the GEO system information regarding the TFRs would not download in real time at the takeoff location. In order for the system to have warned the pilot, he would have had to connect to the internet at some point while the TFR was active; however, at the time of the incident, the TFR system within DJI GEO and displayed to customers through DJI GO4 was not active. During August 2017, an issue was identified with the GEO function that inadvertently and intermittently rendered the self-unlock feature for certain TFRs ineffective for some users. After a significant number of complaints about the problem, DJI decided to temporarily disable the TFR functionality in GEO until the feature was investigated and confirmed to be working properly. Therefore, at the time of the incident, no TFR information was available in GEO. Since GEO is meant to be an advisory system to pilots, DJI decided it was better to disable this feature until the problem could be corrected to enable authorized users to support recovery efforts and other authorized missions across the country, including firefighting response and demonstrations at air shows. There was no notice or advisory to users that this advisory function had been disabled. The TFR functionality in GEO was restored in October 2017.

## Meteorological Information and Flight Plan

<b>Conditions at Accident Site:</b>	Visual (VMC)	<b>Condition of Light:</b>	Dusk
<b>Observation Facility, Elevation:</b>	KLDJ	<b>Distance from Accident Site:</b>	10 Nautical Miles
<b>Observation Time:</b>	23:15 Local	<b>Direction from Accident Site:</b>	290°
<b>Lowest Cloud Condition:</b>	Clear	<b>Visibility</b>	10 miles
<b>Lowest Ceiling:</b>	None	<b>Visibility (RVR):</b>	
<b>Wind Speed/Gusts:</b>	3 knots / None	<b>Turbulence Type Forecast/Actual:</b>	/ None
<b>Wind Direction:</b>	40°	<b>Turbulence Severity Forecast/Actual:</b>	/
<b>Altimeter Setting:</b>	29.98 inches Hg	<b>Temperature/Dew Point:</b>	-11°C
<b>Precipitation and Obscuration:</b>			
<b>Departure Point:</b>	Linden, NJ (KLDJ)	<b>Type of Flight Plan Filed:</b>	VFR
<b>Destination:</b>	Linden, NJ (KLDJ)	<b>Type of Clearance:</b>	None
<b>Departure Time:</b>	18:45 Local	<b>Type of Airspace:</b>	Class G

The LDJ surface observation at 1915 reported clear skies, 10 miles visibility and light northeasterly winds. Sunset was at 1855 and the end of civil twilight occurred at 1922.

## Wreckage and Impact Information

<b>Crew Injuries:</b>	4 None	<b>Aircraft Damage:</b>	Minor
<b>Passenger Injuries:</b>		<b>Aircraft Fire:</b>	None
<b>Ground Injuries:</b>	N/A	<b>Aircraft Explosion:</b>	None
<b>Total Injuries:</b>	4 None	<b>Latitude, Longitude:</b>	40.5,-74(est)

One motor and a portion of an arm of the sUAS was recovered from the helicopter. Debris was found in the engine oil cooler fan by Army maintenance personnel. The components were transferred by the US Army to a representative of the FAA Teterboro, New Jersey, Flight Standards District Office, then to the NTSB. Manufacturing serial number information inscribed on the motor enabled sales records provided by the manufacturer to aid in identifying the pilot, as the sUAS was purchased directly from the manufacturer. The remainder of the sUAS was not recovered.

## Damage to Aircraft

A 1 1/2-inch dent was found on the leading edge of one of the UH-60's main rotor blades, surrounded by various scratches and material transfer. Some cracks were observed in the composite fairing and window frame material.

The Phantom 4 sUAS was destroyed and several components were lodged in the helicopter.

## **Additional Information**

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The investigation reviewed pertinent regulations and guidance regarding helicopter and sUAS operation.

### Helicopter Operating Altitude

14 *Code of Federal Regulations (CFR)* Part 91.119 states in part:

Except when necessary for takeoff or landing, no person may operate an aircraft below the following altitudes:

(c) Over other than congested areas. An altitude of 500 feet above the surface, except over open water or sparsely populated areas. In those cases, the aircraft may not be operated closer than 500 feet to any person, vessel, vehicle, or structure. . . .(d) Helicopters, . . . If the operation is conducted without hazard to persons or property on the surface - (1) A helicopter may be operated at less than the minimums prescribed in paragraph (b) or (c).

### Statutes, Regulations, and Guidelines applicable to sUAS

Public Law 112-95 section 336(c) (Feb. 14, 2012) defines "model aircraft" as an unmanned aircraft that is:

- (1) Capable of sustained flight in the atmosphere;
- (2) Flown within visual line of sight of the person operating the aircraft; and
- (3) Flown for hobby or recreational purposes.

14 *CFR* 1.1 (and 101.1) state in part:

Model aircraft means an unmanned aircraft that is:

- (2) Flown within visual line of sight of the person operating the aircraft; and
- (3) Flown for hobby or recreational purposes.

14 *CFR* 101.41 states in part:

Applicability.

This subpart prescribes rules governing the operation of a model aircraft that meets all of the following conditions ...

- (a) The aircraft is flown strictly for hobby or recreational use;
- (b) The aircraft is operated in accordance with a community-based set of safety guidelines;...
- (d) The aircraft is operated in a manner that does not interfere with and gives way to any manned aircraft...

The Academy of Model Aeronautics (AMA) publishes such safety guidelines. The AMA Safety Code states in part:

9. The pilot of an RC model aircraft shall:

- (a) Maintain control during the entire flight, maintaining visual contact without enhancement other than by corrective lenses prescribed for the pilot.

Temporary Flight Restrictions

According to the FAA, TFRs are tools used by the FAA to restrict aircraft operations within designated areas. [In recent] years, TFRs, along with Air Defense Identification Zones and Flight Restriction Zones, have been widely used to restrict overflights through certain airspace for reasons of national security. Two TFRs were in effect in the area and time of the incident, as noted in the History of Flight section above.

## Administrative Information

**Investigator In Charge (IIC):** English, William

**Additional Participating Persons:**

**Original Publish Date:** December 14, 2017

**Last Revision Date:**

**Investigation Class:** [Class](#)

**Note:** The NTSB did not travel to the scene of this incident.

**Investigation Docket:** <https://data.ntsb.gov/Docket?ProjectID=96058>

The National Transportation Safety Board (NTSB) is an independent federal agency charged by Congress with investigating every civil aviation accident in the United States and significant events in 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)). A factual report that may be admissible under 49 *United States Code* section 1154(b) is available [here](#).