Testimony of

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— On —

State of Aviation Safety

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NTSB | National Transportation Safety Board

An Independent Federal Agency

Good morning, Chairman LoBiondo, Ranking Member Larsen, and the Members of the Subcommittee. Thank you for inviting the National Transportation Safety Board (NTSB) to testify before you today.

The NTSB is an independent federal agency charged by Congress with investigating every civil aviation accident in the United States and significant accidents in other modes of transportation—highway, rail, marine, and pipeline. We determine the probable cause of the accidents we investigate and we issue safety recommendations aimed at preventing future accidents. In addition, we conduct special transportation safety studies and coordinate the resources of the federal government and other organizations to assist victims and their family members who have been impacted by major transportation disasters.

Our Office of Aviation Safety investigates all civil domestic air carrier, commuter, and air taxi accidents; in-flight collisions; general aviation accidents; and certain public-use aircraft accidents, amounting to approximately 1,500 investigations annually since 2007. We also participate in the investigation of major airline accidents in foreign countries that involve US carriers, US-manufactured or -designed equipment, or US-registered aircraft to fulfill US obligations under International Civil Aviation Organization (ICAO) agreements.

This testimony will address the state of aviation safety from the NTSB's perspective and is based on our investigations. It will include a description of safety issues we have identified and recommendations we have made, and will conclude with a description of the work we are doing with emerging transportation technologies in aviation.

Preliminary Aviation Accident Statistics, 2016

The US aviation system is experiencing a record level of safety, and preliminary aviation accident statistics for 2016 show an overall decline in the number of US-registered civil aviation accidents.[1] For the third straight year, there were no passenger fatalities as a result of accidents involving US air carriers operating under the provisions of Title 14 *Code of Federal Regulations* (*CFR*) Part 121.[2] Notably, since the crash of Colgan flight 3407 in 2009, there have been no passenger fatalities as a result of accidents involving US air carriers operating under Part 121 providing scheduled service.[3]

Overall, aviation deaths in the United States decreased slightly from 416 in 2015 to 412 in 2016. Nearly 94 percent of aviation fatalities (386 instances) occurred in general aviation accidents, with the remainder primarily in 14 *CFR* Part 135 operations, which includes charters, air taxis, air tours, and medical services (when a patient is on board). While the number of fatalities from general aviation accidents increased slightly from 378 in 2015, the fatal accident rate fell below 1 fatal accident per 100,000 flight hours for the first time in the NTSB's 50-year history.

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[1] National Transportation Safety Board, 2016 preliminary aviation statistics.

[2] In 2013, there were two fatal accidents involving nonscheduled cargo flights operating under Part 121—National Air Cargo crash after takeoff at Bagram Air Base, Afghanistan, and United Parcel Service flight 1354 crash during approach in Birmingham, Alabama.

[3] National Transportation Safety Board, *Loss of Control on Approach, Colgan Air, Inc., Operating as Continental Connection Flight 3407, Bombardier DHC 8 400, N200WQ*, Rpt. No. AAR-10-01 (Washington, DC: NTSB, 2012).

Over the last several decades, significant advances in technology, important legislative and regulatory changes, and more comprehensive crew training have contributed to the current level of aviation safety. However, we continue to see accidents and incidents that remind us of the need to be ever vigilant in improving safety.

Most Wanted List Issue Area—Prevent Loss of Control in Flight in General Aviation

On November 14, 2016, we announced our Most Wanted List of Transportation Safety Improvements for 2017–2018.[4] This list identifies 10 focus areas for transportation safety improvements based on safety issues identified by our investigations. Many of the issues on the Most Wanted List address multimodal challenges for improving safety, including many that are identified in our aviation accident investigations, such as alcohol and drug impairment, distraction, occupant protection, fatigue, medical fitness, safe shipment of hazardous materials, and use of recorders. One issue area is specific to aviation: addressing loss of control (LOC) in flight in general aviation.

Since 2008, nearly 46 percent of fatal fixed-wing general aviation accidents in the United States resulted from pilots losing control of their aircraft in flight. As defined by the Federal Aviation Administration (FAA), an LOC accident involves an aircraft's unintended departure from controlled flight, which can be due to a variety of reasons, such as pilot distraction, loss of situational awareness, or weather. The most common type of LOC is an aerodynamic stall, including the possibility of poststall spin, which can occur when the pilot allows the aircraft to enter a flight regime outside its normal flight envelope. Unfortunately, the circumstances for these accidents are often repeated over time, and too many preventable crashes occur. We have focused on working with stakeholders, including the FAA, pilots, flight instructors, and other members of the general aviation community, to increase awareness, education, and training to address the risk of these events.

In 2013, we began holding a series of safety seminars focused on general aviation safety issues, including LOC, weather, impairment, experimental aircraft, and, most recently, ensuring adequate flight experience in different types of aircraft.[5] On April 24, 2018, we will hold a roundtable of industry and government experts to discuss inflight LOC and to highlight available technologies and training. We have also held events in locations such as Alaska and New York to share lessons learned about LOC from our accident investigations with the general aviation communities in those areas. We regularly issue Safety Alerts and videos for general aviation pilots and aviation maintenance technicians to increase awareness, education, and training on issues that we have seen in our accident investigations.[6] Our focus has been on continued collaboration with the FAA and the aviation community to develop and participate in initiatives to help reduce the number of fatal accidents. These efforts have played a major role in the progress made toward improving aviation safety.

[4] National Transportation Safety Board, *2017–2018 Most Wanted List* (Washington, DC: NTSB, 2016).
[5] National Transportation Safety Board, General Aviation Safety Seminars.
[6] National Transportation Safety Board, NTSB Safety Alerts.

Most Wanted List Issue Area—Expand Recorder Use to Enhance Safety

Expanding use of recorders is another Most Wanted List issue area that is important in all modes. In aviation, data, audio/voice, and video recorders capture and store critical information that can help investigators determine the cause of plane and helicopter accidents and companies and operators take proactive steps to prevent accidents. Yet, some aircraft, especially general aviation aircraft and rotorcraft, are still not equipped with these critical technologies, even though recorders are readily available, easily installed, and largely affordable.

Although we have used recorder data to determine the cause of accidents and to develop recommendations to help prevent future accidents, some questions can only be answered through the data provided by an image recorder. These devices help investigators and operators fill in the gaps when data and voice/audio recordings cannot capture all of the information. For example, although we obtained recorded cockpit audio and extensive parametric data during our investigation of the SpaceShipTwo accident, our investigators were only able to determine the true cause of the accident from video that showed the copilot prematurely moving the feather lock handle.[7]

We have recommended use of image recorders for more than 18 years. Although there may be technical solutions other than image recorders that can capture instrument readings displayed to the flight crew, those solutions do not also capture critical information about the cockpit environment conditions (for example, crew actions and visibility), instrument indications available to crewmembers, and aircraft system degradation. In 2013, we recommended that the FAA require installation of a crash-resistant flight recorder system, which should record cockpit audio and images and parametric data in certain newly manufactured aircraft as well as in certain existing aircraft.[8] Both recommendations are currently classified "Open—Acceptable Response."

Recorders not only help with determining the cause of a crash or accident, but, perhaps more importantly, they also help companies and operators establish effective safety management strategies. Data from recorders can be used to adjust procedures and enhance crew training to prevent accidents from happening in the first place. Although some operators have implemented—or are in the process of implementing—recorder programs and systems, many are slow to do so without regulatory requirements.

Recent Aviation Accident Investigations

I want to highlight several aviation accidents that we have investigated during the last 2 years that have raised additional safety issues.

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[7] National Transportation Safety Board, *In-Flight Breakup During Test Flight Scaled Composites SpaceShipTwo, N339SS Near Koehn Dry Lake, California October 31, 2014*, Rpt. No. AAR-15/02 (Washington, DC: NTSB, 2015).

[8] Aircraft covered by the recommendations are turbine-powered, nonexperimental, nonrestricted-category aircraft that are not equipped with a flight data recorder and a cockpit voice recorder and are operating under 14 *Code of Federal Regulations* Parts 91, 121, or 135. Safety Recommendation A-13-12 applies to newly manufactured aircraft, and Safety Recommendation A-13-13 applies to existing aircraft.

Lockhart, Texas

On July 30, 2016, the deadliest US aviation accident since Colgan flight 3407 occurred in Lockhart, Texas.[9] A commercial hot air balloon pilot and his 15 passengers tragically died when their balloon struck power lines; crashed in a field near Lockhart, Texas; and caught fire. We determined that the pilot of the balloon made several poor decisions, both before and during the flight; for instance, he elected to fly in cloudy and foggy conditions that decreased his ability to see and avoid obstacles. However, in this accident, we also identified other decisions made by the government that raise safety concerns, such as a lack of medical oversight for commercial balloon pilots and a lack of targeted FAA oversight of potentially risky commercial balloon operations.

Currently, commercial balloon pilots are not required to hold a medical certificate of any kind. The Lockhart accident pilot had been diagnosed with medical conditions known to cause cognitive deficits that may affect decision-making and, ultimately, flight safety. In addition, medications were found in the pilot's system that are known to cause impairment and are listed on the FAA's "Do Not Issue" and "Do Not Fly" lists. Altogether, these issues would likely have led an aviation medical examiner to either defer or deny a medical certificate. As a result of this accident, we recommended that the FAA remove the medical certification exemption in 14 *CFR* 61.23(b) for pilots who are exercising their privileges as commercial balloon pilots and receiving compensation for transporting passengers.[10]

The FAA conducts almost all of its oversight of balloon operators at large balloon gatherings. Thus, those operators who do not attend the gatherings, such as the accident pilot, likely do not to receive any FAA oversight. This focus on balloon gatherings does not support the FAA's risk-based, data-informed approach to oversight. It also does not provide the FAA with opportunities to educate all commercial balloon operators and mitigate risk before an accident occurs. As a result of this accident, we recommended that the FAA analyze its current policies, procedures, and tools for overseeing commercial balloon operations and develop and implement more effective ways to target oversight of the operators and operations that pose the most significant safety risks to the public.[11]

The status of each of these recommendations is "Open—Await Response."

Frisco, Colorado

On July 3, 2015, an Airbus Helicopters AS350 B3e, registered to and operated by Air Methods Corporation, lifted off from the Summit Medical Center Heliport in Frisco, Colorado, and then crashed into a nearby parking lot and caught fire.[12] The pilot was fatally injured, and the two flight nurses were seriously injured. We determined that the probable cause of this accident was the helicopter's preflight hydraulic check procedure and lack of an alert to the pilot that

[9] National Transportation Safety Board, *Impact with Power Lines, Heart of Texas Hot Air Balloon Rides, Balóny Kubíček BB85Z, N2469L*, Rpt. No. AAR-17/03 (Washington, DC: NTSB, 2017).
[10] National Transportation Safety Board, Safety Recommendation A-17-34, October 31, 2017.
[11] National Transportation Safety Board, Safety Recommendation A-17-45, October 31, 2017.
[12] National Transportation Safety Board, *Loss of Control at Takeoff, Air Methods Corporation, Airbus Helicopters AS350 B3e, N390LG*, Rpt. No. AAR-17/01 (Washington, DC: NTSB, 2017).

hydraulic pressure was not restored, which resulted in an LOC after takeoff. We found that the impact forces of this accident were survivable for the helicopter occupants; however, the helicopter's fuel system, which was not crash resistant and facilitated a fuel-fed postcrash fire, contributed to the severity of the injuries.

The helicopter in this accident did not have—and was not required to be equipped with—a crash-resistant fuel system. The AS350-series helicopters received initial FAA type certificate design approval in 1977, and were not subject to the airworthiness standards revised by the FAA in October 1994 for "comprehensive crash resistant fuel system design and test criteria."[13] These design features were intended to reduce the risk of a postcrash fire and, for more severe crashes, minimize fuel spillage near ignition sources to improve the evacuation time needed for crew and passengers to escape a postcrash fire. The improved standards were not applicable to newly manufactured helicopters whose certification basis and approval predated the effective date of the revised airworthiness standards, which was November 2, 1994. According to Airbus Helicopters and Air Methods, no options existed for retrofitting an AS350 B3e helicopter with a crash-resistant fuel system until March 2016.

Shortly after the accident in Frisco, we issued a safety recommendation to the FAA as a result of a Bell Helicopter accident in Wichita Falls, Texas, in which the helicopter crashed and was destroyed by a postcrash fire.[14] The recommendation asked the FAA to require, for all newly manufactured rotorcraft regardless of the design's original certification date, that the fuel systems meet the crashworthiness requirements.[15]

In September 2017, the FAA responded to our recommendation by noting that its aviation rulemaking advisory committee (ARAC) created a subcommittee to examine the issue. The subcommittee analyzed the costs and benefits of such a regulation and determined that, although crash-resistant fuel systems were highly effective, the cost of such a mandate outweighed the benefits. The FAA asked the subcommittee to analyze whether partial compliance with the standards might show benefits with reduced compliance costs. In June 2017, at a public meeting of the ARAC, the subcommittee reported that it examined six models of in-service helicopters from three different manufacturers that met parts of the improved standards adopted in 1994. The analysis showed that none of the helicopter models had a postcrash fire in a survivable accident, while 11 percent of helicopters that met none of fire-resistant fuel systems standards had postcrash fires. The subcommittee is examining which parts of the fuel tank standards were in the six models of helicopters and will propose partial compliance standards that should have substantially reduced compliance costs while resulting in comparable safety benefits. The status of this recommendation is "Open—Acceptable Response."

Akron, Ohio

On November 10, 2015, Execuflight flight 1526, a Hawker 700A, departed controlled flight while on approach to Akron Fulton International Airport and impacted a four-unit apartment building in Akron, Ohio. The captain, first officer, and seven passengers died. Fortunately, no one

[13] 59 *Federal Register* 50380
[14] Accident CEN15FA003
[15] National Transportation Safety Board, Safety Recommendation A-15-12, July 23, 2015.

on the ground was injured. The airplane was destroyed by impact forces and postcrash fire.[16] We determined that the probable cause of this accident was the flight crew's mismanagement of the approach and multiple deviations from company standard operating procedures (SOPs), which placed the airplane in an unsafe situation. Contributing to the accident was Execuflight's casual attitude toward compliance with standards; its inadequate hiring, training, and operational oversight of the flight crew; and its lack of a formal safety program, and the FAA's insufficient oversight of the company's training program and flight operations. Among the safety issues identified was the lack of a requirement for flight data monitoring (FDM) programs for Part 135 operators.

In this accident, Execuflight had established SOPs, but the flight crew consistently failed to follow them. Execuflight had no means of monitoring its airplanes' daily operations, identifying operational deficiencies (such as noncompliance with SOPs), and correcting those deficiencies before an accident occurred. Absent continual surveillance of an operation through en-route inspections by company check airmen, the only means an operator can use to consistently and proactively monitor its line operations is through comprehensive data collection over the entirety of its operation, which can be accomplished through an FDM program. We believe that, as demonstrated by this and many other accidents, all Part 135 operators need FDM programs. Had an FDM program been in place at Execuflight, failure of either pilot to follow SOPs on earlier flights might have provided Execuflight the opportunity to take corrective action that could have avoided the accident.

As a result of this investigation, we recommended that the FAA require all Part 135 operators to install flight data recording devices capable of supporting an FDM program, and to require Part 135 operators to establish a structured FDM program that reviews all available data sources to identify deviations from established norms and procedures and other potential safety issues.[17] We understand that the FAA plans to review whether a cost–benefit analysis will justify such mandates. The status of these recommendations are "Open—Acceptable Response" and "Open—Acceptable Alternate Response," respectively.

Chicago, Illinois; Las Vegas, Nevada; Pensacola, Florida

On October 28, 2016, American Airlines flight 383, bound for Miami, Florida, experienced a right engine uncontained failure and subsequent fire during takeoff at Chicago O'Hare International Airport.[18] The flight crew aborted the takeoff and stopped the aircraft on the runway, and an emergency evacuation was conducted. Of the 161 passengers and 9 crewmembers onboard, one passenger received serious injuries during the evacuation. The airplane was substantially damaged by the fire, which was caused by a fuel leak that resulted in a pool fire under the right wing. A turbine disk in the right engine fractured into at least four pieces, with one piece going

[16] National Transportation Safety Board, *Crash During Nonprecision Instrument Approach to Landing, Execuflight Flight 1526, British Aerospace HS 125-700A, N237WR*, Rpt. No. AAR 16/02 (Washington, DC: NTSB 2016).
[17] National Transportation Safety Board, Safety Recommendations A-16-034 and A-16-035.
[18] National Transportation Safety Board, *Uncontained Engine Failure and Subsequent Fire, American Airlines Flight 383, Boeing 767-323, N345AN*, Rpt. No. AAR -18/01 (Washington, DC: NTSB 2018).

through the inboard section of the right wing, over the fuselage, and into a warehouse facility a third of a mile away.

We are currently investigating other accidents involving uncontained engine failures. On September 8, 2015, British Airways flight 2276 experienced an uncontained failure during takeoff at McCarran International Airport, Las Vegas, Nevada.[19] The plane sustained fire damage and the 157 passengers and 13 crewmembers evacuated via emergency slides on the runway. Five people sustained minor injuries and one person suffered a serious injury as a result of the evacuation. The airplane was substantially damaged. In addition, on August 27, 2016, Southwest Airlines flight 3472, en route from New Orleans, Louisiana, to Orlando, Florida, experienced an uncontained engine failure and cabin depressurization while climbing.[20] None of the 99 passengers and 5 crewmembers onboard were injured, but the airplane sustained substantial damage. The flight crew declared an emergency and diverted to Pensacola International Airport.

We held a Board meeting on January 30, 2018, to determine the probable cause of the Chicago accident and to issue relevant safety recommendations. The Board determined that the failure was caused by an internal defect in a turbine disk, which was likely undetectable when the disk was manufactured in 1997 and during subsequent inspections. The investigation also found numerous problems with the evacuation, including a lack of communication between the flight deck and cabin crew, deviation by a flight attendant from emergency evacuation procedures, and the crew's lack of coordination following the evacuation. The Board adopted nine new recommendations—seven to the FAA and one each to Boeing and to American Airlines—and reiterated two recommendations to the FAA.

One of the recommendations to the FAA addresses passengers evacuating airplanes with carry-on baggage, which has been a recurring concern. Flight attendants are trained to instruct passengers not to evacuate with carry-on baggage because doing so could potentially slow passenger egress and block an exit during an emergency. In June 2000, we released a safety study on emergency evacuations of commercial airplanes, which found that passengers exiting with carry-on baggage was "the most frequently cited obstruction to evacuation."[21]

Video taken during the Chicago evacuation and postaccident interviews with flight attendants indicated that some passengers evacuated from all three usable exits with carry-on baggage. In one case, a flight attendant tried to take a bag away from a passenger who did not follow the instruction to evacuate without baggage, but the flight attendant realized that the struggle over the bag was prolonging the evacuation and allowed the passenger to take the bag. In another case, a passenger came to the left overwing exit with a bag and evacuated with it despite being instructed to leave the bag behind. In addition, video from the British Airways event in Las Vegas and an October 29, 2015, Dynamic International Airways event in Fort Lauderdale

[19] National Transportation Safety Board, Uncontained Engine Failure, Las Vegas, NV.
[20] National Transportation Safety Board, SWA 737 uncontained engine failure and loss of inlet cowl, Pascagoula, FL.
[21] National Transportation Safety Board, *Emergency Evacuation of Commercial Airplanes*, Rpt. No. SS-00/01, (Washington, DC: NTSB 2000).

show passengers who evacuated with carry-on baggage despite the standard instruction to leave their baggage and similar items behind in the event of an emergency.

Evidence of passengers retrieving carry-on baggage during recent emergency evacuations demonstrates that previous actions to mitigate this potential safety hazard have not been effective. As a result of the Chicago investigation, we recommended that the FAA measure the potential delays associated with passengers retrieving and carrying baggage during an emergency evacuation, and determineappropriate countermeasures to mitigate any related potential safety risks.

Current Aviation Accident Investigations

I would also like to take this opportunity to highlight and provide an update on several aviation accidents that we are currently investigating.

San Francisco, California

Around midnight on July 7, 2017, Air Canada flight 759 was cleared to land on runway 28R at San Francisco International Airport (SFO), but instead lined up on a parallel taxiway where four air carrier airplanes were awaiting takeoff clearance.[22] Flight 759 descended below 100 feet above the ground, and the flight crew initiated a go-around about the time it overflew the first airplane on the taxiway.

We were notified of the incident on July 9, 2017, and initiated an investigation. Parties to the investigation include the FAA and the National Air Traffic Controllers Association. In accordance with ICAO Annex 13, the Transportation Safety Board of Canada has appointed an accredited representative as the state of registration/operator. The Canadian accredited representative has appointed Air Canada, Transport Canada, and the Air Canada Pilots Association as technical advisors.

The investigation team has reviewed Airport Surface Detection Equipment Model X/Airport Surface Surveillance Capability data associated with the incident, and has also interviewed controllers and management personnel at the SFO air traffic control tower and the Northern California Terminal Radar Approach Control, as well as personnel among the incident flight crew and other flight crews that were landing or on the taxiway at time of the incident. The incident airplane's cockpit voice recorder had been overwritten, so NTSB investigators did not have that data.

The preliminary information from our investigation indicates that runway 28L, next to runway 28R, was closed to accommodate construction and was appropriately lit, and notices to airmen had been issued to alert operators of the runway's operational status. The appropriate runway and approach lighting for runway 28R and for taxiway C were also operational. The captain had over 20,000 total flight hours, and the first officer had about 10,000 total flight hours. There were no known air traffic control equipment discrepancies. Normal air traffic staffing for

[22] National Transportation Safety Board, Landing Approach to Taxiway at San Francisco International Airport (SFO), San Francisco, CA.

the midnight shift included two controllers. On the evening of the incident, one controller was in the tower cab.

In addition to the Air Canada incident, there are two actual runway incursions at SFO involving runway 28L that we are currently investigating.[23] Runway incursions—or the incorrect presence of an aircraft, vehicle, or person on a runway—have increased since 2011.[24] On September 19 and 20, 2017, we held a 2-day forum to bring together safety experts from the aviation industry to raise awareness of the increase in runway incursions in the United States and the need to effectively reverse the trend.[25] The forum provided the opportunity for pilots, air traffic controllers, and others involved to discuss their perspectives on the runway incursion issue and what is needed to address it. We will be releasing some of the lessons learned from that forum in the near future.

Pullman, Washington

On December 29, 2017, a Horizon Air plane landed on a taxiway at Pullman-Moscow Regional Airport in Washington. Taxiway landings are reportable incidents under 49 *CFR* 830.5, and Horizon Air notified us of this incident after it occurred. At that time, investigators requested that the cockpit voice recorder and flight data recorder be preserved, and that pilot statements be obtained. Horizon Air is a Part 121 carrier and was transporting the public. We have investigated previous Part 121 taxiway landings because of the potential for a catastrophic outcome, and decided on January 26, 2018, to launch a formal investigation.

Brampton, Ontario

On June 3, 2016, a FedEx delivery truck was making its final delivery of four large, custom-designed, lithium-ion batteries to a Brampton, Ontario, address and was destroyed by a fire. The driver discovered that one of the large battery shipments contained a smoking package and, shortly after the discovery, the package burst into flames. The fire spread to the remaining packages in the cargo area and eventually destroyed the truck. The driver was not injured. The four batteries were designed and packaged by Braille Battery Inc., and transported from their Florida facility on two FedEx cargo flights. They were then loaded onto the FedEx truck for final delivery when the incident occurred, 10 hours after they were offloaded from the second aircraft.

Although this fire occurred in Canada, we are investigating this incident because the shipment involved a US air carrier and included lithium batteries that were presumably shipped in a configuration that would ensure safe shipment and containment of any battery failure. We believe our investigation findings may have significant implications on current regulations addressing the safe transportation of lithium batteries.

[23] Incidents OPS17IA008A and OPS17IA014A.
[24] Federal Aviation Administration, Runway Safety Trends and Runway Incursion Analysis, September 19–20, 2017.
[25] National Transportation Safety Board Forum, Runway Incursion Safety Issues, Prevention, and Mitigation, September 19–20, 2017.

International Aviation Accident Investigations

We fulfill the US obligations to foreign accident investigations established by treaty under the auspices of the ICAO. Although accidents involving US air carriers have been declining, we are participating in some significant international accident investigations. The key objectives of our international aviation accident investigations are to:

- Identify safety deficiencies affecting US aviation interests;
- Capture safety lessons learned to prevent accidents in the US; and
- Enable credible and comprehensive accident investigations where US interests are concerned.

Given the international nature of air transportation and the leading role the United States plays in developing aviation technologies, our participation in foreign investigations is essential to enhancing aviation safety worldwide.

Emerging Transportation Technologies

Advances in technology are transforming transportation and hold promise for improving transportation safety, but they also pose new challenges. Among those advancing technologies are commercial space transportation and unmanned aircraft systems (UASs).

Commercial Space

We have been involved in commercial space accident investigations for almost 25 years, since leading the investigation of a procedural anomaly associated with the launch of an Orbital Sciences Corporation Pegasus expendable launch vehicle in 1993.[26] Most recently, we led the investigation of the fatal in-flight breakup of SpaceShipTwo in October 2014.[27] Foremost among the safety issues identified was the need to consider and protect against human error for safe manned spaceflight, which is the responsibility of designers, operators, and overseers. We made recommendations to the FAA and the Commercial Spaceflight Federation to establish human factors guidance for commercial space operators and to strengthen the FAA's evaluation process for experimental permit applications by promoting stronger collaboration between FAA technical staff and commercial space vehicle operators.

Our work in commercial space transportation supports our broader mission of improving transportation safety through investigating accidents and serious incidents, collaborating outreach and education efforts related to commercial space vehicles, and developing and disseminating safety investigation techniques in commercial space with the international community. To develop and maintain the necessary investigative expertise and tools in this emerging segment of transportation, we are focused on training for NTSB staff and outreach with commercial space stakeholders.

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[26] National Transportation Safety Board, *Commercial Space Launch Incident, Launch Procedure Anomaly, Orbital Sciences Corporation, Pegaus/SCD-1*, Rpt. No. SIR 93/02 (Washington, DC: NTSB 1993).
[27] National Transportation Safety Board. *In-Flight Breakup During Test Flight, Scaled Composites SpaceShipTwo, N339SS, Near Koehn Dry Lake, California, October 31, 2014*, Rpt. No. AAR 15/02 (Washington, DC: NTSB 2015).

Unmanned Aircraft Systems

The growing number of UASs and reports of near-collisions with manned aircraft have raised safety concerns regarding UAS integration into the airspace. In August 2010, we revised our Part 830 regulations to clarify that accident and incident notification requirements also apply to unmanned aircraft.[28] An advisory to operators was released in July 2016 clarifying the reporting requirements (i.e., if there is death or serious injury, the aircraft weighs more than 300 pounds and sustains substantial damage, or other specific serious incidents occur).[29]

On September 21, 2017, the pilot of a US Army UH-60 helicopter reported a collision with a small drone just east of Midland Beach, Staten Island, New York, representing the first confirmed accident involving a UAS and another aircraft. The helicopter sustained damage to its main rotor blade, window frame, and transmission deck. We determined that the probable cause of the incident was the failure of the UAS pilot to see and avoid the helicopter due to his intentional flight beyond visual line of sight. Contributing to the incident was the UAS pilot's incomplete knowledge of regulations and safe operating practices.[30] As the number and complexity of UAS operations continues to grow, it is inevitable that the number of NTSB UAS investigations will also increase.

We are also performing proof-of-concept testing using UASs as an accident investigation tool in all modes. UASs are rapidly becoming a standard tool in the domestic and international accident investigation community. Small UASs can be very rapidly deployed, which allows wreckage fields to be documented quickly and thoroughly when the accident area must be cleared expeditiously for safety or operational purposes. In addition, small UASs can access unique points of view useful to the investigator as well as areas otherwise inaccessible by conventional aircraft. Data collected is shared immediately, allowing investigators, managers, and support staff in distant locations instant access to accident site information not otherwise available.

Our ability to continue to provide outstanding investigative services and analyses requires the resources to acquire additional staff, develop staff expertise, and employ the appropriate equipment and analytical tools to investigate those transportation accidents where the latest technologies may have contributed to accident.

Conclusion

Thank you again for the opportunity to be here today to discuss the work that the NTSB is doing to make transportation safer. I will be happy to answer any questions.

[28] 49 CFR 830.2

[29] National Transportation Safety Board, *Advisory to Operators of Civil Unmanned Aircraft Systems in the United States*, July 29, 2016.

[30] National Transportation Safety Board, Inflight collision of UAS and helicopter, Staten Island, NY.