NTSB | National Transportation Safety Board

AVIATION HIGHWAY MARINE RAILROAD PIPELINE

2021 ANNUAL REPORT TO CONGRESS

NATIONAL TRANSPORTATION SAFETY BOARD

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2021

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ANNUAL REPORT TO CONGRESS

NTSB 2021

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[1] Ongoing investigations are those that, as of December 31, 2021, were not yet completed. Any completed as of June 30, 2022, are noted in this report. Additional updates will be provided in the 2022 Annual Report.

Abbreviations, Acronyms, and Initialisms

ADS-B	automatic dependent surveillance broadcast
ASOS	automated surface observing systems
AWOS	automated weather observing systems
BAC	blood alcohol concentration
CAROL	NTSB crash investigation query tool
CFR	*Code of Federal Regulations*
COVID-19	the coronavirus disease of 2019
CSX	CSX Transportation
CVR	cockpit voice recorder
d.b.a.	doing business as
DUI	driving under the influence
DUKW	(pronounced "duck") amphibious passenger vessel
FAA	Federal Aviation Administration
FDR	flight data recorder
FRA	Federal Railroad Administration
FTA	Federal Transit Administration
GPS	global positioning system
ICAO	International Civil Aviation Organization
IMO	International Maritime Organization
ITV	inspected towing vessel
LHFE	living history flight experience
LR	Liberia
MAIIF	Marine Accident Investigators' International Forum
MBI	Marine Board of Investigation
MOU	memorandum of understanding
MV	motor vessel
MWL	NTSB Most Wanted List of Transportation Safety Improvements
NHTSA	National Highway Traffic Safety Administration
NO	Norway
NTSB	National Transportation Safety Board
NYCT	New York City Transit
PATCO	Port Authority Transit Corporation
PG&E	Pacific Gas & Electric Company
PHMSA	Pipeline and Hazardous Materials Safety Administration
PN	The Philippines
SAFTI	NTSB database for surface investigations
SEPTA	Southeastern Pennsylvania Transportation Authority
SMS	safety management system
SUV	sport utility vehicle
VRU	vulnerable road users
UAS	unmanned aircraft system
Uber ATG	Uber Advanced Technologies Group
USCG	US Coast Guard
USCGC	US Coast Guard cutter
US DOT	US Department of Transportation

NTSB on Social Media

www.twitter.com/ntsb
www.instagram.com/ntsbgov
www.facebook.com/ntsbgov
www.youtube.com/user/ntsbgov
www.flickr.com/ntsb
www.linkedin.com/company/ntsb

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On the cover

An NTSB investigator examining the forward section of the fuselage of a TransAir B-737 after its recovery from the Pacific Ocean about 2 miles from Ewa Beach near Honolulu, Hawaii. The cargo jet was ditched after the flight crew reported engine anomalies shortly after departing Daniel K. Inouye International Airport on July 2, 2021. A multimodal team including investigators from the Offices of Aviation Safety, Marine Safety, and Research and Engineering continues to work on this investigation.

Chair's Message

Chair Jennifer Homendy

I am honored to present the 2021 Annual Report to Congress for the National Transportation Safety Board (NTSB). Since our inception in 1967, the agency has been at the forefront of transportation safety and has long been recognized internationally for our investigation expertise in all modes of transportation. In our 55 years of operation, we have conducted more than 152,000 aviation-related investigations and thousands of highway, transit, marine, rail, pipeline, and commercial space investigations. From those investigations, we have issued more than 15,200 safety recommendations.

In 2021, NTSB staff continued to accomplish our strategic goals of ensuring our preparedness for investigations involving emerging transportation technologies and systems; improving processes and products; and optimizing organizational effectiveness and efficiency. We also issued our latest Most Wanted List of Transportation Safety Improvements (MWL). There are 175 safety recommendations associated with the 10 items on the MWL that, when implemented, will reduce the number and severity of injuries across all modes of transportation and save lives.

In 2021, the NTSB participated in 434 international investigations and completed 1,438 domestic investigations, which included the following:

- Amtrak Roadway Worker Fatality in Bowie, Maryland
- Union Pacific Railroad Derailment with Hazardous Materials Release and Subsequent Fire in Fort Worth, Texas
- Pacific Gas & Electric Third-Party Line Strike and Fire in San Francisco, California
- Fire aboard Roll-on/Roll-off Vehicle Carrier *Höegh Xiamen* in Jacksonville, Florida
- Medium-Size Bus Roadway Departure, Return, and Rollover in Bryce Canyon City, Utah
- Rapid Descent into Terrain, Island Express Helicopters Inc. in Calabasas, California

We also completed a safety research report on Preventing Turbulence Related Injuries in Air Carrier Operations Conducted Under Title 14 *Code of Federal Regulations* Part 121, released a report addressing our safety concerns related to revenue passenger-carrying aviation operations, and called on the Federal Aviation Administration to Enhance Safety of Revenue Passenger-Carrying Operations Conducted Under Title 14 *Code of Federal Regulations* Part 91.

Because of limited in-person events held as a result of the COVID-19 public health crisis, the agency continued to connect with our industry and public stakeholders via virtual events, including roundtables on Teen Driver Safety, the Safe System Approach to Highway Safety, Improving Fishing Vessel Safety, and a Seafloor Investigations workshop.

We hope you find the *2021 Annual Report to Congress* to be an informative presentation of the agency's accomplishments.

Sincerely,

Jennifer Homendy
Chair

Who We Are and What We Do

The 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, highway and transit, marine, pipeline, and commercial space. We determine the probable cause of the accidents we investigate and issue safety recommendations aimed at preventing future accidents.

In addition, we conduct 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.

History

The NTSB's origins can be traced to the Air Commerce Act of 1926, in which the US Congress charged the US Department of Commerce with investigating the causes of aircraft accidents. That responsibility was transferred to the Civil Aeronautics Board's Bureau of Aviation Safety when it was created in 1940. In 1967, Congress consolidated all US transportation agencies into a new US Department of Transportation (DOT) and established the NTSB as an independent agency within the US DOT. In creating the NTSB, Congress envisioned that a single organization with a clearly defined mission could more effectively promote a higher level of safety in the transportation system than the individual modal agencies could working separately. Since 1967, the NTSB has investigated accidents in the aviation, highway, marine, pipeline, and railroad transportation modes, as well as those related to the transportation of hazardous materials.

In 1974, Congress reestablished the NTSB as a separate entity outside the US DOT, reasoning that "no federal agency can properly perform such [investigatory] functions unless it is totally separate and independent from any other . . . agency of the United States." Because the US DOT has broad operational and regulatory responsibilities that affect the safety and efficiency of the transportation system, and transportation accidents may suggest deficiencies in that system, the NTSB's independence was deemed necessary to provide objectivity in its investigations and recommendations.

SOURCE: US DOT

Figure 1. In 1966, President Lyndon Johnson signed the Department of Transportation Act that created the NTSB.

Role in Transportation Safety

Since its inception in 1967, the NTSB has investigated more than 152,000 aviation accidents, and thousands of surface transportation crashes and accidents. On call 24 hours a day, 365 days a year, our investigators travel throughout the country and to every corner of the world in response to transportation disasters. The NTSB investigates to determine the probable cause, examine the safety issues, and devise recommendations to prevent the occurrence of similar accidents in the future. We have issued more than 15,200 safety recommendations to more than 2,400 recipients in all transportation modes. The recommended action has been implemented for 82 percent of the over 12,700 recommendations that have been closed. Since 1990, we have compiled and published an annual or biennial Most Wanted List of Transportation Safety Improvements (MWL), which increases awareness of—and support for—the most critical changes needed to reduce transportation accidents and save lives. The agency also develops safety studies focused on broader safety questions and topic areas, enabling us to better perform our mission.

Additionally, we serve as the appellate authority for enforcement actions involving airman and mariner certificates issued by the Federal Aviation Administration (FAA) and the US Coast Guard, and we adjudicate appeals of civil penalty actions taken by the FAA.

OUR MISSION

Making transportation safer by conducting independent accident investigations, advocating safety improvements, and deciding pilots' and mariners' certification appeals

OUR CORE VALUES

Integrity
Transparency
Independence
Excellence
Diversity and Inclusion

Legislative Mandate

Maintaining our congressionally mandated independence and objectivity

Conducting objective, precise accident investigations and safety studies

Performing fair and objective airman and mariner certification appeals

Advocating and **promoting** safety recommendations

Assisting victims of transportation accidents and their families

Strategic Goals and Objectives

1. Ensure our preparedness for investigations involving emerging transportation technologies and systems

Objective:

- **Prepare the agency for new transportation technologies and systems**

2. Improve processes and products

Objectives:

- **Improve enterprise data governance**
- **Enhance enterprise risk management**
- **Improve information technology planning**
- **Improve the effectiveness of agency processes and products**

3. Optimize organizational effectiveness and efficiency

Objectives:

- **Strengthen human capital planning**
- **Engage, connect, and protect the workforce**
- **Develop model supervisors and leaders**
- **Attract, develop, and retain a diverse and inclusive workforce**

Organization and Program Structure

The NTSB's organizational structure is designed around sound business and management principles. The Board comprises five members, each nominated by the president and confirmed by the US Senate to serve a 5-year term. One of these is nominated by the president to serve a 3-year term as chair, which requires separate Senate confirmation. Another, designated by the president to be vice chair, serves in that position for 3 years and as acting chair when the Board has no designated chair.

Our current Board members are pictured on the next page (Figure 3). The NTSB currently has one vacant Board member seat.

Figure 4 shows our organizational structure. For more information about our offices and their functions, please visit the Organization page of our website.

Figure 2. NTSB Board Members

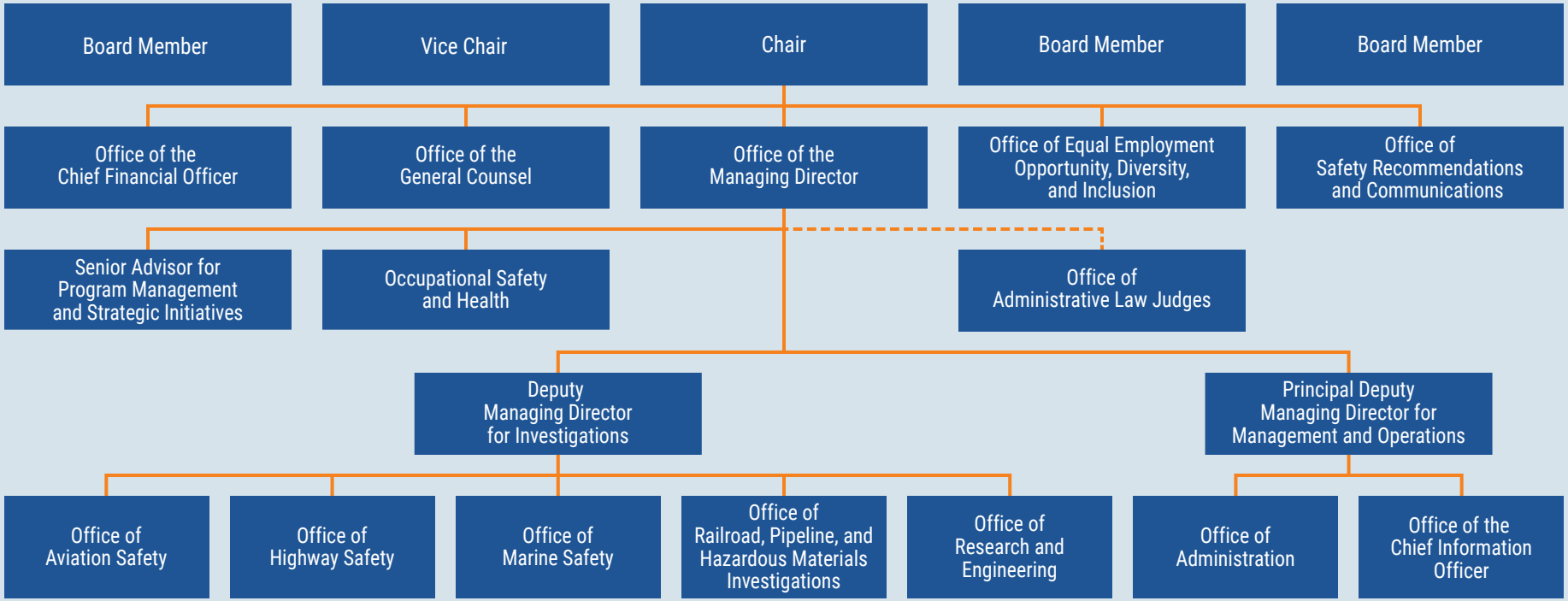
Honorable
Jennifer Homendy
Chair

Honorable
Bruce Landsberg
Vice Chair

Honorable
Michael E. Graham
Board Member

Honorable
Thomas B. Chapman
Board Member

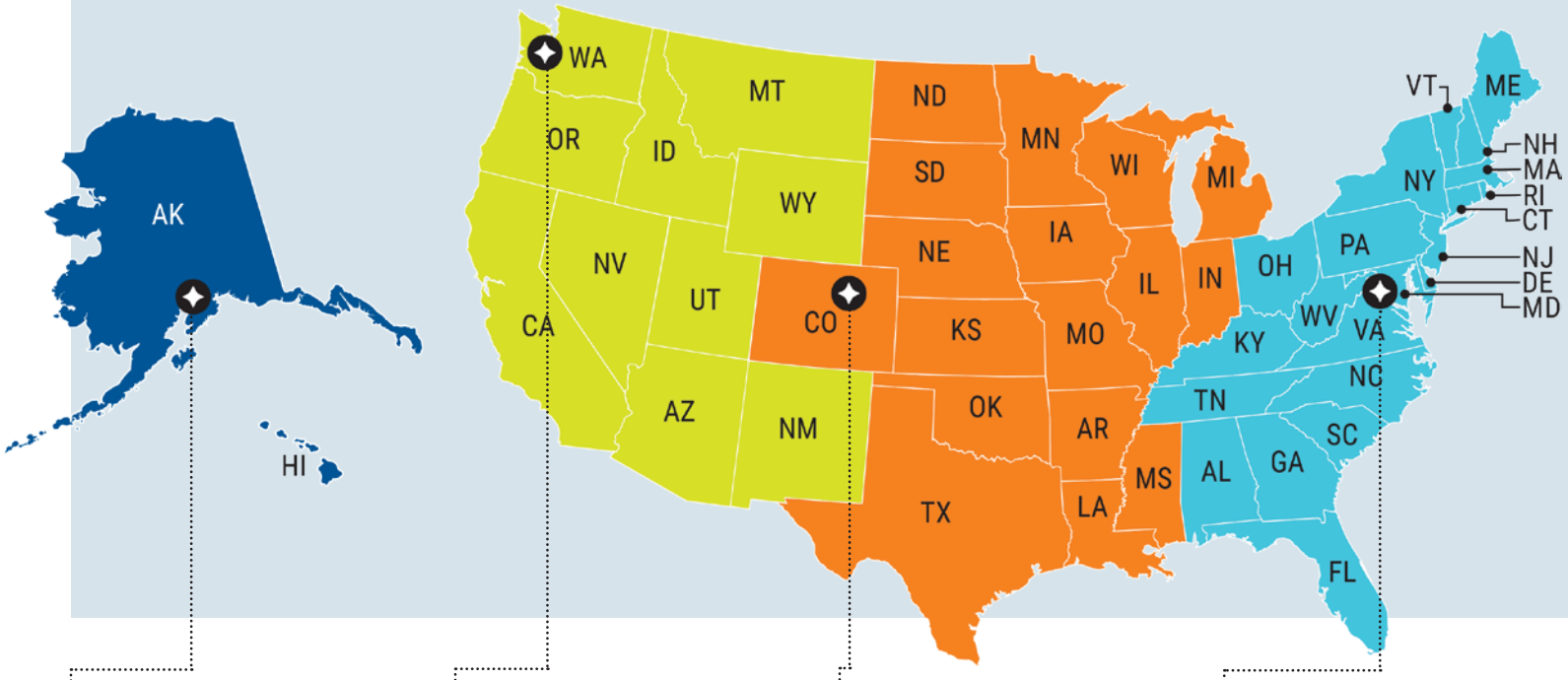
Figure 3. NTSB Organization Chart



We are headquartered in Washington, DC, where most of our staff work. Others work remotely throughout the country or are assigned to regional offices in Ashburn, Virginia; Denver, Colorado; Anchorage, Alaska; or Federal Way, Washington.

The map in Figure 4 depicts the four NTSB regions.

Figure 4. NTSB Regions



ANC: Alaska Region
Anchorage, Alaska

Alaska
Hawaii

WPR: Western Pacific Region
Federal Way, Washington

Arizona
California
Idaho
Montana
Nevada
New Mexico
Oregon
Utah
Washington
Wyoming
. . .
American Samoa
Guam
Northern Mariana Islands

CEN: Central Region
Denver, Colorado

Arkansas
Colorado
Indiana
Illinois
Iowa
Kansas
Louisiana
Michigan
Minnesota
Missouri
Nebraska
North Dakota
Oklahoma
South Dakota
Texas
Wisconsin

ERA: Eastern Region
Ashburn, Virginia

Alabama
Connecticut
Delaware
Florida
Georgia
Kentucky
Maine
Maryland
Massachusetts
Mississippi
North Carolina
New Hampshire
New Jersey
New York
Ohio
Pennsylvania
Rhode Island
South Carolina
Tennessee
Vermont
Virginia
Washington, DC
West Virginia
. . .
Puerto Rico
US Virgin Islands

Table 1, below, provides a "snapshot" of the agency's activities over the past year,[2] and highlights key accomplishments of offices and divisions across the NTSB.

Table 1. 2021 NTSB Safety Statistics at a Glance

Safety Recommendations	
Issued	124
Closed *Acceptable*[3]	118
Closed *Unacceptable*	23
Urgent Closed *Acceptable*	1
Urgent Closed *Unacceptable*	0

Reports and Products	
Board-Adopted Investigative Reports	20
Briefs (Delegated Investigative Reports)	1,416
Public Safety Forums, Hearings, Roundtables, Seminars, Webinars and Workshops	10
Safety Alerts and Videos	1
Safety Actions[4]	163

Accident Launches[5]	
Major Investigation Launches	6
Field Investigation Launches	333
International Launches	5

Research and Engineering/Laboratory	
Safety Research Published	3
Safety Data Analyses Completed	198
Readouts of Vehicle Recorders and Other Electronic Devices Completed	252
Material Laboratory Exam Reports Completed	158
Vehicle Performance Reports and Animations Completed	32
Medical Investigation Reports Completed	180

Advocacy and Outreach	
Journal Publications	6
Advocacy and Outreach Events	379
Testimony or Legislative Support to State Legislative Committees	20
Family Members and Victims Assisted	2,921

Aviation Certificate Appeals	
Total Cases Received	272
Total Cases Closed	237
Emergency Cases Received	112
Emergency Cases Closed	101
Hearings Held	18

NTSB Training Center	
Courses, Programs, and Seminars Offered	153
Total Attendance	3,781

[2] This annual report reflects NTSB activities from January 1 through December 31, 2021.
[3] Closed *Acceptable* classifications include *Closed—Acceptable Action*, *Closed—Acceptable Alternate Action*, and *Closed—Exceeds Recommended Action*.
[4] A safety action is a positive change within the transportation environment brought about by an NTSB investigation or study *without* the NTSB's issuing a formal safety recommendation. Safety actions may be initiated either as a result of an NTSB investigation or independent of one.
[5] Although the COVID-19 pandemic persisted into 2021, limiting the number of accidents to which we launched, we continued to investigate newly occurring accidents and carried on with investigations that were in progress at the start of the pandemic.

2020–2021 NTSB **MOST WANTED LIST** OF TRANSPORTATION SAFETY IMPROVEMENTS

Critical changes needed to reduce accidents, injuries, and fatalities in transportation

Tens of thousands of people die in preventable transportation accidents and crashes every year—our neighbors, coworkers, schoolmates, family members, and other loved ones. With each investigation, we learn lessons about safety gaps and make recommendations that could close these gaps.

The NTSB plays a vital role in advancing transportation safety by investigating and determining the probable cause of accidents and crashes across all modes of transportation and issuing safety recommendations to prevent similar events from happening in the future. These recommendations, if acted upon, would do the most to improve transportation safety; however, we do not have the authority to require their implementation.

At any given time, our agency has more than 1,100 open, unimplemented safety recommendations. The NTSB's MWL highlights transportation safety improvements needed now to prevent accidents and crashes, reduce injuries, and save lives. It is a list of the safety solutions on which we most want action. We use the list to focus our advocacy efforts during the current MWL cycle.

The NTSB issued its 2021–2022 MWL on April 6, 2021. The list, provided below, highlights 10 safety improvements that, if acted upon, will help prevent loss of life across the nation's transportation system. During the creation of the 2021–2022 MWL, we identified 175 open safety recommendations addressing these 10 key safety items. Of those recommendations, one was classified *Closed—Acceptable Action* as of December 31, 2021.

AVIATION

Require and Verify the Effectiveness of Safety Management Systems in all Revenue Passenger-Carrying Aviation Operations

By establishing an effective safety management system (SMS) and creating a safety culture aimed at making safety a focus first and always, operators will improve aviation safety and reduce the risk of accidents.

An SMS should address four components: safety policy, safety risk management, safety assurance, and safety promotion. It can be scalable to the size and complexity of operations, yet too many operators either have none in place or have an ineffective one.

In 2015, the FAA required commercial airliners to develop a comprehensive SMS to improve safety for the flying public, but the FAA has not required other revenue passenger-carrying operators to have one.

Although we have seen some voluntary adoption of SMS programs, most operators continue operating without an SMS in place. It's time more got on board. The risk to the flying public is too great not to do so.

Install Crash-Resistant Recorders and Establish Flight Data Monitoring Programs

When planes crash, we want to know what happened. The good news is that technology is available today that can give us the answers. The bad news is that the FAA has not mandated that aircraft operators install it, citing privacy, security, cost, and other concerns.

Commercial airliners are required to have only flight data recorders (FDR) and cockpit voice recorders (CVR), commonly called "black boxes," but the NTSB has long called for cockpit image recorders as well. Such video would have been extremely helpful in determining flight crew actions in recent crashes in Texas, Indonesia, and Ethiopia.

The NTSB believes other types of passenger-carrying commercial aircraft, such as charter planes and air tours, should be equipped with data, audio, and video recording devices. These operators should also have programs in place that analyze the data derived from these devices. Recorders and flight data management programs not only would help investigators identify the causes of accidents, but also would help aircraft operators prevent crashes in the first place by allowing crew actions to be evaluated regularly.

Regardless of the recorder type, it must be able to survive a crash.

HIGHWAY

Implement a Comprehensive Strategy to Eliminate Speeding-Related Crashes

Speeding is typically defined as exceeding a speed limit, but it can also mean driving at the speed limit but too fast for road conditions. Between 2010 and 2019, speeding-related crashes resulted in over 108,300 fatalities—that's about one-fourth of all traffic fatalities in the United States.

The true extent of the problem is likely underestimated because the reporting of speeding-related crashes is inconsistent. Speeding can result in a loss of vehicle control, which increases both the likelihood of a crash and the severity of injuries sustained. Higher vehicle speeds lead to greater changes in velocity, which, in turn, lead to increased injury severity—that's just basic science.

Intelligent speed adaptation devices on large trucks, automated enforcement (speed safety cameras), expert speed analysis tools, and education campaigns are underused in our communities. These critical tools and strategies must be implemented to address this safety problem.

Protect Vulnerable Road Users Through a Safe System Approach

Our roadways were designed to move motor vehicles safely and efficiently. They often do not fully meet the needs of pedestrians, bicyclists, and motorcyclists—our vulnerable road users (VRU). As a result, we are seeing increasing dangers to this population and too many crashes involving vehicles and VRUs.

We must use a Safe System Approach to better protect VRUs and ensure safe roads for all. A Safe System addresses all aspects of traffic safety: road users, vehicles, speeds, roads, and postcrash care. We must make better safety investments, from road treatments, vehicle design, and collision-avoidance systems to strong traffic safety laws and robust education efforts to mitigate injury risks for all road users.

Unlike motor vehicles, VRUs lack an external structure to protect them when crashes occur, and they're more likely to suffer a serious injury or death. Proven, effective countermeasures are being underused at the federal, state, and local levels to protect pedestrians, bicyclists, and motorcyclists. We have long been concerned with the threat to VRUs. In 2018 and 2019, we published three reports on the risks to this vulnerable population and issued more than 30 new recommendations focused on reducing VRU traffic deaths.

Prevent Alcohol- and Other Drug-Impaired Driving

Driving under the influence of alcohol and other drugs remains a leading cause of highway crashes. In 2019, one in four traffic fatalities resulted from crashes involving alcohol-impaired drivers. And many of these impaired-driving crashes involve drivers who both drink and use other drugs (legal, illicit, and over the counter). Complicating matters, each year, more states are passing laws allowing the use of recreational marijuana and marijuana for medicinal use.

Impaired driving is 100 percent preventable. We know a per se blood alcohol concentration (BAC) of .08 g/dL is too high. States need to lower per se BACs to .05, an action only Utah has taken. Too many alcohol-impaired crashes have occurred involving drivers who had previously been convicted of drunk driving. All states need to implement laws requiring all drivers convicted of alcohol-impaired driving to use an interlock device, preventing future impaired driving.

We have investigated many crashes involving drug-impaired drivers, but the fact is, we don't really know how extensive the drug-impaired driving problem is because, unlike for alcohol, no standardized drug testing protocols exist. There is no established limit or threshold to determine other drug impairment. Additionally, evaluating the impact of other drugs on drivers is challenging because many drugs impair individuals differently than alcohol. Bottom line: we need to develop better drug-testing procedures and tests.

HIGHWAY

Require Collision-Avoidance and Connected-Vehicle Technologies on all Vehicles

Each year, thousands of people are killed and injured in preventable crashes. Collision-avoidance and connected-vehicle technologies can help mitigate the severity of such crashes or even stop them from occurring in the first place.

These technologies include forward-collision warning and automatic emergency braking, which can warn the driver of an upcoming hazard and act if the driver doesn't respond. Connected-vehicle technologies allow vehicles to relay important safety information to each other to avoid crashes.

Yet most passenger vehicles and commercial vehicles (such as heavy-duty trucks and school buses) on the road today are not equipped—nor required to be equipped—with such life-saving technologies. And consumers are often unaware of the availability and capabilities of these technologies. The National Highway Traffic Safety Administration (NHTSA) has not developed comprehensive performance standards for these technologies, nor does it effectively evaluate them and include this information in its vehicle safety ratings.

We were alarmed by the recent regulatory decision by the Federal Communications Commission that decreased the allocated spectrum for connected-vehicle technology by 60 percent and introduced the likelihood for harmful interference by allowing unlicensed devices to operate in adjacent bands without appropriate safeguards. This decision threatens the basic viability and safety promise of connected-vehicle technology.

Eliminate Distracted Driving

Distraction occurs when drivers divert their attention away from the driving task. Crash data and research indicate personal electronic devices, such as cell phones and tablets, are among the greatest contributors to driver distraction.

Hands-free is not risk free. Using a device hands-free does not reduce driver distraction; in fact, drivers are still distracted by the conversation—this is called "cognitive distraction."

Many drivers believe they can multitask and still operate a vehicle safely. But multitasking is a myth. Humans can only focus cognitive attention on one task at a time. That's why the driving task should be a driver's sole focus.

Distracted driving is widespread, killing thousands and injuring hundreds of thousands in the United States every year. States are making some progress addressing this public health problem, but no state has implemented our recommendation calling for a ban on the use of all personal electronic devices while driving except in the case of emergency. Today, 24 states and the District of Columbia prohibit drivers of all ages from using handheld cell phones while driving. Forty-eight states and the District of Columbia have an all-driver text messaging restriction. However, Missouri and Montana have yet to adopt an all-driver text messaging ban, and drivers in Nebraska and Ohio are subject only to secondary enforcement. Thirty-seven states and the District of Columbia restrict the use of cell phones by novice drivers.

MARINE

Improve Passenger and Fishing Vessel Safety

Passenger and fishing vessels present distinct safety challenges within the marine transportation industry.

PASSENGER VESSELS

Passenger vessels range in size from small charter vessels, such as dive boats and amphibious passenger vessels (DUKW boats or "duck boats") to large cruise ships operating in international waters. The number of passengers and crew on these types of vessels varies.

Fires pose a catastrophic threat to small passenger vessels, as we saw in the *Conception* dive boat fire off the coast of California in which 34 people died. Our investigations have revealed that crew training and safety regulations for these vessels vary, increasing the risk to passengers and crew.

To prevent needless deaths and mitigate injuries, passenger vessels should have SMSs, use voyage data recorders, and provide adequate fire-detection and extinguishing systems and enhanced emergency egress options. Operators need to ensure that their crews have enhanced training that includes fire drills and firefighting techniques. We also need to see more roving patrols on our waterways to ensure that passengers are being transported safely.

MARINE

COMMERCIAL FISHING

The domestic commercial fishing industry, which remains largely uninspected, is another marine sector of concern. Fishing consistently tops the list of most deadly occupations, due, in large part, to challenging work environments, such as poor weather and rough waters. These conditions threaten vessel stability and integrity—issues we have seen in our investigations.

We need new standards to address—and periodically reassess—intact stability, subdivision, and watertight integrity in commercial fishing vessels up to 79 feet long. More than 800 fatalities have occurred on fishing vessels in the past two decades, yet many fishing crews still aren't trained in stability management techniques or emergency response. Equally concerning, we have found that many vessels do not carry proper life-saving equipment, such as flotation and search and-rescue locator devices, on board.

The US Coast Guard can improve safety on both passenger and fishing vessels by implementing our recommendations.

PIPELINE

Improve Pipeline Leak Detection and Mitigation

All pipelines leak. Leak-detection and mitigation tools are essential and can make the difference between a minor incident and a deadly explosion. Pipeline systems equipped with leak-detection systems and automatic shutoff valves, or remote-control valves, can warn operators of an imminent accident and allow for quick mitigation.

The NTSB first identified the need for leak-detection and mitigation methods in natural gas transmission and distribution pipelines nearly 50 years ago, but the Pipeline and Hazardous Materials Safety Administration (PHMSA) has yet to require operators to use these life-saving measures, and many operators won't act without regulation.

Placing service regulators outside buildings is another mitigation tool. Yet many older homes and multifamily structures still have regulators inside, which can trap accumulating gas and lead to an explosion. Methane detection also helps mitigate consequences by alerting the public to natural gas leaks, thereby minimizing public exposure.

Every day we wait to enhance our mitigation systems is a day we put the public in danger.

RAILROAD

Improve Rail Worker Safety

Too many people working on or around railroad tracks, such as train crews, maintenance-of-way employees, and mechanical workers, have been killed or injured in accidents involving train or equipment movement. Many of these workers were conducting routine maintenance or switching operations when they were struck.

Roadway workers—those who protect the track—are being killed in preventable accidents, such as those involving the use of train-approach warning systems. These systems are vulnerable to human errors, such as miscalculating site distance and underestimating the time needed for workers to clear tracks. They lack safety redundancy and should not be used as the primary form of worker protection. Without proper warning, workers may not have enough time to react to an oncoming train. The Federal Railroad Administration (FRA) and the Federal Transit Administration (FTA) need to require railroads to implement technology to provide safety redundancy. Industry must also improve roadway worker training and scheduling practices and develop and routinely audit procedures for delivering job briefings. Watchmen, or lookouts, should also receive proper training and the required equipment. To prevent fatigue, railroads and transit agencies must develop work schedules and limitations based on science. The FRA's Roadway Worker Protection Regulations, issued in 1997, are inadequate, and the FTA needs to establish specific regulations for roadway workers.

Operations crews and mechanical workers have also been at risk of injury in preventable accidents because of inadequate separation between train crews and rail cars carrying hazardous materials. Although PHMSA requires buffer cars, the distance the agency established is too short and threatens safety. Railroads should be required to implement a minimum of five cars as a buffer between train crews and highly hazardous flammable materials. PHMSA must issue a regulation on the appropriate separation distance for keeping train crews safe.

Office of Aviation Safety

Table 2. Office of Aviation Safety Statistics

Recommendations Issued	59
Recommendations Closed *Acceptable*	52
Recommendations Closed *Unacceptable*	15
Board-Adopted Investigative Reports	9
Briefs (Delegated Investigative Reports)	1,381
Major Investigation Launches	1
Field Investigation Launches	295
International Launches	5
Safety Actions	158
Advocacy and Outreach Events	115

The mission of the Office of Aviation Safety is to—

- Investigate all air carrier, commuter, and air taxi accidents and certain serious incidents; fatal and nonfatal general aviation accidents and serious incidents; unmanned aircraft systems (UAS) and public aircraft accidents and serious incidents; and commercial space launch/reentry accidents.
- Participate in the investigation of aircraft accidents that occur in foreign countries involving US carriers, US-manufactured or -designed equipment, or US-registered aircraft to identify potential safety issues with US products or service providers and fulfill US obligations under International Civil Aviation Organization (ICAO) agreements.
- Investigate safety issues that extend beyond a single accident to examine specific aviation safety problems from a broader perspective.

The Office of Aviation Safety conducts investigative activities through five specialty divisions based in Washington, DC, and a regional investigation management structure consisting of four regions. Investigators are located throughout the country. International aviation activities are coordinated from the Washington, DC, office.

Investigation Reports

Runway Overrun During Landing, Peninsula Aviation Services Inc., d.b.a. PenAir flight 3296, Saab 2000, N686PA

Unalaska, Alaska | October 17, 2019

On October 17, 2019, about 5:40 p.m. local time, Peninsula Aviation Services Inc. d.b.a. PenAir flight 3296, a Saab SA-2000, N686PA, was landing at Unalaska Airport, Unalaska, Alaska, when the airplane overran the end of the runway, passed through the airport perimeter fence, crossed a road, and pitched down over shoreline rocks with its nosewheel coming to rest at the edge of Dutch Harbor. The captain, first officer, flight attendant, and 29 of the 39 passengers were not injured. Of the remaining 10 passengers, 1 sustained fatal injuries, 1 sustained serious injuries, and 8 sustained minor injuries. The airplane, which was operating as a regularly scheduled passenger flight from Ted Stevens Anchorage International Airport, Anchorage, Alaska, under the provisions of Title 14 *Code of Federal Regulations* (*CFR*) Part 121, was substantially damaged.

Figure 5. Airplane in its final resting location.

SOURCE: UNALASKA DEPARTMENT OF PUBLIC SAFETY

We determined that the probable cause of this accident was the landing gear manufacturer's incorrect wiring of the wheel speed transducer harnesses on the left main landing gear during overhaul. The incorrect wiring caused the antiskid system not to function as intended, resulting in the failure of the left outboard tire and a significant loss of the airplane's braking ability, which led to the runway overrun. Contributing to the accident were (1) Saab's design of the wheel speed transducer wire harnesses, which did not consider and protect against human error during maintenance; (2) the FAA's lack of consideration of the runway safety area dimensions at Unalaska Airport during the authorization process that allowed the Saab 2000 to operate at the airport; and (3) the flight crewmembers' inappropriate decision, due to their plan continuation bias, to land on a runway with a reported tailwind that exceeded the airplane manufacturer's limit. The safety margin was further reduced due to PenAir's failure to correctly apply its company-designated pilot in command airport qualification policy, which allowed the accident captain to operate at one of the most challenging airports in PenAir's route system with limited experience at the airport and in the Saab 2000 airplane.

We identified the following safety issues during this investigation: (1) the potential for cross-wiring of airplane antiskid brake systems; (2) insufficient FAA guidance to identify safety risks for air carriers experiencing significant organizational changes, including bankruptcy, acquisition, and merger; (3) lack of FAA consideration of runway safety area dimensions during the process of authorizing an air carrier to operate its aircraft at a specific Part 139-certificated airport; and (4) the benefits of SMSs for design, manufacturing, and maintenance organizations.

We issued safety recommendations to the FAA, the European Union Aviation Safety Agency, and the Saab Group.

Recommendations: 10 new
Report Adopted: November 2, 2021

Midair Collision over George Inlet, de Havilland DHC-2, N952DB, and de Havilland DHC-3, N959PA

Ketchikan, Alaska | May 13, 2019

On May 13, 2019, about 12:21 a.m. local time, two float-equipped airplanes, a de Havilland DHC-2 and a de Havilland DHC-3, collided in midair about 8 miles northeast of Ketchikan, Alaska. The DHC-2 pilot and four passengers sustained fatal injuries. The DHC-3 pilot sustained minor injuries, nine passengers sustained serious injuries, and one passenger sustained fatal injuries. The DHC-2 was destroyed and the DHC-3 sustained substantial damage. Both were operated under the provisions of Title 14 *CFR* Part 135 as on-demand sightseeing flights; the DHC-2 was registered to and operated by Mountain Air Service LLC, Ketchikan, Alaska, and the DHC-3 was registered to Pantechnicon Aviation Ltd, Minden, Nevada, and operated by Venture Travel, LLC, doing business as Taquan Air, Ketchikan, Alaska.

We determined that the probable cause of the accident was the inherent limitations of the see-and-avoid concept, which prevented either of the pilots from seeing the other airplane before the collision, and the absence of visual and aural alerts from both airplanes' traffic display systems, while the airplanes were being operated in a geographic area with a high concentration of air tour activity. Contributing to the accident were (1) the FAA's provision of new transceivers that lacked alerting capability to Capstone Program operators without adequately mitigating the increased risk associated with the consequent loss of the previously available alerting capability and (2) the absence of a requirement for airborne traffic advisory systems with aural alerting among operators who carry passengers for hire.

We identified the following safety issues during this investigation: (1) the inherent limitations of the see-and-avoid collision avoidance concept, (2) the benefit of automatic dependent surveillance broadcast (ADS-B) Out– and In–supported traffic advisory systems in high-traffic tour areas, (3) the lack of an ADS-B In requirement for 14 *CFR* Part 135 operations, (4) the lack

of cockpit display of traffic information alerting on both aircraft, (5) the loss of alerting capabilities with ADS B systems installed as part of the FAA's post-Capstone upgrade program, (6) an inadequate checklist used in Taquan Air's operation, and (7) the lack of a requirement for SMSs in Part 135 operations.

We issued safety recommendations to the FAA, ForeFlight, Taquan Air, aviation industry groups, the National Association of Flight Instructors, and the Society of Aviation and Flight Educators. We also reiterated a safety recommendation to the FAA.

Recommendations: 10 new, 1 reiterated
Report Adopted: April 20, 2021

Collision with Terrain During Takeoff of Parachute Jump Flight Beech King Air 65 A90, N256TA

Mokuleia, Hawaii | June 21, 2019

On June 21, 2019, about 6:22 p.m. local time, a Beech King Air 65-A90 airplane impacted terrain after takeoff from Dillingham Airfield, Mokuleia, Hawaii. The pilot and 10 passengers were fatally injured, and the airplane was destroyed. The airplane was owned by N80896 LLC and was operated by Oahu Parachute Center LLC under the provisions of Title 14 *CFR* Part 91 as a local parachute jump (skydiving) flight.

We determined that the probable cause of this accident was the pilot's aggressive takeoff maneuver, which resulted in an accelerated stall and subsequent loss of control at an altitude that was too low for recovery. Contributing to the accident were (1) the operation of the airplane near its aft center of gravity limit and the pilot's lack of training and experience with the handling qualities of the airplane in this flight regime; (2) the failure of Oahu Parachute Center and its contract mechanic to maintain the airplane in an airworthy condition and to detect and repair the airplane's twisted left wing, which reduced the airplane's stall margin; and (3) the FAA's insufficient regulatory framework for overseeing parachute jump operations. Contributing to the pilot's training deficiencies was the FAA's lack of awareness that the pilot's flight instructor was providing substandard training.

We identified the following safety issues during this investigation: (1) the need for an appropriate regulatory framework for parachute jump operations, including standards for initial and recurrent training and maintenance and management policies and procedures; (2) the need for increased FAA oversight of parachute jump operations; and (3) the need for SMSs for parachute jump operators.

These issues were further evaluated in the aviation investigation report *Enhance Safety of Revenue Passenger-Carrying Operations Conducted Under Title 14 CFR Part 91* (see Special Investigative Report below, for more information)

Recommendations: 3 new
Report Adopted: March 16, 2021

Rapid Descent into Terrain, Island Express Helicopters Inc. Sikorsky S-76B, N72EX

Calabasas, California | January 26, 2020

On January 26, 2020, about 9:46 a.m. local time, a Sikorsky S-76B helicopter entered a rapidly descending left turn and crashed into terrain in Calabasas, California. The pilot and eight passengers died, and the helicopter was destroyed. The on-demand flight was operated by Island Express Helicopters Inc., Long Beach, California, under visual flight rules and the provisions of Title 14 *CFR* Part 135. The flight had departed from John Wayne Airport, Orange County, Santa Ana, California, about 9:07 a.m., destined for Camarillo Airport, Camarillo, California, about 24 miles west of the accident site.

We determined that the probable cause of this accident was the pilot's decision to continue flight under visual flight rules into instrument meteorological conditions, which resulted in the pilot's spatial disorientation and loss of control. Contributing to the accident was the pilot's likely self-induced pressure and the pilot's plan continuation bias, which adversely affected his decision-making, and Island Express Helicopters Inc.'s inadequate review and oversight of its safety management processes.

We identified the following safety issues during this investigation: (1) the pilot's preflight weather and flight risk planning, (2) the flight's entry into instrument meteorological conditions and the pilot's inadequate adverse weather avoidance, (3) the pilot's spatial disorientation, (4) influences on the pilot's decision to continue flight into adverse weather, (5) Island Express's incomplete implementation of its SMS, (6) the benefits of a mandatory SMS, (7) the benefits of flight simulation devices for pilot training in adverse weather avoidance, (8) the benefits of a flight data monitoring program, and (9) the value of crash-resistant flight recorder systems in preventing future accidents.

We issued safety recommendations to the FAA and Island Express Helicopters Inc. We also reiterated safety recommendations to the FAA.

Recommendations: 4 new, 5 reiterated
Report Adopted: February 9, 2021

Figure 6. Radar tracking of last minute of the flightpath of the Sikorsky S-76B accident helicopter.
BACKGROUND SOURCE: GOOGLE EARTH

Briefs Adopted and Issued

Investigations resulting in briefs are more limited in scope than those leading to major reports and have the primary purpose of determining probable cause. These briefs may be issued by the office director under delegated authority or may be adopted by the Board.

This report details 5 of the 1,381 briefs completed through December 31, 2021.

Miami Air Boeing 737 Runway Overrun

Jacksonville, Florida | May 3, 2019

On May 3, 2019, at 9:42 p.m. local time, Miami Air International flight 293, a Boeing 737 81Q, N732MA, departed the end of runway 10 while landing at Jacksonville Naval Air Station, Jacksonville, Florida, and came to rest in shallow water in St. Johns River. Of the 2 pilots, 4 flight attendants, 1 mechanic (in the jumpseat), and 136 passengers onboard, only 1 minor injury was reported. The airplane, however, was substantially damaged. The flight was operated as a Title 14 *CFR* Part 121 supplemental nonscheduled passenger flight from Leeward Point Field, Guantanamo Bay, Cuba, to Jacksonville Naval Air Station.

We determined that the probable cause of this accident was the airplane's extreme loss of braking friction due to heavy rain and the water depth on the ungrooved runway, which resulted in viscous hydroplaning. Contributing to the accident was the operator's inadequate guidance for evaluating runway braking conditions and conducting en-route landing distance assessments. Contributing to the flight crew's continuation of an unstabilized approach were (1) the captain's plan continuation bias and increased workload due to the weather and performing check airman duties, and (2) the first officer's lack of experience.

We identified the following safety issue during this investigation: a loss of braking friction during landing due to the presence of standing water on the runway.

Recommendations: None
Brief Adopted: July 28, 2021

Impact with Terrain Short of the Runway

Windsor Locks, Connecticut | October 2, 2019

On October 2, 2019, about 9:53 a.m. local time, a Boeing B-17G was destroyed when it impacted terrain short of runway 6 at Bradley International Airport, Windsor Locks, Connecticut. The commercial pilot, airline transport pilot, and five passengers were fatally injured; the crew chief/flight engineer and four passengers were seriously injured; and one passenger and one person on the ground sustained minor injuries. The airplane was operated by the Collings Foundation as a Title 14 *CFR* Part 91 local commercial sightseeing flight.

We determined that the probable cause of the accident was the pilot's failure to properly manage the airplane's configuration and airspeed after he shut down the No. 4 engine following its partial loss of power during the initial climb. Contributing to the accident were (1) the pilot/maintenance director's inadequate maintenance while the airplane was on tour, which resulted in the partial loss of power to the Nos. 3 and 4 engines, (2) the Collings Foundation's ineffective SMS, which failed to identify and mitigate safety risks, and (3) the FAA's inadequate oversight of the Collings Foundation's SMS.

We identified the following safety issues in this investigation: (1) the need for an appropriate regulatory framework for living history flight experience (LHFE) flights, including maintenance and management policies and procedures, (2) the need for increased FAA oversight of LHFE operations, and (3) the need for FAA oversight of LHFE operators' SMSs.

These issues were further evaluated in the aviation investigation report *Enhance Safety of Revenue Passenger-Carrying Operations Conducted Under Title 14* CFR *Part 91* (see Special Investigative Report below, for more information).

We issued safety recommendations to the FAA.

Recommendations: 6 new
Brief Adopted: May 17, 2021

Figure 7. Wreckage of the Boeing B-17 at Windsor Locks, Connecticut.

Loss of Control During Takeoff

Addison, Texas | June 30, 2019

On June 30, 2019, about 9:11 a.m. local time, a Textron Aviation B 300 (marketed as King Air 350) was destroyed when it impacted a hangar shortly after takeoff from runway 15 at Addison Airport, Addison, Texas. A postimpact fire ensued, and the airline transport pilot, the commercial co-pilot, and eight passengers sustained fatal injuries. The airplane was owned by EE Operation LLC and operated as a Title 14 *CFR* Part 91 personal flight en route to Albert Whitted Airport, St. Petersburg, Florida.

We determined that the probable cause of this accident was the pilot's failure to maintain airplane control following a reduction of thrust in the left engine during takeoff. The reason for the reduction in thrust could not be determined. Contributing to the accident was the pilot's failure to conduct the airplane manufacturer's emergency procedure following a loss of power in one engine and to follow the manufacturer's checklists during all phases of operation.

We identified the following safety issue during this investigation: the pilot's improper response to a loss of thrust in the left engine.

Recommendations: None
Brief Adopted: May 13, 2021

Loss of Tail Rotor Effectiveness During Aerial Firefighting Operations

Tujunga, California | September 2, 2017

On September 2, 2017, about 9:48 a.m. local time, a Leonardo AW139 helicopter was substantially damaged when it entered an uncommanded right yaw and descent while conducting a water drop during an aerial firefighting mission near Tujunga, California. The pilot and crewmember were not injured. The helicopter was operated as a public aerial firefighting flight. The pilot reported, and onboard data confirmed, that there were no mechanical malfunctions or anomalies that would have precluded normal operation of the helicopter. Review of the conditions surrounding the accident indicated that, as the pilot performed the water drop, the helicopter likely encountered radiant heat from the fire and its associated smoke columns, which reduced the helicopter's performance. The helicopter was also operating with a quartering tailwind at the time of the loss of control, which was within the critical wind azimuth published by the manufacturer.

Figure 8. Damage to the helicopter's empennage, and embedded tree branches. SOURCE: LAFD

We determined that the probable cause of this accident was a yaw excursion and uncontrolled descent due to a loss of tail rotor effectiveness during aerial firefighting operations, resulting in an impact with trees. A contributing factor was the pilot's failure to maintain sufficient airspeed, coupled with a quartering tailwind, and the operator's lack of guidance about the hazards associated with aerial firefighting operations near and around smoke columns.

We identified the following safety issue during this investigation: a loss of tail rotor effectiveness.

As a result of the investigation, on May 7, 2020, the Department of Interior published an Interagency Aviation Accident Prevention Bulletin to discuss the hazards associated with smoke columns in wildland fires.

Recommendations: None
Brief Issued: May 6, 2021

Impact with Terrain Following Weather Encounter

Ely, Nevada | February 15, 2019

On February 15, 2019, about 5:30 p.m. local time, a Cirrus SR22 airplane was destroyed when it impacted terrain near Ely, Nevada. The pilot and passenger were fatally injured. The pilot was conducting a visual flight rules cross-country flight when he encountered weather en route and chose to divert to another airport. Although a snowstorm was in progress at the airport, with visibility around 1/4 to 1/2 mile, the airport's weather reporting facility indicated 9 statute miles visibility and light snow. The airplane impacted terrain while maneuvering in icing conditions in the vicinity of the airport. The investigation revealed that the visibility reporting at the airport had not been accurate for weeks before the accident and had been a concern for pilots operating there.

We determined that the probable cause of the accident was the pilot's decision to continue the visual flight rules flight into instrument meteorological conditions and icing conditions, which resulted in a high rate of descent and impact with terrain. Contributing to the accident was the inaccurate weather reporting from the airport weather reporting facility.

We identified the following safety issues during this investigation: (1) a lack of clarity in guidance concerning definitions and procedures intended to support timely automated surface observing systems (ASOS) maintenance, (2) a lack of consistent criteria for issuing ASOS-related and automated weather observing systems (AWOS)-related notices to airmen, and (3) ineffective maintenance procedures intended to mitigate internal clock drift and resulting erroneous timestamping of observations on some non-federal AWOSs.

We issued safety recommendations to the National Weather Service and the FAA in a separate report, *Revise Processes, Procedures, and Reporting Capabilities for Automated Weather Systems* (see Safety Recommendation Reports, below, for more information).

Recommendations: 3 new
Brief Issued: February 11, 2021

International Investigations

The United States is a signatory to the Chicago Convention on International Civil Aviation, which is administered by ICAO. The NTSB is charged with fulfilling the US obligation for accident and incident investigations in accordance with Annex 13 of this agreement in full coordination with the US Department of State.

The international investigative process is critical to maintaining aviation safety in the United States and throughout the world. When an aircraft operated by—or designed, manufactured, or registered to—a US company has been involved in an accident in a foreign state, NTSB participation in that investigation enables the United States to ensure the airworthiness and operation of its aircraft operated here and overseas. ICAO Annex 13 protocols also define the agency's engagement with international authorities whose products or operations are involved in accidents within the United States. This international process of collaboration plays an important role in enabling us to identify safety concerns and issue appropriate recommendations. We have issued numerous safety recommendations that have resulted in safety improvements worldwide as a direct result of our participation in these foreign investigations.

Through December 31, 2021, the Office of Aviation Safety was notified of, and assisted on, 219 international investigations. Of these, investigators launched or traveled in support of 5 investigations. The following investigation required significant US involvement:

- On January 9, 2021, Sriwijaya Air flight 182, a Boeing 737-500, crashed into the Java Sea after takeoff from Jakarta's Soekarno-Hatta International Airport, Pontianak-Borneo Island, Indonesia; there were 62 fatalities. The accident is being investigated by the National Transportation Safety Committee of Indonesia. The NTSB appointed a US-accredited representative in accordance with ICAO Annex 13 because the United States is the state of manufacture and design of the airplane.

Ongoing Significant Aviation Investigations[6]

As of December 31, 2021, the Office of Aviation Safety had 1,805 open domestic investigations. The following investigations on which we launched involved significant safety issues.

Table 3. Office of Aviation Safety Ongoing Significant Investigations

Location	Date	Description	Fatalities
Honolulu, Hawaii	7/2/2021	Engine failure after takeoff	0
Denver, Colorado	2/20/2021	Right engine failure after takeoff	0
Palmer, Alaska	3/27/2021	Impact with terrain	5
Soldotna, Alaska	7/31/2020	Midair collision	7
*Lafayette, Louisiana	12/28/2019	Crash after takeoff	5
*Kekaha, Hawaii	12/26/2019	Helicopter crash during air tour	7

* As of June 30, 2022, this investigation has been completed.

Special Investigative Report

Safety of Revenue Passenger-Carrying Operations Conducted under Title 14 *Code of Federal Regulations* Part 91

The NTSB has a long history of concerns about the safety of various revenue passenger-carrying operations conducted under Title 14 *CFR* Part 91. These operations, which carry thousands of passengers for compensation or hire each year, are not held to the same maintenance, airworthiness, or operational standards as air carrier, commuter, on-demand, and air tour operations conducted under 14 *CFR* Parts 121, 135, and 136, respectively.

Members of the public who pay to participate in Part 91 revenue passenger-carrying activities are likely unaware that these operations have less stringent requirements than other commercial aviation operations. Although the types of Part 91 revenue passenger-carrying operations are diverse, the need for greater safety requirements and more comprehensive oversight applies to all of these operations.

We evaluated the following safety issues in examining eight fatal NTSB accident investigations that occurred between 2010 and 2019 (including the Mokuleia, Hawaii, and Windsor Locks, Connecticut, accidents discussed previously): (1) the need for an appropriate framework for Part 91 revenue passenger-carrying operations, (2) the need to identify regulatory loopholes and omissions and address them in the new framework, (3) the need for increased FAA oversight, and (4) the need for SMSs.

We issued safety recommendations and reiterated previously issued recommendations to the FAA.

Recommendations: 6 new, 4 reiterated
Report Adopted: March 23, 2021

[6] We are devoting significant resources to the investigations listed and anticipate producing a report or brief for adoption or issuance upon the completion of each investigation.

Safety Recommendation Reports

During investigations, safety issues are sometimes identified that warrant Board adoption of safety recommendations outside of a final report or brief. Safety recommendation reports, which may be issued at any time during an investigation, are used to make recommendations on such issues. If the Board determines that a recommended course of action requires immediate attention to avoid imminent loss of life from a similar accident, the safety recommendation is designated "urgent."

Require Fuel Minimums for Class C Rotorcraft External Load Operations

This recommendation addresses concerns involving helicopters that experienced an in-flight loss of engine power due to fuel starvation as the pilots maneuvered during Class C rotorcraft-load combination operations. The report identified the following safety issue: the dynamic flight profiles that may be encountered during these operations can cause fuel to become unported at fuel levels higher than that required by Title 14 *CFR* 91.151, which can result in fuel starvation.

We issued one safety recommendation to the FAA.

Recommendation: 1 new
Report Adopted: November 10, 2021

Revise Processes, Procedures, and Reporting Capabilities for Automated Weather Systems

These recommendations address various concerns with malfunctioning ASOSs and AWOSs, as well as their respective reporting capabilities, which can result in erroneous weather information being provided to the transportation community. The recommendations derive from the NTSB's investigation of a fatal accident involving a privately operated Cirrus SR22 that crashed while maneuvering at low altitude near Ely, Nevada, on February 15, 2019, as well as our investigation of the sinking of the amphibious passenger vessel *Stretch Duck 7* on July 19, 2018, near Branson, Missouri.

We identified the following safety issues in this report: (1) a lack of clarity in National Weather Service guidance concerning the terms "outage" and "failure" and concerning specific maintenance actions to address erroneous sensor reporting that does not generate failure flags and can negatively impact safety if users are provided erroneous weather information, (2) inconsistent criteria for issuing ASOS- and AWOS-related notices to airmen, which could prevent pilots from being advised via such notices that ASOS-provided information may be inaccurate or unreliable, and (3) ineffective maintenance procedures to account for internal clock drift on some models of non-federal AWOSs, leading to erroneous observation timestamping and obsolete longline dissemination of AWOS observations.

We issued safety recommendations to the National Weather Service and the FAA.

Recommendations: 4 new
Report Adopted: February 1, 2021

Significant Achievements

- Maintained the use of a risk assessment protocol for continuing investigative activity during the COVID-19 pandemic.
- Designated the former Major Investigations Divisions as the Air Carrier and Space Investigations Division to reflect that the agency is positioned to investigate accidents effectively in this burgeoning industry.
- Streamlined the aviation investigation process through the Aviation Report Timeliness Project with ongoing assessment of metrics and incremental process changes.
- Continued expansion of the agency's UAS program through an office-wide training plan for UAS investigations.
- Provided extensive office support for the Turbulence Safety Research Report project led by the Office of Research and Engineering, including aviation case studies management, and knowledge and skills in meteorology, operational factors, air traffic control, human performance, aircraft systems, and cabin safety.

Office of Highway Safety

Table 4. Office of Highway Safety Statistics

Recommendations Issued	8
Recommendations Closed *Acceptable*	35
Recommendations Closed *Unacceptable*	5
Board-Adopted Investigative Reports	2
Briefs (Delegated Investigative Reports)	1
Major Investigation Launches	3
Field Investigation Launches	6
Public Roundtables	4
Advocacy and Outreach Events	39

The Office of Highway Safety investigates crashes that have significant safety implications nationwide, highlight national safety issues, involve the loss of numerous lives, or generate high interest because of emerging technologies or their circumstances. Such investigations may focus on collapses of bridges spanning roadways or tunnel structures, mass casualties and injuries on public transportation vehicles (such as motorcoaches and school buses), or collisions at highway–railroad grade crossings. This office also investigates crashes that involve new safety issues or technologies (such as automated vehicles and alternatively fueled vehicles) and develops special reports based on trends emerging from NTSB investigations and from research and data that identify common risks or underlying causes of crashes, injuries, and fatalities.

The NTSB is the only organization that performs independent, comprehensive, and transparent multidisciplinary investigations to determine the probable causes of highway crashes, with the goal of making recommendations to prevent similar events and to reduce injuries and fatalities. Our investigations result in recommendations that, if implemented, reduce or eliminate the risks identified in the investigations and provide policymakers with unbiased analysis.

The Office of Highway Safety comprises the Investigations Division and the Report Development Division.

Investigation Reports

Collision Between Sport Utility Vehicle and Medium-Size Bus Transporting Adult Passengers with Disabilities and Special Needs

Belton, South Carolina | December 17, 2019

On Tuesday, December 17, 2019, about 3:30 p.m. eastern standard time, a sport utility vehicle (SUV) was traveling east on US Highway 76 (US-76) in Belton, South Carolina, where the posted speed limit was 45 mph. Meanwhile, a medium-size bus—occupied by a driver and seven passengers, including two in wheelchairs—was traveling west on US-76 at about 45 mph. Shortly before the crash, the SUV accelerated to a speed of about 75 mph and, about 1 to 2 seconds before impact, crossed the center line and collided with the left side of the bus, intruding just behind the driver. The unbelted SUV driver was ejected and fatally injured. A lap-belted bus passenger seated in the intrusion area sustained fatal injuries. The remaining bus occupants sustained minor to serious injuries.

We determined that the probable cause of the crash was the SUV driver's loss of control of her vehicle due to distraction from cell phone use, resulting in the SUV's crossing into the opposite travel lane and colliding with the medium-size bus. Contributing to the severity of the crash was the excessive speed of the SUV.

We identified the following safety issues during this investigation: (1) driver distraction due to cell phone use while driving and (2) the need for improvements to wheelchair securement training.

We issued safety recommendations to the National Association of State Directors of Developmental Disabilities Services. We also reiterated recommendations to the 50 states and the District of Columbia and to the manufacturers of portable electronic devices (Apple, Google, HTC, Lenovo, LG, Motorola, Nokia, Samsung, and Sony).

Recommendations: 1 new, 2 reiterated
Report Adopted: November 17, 2021

Medium-Size Bus Roadway Departure, Return, and Rollover

Bryce Canyon City, Utah | September 20, 2019

On September 20, 2019, about 11:30 a.m. local time, a 2017 medium-size bus was traveling east on Utah State Route 12, a two-lane highway, near Bryce Canyon City in Garfield County, Utah. The posted speed limit was 65 mph; the bus was traveling at about 64 mph. The bus was operated by the motor carrier America Shengjia and occupied by a 60-year-old driver and 30 passengers on a tour from Los Angeles, California, to Salt Lake City, Utah. When the bus's right wheels departed the right edge of the roadway, the driver steered left, which redirected the bus into the westbound travel lane. The driver then steered sharply to the right, causing the bus to roll onto its left side. It slid for about 85 feet, struck and rolled over the guardrail, and came to rest upright, with its front end partially blocking the westbound travel lane. Four passengers were fatally injured, 17 sustained serious injuries, and 9 sustained minor injuries; 13 passengers were either fully or partially ejected from the bus during the crash sequence. The bus driver was not injured. All rear seating positions were equipped with lap belts, and the driver and front passenger seats were equipped with lap/shoulder belts.

We determined that the probable cause of the crash was the bus driver's failure, for undetermined reasons, to maintain the bus within its travel lane and his subsequent steering overcorrections, which caused the bus to become unstable and roll over. Contributing to the severity of the crash was the roof's deformation, caused by the rollover, and its further collapse upon impact with the guardrail, which created ejection portals and compromised the survival space of the passenger seating compartment. Also contributing to the severity of the crash was the failure of NHTSA to develop and promulgate standards for bus roof strength and window glazing to enhance the protection of bus passengers. Contributing to the ejections and the severity of the injuries was the lack of passenger lap/shoulder belts on the bus.

Figure 9. Bus at final rest on top of guardrail.
SOURCE: UTAH HIGHWAY PATROL

We identified the following safety issues during this investigation: (1) the lack of requirements for vehicle technology to prevent medium-size bus road departures and rollovers, and (2) the lack of occupant protection and crashworthiness standards for medium-size buses.

We issued safety recommendations, and reiterated previously issued recommendations, to NHTSA. We also reiterated previously issued recommendations to bus manufacturers ARBOC Specialty Vehicles LLC, Coach & Equipment Manufacturing Corporation, Rev Group Inc., Diamond Coach Corporation, Forest River Inc., Girardin Blue Bird, SVO Group Inc., and Thomas Built Buses, and bus seat manufacturers Freedman Seating Company and HSM Transportation Solutions.

Recommendations: 3 new, 5 reiterated
Report Adopted: May 10, 2021

Brief Issued

An investigation resulting in a brief is more limited in scope than one leading to a major report and has the primary purpose of determining probable cause. A brief may be issued by the office director under delegated authority or may be adopted by the Board. The Office of Highway Safety completed the following brief in 2021.

Median-Crossing Multivehicle Crash and Postcrash Fire on Interstate 75

Alachua, Florida | January 3, 2019

On January 3, 2019, about 3:41 p.m. local time, a 2016 Freightliner truck-tractor in combination with a semitrailer, operated by Eagle Express Lines, was traveling north in

the right lane of Interstate 75 in Alachua County, Florida, when it abruptly veered to the left and traveled across the other two travel lanes. The posted speed limit was 70 mph, and the Freightliner was traveling at 69 to 70 mph. The semitrailer sideswiped and ensnared a 2016 Acura MDX, then crashed through a median barrier and entered oncoming traffic, striking a 2006 Chevrolet 12-passenger van that was owned and operated by a church group. The van rolled over twice before coming to rest in an upright position, and 10 of the 12 persons on board were ejected through windows and openings in the vehicle structure. Two of the ejected passengers as well as debris from the collision struck a 2006 Chevrolet pickup truck; the 2016 Freightliner next struck a 2018 Freightliner truck tractor semitrailer traveling in the far-right southbound lane. The unbelted driver of the 2016 Freightliner was ejected, and a postcrash fire ignited. Although the Acura was wedged underneath the Freightliner's semitrailer, the Acura's driver was able to exit the vehicle before it was fully engulfed in flames.

Seven vehicle occupants were fatally injured, including the two Freightliner drivers and five of the passengers ejected from the van. Of the remaining nine vehicle occupants, only the driver of the pickup truck was not injured. Five van passengers were wearing their available restraints, including three that were ultimately ejected from the vehicle. The driver and front seat passenger were restrained with lap/shoulder belts. The drivers of the passenger car, the 2018 Freightliner, and the pickup truck were all wearing their seat belts at the time of the crash.

We determined that the probable cause of the crash was the medical incapacitation of the Eagle Express truck driver, which resulted in his failure to maintain his travel lane and led to the truck's crossing the highway's center median and colliding with several vehicles in the opposite lanes of travel.

We identified medical incapacitation as a safety issue during the investigation.

Recommendations: None
Brief Issued: May 17, 2021

Ongoing Significant Highway Investigations[7]

As of December 31, 2021, the Office of Highway Safety had 16 open domestic investigations. The following ongoing investigations on which we launched involved significant safety issues.

Table 5. Office of Highway Safety Ongoing Significant Investigations

Location	Date	Description	Fatalities
Monaville, Texas	12/17/2021	Loss of control and rollover crash of a school bus	1
Big Spring, Texas	11/19/2021	Frontal collision of a wrong-way driver and a motorcoach	3
Coral Gables, Florida	9/13/2021	Crash and postcrash fire of a single, electric vehicle in a residential area	2
Greenville, Alabama	6/19/2021	Multivehicle crash in wet weather conditions	10
Phoenix, Arizona	6/9/2021	Multivehicle crash involving a traffic queue resulting from previous lane closures	4
Spring, Texas	4/17/2021	Crash and postcrash fire of a single, electric vehicle in a residential area	2
Fort Worth, Texas	2/11/2021	Multivehicle crash in winter weather conditions	6
Avenal, California	1/1/2021	Roadway departure followed by an overcorrection resulting in a head-on collision	8
Searchlight, Nevada	12/10/2020	Collision of a box truck with a group of bicyclists and a support vehicle on a high-speed roadway	5
Decatur, Tennessee	10/27/2020	Crash involving a boom truck and a school bus	2
*North Charleston, South Carolina	7/1/2020	Collision of a pickup truck with a state patrol vehicle and a tow truck parked in the traffic lanes, working an earlier crash (police officer and tow truck operator out of their vehicles at time of collision)	1
*Arlington, Wisconsin	6/12/2020	Crash of a truck-tractor in combination with a semitrailer into a passenger vehicle	4
*Pala Mesa, California	2/22/2020	Rollover of a medium-size bus that departed the roadway, collided with a roadside barrier, rolled down an embankment, and came to rest on its roof	3
*Mt. Pleasant, Pennsylvania	1/5/2020	Multivehicle crash involving a motorcoach that overturned on the roadway and impacted three truck-tractor semitrailer combination vehicles	5

* As of June 30, 2022, this investigation has been completed.

[7] We are devoting significant resources to the accident investigations listed and anticipate producing a report or brief for adoption upon the completion of each investigation.

Public Roundtables

Teen Driver Safety Virtual Roundtable Series, Parts 1 and 2

October 17–23 was National Teen Driver Safety Week, a week dedicated to raising awareness and seeking solutions to prevent teen injuries and deaths on the road. In our roundtable, NTSB representatives talked to experts in teen safety programming and related research about the state of teen driver safety in the United States and how we can achieve zero traffic deaths involving teen drivers. We focused on the risks impacting these drivers—such as distraction, fatigue, and impairment—and discussed actions that can reduce teen driving crashes. NTSB Board member Tom Chapman provided opening remarks.

Safe System Approach Roundtable Series

July and September 2021

In 2021, The Office of Highway Safety supported the Office of the Chairman and the Office of Safety Recommendations and Communications in launching a Safe System Approach roundtable series. The main objectives for the series were (1) to better understand the Safe System Approach, its benefits, and ways that it differs from our current approach to road safety in the United States; (2) to explore the current state of the Safe System Approach in the United States and to learn from international partners and from cities across the nation that have moved toward such an approach; and (3) to identify what actions need to be taken to move toward this approach nationwide.

Other Significant Achievements

- **Illustrated Digest: Pedestrian Bridge Collapse Over SW 8th Street, Miami, Florida, March 3, 2018**
  The illustrated digest of the NTSB's Report NTSB/HAR-19/02 (issued in 2019), which can be found at www.ntsb.gov, contains a description of the bridge collapse, its probable cause, safety issues, and the safety recommendations that are detailed in the full report. The digest, developed to strengthen awareness and knowledge in the bridge community and the public regarding the failure mechanisms, as well as the safety changes needed to avoid similar failures in the future, provides users a concise way of acquiring an in-depth understanding into the NTSB investigation of the bridge collapse.

- **Safety Risks to Emergency Responders from Lithium-Ion Battery Fires in Electric Vehicles (video); Multiple Locations including West Hollywood, California, June 15, 2018**
  We issued Safety Report 20/01, *Safety Risks to Emergency Responders from Lithium-Ion Battery Fires in Electric Vehicles*, on January 13, 2021. This video summarizes that report and focuses on the safety risks to first and second responders posed by electric vehicles that are powered by high voltage, lithium-ion batteries. Images from the investigations and graphics highlighting the design of electric vehicle battery systems aid users in understanding the complexities faced by emergency responders when encountering a postcrash fire in an electric vehicle. The video is available on the NTSB YouTube channel.

- **Closure of Automated Vehicle Recommendation: Safety Recommendation H-19-52**
  On a March evening in 2018, an automated vehicle being tested by Uber Advanced Technologies Group (ATG) in Tempe, Arizona, struck and killed a pedestrian who was pushing a bicycle across the roadway. The safety driver was distracted by a video on her phone and, although it detected the pesdestrian, the automated vehicle did not stop. The NTSB issued a safety recommendation to Uber ATG in 2019 to "Complete the implementation of a safety management system (SMS) for automated driving system testing that, at a minimum, includes safety policy, safety risk management, safety assurance, and safety promotion."

  In response, Uber ATG implemented a robust SMS and then went on to share its knowledge and experience with other companies to ensure the safe testing of automated vehicles throughout the industry. Because Uber ATG's effort exceeded the intent of Safety Recommendation H-19-52, the NTSB classified the recommendation "Closed—Exceeds Recommended Action."

- **Historic Safety Cases**
  In 2021, the Office of Highway Safety worked to transition our historic investigative cases to the new NTSB database for surface investigations, SAFTI. Through this effort, highway crash investigation information for cases from 2010 to the present are available to the public through our CAROL query tool.

Responses to Notices of Proposed Rulemaking

- Provided NTSB comments on NHTSA's proposed rulemaking, *Framework for Automated Driving System Safety*.
- Provided NTSB comments on the Federal Highway Administration's proposed rulemaking, *Manual on Uniform Traffic Control Devices for Streets and Highways*.

Office of Marine Safety

Table 6. Office of Marine Safety Statistics

Recommendations Issued	27
Recommendations Closed *Acceptable*	13
Recommendations Closed *Unacceptable*	2
Board-Adopted Investigative Reports	4
Briefs (Delegated Investigative Reports)	26
Major Investigation Launches	1
Field Investigation Launches	17
Public Hearing, Roundtable, and Workshops	4
Advocacy and Outreach Events	10

The Office of Marine Safety investigates and determines the probable cause of major marine casualties on or under US territorial waters, major marine casualties involving US-flagged vessels worldwide, and accidents involving both US public (federal) and nonpublic vessels in the same casualty. In addition, the office investigates select catastrophic marine accidents and those of a recurring nature.

The US Coast Guard conducts preliminary investigations of all marine accidents and notifies the NTSB when an accident qualifies as a major marine casualty, which includes any one of the following:

- The loss of six or more lives.
- The loss of a mechanically propelled vessel of 100 or more gross tons.
- Property damage initially estimated to be $500,000 or more.
- A serious threat, as determined by the commandant of the Coast Guard and concurred with by the NTSB chair, to life, property, or the environment by hazardous materials.

For select major marine casualties, the office launches a full investigative team and presents the investigative report to the Board. For all other major marine casualties, the office launches a field team of marine investigators to the scene to gather information to develop either an investigation report or brief. Most briefs are issued by the office director through delegated authority; those involving public or nonpublic marine accidents and those that contain safety recommendations are adopted and issued by the Board.

The office is also responsible for the overall management of the NTSB's international marine safety program, under which the office investigates major marine casualties involving foreign flagged vessels in US territorial waters and those involving US-flagged vessels anywhere in the world. Accidents involving foreign-flagged vessels accounted for 34 percent of NTSB marine investigations over the past 5 years.

Under the International Maritime Organization (IMO) *Code of International Standards and Recommended Practices for a Safety Investigation into a Marine Casualty or Marine Incident* (Casualty Investigation Code), the office also participates with the US Coast Guard as a substantially interested State in investigations of serious marine casualties involving foreign-flagged vessels in international waters. The international program involves reviewing US administration position papers related to marine investigations and participating in select IMO subcommittee meetings.

As part of the international program, the office coordinates with other US and foreign agencies to ensure consistency with IMO conventions. We also cooperate with other accident investigation organizations worldwide at annual meetings held virtually, such as the Marine Accident Investigators' International Forum (MAIIF), a nongovernmental organization status with IMO, Europe MAIIF, and MAIIF Americas, which track developments related to marine accident investigations and prevention.

The NTSB is the only federal organization that performs independent, comprehensive, and transparent multidisciplinary investigations to determine the probable cause of marine accidents, with the goal of making safety recommendations to prevent similar events from occurring in the future. The thoroughness and independence of these investigations maintain public confidence in marine transportation systems and provide policymakers with unbiased analysis.

The Office of Marine Safety comprises the Marine Investigations Division and the Product Development Division.

Investigation Reports

Hazardous Liquid Pipeline Strike and Subsequent Explosion and Fire Aboard Dredging Vessel *Waymon Boyd*, EPIC Marine Terminal

Corpus Christi, Texas | August 21, 2020

On August 21, 2020, about 8:02 a.m. local time, the US-flagged dredge *Waymon Boyd* struck a submerged 16-inch liquid propane pipeline during dredging operations in Corpus Christi, Texas. A geyser of propane gas and water erupted adjacent to the vessel. Shortly thereafter, propane gas engulfed the vessel and an explosion occurred. Fire damaged the vessel and surrounding shoreline. A total of 18 people employed by Orion Marine Group were working or resting on the dredge and assist boats (tender boats, anchor barges, booster barges, and a supply barge); three crewmembers aboard the *Waymon Boyd* and one on an adjacent anchor barge died in the explosion and fire, and six crewmembers aboard the dredge were injured, one of whom later died from his injuries. The *Waymon Boyd*, valued at $9.48 million, was a total loss. The cost of pipeline damage was $2.09 million. The cost of physical damage to the EPIC facility was $120,000.

Figure 10. A tugboat fights the fire that engulfed the *Waymond Boyd*. SOURCE: US COAST GUARD

We determined that the probable cause of the explosion and fire was Orion Marine Group's inadequate planning and risk management processes, which failed to identify the proximity of their dredging operation to Enterprise Products' pipeline TX219 and resulted in the absence of effective controls to prevent the dredge's cutterhead from striking the pipeline. Contributing to the event were deficient dredging plans provided by Schneider Engineering and Consulting, which resulted in incomplete and inaccurate information communicated to Enterprise Products by Orion Marine Group during the one-call process, which resulted in insufficient measures to protect the pipeline from excavation damage.

We identified the following safety issues during this investigation: (1) the need for pipeline protection measures specific to dredging, such as greater collaboration between pipeline operators and dredging companies; (2) the need for pipelines to share GPS coordinates; (3) the need for improved marking requirements; and (4) the need for tolerance zones for dredging.

We issued safety recommendations to PHMSA, Coastal and Marine Operators, the Council for Dredging and Marine Construction Safety, Orion Group Holdings, and Enterprise Products.

Recommendations: 10 new
Report Adopted: December 7, 2021

Fire aboard Roll-on/Roll-off Vehicle Carrier *Höegh Xiamen*

Jacksonville, Florida | June 4, 2020

On June 4, 2020, about 2:30 p.m. local time, the crew of the 600-foot-long, Norwegian-flagged roll-on/roll-off vehicle carrier *Höegh Xiamen* were preparing to depart the Blount Island Horizon Terminal in Jacksonville, Florida, en route to Baltimore, Maryland, when they saw smoke coming from a ventilation housing for one of the exhaust trunks that ran from deck 12 (the weather deck) to one of the cargo decks.

Crewmembers discovered a fire on deck 8, which had been loaded with used vehicles. The crew attempted to fight the fire but was repelled by heavy smoke. After the Jacksonville Fire and Rescue Department arrived, the captain had carbon dioxide from the vessel's fixed fire extinguishing system released into decks 7 and 8, and the crew evacuated the vessel. The fire continued to spread to the higher cargo decks and the accommodations, and nine firefighters were subsequently injured, five of them seriously, in an explosion. The fire was extinguished over a week later, on June 12.

Figure 11. Firefighters conducting exterior boundary-cooling on the *Höegh Xiamen*.
SOURCE: JFRD

The *Höegh Xiamen* and its cargo of 2,420 used vehicles were declared a total loss valued at $40 million, and in August 2020, the vessel was towed to Turkey to be recycled.

We determined that the probable cause of the fire aboard the vehicle carrier *Höegh Xiamen* was Grimaldi's and SSA Atlantic's ineffective oversight of longshoremen, which did not identify that Grimaldi's vehicle battery securement procedures were not being followed, resulting in an electrical fault from an improperly disconnected battery in a used vehicle on cargo deck 8. Contributing to the delay in the detection of the fire was the crew not immediately reactivating the vessel's fire detection system after the completion of loading. Contributing to the extent of the fire was the master's decision to delay the release of the carbon dioxide fixed fire-extinguishing system.

We identified the following safety issues during this investigation: (1) the exception from hazardous materials regulations for the transportation of used vehicles when a vessel has a stowage area specifically designed and approved for carrying vehicles and (2) the elevated risk of fire involving used, often damaged, vehicles aboard roll-on/roll-off vehicle carriers.

We issued safety recommendations to PHMSA, the US Coast Guard, the National Maritime Association, Grimaldi Deep Sea, and Höegh Technical Management.

Recommendations: 8 new
Report Adopted: December 1, 2021

Capsizing of Roll-on/Roll-off Vehicle Carrier *Golden Ray*

Brunswick, Georgia | September 8, 2019

On September 8, 2019, about 1:00 a.m. local time, after unloading and loading vehicle cargo the previous day, the 656-foot-long, Marshall Islands-flagged roll-on/roll-off vehicle carrier *Golden Ray* departed the Colonel's Island Terminal in the Port of Brunswick, Georgia, en route to Baltimore, Maryland. As the vessel approached the right turn into Plantation Creek Range, leading to the Atlantic Ocean, the helmsman turned the vessel to starboard, and it began to heel quickly to port. Attempts to counter the heeling failed, the rate of turn increased, and the vessel heeled to port to about 60 degrees in less than a minute, finally settling on its port side at an angle of 90 degrees.

The US Coast Guard, tugboats and pilot boats from the Port of Brunswick, first responders from the Georgia Department of Natural Resources and Glynn County, and vessels from Sea Tow all responded. They were initially able to rescue the pilot and 19 of the 23 crewmembers on board, but four engineering crewmembers remained trapped in the engine room until the following evening, when responders cut into the vessel's hull to rescue them.

Figure 12. The *Golden Ray* settled at an angle of 90° after heeling quickly to port following a turn.
SOURCE: US COAST GUARD

Two crewmembers suffered serious injuries. Total costs for the loss of the vessel were estimated at $62.5 million, and total costs for the loss of the cargo were estimated at $142 million.

We determined that the probable cause of the capsizing of the *Golden Ray* was the chief officer's error entering ballast quantities into the stability calculation program, which led to his incorrect determination of the vessel's stability and resulted in the vessel having an insufficient righting arm to counteract the forces developed during a turn while transiting outbound from the Port of Brunswick through St. Simons Sound. Contributing to the capsizing was G-Marine Service Co. Ltd.'s lack of effective procedures in its SMS for verifying stability calculations.

We identified the following safety issues during this investigation: (1) improperly calculating vessel stability and (2) a lack of company oversight for calculating vessel stability.

We issued safety recommendations to G-Marine Service Co. Ltd.

Recommendations: 2 new
Report Adopted: August 26, 2001

Capsizing and Sinking of Commercial Fishing Vessel *Scandies Rose*

Sutwik Island, Alaska | December 31, 2019

On December 31, 2019, about 10:00 p.m. local time, the fishing vessel *Scandies Rose* was en route from Kodiak to fishing grounds in the Bering Sea when it capsized about 2.5 miles south of Sutwik Island, Alaska, and sank several minutes later. At the time, the *Scandies Rose* had seven crewmembers aboard, two of whom were rescued by the US Coast Guard several hours later. The other missing crewmembers were not found and are presumed dead. The *Scandies Rose*, valued at $15 million, was declared a total loss.

According to the surviving crewmembers, the vessel had begun to encounter freezing spray and accumulate ice from 2 a.m. to 8 a.m. on the day of the sinking. By 8:37 p.m., the captain noted that his vessel was icing "really bad" and had

developed a 20-degree starboard list. He was trying to seek shelter southeast of Sutwik Island, but when he changed course, the vessel's list worsened. At 9:55 p.m. local time, the captain of the *Scandies Rose* broadcasted a mayday call.

We determined that the probable cause of the capsizing and sinking of the *Scandies Rose* was the inaccurate stability instructions for the vessel, which resulted in a low margin of stability to resist capsizing, combined with the heavy asymmetric ice accumulation on the vessel due to localized wind and sea conditions that were more extreme than forecasted during the voyage.

We identified the following safety issues during this investigation: (1) the effect of extreme icing conditions, (2) the vessel's inaccurate stability instructions, (3) the need to update regulatory guidelines on calculating and communicating icing for vessel stability instructions, and (4) the lack of accurate weather data for the area.

We issued safety recommendations to the US Coast Guard, the National Oceanic and Atmospheric Administration, the National Weather Service, and the North Pacific Fishing Vessel Owners' Association. We also reiterated safety recommendations to the Coast Guard.

Recommendations: 7 new, 2 reiterated
Report Adopted: June 29, 2021

Figure 13. The *Scandies Rose* wreck, located on February 11, 2020. SOURCE: GLOBAL

Figure 14. View from on board the *Voyager* at the moment that the *Genesis River* struck barge *30015T*.
SOURCE: KIRBY INLAND MARINE, LP

Collision between Liquefied Gas Carrier *Genesis River* and *Voyager* Tow

Houston Ship Channel, Upper Galveston Bay, Texas | May 10, 2019

On May 10, 2019, at 3:16 p.m. local time, the 754-foot-long, 122-foot-wide liquefied gas carrier *Genesis River* collided with a 297-foot-long tank barge being pushed ahead by the 69-foot-long towing vessel (TV) *Voyager*. As a result of the collision, two cargo tanks in the barge were breached, spilling over 11,000 barrels of reformate, a gasoline blending stock, into the waterway. The Houston Ship Channel was closed to navigation for 2 days during response operations and did not fully reopen for navigation until May 15. The total cost of damages to the *Genesis River* and the barges was estimated at $3.2 million. The cost of reformate containment and cleanup operations totaled $12.3 million. There were no injuries reported.

We determined that the probable cause of the collision was the *Genesis River* pilot's decision to transit at sea speed, out of maneuvering mode, which increased the hydrodynamic effects of the Bayport Flare's channel banks, reduced his ability to maintain control of the vessel after meeting another deep-draft vessel, and resulted in the *Genesis River*'s sheering across the channel toward the tow.

We identified the following safety issues in this report: (1) the challenges of navigating large vessels in the Bayport Flare area of the Houston Ship Channel and (2) vessel speed while transiting in a narrow channel.

We issued safety recommendations to K-Line Energy Ship Management and the Houston Pilots. We also reiterated safety recommendations to the US Coast Guard.

Recommendations: 6 new, 2 reiterated
Report Adopted: March 10, 2021

Briefs Issued

The Office of Marine Safety completed 26 briefs completed through December 31, 2021. Here are summaries of eight of them.

Diesel Generator Engine Failure Aboard Offshore Supply Vessel *Ocean Intervention*

Honolulu, Hawaii | December 19, 2021

On December 19, 2020, at 1:03 p.m. local time, the No. 3 diesel generator engine aboard the *Ocean Intervention* suffered a mechanical failure while the offshore supply vessel was anchored off Honolulu, Hawaii. The failure led to the ejection of components from the engine and resulted in a fire in the engine room. The crew isolated the fire before it could spread throughout the vessel. No pollution or injury to the 16 crewmembers on board was reported. Damage to the vessel totaled $3,046,624.

We determined that the probable cause of the diesel generator engine failure aboard the *Ocean Intervention* was a cylinder's connecting rod bearing adhering to the crankshaft, which led to the ejection of the connecting rod and catastrophic damage to the engine.

We identified the following safety issue during this investigation: the need for vessel crews to familiarize themselves and train frequently on machinery, fuel oil, lube oil, and ventilation shutoff systems to enable them to act quickly to contain and suppress engine room fires before they can spread to other spaces or cause a loss of propulsion and electrical power.

Recommendations: None
Brief Issued: December 2, 2021

Contact of Tanker *Atina* with Oil Platform

Southwest Pass Fairway Anchorage, Gulf of Mexico | October 17, 2020

On October 17, 2020, at 4:46 p.m. local time, the tanker *Atina* with a crew of 21 was attempting to anchor in the Southwest Pass Fairway Anchorage in the Gulf of Mexico, about 21.5 miles from Pilottown, Louisiana, when it struck the occupied oil and gas production platform SP 57B. The platform's four crewmembers and one technician evacuated to a nearby platform by helicopter after activating the emergency shutdown device to shut in wells to the SP-57B platform. No pollution or injuries were reported. Estimated damages to the platform ($72.3 million) and vessel ($598,400) totaled $72.9 million.

We determined that the probable cause of the contact of the *Atina* with platform SP-57B was the vessel-operating company's failure to ensure sufficient time for the master's turnover, which resulted in the master's acute fatigue and poor situational awareness during an attempted nighttime anchoring evolution.

We identified the following safety issue during this investigation: the need for vessel operating companies to ensure that joining crewmembers/personnel are given the opportunity to obtain a sufficient handover period and adequate rest before taking over critical shipboard duties, such as navigation, that could impact the safety of the crew, property, and the environment.

Recommendations: None
Brief Issued: November 10, 2021

Breakaway of Containership CMA CGM *Bianca*

Mississippi River, New Orleans, Louisiana | August 2, 2020

On August 2, 2020, about 2:02 p.m. local time, the containership *CMA CGM Bianca* was loading cargo while moored at the Napoleon Avenue Container Terminal in New Orleans, Louisiana, when a sudden, localized thunderstorm passed through the area. The vessel's mooring lines parted in the high winds, and the ship moved away from the pier. Containers being lifted by shoreside gantry cranes struck the ship, and one damaged container dropped in the water, spilling a cargo of plastic pellets. A crane operator suffered a minor injury; no other injuries were reported by ship or shore personnel. The total cost of damages was estimated at $15 million for the shoreside gantry cranes and $60,196 for the ship.

We determined that the probable cause of the breakaway of the containership and the ensuing equipment damage was the sudden onset of unforecasted severe winds likely originating from the outflow of a thunderstorm generated downburst.

We identified the following safety issue during this investigation: the combination of three different materials with similar or equal breaking strengths and possibly other properties that differed and affected performance in the mooring lines on the *CMA CGM Bianca*.

If lines with differing elasticity are combined, the less elastic lines may take greater load than the more elastic lines when under heavy tension. In extreme conditions, this may result in unexpected failure of the less elastic lines and successive failure of all lines.

Recommendations: None
Brief Issued: September 2, 2021

Collision of Cargo Vessel *Nomadic Milde* and Bulk Carrier *Atlantic Venus*

Mississippi River, South Kenner, Louisiana | May 8, 2020

On May 8, 2020, about 4:55 p.m. local time, the anchored general cargo vessel *Nomadic Milde* collided with the anchored bulk carrier *Atlantic Venus* on the Lower Mississippi River near New Orleans, Louisiana, after the *Nomadic Milde* had begun to swing and drag its anchors in the current. After colliding with the *Atlantic Venus*, which had been anchored directly behind the cargo ship, the *Nomadic Milde* then struck a nearby chemical dock and grounded on the bank. No injuries were reported. The *Nomadic Milde* released an estimated 13 gallons of lube oil into the river. Damage to both vessels and the dock was estimated at $16.9 million.

We determined that the probable cause of the collision was the bridge team on the *Nomadic Milde* not effectively monitoring the vessel's position and therefore not detecting that the vessel was dragging anchor and had moved from its original position during high-water conditions in proximity to other vessels.

We identified the following safety issue during this investigation: the need for bridge teams to maintain an effective anchor watch, especially in high-water conditions and when in proximity to other vessels or hazards.

Recommendations: None
Brief Issued: August 11, 2021

Figure 15. The *Nomadic Milde* lying against the bow of the *Atlantic Venus*.
SOURCE: ATLANTIC VENUS CREWMEMBER

Container Damage and Loss aboard Deck Cargo Barge *Ho'omaka Hou*, Towed by *Hoku Loa*

Hilo, Hawaii | June 22, 2020

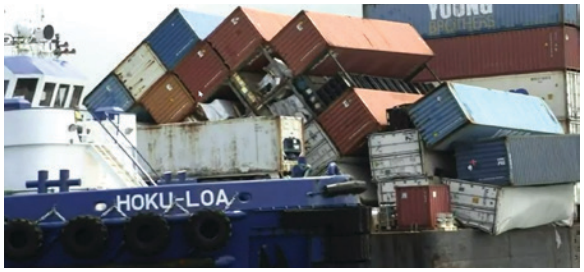
On June 22, 2020, about 2:30 a.m. local time, the deck cargo barge *Ho'omaka Hou* was under tow by the towing vessel *Hoku Loa* off the northeast coast of the big island of Hawaii enroute to Hilo, when 50 40-foot containers stacked on the after deck of the barge toppled, causing 21 to fall into the ocean. There were no injuries or pollution reported. Eight containers were eventually recovered by salvors, and 13 remain missing. Cargo loss was estimated at $1.5 million, and damage to the barge and containers was estimated at $131,000.

We determined that the probable cause of the collapse of container stacks was the company's failure to provide the barge team with an initial barge load plan, as well as inadequate procedures for monitoring stack weights, which led to undetected reverse stratification of container stacks that subjected the stacks' securing arrangements to increased forces while in transit at sea.

We identified the following safety issue during this investigation: the need for cargo planners to have tools, such as stow plans and calculations, to assist with determining proper stowage and the sufficiency of securing arrangements for containers stacked on barges. These tools should address the potential that container stacks may be stacked in a reverse stratified manner.

Recommendations: None
Brief Issued: April 6, 2021

Figure 16. Collapsed containers from the starboard quarter of the *Ho'omaka Hou*. SOURCE: US COAST GUARD



Flooding of Towing Vessel *Alton St. Amant*

New Orleans, Louisiana | May 17, 2020

On May 17, 2020, about 5:30 a.m. local time, a shipyard worker reported that the towing vessel *Alton St. Amant* was partially submerged while moored at a shipyard in the Harvey Canal in New Orleans, Louisiana. There were no crewmembers or shipyard workers aboard the vessel. Approximately 5 gallons of diesel fuel were released into the water. Damage to the vessel was estimated at $1.5 million. No injuries were reported.

We determined that the probable cause of the flooding of the *Alton St. Amant* was the absence of shipyard pre-inspection and monitoring procedures for water transfer, which resulted in potable water tanks overflowing through their open access hatches during an unmonitored transfer.

We identified the following safety issue during this investigation: the need for crew and shipyard personnel designated to conduct liquid transfers to be aware of the status of a vessel's tanks, including access hatches and associated piping systems, whether ashore or at sea.

When filling a tank, open access hatches create a risk of unintended flooding. Pre-inspection and monitoring of transfers provide the opportunity to identify and remedy any issues to ensure that transfers are safely completed.

Recommendations: None
Brief Issued: March 11, 2021

Contact of Cooperative *Spirit Tow* with Hale Boggs Memorial Bridge Pier

Luling, Louisiana | March 15, 2020

On March 15, 2020, about 1:13 a.m. local time, the towing vessel *Cooperative Spirit*, pushing a 29-barge tow, was transiting downstream on the Lower Mississippi River at mile 121.6 near Luling, Louisiana, when the port side of the tow struck the eastern tower pier of the Hale Boggs Memorial Bridge. The tow broke apart and began floating downriver. One of the barges sank, and the remaining barges were recovered by the *Cooperative Spirit* and other towing vessels in the area. No pollution or injuries were reported. Multiple barges in the tow, along with other barges moored along the riverbanks that were struck by drifting barges, were damaged and required repairs. Two barges were determined to be total constructive losses. The estimated loss totaled $1.65 million.

We determined that the probable cause of the contact of the tow with the pier was the pilot's failure to effectively compensate for the strong current while navigating a turn and approaching the bridge in high-water conditions.

We identified the following safety issue during this investigation: the possibility of a strong current producing atypical eddies in high-water conditions, which can make maneuvering more difficult.

Recommendations: None
Brief Issued: February 10, 2021

Contact of Liquid Petroleum Gas Carrier *Levant* with Mooring Dolphin

Ferndale, Washington | December 15, 2019

On December 15, 2019, about 4:06 a.m. local time, the liquefied petroleum gas carrier *Levant* was shifting 0.7 miles from its anchorage to the Petrogas Ferndale Wharf in Ferndale, Washington, when it struck the wharf's south mooring dolphin. The mooring dolphin and catwalk connecting it to the wharf were destroyed, and the *Levant*'s forward ballast tank was penetrated and flooded. There were no injuries to the vessel's crew or persons on the wharf. There was no release of pollutants or the ship's liquified cargo of propane and butane. Damage to the vessel was estimated at $1.5 million. Damage to the south mooring dolphin and adjoining catwalk was estimated at $6.75 million.

We determined that the probable cause of the contact of the *Levant* with the mooring dolphin was the pilot's approach with excessive speed and at too steep an angle, resulting from the pilot's and bridge team's poor bridge resource management.

We identified the following safety issue during this investigation: the need to emphasize the importance of the master/pilot exchange as a critical opportunity for a pilot and bridge team to establish and share necessary information (shared mental model), regardless of the length of the transit or maneuver.

Recommendations: None
Brief Issued: January 19, 2021

International Investigation and Brief

The Office of Marine Safety is responsible for the overall management of the NTSB's international marine safety program, under which the office investigates major marine casualties involving foreign-flagged vessels in US territorial waters. In a unique case, a Canadian-flagged bulker on domestic voyage between two Canadian ports experienced a marine casualty approaching the Soo Locks, in Sault Sainte Marie, Michigan.

The Transportation Safety Board of Canada requested to be granted substantially interested State status from the US Coast Guard and reviewed both the NTSB's and the Coast Guard's completed reports.

Contact of Bulk Carrier *Atlantic Huron* with the Soo Locks West Center Pier

Sault Sainte Marie, Michigan | July 5, 2020

On July 5, 2020, about 2:50 a.m. local time, the self-unloading bulk carrier ***Atlantic Huron*** was transiting the Upper St. Mary's River, west of the Soo Locks, in Sault Sainte Marie, Michigan, with a crew of 25. While on approach to the locks and attempting to slow, the vessel experienced a propulsion problem involving the vessel's controllable pitch propeller system. The vessel subsequently contacted the west center pier at 6.8 knots. Before reaching the lock gate, the vessel's motion was halted, and the crew moored the vessel to the pier. No pollution or injuries were reported. Damages to the vessel ($1,633,000) and pier ($573,000) were estimated at $2.2 million.

We determined that the probable cause of the contact between the vessel and the pier was a failure to follow the manufacturer's requirement to use thread-locking fluid during installation of the feedback ring locking pin set screw on the vessel's controllable pitch propeller system, which led to the failure of the controllable pitch propeller's oil distribution box.

We identified the following safety issues during this investigation: (1) the critical need for crewmembers to act quickly to mitigate potential accidents when a loss of propulsion control occurs during a critical phase of operation; (2) the need for an SMS to address potential emergency shipboard situations, including loss of propulsion, collision, and contact, and to establish ways to respond to them; (3) the need for vessels with controllable pitch propellers to have specific procedures for loss of engine and loss of pitch control because of these vessels' unique blade control; and (4) the need for these emergency procedures to be well understood and practiced by crewmembers, both on the bridge and in the engine room.

Recommendations: None
Brief Issued: April 13, 2021

Ongoing Significant Marine Investigations[8]

As of December 31, 2021, the Office of Marine Safety had 36 open domestic investigations. The following ongoing investigations that we launched involved significant safety issues.

Table 7. Office of Marine Safety Ongoing Significant Investigations

Location	Date	Description	Fatalities
Amelia, Louisiana	12/23/2021	Contact of ITV *Miss Mollye D* (US) with Bayou Ramos Bridge	0
*Tampa, Florida	12/17/2021	Fire on board the USCGC *Benjamin Dailey* (US) while in shipyard (NTSB fire investigator assistance under MOU)	0
Port Neches, Texas	11/25/2021	Collision of tanker *Gas Ares* (PA), tug *Sabine* (US), and tug *Florida* (US)	0
Belleview, Kentucky	11/09/2021	Explosion and fire on board the *Capt Kirby Dupuis* (US)	0
Newport Beach, California	10/01/2021	Breach of Elly pipeline	0
*Bath, Maine	7/30/2021	Listing and capsizing of SV *Mary E* (US)	0
New Orleans, Louisiana	7/12/2021	Collision of bulk vessel *Jalma Topic* (LR) with shoreside structure	0
New York, New York	6/5/2021	Grounding and stranding of PV *Seastreak Commodore* (US)	0
*St. Louis, Missouri	5/18/2021	Engine room fire on board TV *Mary Lynn* (US)	0
*Atlantic Ocean, 85 mi east of Cape Cod, Massachusetts	4/30/2021	Engine room fire on board FV *Nobska* (US)	0
*Santa Barbara Channel, California	4/28/2021	Engine room fire on board container ship *President Eisenhower* (US)	0
*Seattle, Washington	4/22/2021	Engine room fire on board ferry MV *Wenatchee* (US)	0
Gulf of Mexico, Port Fourchon, Louisiana	4/13/2021	Listing and capsizing of lift boat *Seacor Power* (US)	13
*Abbeville, Louisiana	3/22/2021	Contact of TV *Ava Claire* (US) with lock	0
*Baton Rouge, Louisiana	3/17/2021	Engine room fire on board TV *Miss Dorothy* (US)	0
*New Orleans, Louisiana	3/16/2021	Contact of MV *Bow Tribute* (NO) with water intake facility	0
20 nm north of Provincetown, Massachusetts	11/23/2020	Flooding of FV *Emmy Rose* (US)	4
*Sabine Pass, Texas	10/11/2020	Collision of *Cheramie Bo-TRUC No. 33* (US) with the USCGC *Harry Claiborne*	0

* As of June 30, 2022, this investigation has been completed.

Investigative Hearings

Investigative hearings are public hearings related to investigations at which the agency is authorized to obtain testimony under oath. When the US Coast Guard, as part of the investigation of a major marine casualty, holds a Marine Board of Investigation (MBI) hearing, NTSB investigators join in as an equal partner. Consistent with Coast Guard responsibility to direct the course of the investigation, those NTSB investigators designated by the MBI may (1) make recommendations about the scope of the investigation, (2) call and examine witnesses, and (3) submit or request additional evidence.

USCG Formal Marine Board of Investigation Investigative Hearing into the Sinking of the US Fishing Vessel *Scandies Rose*

Seattle, Washington | February 22 to March 5, 2021

The NTSB did not hold a public hearing or take depositions for this sinking; however, from February 22 to March 5, 2021, the US Coast Guard conducted a formal hearing about the accident. During the hearing, Coast Guard and NTSB investigators questioned 43 individuals, including the surviving crewmembers, company management, commercial fishing vessel workers, industry safety educators and advocates, naval architects, Coast Guard personnel, and commercial fishing industry stakeholders.

[8] We are devoting significant resources to the investigations listed and anticipate producing a report or brief for adoption or issuance upon the completion of each investigation.

Public Roundtable and Workshop

Fishing Vessel Safety Roundtable

On October 14, 2021, the Office of Marine Safety held a virtual roundtable, hosted by Chair Jennifer Homendy, to discuss new solutions aimed at improving commercial fishing vessel safety. More than a dozen experts and safety advocates from government and industry participated in this discussion, webcast through the NTSB website and viewed by more than 2,000 viewers worldwide. More than 800 fatalities have occurred on fishing vessels in the last two decades, and fishing consistently tops the list of most deadly occupations, due in large part to challenging work environments, such as poor weather and rough waters. These conditions threaten vessel stability and integrity—issues we have seen in our investigations and that we have highlighted on the NTSB's current MWL.

Seafloor Investigative Workshop – Surveys and Other Related Activities

The NTSB Seafloor Workshop was developed to help retain expertise learned from NTSB investigations at the seafloor, such as the 2015–2016 search for the *El Faro*. The ongoing project shared lessons from current aviation and marine investigations with interested stakeholders who may need to plan future operations. The workshop held in 2020 included over 70 participants representing investigative agencies, seafloor technology companies, and science organizations from across the world who discussed technologies, trends, and issues related to seafloor operations.

In 2021, the Office of Marine Safety used the information developed from the Seafloor Workshop in two projects. First, the office worked with the US Coast Guard on a seafloor survey of the FV *Emmy Rose*, which will be used in an upcoming investigation report in 2022. The *Emmy Rose* survey consisted of two operations, concluding with a comprehensive sonar and video hull survey. Next, office staff provided seafloor technical assistance to the Office of Aviation Safety in its underwater sonar and video hull survey and recovery of a 737 aircraft wreck off Honolulu.

In November 2021, a representative of the Office of Marine Safety presented information on the Seafloor Workshop to the MAIIF to interest its members in the ongoing project. The MAIIF requested that the NTSB create a new section for the MAIFF manual to address best practices in seafloor investigations for organizations to use; the office plans to develop an outline for the revised manual in 2022, to be followed by another virtual workshop.

Significant Achievement

2020 *Safer Seas Digest*

Our *Safer Seas Digest* comprises concise summaries of the previous year's accident investigations and represents the NTSB's continuing commitment to sharing the lessons that we learn through our marine investigations. The important safety issues examined in the 2020 edition (published in 2021) included the following:

- Navigating through bridges
- Standard operating procedures
- Smoke detection
- Voyage planning and dynamic risk assessment
- Effective communication
- Operating in high-water/high-current conditions
- Lithium-ion battery hazards
- Crew training
- Vessel speed
- Storage of flammable or combustible materials
- Closing ventilation inlets during a fire
- Effective hull inspection and maintenance
- Inspection of control linkages
- Fatigue

Memorandum of Understanding with the US Coast Guard

The Office of Marine Safety worked with the Office of General Counsel and the US Coast Guard to draft and sign a new memorandum of understanding (MOU) to replace the previous agreement that was signed in 2008.

The new MOU, signed by the Coast Guard commandant and the NTSB chair at Coast Guard headquarters on June 17, 2021, incorporates significant changes, such as how the two agencies cooperate and share information—including such digital evidence as that captured by voyage data recorders—and lessons learned from recent major investigations. The agreement also contemplates changes to the investigative landscape, such as the risks to safety posed by breaches in cybersecurity.

Figure 17. Cover of the 2020 *Safer Seas Digest*.

Office of Railroad, Pipeline and Hazardous Materials Investigations

Table 8. Office of Railroad, Pipeline and Hazardous Materials Investigations Statistics

Recommendations Issued	30
Recommendations Closed *Acceptable*	18
Recommendations Closed *Unacceptable*	1
Urgent Recommendation Closed *Acceptable*	1
Board-Adopted Investigative Reports	5
Briefs (Delegated Investigative Reports)	8
Major Investigation Launches	1
Field Investigation Launches	15
Safety Actions	5
Safety Alerts	1
Public Roundtables and Workshops	2
Advocacy and Outreach Events	17

The Office of Railroad, Pipeline and Hazardous Materials Investigations comprises four divisions: Railroad, Pipeline and Hazardous Materials, System Safety, and Report Development. The office investigates accidents involving railroads, pipelines, and hazardous materials, and evaluates the associated emergency response.

Based on the findings of these investigations, the NTSB may issue safety recommendations to federal and state regulatory agencies, unions, industry and safety standards organizations, carriers and pipeline operators, equipment and container manufacturers, producers and shippers of hazardous materials, and emergency response organizations. The office may also issue safety alerts to industry.

Railroad Investigation Reports

Amtrak Roadway Worker Fatality

Bowie, Maryland | April 24, 2018

On April 24, 2018, about 8:58 a.m. local time, northbound Amtrak train 86 struck and killed an Amtrak rail gang watchman near the Bowie State Train Station in Bowie, Maryland. The fatality occurred on main track 1 at milepost 119.2 on the Philadelphia to Washington line, located on Amtrak's Northeast Corridor. At the time, main track 2 was out of service under a continuous track outage for track maintenance, and the adjacent tracks immediately to the east and west of main track 2 (main tracks 1 and 3, respectively) were in service for train movements. Three watchmen were protecting the roadway workers and watching for trains moving on adjacent tracks to warn workers of approaching trains. One watchman was positioned near the boarding platform, another was positioned in a nearby curve, and the third—who was struck by the train—was positioned toward the end of the curve, near a work gang of welders. No passengers or crewmembers on Amtrak train 86 were injured.

We determined that the probable cause of the worker fatality was Amtrak's insufficient site-specific safety work plan for the work project that (1) did not consider the multiple main tracks in a high-noise environment, and (2) did not provide the rail gang watchman with a safe place to stand with level footing and sufficient sight distance to perform his duties, which led the rail gang watchman to stand on an active track in a work zone in the path of Amtrak train 86. Contributing to this accident was Amtrak's decision to use train approach warning for roadway worker protection in lieu of the protections that could have been provided by the positive train control system.

We identified the following safety issues during this investigation: (1) inadequate site-specific safety risk assessment, (2) unsafe train speeds in established work zones, and (3) ineffective roadway worker protection.

We issued recommendations to the FRA, Amtrak, and all Class I Railroads. We also reiterated a recommendation to Amtrak.

Recommendations: 3 new
Report adopted: September 27, 2021

BNSF Railway Collision

Kingman, Arizona | June 5, 2018

On June 5, 2018, about 2:50 p.m. local time, a westbound BNSF Railway intermodal train operating in multiple main tracks in centralized traffic control territory collided with the rear of a slow-moving eastbound work train in an area known as Crozier Canyon, about 33 miles east of Kingman, Arizona. The westbound intermodal train consisted of one forward facing locomotive and two rear-facing locomotives at the front of the train and 72 loaded cars; the loaded eastbound work train consisted of 29 cars and 2 forward-facing locomotives. After assuming the work train was headed west based on radio transmissions, the westbound intermodal train crew had decided to proceed past a red restrictive signal at a speed slow enough (not exceeding 15 mph) to permit stopping short of a train, a car, an obstruction, a stop signal, a derail, or an improperly lined switch, but tall trees on the inside of the curve impaired their visibility. Both trains were operating with positive train control. The collision took the life of one contract employee who was traveling on the work train; another contract employee was airlifted to a hospital in Las Vegas with serious injuries.

Figure 18. Overhead view of the BNSF railway collision point. SOURCE: BNSF

We determined that the probable cause of the collision was the failure of the BNSF Railway train crew of the intermodal train to operate in accordance with restricted speed requirements and to stop short of the opposing train. Contributing to the collision was (1) BNSF Railway's failure to establish sufficient on-track safety and (2) the FRA's interpretation of Title 49 *CFR* Part 214 Subpart C, which allows work trains to lay rail without using a form of on-track safety.

We identified the following safety issues during this investigation: (1) protection of roadway workers and (2) restricted speed accidents.

We issued safety recommendations to the FRA.

Recommendations: 2 new
Report adopted: May 10, 2021

Railroad Briefs

The Office of Railroad, Pipeline and Hazardous Materials investigations completed eight briefs through December 31, 2021. Here are summaries of seven of them.

Southeastern Pennsylvania Transportation Authority Light Rail Vehicle Collision

Upper Darby, Pennsylvania | August 22, 2017

On August 22, 2017, about 12:11 a.m. local time, a southbound Southeastern Pennsylvania Transportation Authority (SEPTA) single light-rail passenger car (car 155) carrying 42 passengers on the Norristown high-speed line collided with another SEPTA single light-rail passenger car (car 148), which was unoccupied and was stopped at passenger platform 1 of the 69th Street Transportation Center Station (69th Street Station) in Upper Darby, Pennsylvania. The 43 persons on board car 155, including the operator, suffered non-life-threatening injuries, and were transported to local medical facilities. Both cars remained on the rails and upright. SEPTA estimated the damage to the equipment to be $331,680.

We determined that the probable cause of this collision was an intermittent anomaly in the braking system of car 155 that degraded its stopping performance on approach to the 69th Street Station, resulting in the collision with car 148.

Figure 19. Aerial view of accident location on the morning after the collision. SOURCE: SEPTA

We identified the following safety issues during this investigation: (1) the need for reduced speed restrictions in several of SEPTA's track territories, (2) the need for updated reporting requirements for slippery rail conditions, and (3) the need for refresher training on brake procedures for all SEPTA rail operators.

Recommendations: None
Brief Issued: November 10, 2021

New York City Transit Employee Fatality

Bronx, New York | September 10, 2020

On September 10, 2020, at 5:00 a.m. local time, a New York City Transit (NYCT) employee was found unresponsive between two tracks in the 239th Street Yard in Bronx, New York. The employee, a transit car cleaner, was found by an NYCT car inspector who radioed management. Emergency medical services personnel were notified, arrived on the scene, and declared the employee deceased.

We determined that the probable cause of this fatality was electrocution as a result of contact with an electrified transit car current collector that likely occurred when the employee walked between a light pole and a stationary transit car.

We identified the following safety issues during this investigation: (1) the need for improved warning signs for employees on restricted clearance areas, (2) the need for improved safety communications to ensure that employees attend and acknowledge daily safety briefings, (3) the need to ensure that employees are aware of hazards in rail yards, including close clearances and safe means of egress, and (4) the need to ensure that personnel maintain hourly communications with management.

Recommendations: None
Brief Issued: November 1, 2021

CSX Transportation Employee Fatality

Estill, South Carolina | November 30, 2018

On November 30, 2018, at 10:20 a.m. local time, CSX Transportation (CSX) northbound freight train F-794-30, traveling about 50 mph, struck and killed a CSX track welder. The fatality occurred at the North End Estill siding switch, milepost S-449.7, on the CSX Columbia subdivision in Estill, South Carolina. The welder was occupying the track as the train approached. An additional roadway worker, a trackman, had been assigned as a watchman at the work location, which involved watching for approaching trains and providing a warning to the welder. The crewmembers of train F-794-30 told NTSB investigators that they did not realize that a person was on the track until moments before impact. The crew of train F-794-30 sounded the train horn and bell; however, there was no response from the roadway work group.

We determined that the probable cause of this fatality was the failed implementation of train approach warning. Contributing to the accident were (1) the decision by CSX management to use train approach warning instead of establishing working limits, (2) the decision by the watchman to cease his train detection and warning efforts to engage in other work while the welder was still working on an active track, and (3) the decision of the welder to remove his high-visibility safety apparel before leaving the work site.

We identified the following safety issues during this investigation: (1) the need for improved operating rules to ensure safety when welding components on controlled tracks, to include contact with the train dispatcher, obtaining track authority for the work, and use of temporary speed restrictions at the work location and (2) the need for a watchman/lookout at the work location.

Recommendations: None
Brief Issued: September 28, 2021

Union Pacific Railroad Employee Fatality

Northlake, Illinois | April 23, 2020

On April 23, 2020, at 10:02 a.m. local time, Union Pacific Railroad train YPR6423, consisting of two locomotives and four rail cars, collided with a truck tractor in combination with a semi-trailer (combination vehicle) as the train entered a public highway–rail grade crossing outside of the Proviso Yard in Northlake, Illinois. The train was traveling at a speed of 10 mph while shoving rail cars into an industry track. The remote-control locomotive operator was controlling the movement of the train from the end rail car and died due to the collision as the train entered the grade crossing at Railroad Avenue.

We determined that the probable cause of this collision was Union Pacific Railroad's allowance of train movement through a grade crossing without first stopping the train to provide warning. Also contributing to the collision was the combination vehicle driver's failure to yield to the train as he approached the public highway–rail grade crossing.

We identified the following safety issues during this investigation: (1) inadequate operational safety procedures and rules; (2) the need to ensure that employees are aware of this accident; (3) the need to ensure that employees understand the safety precautions needed for shoving movements, warnings over road crossing, job briefings, and riding equipment; and (4) ineffective safety warning signs and access controls at the public road crossing.

Recommendations: None
Brief Issued: August 30, 2021

Union Pacific Railroad Derailment with Hazardous Materials Release and Subsequent Fire

Fort Worth, Texas | April 24, 2019

On April 24, 2019, at 12:33 a.m. local time, a southbound Union Pacific Railroad high-hazard flammable key train carrying denatured ethanol derailed in Fort Worth, Texas. The train was 6,122 feet long; weighed 13,230 tons; and consisted of three locomotives, two buffer cars, and 96 loaded tank cars. Twenty-six tank cars derailed, and three tank cars were breached, leaking 65,270 gallons of denatured ethanol. Several cars caught fire. The released ethanol ignited and formed pool fires; some product also entered a tributary of the Trinity River. It was raining at the time of the derailment. UP estimated the damages to be $6,313,217.

We determined that the probable cause of the derailment was a weakened track structure and wash out resulting from water overflow related to Echo Lake flooding. Contributing factors include deferred maintenance of primary and emergency spillways at Echo Lake, and the absence of dynamic weather reporting criteria at the railroad.

We identified the following safety issues during this investigation: (1) placement of DOT-111 tank cars in high-hazard flammable trains and (2) the use of buffer cars for the protection of train crews from hazardous materials releases.

Recommendations: None
Brief Issued: August 3, 2021

Figure 20. Aerial view of derailed UP train UEBLTG20.

Port Authority Transit Corporation Employee Fatality

Lindenwold, New Jersey | July 26, 2020

On July 26, 2020, a Port Authority Transit Corporation (PATCO) maintenance employee was struck and killed between two railcars at the Lindenwold Yard facility on track 12 east. The deceased employee was found by another maintenance employee at about 9:03 p.m., approximately two car lengths away from the designated walkway between railcars on track 12 east and a train stored on track 12 west that was blocking the walkway. When found, the deceased employee was not wearing a reflective vest and had no portable radio.

We determined that the probable cause of the fatality was the employee's walking in an area not designated for foot traffic between two railcars with insufficient clearance, leading to his being struck during an uncoupling maneuver. Contributing to the accident was PATCO's storage of railcars on the designated employee walkway and failure to require employees to use these walkways in the yard.

We identified the following safety issues during this investigation: (1) the need for designated walkways and pathways for employees working in the yard, (2) the need to eliminate close clearance areas between stored railcars, and (3) the need to improve employee personal protective gear and review of internal safety rules.

Recommendations: None
Brief Issued: June 28, 2021

CSX Transportation Employee Fatality

Chattanooga, Tennessee | April 13, 2019

On April 13, 2019, a CSX carman was struck and killed by a remote-control locomotive operating in a remote-control zone at the Wauhatchie Rail Yard in Chattanooga, Tennessee, during a switching maneuver at the north end of the yard. The accident carman was on foot crossing the lead track in the remote-control zone at the time.

We determined that the probable cause for the fatality was the inability of the carman to maintain situational awareness in the remote-control zone due to the intoxicating effects of alcohol.

We identified the following safety issue during this investigation: the need to expand requirements of drug and alcohol testing for mechanical employees in safety-sensitive positions.

Recommendations: None
Brief Issued: June 28, 2021

Ongoing Significant Railroad Investigations[9]

As of December 31, 2021, the Office of Railroad, Pipeline and Hazardous Materials Investigations had 23 open ongoing railroad investigations. The following ongoing investigations on which we launched involved significant safety issues.

Table 9. Office of Railroad, Pipeline and Hazardous Materials Investigations Ongoing Significant Railroad Investigations

Location	Date	Description	Fatalities
Darby, Pennsylvania	12/09/2021	Collision of CSX freight train with SEPTA Trolley	0
Arlington, Virginia	10/12/2021	Derailment of WMATA passenger train and evacuation of passengers	0
Joplin, Montana	9/25/2021	Derailment of Amtrak passenger train	3
Saint Paul, Minnesota	8/25/2021	Collision of Canadian Pacific freight train with Union Pacific freight train and impact with stopped BNSF train	0
*Tempe, Arizona	7/29/2020	Derailment of 12 cars of Union Pacific Railroad freight train	0
Draffin, Kentucky	2/13/2020	Derailment of CSX freight train with hazardous materials release	0
*Sacramento, California	8/22/2019	Collision between Sacramento Regional Transit District light rail vehicles	0
*Baltimore, Maryland	2/7/2019	Fatality of Norfolk Southern Railway conductor	1

* As of June 30, 2022, this investigation has been completed.

Pipeline Investigation Reports

Pacific Gas & Electric Third-Party Line Strike and Fire

San Francisco, California | February 6, 2019

On February 6, 2019, at 1:07 p.m. local time, the excavator operator for a third-party contractor, Kilford Engineering Inc., impacted a Pacific Gas & Electric Company (PG&E) branch connection with the mini excavator trenching bucket attachment during mechanical excavation for fiberoptic conduit installation in the Richmond District of San Francisco, California, resulting in the release and ignition of natural gas. A nearby restaurant with a rental unit above caught fire. There were no injuries. Estimated damages to nearby buildings and the pipeline system exceeded $10 million.

The San Francisco Fire Department was dispatched and arrived on scene. It focused on containing the fire and minimizing its spread while PG&E crews worked to isolate and shut down the gas line. The fire and police departments evacuated about 100 people, and PG&E shut off natural gas service to 328 customers. At 3:36 p.m., the damaged pipelines and branch connection were isolated, and the fire department extinguished the gas fire 2 minutes later.

Figure 21. Northwest-facing view of fire during emergency response. PHOTO COURTESY OF PG&E

[9] We are devoting significant resources to the accident investigations listed and anticipate producing an accident report or brief for adoption upon the completion of each investigation.

We determined that the probable cause of the release of natural gas from the pipeline and the subsequent fire was the failure of the Kilford Engineering Inc. operator and spotter to follow safe excavation practices within the tolerance zone, which resulted in the trenching bucket's impacting the branch connection.

We identified the following safety issues during this investigation: (1) third-party excavation damage to buried natural gas pipelines, (2) enforcement challenges of California's damage prevention law, (3) PG&E's data integration gaps during the development of the valve isolation plan, and (4) insufficient joint emergency response planning between PG&E and San Francisco, California, emergency response agencies.

We issued safety recommendations to the San Francisco Police Department, the San Francisco Fire Department, San Francisco Department of Emergency Management, and PG&E.

Recommendations: 3 new
Report adopted: July 27, 2021

Atmos Energy Corporation Natural Gas-Fueled Explosion

Dallas, Texas | February 23, 2018

On February 23, 2018, at 6:38 a.m. local time, a natural gas–fueled explosion occurred at a residence in Dallas, Texas. The residence sustained major structural damage, but when first responders arrived on scene at 6:44 a.m., they observed no smoke or fire. Four family members had been injured and one killed in the explosion. Following the explosion, NTSB investigators located a through-wall crack in the 71-year-old natural gas main that served the residence. In the 2 days before the event, two gas-related incidents had occurred on the same block at houses served by the same natural gas main, each incident resulting in significant structural damage and burn injuries to one occupant.

We determined that the probable cause of the explosion was the ignition of an accumulation of natural gas that had leaked from a gas main damaged during a sewer replacement project 23 years earlier, and undetected by Atmos Energy Corporation's investigation of the two related incidents on the days prior to the explosion.

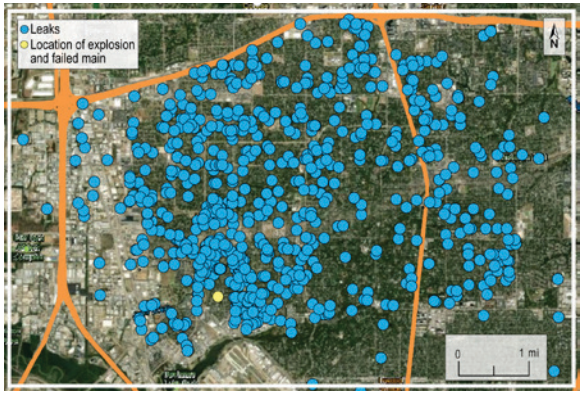


Figure 22. Leaks identified as Grade 1 or Grade 2, which were beyond the scope of this investigation.
BACKGROUND SOURCE: GOOGLE EARTH

Contributing to the explosion was the company's insufficient investigation procedures for wet weather leaks. Contributing to the severity of the explosion was Atmos's inaction to isolate the affected main and evacuate the houses. Contributing to the degradation of the pipeline system was Atmos's inadequate integrity management program.

We identified the following safety issues during this investigation: (1) incident investigation, (2) leak investigation, (3) methane detection, (4) incident reporting, and (5) integrity management.

We issued safety recommendations to PHMSA, the Railroad Commission of Texas, the Dallas Fire-Rescue Department, Atmos Energy Corporation, and the Gas Piping Technology Committee. We also reiterated safety recommendations to the International Code Council, National Fire Protection Association, and Gas Technology Institute.

Recommendations: 13 new, 3 reiterated
Report adopted: January 12, 2021

Ongoing Significant Pipeline Investigations[10]

As of December 31, 2021, the Office of Railroad, Pipeline and Hazardous Materials Investigations had four open ongoing pipeline investigations. The following ongoing investigations on which we launched involved significant safety issues.

Table 10. Office of Railroad, Pipeline and Hazardous Materials Investigations Ongoing Significant Pipeline Investigations

Location	Date	Description	Fatalities
Coolidge, Arizona	8/15/2021	Rupture of natural gas transmission pipeline and release and ignition of natural gas, impacting nearby residential structure	2
Farmersville, Texas	6/28/2021	Explosion that occurred when Atmos contractors were loading a pig into a pipeline	2
*Hillsboro, Kentucky	5/4/2020	Failure of Texas Eastern Gas Company pipeline	0
Danville, Kentucky	8/1/2019	Failure of natural gas transmission pipeline	1

* As of June 30, 2022, this investigation has been completed.

[10] We are devoting significant resources to the accident investigations listed and anticipate producing an accident report or brief for adoption upon the completion of each investigation.

Ongoing Significant Hazardous Materials Investigations[11]

As of December 31, 2021, the Office of Railroad, Pipeline and Hazardous Materials Investigations had four open ongoing hazardous materials investigations. The following ongoing investigation on which we launched involved significant safety issues.

Table 11. Office of Railroad, Pipeline and Hazardous Materials Investigations Ongoing Significant Hazardous Materials Investigation

Location	Date	Description	Fatalities
Beach Park, Illinois	4/25/2019	Release of anhydrous ammonia from nurse tanks	0

Ongoing Special Investigative Reports, Safety Recommendation Reports, and Safety Research Reports

Positive Train Control: Gaps and Needed Enhancements

The Railroad Division is exploring improvements from and possible deficiencies in the implementation of positive train control.

Safety Alerts

Through December 31, 2021, Office of Railroad, Pipeline and Hazardous Materials Investigations developed the following safety alert for issuance by the Board:

NTSB Safety Alert 083 Passenger Railcar Wheelset Alert

Because out-of-specification wheelsets are not easily identifiable with a routine visual inspection, the NTSB urged rail transit agencies and commuter railroads to assess their fleets for wheelsets not meeting their specifications and take immediate action to correct the problem.

SAFETY ALERT
NTSB
Passenger Railcar Wheelset Alert
The problem
What can rail transit agencies and commuter railroads do?

Other Significant Achievements

Responses to Notices of Proposed Rulemaking

- Provided NTSB comments on the Surface Transportation Board's proposed rulemaking *Railroad Consolidation Procedures—Exemption for Emergency Temporary Trackage Rights*.
- Provided NTSB comments on the FRA's proposed rulemaking *Fatigue Risk Management for Certain Passenger and Freight Railroads*.
- Provided NTSB comments on the FRA's proposed rulemaking *Control of Alcohol and Drug Use: Coverage of Mechanical Employees and Miscellaneous Amendments*.

Safety Actions

- **SEPTA, Philadelphia:** SEPTA started to assign qualified watchpersons to station platforms preceding the track inspection crews. In this role, the watchperson communicates with train operators to warn them of the track workers and warns track workers via radio communication of approaching trains. SEPTA will monitor the effectiveness of this practice and adjust as needed to further enhance the protection. SEPTA hired additional full-time positions to support this role. RAB-21-06
- **NYCT, Bronx:** NYCT issued three safety advisories, addressing (1) safety briefings and personal protective equipment, (2) hazards employees might encounter in rail yards, and (3) communications between workers and supervisors while working in yards. RAB-21-07
- **UP, Northlake:** UP distributed an incident alert systemwide to all employees and briefed employees in the Chicago area. The alert included rules to review, including those related to (1) shoving movements, (2) providing warning over road crossings, (3) job briefings, and (4) riding equipment. RAB-21-04
- **CSX, Estill:** CSX issued a new operating rule for welding frogs and switch points on controlled track requiring that the roadway worker in charge contact the train dispatcher and attempt to establish working limits. If working limits cannot be established, the speed of trains traveling in the work location is to be reduced to 10 mph. RAB-21-05
- **PATCO, Lindenwold:** PATCO management changed its safety rules to (1) designate walkways as the only permissible route for employees to use in the yard, (2) prohibit the blocking of designated walkways by stored equipment, and (3) require train operators to come to a full stop and activate the horn at all designated walkways. PATCO also established storage limits on specific yard tracks to create greater spacing between stored sets of railcars. RAB-21-01

[11] We are devoting significant resources to the accident investigation listed and anticipate producing an accident report or brief for adoption upon the completion of the investigation.

Office of Research and Engineering

Table 12. Office of Research and Engineering Safety Statistics

Safety Research Published	3
Safety Data Analyses Completed	198
Readouts of Vehicle Recorders and Other Electronic Devices Completed	252
Materials Laboratory Exam Reports Completed	158
Vehicle Performance Reports and Animations Completed	32
Medical Investigation Reports Completed	180
Journal Publications	6
Advocacy and Outreach Events	51

The Office of Research and Engineering is an investigative office providing scientific and technical expertise for NTSB accident investigations in all modes of transportation. The office, which includes four divisions and two program areas, also conducts safety research, generates periodic statistical reviews of aviation accidents, and provides medical and toxicology expertise for investigations in all modes.

The Office of Research and Engineering comprises four divisions: Safety Research, Materials Laboratory, Vehicle Recorders, and Vehicle Performance; and two program areas, Physician Consult Section and Chief Data Scientist.

Safety Research Division

The Safety Research Division examines transportation accidents, accident trends, and technological changes to identify problems and associated remedial actions that will reduce risk and improve the safety of the transportation system. Division staff includes transportation safety researchers, data analysts, and statisticians who conduct systematic examinations of (1) risks or hazards in the transportation environment that may influence accidents or injury; (2) the techniques and methods of accident investigation; and (3) the effectiveness of various safety countermeasures, such as policies, programs, and technologies. The division also provides data science, data visualization, and statistical expertise to support accident launches and investigations, assist in the development of safety recommendations, and publish annual statistical reviews for the NTSB, Congress, and the public.

In 2021, the division published two annual reviews of aviation accident statistics and one safety research study report on preventing turbulence-related accidents and injuries in air carrier operations that resulted in 21 new safety recommendations. Staff also began work on a study of polydrug use among drivers in the United States.

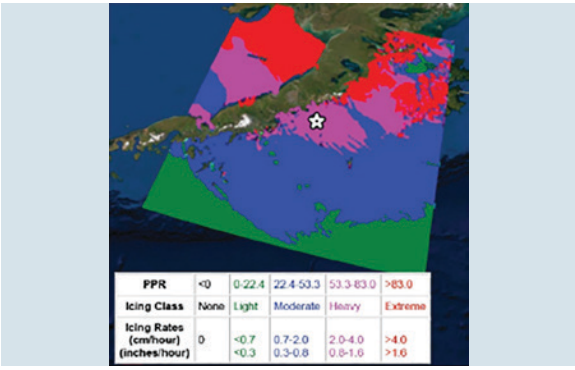


Figure 23. Geospatial analysis showing sea spray ice accretion rates in the vicinity of Sutwik Island, Alaska, at the time of the capsizing and sinking of commercial fishing vessel *Scandies Rose*, December 31, 2019.

TABLE SOURCE: VESSEL ICING PREDICTION, NPS.EDU

In addition, staff generated 4 rapid reports,[12] 35 data reports, and geospatial products to support major accident investigations in aviation, highway, marine, and rail; and completed 159 aviation data report and statistical analysis requests. Division staff also led and participated in multiple presentations and training sessions for internal and external organizations. A new researcher was hired in 2021, improving the NTSB's expertise in impairment, automated vehicles, and transportation safety data analysis.

Materials Laboratory Division

The Materials Laboratory Division performs expert multidisciplinary engineering and scientific analyses to determine whether the performance of materials and structures is related to the cause or severity of an accident. Engineers also analyze wreckage to determine the causes of fires and explosions. The division provides chemical and forensic science expertise, as well as technical advice and resources for experimental testing and research in the physical sciences.

Figure 24. Materials Laboratory Division staff member removing the damaged portion of the pipe struck by dredging vessel *Waymon Boyd* in Corpus Christi, Texas, August 21, 2020.

In 2021, the division completed 158 reports for 119 investigations, launched to two accident sites, and supported numerous NTSB reports and recommendations. Staff supported the investigation of a liquid propane pipeline strike and subsequent explosion and fire aboard the dredging vessel *Waymon Boyd* in the Corpus Christi Ship Channel Inner Harbor. Staff also supported the investigation of a rupture in a 30-inch diameter natural gas transmission pipeline owned and operated by Kinder Morgan Inc. in Coolidge, Arizona. In this ongoing investigation, the division conducted the root cause failure analysis of the pipeline fracture and continues to support the development of a Board report.

Vehicle Recorder Division

The Vehicle Recorders Division extracts, formats, and analyzes data from aircraft FDRs and CVRs, and from recorders installed in locomotives, large ships, and some highway vehicles. Engineers also examine recorded electronic audio and video information captured by aircraft, ship, train, and support communication systems; provide electronic engineering expertise in examining communication and control systems for investigations in all modes; provide time synchronization to correlate voice, data, and video recorder outputs; use advanced digital and analog filtering and signal representation techniques to extract critical recorder information; and perform forensic examinations of personal electronic devices and other computer hardware.

In 2021, the division received 327 devices; completed 252 readouts, transcripts, and studies to support aviation, railroad, marine, and highway investigations; and launched to support one investigation. Of the recorders received, 26 were from foreign accidents and 6 were from US military or other US government agency investigations. Among the devices we downloaded and analyzed were a fire-damaged restraint control module from a Tesla Model 3 electric car involved in a crash in Coral Gables, Florida, and the FDR and CVR from a United Airlines Boeing 777 that experienced an engine failure shortly after takeoff from Denver International Airport.

To bolster the NTSB's capacity to download and analyze digital evidence, the division hired one new engineer in 2021.

[12] If the NTSB decides to launch a Board member as the on-scene spokesperson with an investigation team to the accident site, the Safety Research Division and the Safety Recommendations Division (in the Office of Safety Recommendations and Communications) provide a 1–2-page summary of background information to support the investigation team during the initial stages of the launch. This "rapid report" typically includes publicly available information related to the operator, vehicle, and crash location; relevant safety data and statistics on similar crashes and crash trends; a summary of relevant NTSB investigations, studies, or other products; and additional data on safety issues of interest that may be requested for the team.

Figure 25. Vehicle Recorder Division staff member downloads the CVR from a United Airlines, Boeing 777 that experienced an engine failure shortly after takeoff from Denver International Airport on February 20, 2021.

Vehicle Performance Division

The Vehicle Performance Division provides specialized aeronautical, mechanical, structural, and biomechanical engineering expertise; three-dimensional laser scanning and accident reconstruction; photogrammetry and video analysis; and animation and graphics development for all modes. Engineers use computational and visualization technology to provide accurate time motion histories of the sequence of events and evaluate data from multiple sources to determine vehicle and occupant motion and the underlying causes of that motion. Engineers also develop video animations of accident scenarios, evaluate occupant injury mechanisms, and participate in, and direct research into, special projects as required.

In 2021, division staff completed 32 products in support of investigations (aircraft and surface vehicle performance studies, laser scanning reports, biomechanics studies, video/photograph studies, animations, and video compilations). Staff completed an evaluation of the flight paths of two airplanes involved in a midair collision in Ketchikan, Alaska, that included an assessment of the visibility of each airplane and the traffic information that could have been displayed to each pilot. In addition, the division developed an animation documenting that collision, which was shown at the Board meeting in April 2021. Staff also used computer simulations and evaluated onboard video to investigate a crash involving a motorcoach, three combination vehicles, and a passenger vehicle near Mount Pleasant Township, Pennsylvania.

Figure 26. Still image from the animation depicting the midair collision between a de Havilland DHC-2 Beaver and a de Havilland DHC-3 Otter in Ketchikan, Alaska, May 13, 2019.

Program Areas

Medical Investigations

NTSB medical officers evaluate the medical aspects of investigations, including medical fitness, pathology, toxicology, injury causation, and biomechanics. Examples of medical issues addressed include operator incapacitation, injury prevention, night vision, hypoxia, substance impairment, obstructive sleep apnea, and use of prescription and over-the-counter medications as well as illicit substances.

In 2021, the agency's three physicians participated in more than 135 investigations and completed 180 reports for all transportation modes. This included evaluating and addressing medical issues through formal factual and analytical reports, safety recommendations, coordination with other agencies, and formal presentations to the Board and external audiences.

Chief Data Scientist

The chief data scientist supports the agencywide effort to improve the use of data in strategic decision-making. He is designated as the agency's chief data officer and chairs the agency's data governance body. He is also responsible for applying advanced data science methods and techniques to agency investigations and research, analysis, and emerging transportation safety trend reporting.

During 2021, the chief data scientist, along with representatives from the Offices of the Chief Information Officer and the Office of Aviation Safety, continued to lead improvements to the new multimodal database for our investigations, as directed by Congress in the agency's 2018 budget reauthorization. Using the new reporting capabilities of that system, he developed a library of dashboards for monitoring investigation tasks. He also led an agency workgroup assessing the use of its labor-cost accounting system to aid the management of investigations.

Completed Safety Research Reports

Preventing Turbulence-Related Injuries in Air Carrier Operations Conducted Under Title 14 *Code of Federal Regulations* Part 121

Safety Research Report

Turbulence-related accidents are the most common type of accident involving air carriers operating under Title 14 *CFR* Part 121. From 2009 through 2018, the NTSB found that turbulence-related accidents accounted for more than a third of all Part 121 accidents; most of these resulted in one or more serious injuries but no aircraft damage. This research examined safety issues related to the turbulence problem from a systemwide perspective; more specifically, it (1) summarized the basic types and causes of turbulence, (2) described the safety impacts of turbulence, including characteristics of and trends in turbulence-related accidents and injuries across Part 121 air carrier operations, (3) examined methods used to reduce the likelihood of turbulence encounters and turbulence-related injuries in Part 121 air carrier operations, and (4) identified proven and emerging best practices and safety countermeasures.

Safety issues addressed included (1) insufficient submission and dissemination of turbulence observations, (2) a lack of shared awareness of turbulence risks, (3) the need for mitigation of common turbulence-related injury circumstances, and (4) the need for updated turbulence guidance.

We issued safety recommendations to the FAA, the National Weather Service, Airlines for America, the Regional Airline Association, and the National Air Carrier Association. We also reiterated safety recommendations to the FAA.

Recommendations: 21 new, 4 reiterated
Report Adopted: August 10, 2021

Ongoing Safety Research Reports

Drug and Polydrug Use Among Drivers

Safety Research Report

Impairment from alcohol and other drugs is a major transportation safety issue about which the NTSB's concern has increased over the past decade, particularly in the highway mode. The agency has documented substance impairment in numerous highway crash investigations, many of which involved a driver's use of more than one drug. This safety research is examining the polydrug use problem and developing safety recommendations to help reduce highway accidents and injuries. Specifically, the research goals are (1) to review and describe what is known about the association between the use of various drugs and highway crash risk, (2) to document drugged driving prevalence and trends in the United States using the best currently available data, and (3) to identify and promote the use of best practices for documenting drugged driving prevalence and understanding the associated crash risk.

Other Significant Achievements

Publications

- T. Casanova-Powell, R. Smith. "Rideshare Volume and DUI Incidents in Atlanta, Georgia; Chicago, Illinois; and Fort Worth, Texas." Arlington, VA: National District Attorney's Association (2021).
- G. Ankem, R. Smith, C. Klauer, D. Henclewood, K. Johnson. "A Primer for Evaluating Underage Drinking and Driving Programs (DOT HS 812 953)." Washington, DC: National Highway Traffic Safety Administration (2021).
- M. Budinski and E. Mueller. "Microfractography" in *ASM Handbook, Volume 12, Fractography*. Metals Park, OH: ASM International. (Book chapter in press/2021.)
- M. Fox and A. Lamm. "Keystone Pipeline Rupture Investigation." *Journal of Failure Analysis and Prevention* (2021).
- E. Mueller. "The Unusual Case of a Not-So-Obvious Brake Line Failure." *Journal of Failure Analysis and Prevention*. (Manuscript in management review/2021.)
- E. Mueller and S. Stein. "Investigation of a Leaking Brake Line Fitting on a General Aviation Airplane." *Journal of Failure Analysis and Prevention* (2021).

Office of Safety Recommendations and Communications

Table 13. Office of Safety Recommendations and Communications Statistics

Safety Recommendations Closed *Acceptable*	118
Testimony or Legislative Support to State Legislative Committees	20
Media Mentions (Print, Broadcast, and Online)	186,700
Advocacy and Outreach Events	82

The Office of Safety Recommendations and Communications publicly releases information on NTSB investigations, activities, and safety recommendations across multiple communication channels. The office engages a range of stakeholders, including safety recommendation recipients; members of the transportation industry; transportation workers; federal, state, and local government officials; transportation safety advocates; and the public.

Our work spans an investigation's lifecycle, providing the transparency that supports the NTSB's independence while building public trust and support for our mission. Following an investigation, office staff focus on advocating for and monitoring safety recommendation implementation. The office comprises five divisions: Safety Recommendations, Media Relations, Government and Industry Affairs, Safety Advocacy, and Digital Services.

Safety Recommendations Division

NTSB safety recommendations address specific issues uncovered during investigations and specify actions to help prevent similar accidents and crashes from occurring in the future. These safety recommendations are the agency's most important products because they alert government, industry, and the public to the critical changes that are needed to prevent transportation accidents and crashes, reduce injuries, and save lives.

The NTSB issues its recommendations to the organizations best able to take corrective action, such as the US DOT and its modal administrations, the US Coast Guard, other federal and state agencies, manufacturers, operators, labor unions, and industry and trade organizations. The Safety Recommendations Division helps investigative offices craft recommendations that will encourage recipients to take the corrective action needed to prevent the identified safety issue from occurring in the future.

Once the Board issues a recommendation, the Safety Recommendations Division handles the ongoing correspondence between the agency and each recipient,

tracking and analyzing a recipient's responses and determining a classification—*Acceptable* or *Unacceptable*—for the Board members to consider. The division monitors the progress of action to implement each recommendation until it is closed (which usually takes several years), maintains a database of all recommendations, compiles monthly statistics, and responds to data queries from other offices.

In 2021, 118 open recommendations were closed *Acceptable*;[13] 51 of these had been issued to DOT modal agencies or the US Coast Guard (see Table 14).[14] The number of open recommendations that are closed fluctuates from year to year for various reasons. Over the last 5 years (2017 through 2021), the number of recommendations closed *Acceptable* has averaged 104 per year.

During 2021, the division contacted numerous recommendation recipients who had not updated the NTSB on their actions for some time. In many cases, the recipient had completed the recommended action but had not informed us.

Also in 2021, the NTSB referenced related open safety recommendations in our responses to several notices issued by the US DOT and other federal agencies in the *Federal Register*. Table 15 provides a summary of these actions.

Table 14. Safety Recommendations Issued to the US DOT, Modal Agencies, and the US Coast Guard Closed in 2021

	Safety Recommendations Closed *Acceptable*	Safety Recommendations Closed *Unacceptable*
Federal Aviation Administration	31	12
Federal Highway Administration	5	0
Federal Motor Carrier Safety Administration	1	0
Federal Railroad Administration	2	0
National Highway Traffic Safety Administration	6	0
Pipeline and Hazardous Materials Safety Administration	5	0
US Coast Guard	1	1

Table 15. Open Safety Recommendations Referenced in NTSB Responses to *Federal Register* Notices from Federal Agencies in 2021

	Federal Register Notices	Open Safety Recommendations Referenced
Federal Aviation Administration	1	1
Federal Highway Administration	1	13
Federal Railroad Administration	2	4
National Highway Traffic Safety Administration	1	18
US Coast Guard	1	1

[13] Recommendations closed *Acceptable* include those classified *Closed—Exceeds Recommended Action*, *Closed—Acceptable Action*, and *Closed—Acceptable Alternate Action*.
[14] In addition, 23 safety recommendations were closed *Unacceptable* in 2021; of these, 13 were issued to DOT modal agencies or the US Coast Guard.

Media Relations Division

The Media Relations Division is responsible for providing accurate and timely information on the NTSB's activities to the media and public.

The division provides information about accident, crash, and incident investigations and coordinates the release of reports, safety studies, safety recommendations, safety alerts, and other agency investigative products. The division also amplifies the lessons learned from NTSB investigations, responds to media inquiries, arranges media interviews of agency personnel, and serves as the on-scene public affairs officers supporting Board members during major accident investigations. The division also supports deployed regional investigators and investigators-in-charge, and trains NTSB and transportation industry personnel in successful media engagement.

Division staff launched on every 2021 major investigation, including a deadly Amtrak derailment in Montana, the crash of a Boeing MD-87 in Texas, and the fatal capsizing of a liftboat off the coast of Louisiana.

In addition, as the COVID-19 pandemic continued in 2021, staff provided remote media relations support for every investigation opened by the NTSB. The division also provided virtual media relations training for the transportation industry and a media relations refresher training webinar for agency staff.

As shown previously in Table 13, the division helped the NTSB garner more than 186,700 print, broadcast, and online news mentions in 2021.

Table 16. NTSB Media Mentions

MWL article mentions	22,500
News releases and media advisories	111
Tweets	760
Training conducted	11

Figure 27. Media Relations staff with NTSB investigators at the site of an MD-87 plane crash near Brookshire, Texas, on October 19, 2021.

Government and Industry Affairs Division

The Government and Industry Affairs Division is the NTSB's primary liaison with Congress, the White House, the Government Accountability Office (GAO), other federal agencies, and state and local governments. The division informs Congress, governors, and state legislatures about NTSB activities, including launches, investigations, Board meetings, and the issuance and current implementation status of safety recommendations. It also manages inquiries from federal, state, and local governments. The division communicates with the transportation industry about agency initiatives and works with the Safety Advocacy Division to support programs and legislation consistent with our safety recommendations and to monitor relevant state legislative activity.

In 2021, staff supported launches from headquarters and responded to hundreds of requests for information in each mode of transportation. The division also initiated agency outreach to congressional, state, and local officials who expressed an interest in improving transportation safety and provided technical assistance as they drafted legislation. In addition, staff supported Board member and senior official testimonies and legislative advocacy efforts before state legislatures in North Dakota, Wyoming, Maryland, Hawaii, Connecticut, Ohio, Massachusetts, Kentucky, and Utah.

Safety Advocacy Division

The Safety Advocacy Division leads the agency's advocacy efforts and promotes the implementation of safety recommendations on the NTSB's MWL. The division relays safety messages and lessons learned from NTSB investigations through print, digital, and social media channels. The MWL is the agency's primary advocacy focus, and the division leads the list's biennial development, working with Board members, representatives from the Office of Research and Engineering, and modal office directors to identify issues for inclusion.

Throughout 2021, the division continued advocating for issues included on the 2021–2022 MWL and coordinated the agency's response to the annual US DOT report to Congress describing the progress DOT agencies have made to address these issues. Staff also facilitated meetings with modal offices to respond to the GAO's MWL audit, which recommended improved transparency about how items are selected for the list and how that rationale is explained to the public. The division also continued its use of social and digital media in 2021, hosting virtual meetings to relay information to stakeholders and posting hundreds of social media messages on the NTSB blog, Twitter, Facebook, LinkedIn, Instagram, and YouTube pages. Staff also hosted Twitter chats to call attention to risks to the safety of the transportation system and expanded our use of virtual meeting and webcasting tools, hosting meetings with stakeholders to advance the agency's mission and to advocate for the safety items highlighted on the MWL. (See Tables 17 and 18 below.)

Table 17. Safety Advocacy Division Social Media Followers, Connections, and Subscribers

	2020	2021
Twitter followers	164,240	164,622
Instagram followers	6,500	8,000
LinkedIn connections	20,118	23,600
E-mail subscribers	7,342	7,128

Table 18. Safety Advocacy Division Products and Events

Behind the Scene @NTSB podcasts	9
YouTube videos	9
Advocacy Spotlight newsletters	3
Safety Compass blogs	37
E-mail subscribers	77
Events (conference exhibits, advocacy events, presentations, roundtables, coalition meetings, testimony, and workshops)	82

Figure 28. Social media graphic developed to advocate for impaired driving awareness.

Digital Services Division

The Digital Services Division supports the NTSB's internal and external strategic communications goals. Staff manages agency communications on ntsb.gov and designs and develops graphics and audiovisual products that optimize the agency's ability to communicate investigation findings and safety messages and to facilitate employee engagement. The division also establishes visual style and branding standards for the agency and advises internal stakeholders on how to best use visual information to enhance their products.

In 2021, the division launched a new ntsb.gov website, updating the look to reflect new agency branding and style guidance, improving information presentation and accessibility, and highlighting the most important information requested by stakeholders.

Staff also implemented a digital asset management system to better organize and store imagery and video files, improving the agency's collaborative process and optimizing searchability.

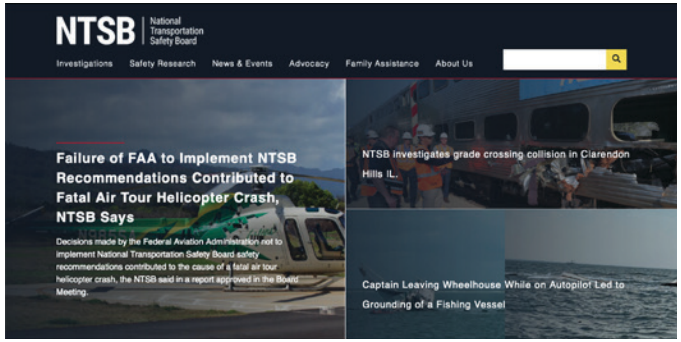


Figure 29. The Digital Services Division worked with staff across the agency to launch the new ntsb.gov.

Transportation Disaster Assistance Division

Table 19. Transportation Disaster Assistance Statistics

Family Members and Victims Assisted	2,921
Advocacy and Outreach Events	65
Agencies/Organizations Supported	281

The Transportation Disaster Assistance Division coordinates federal government resources to support local and state governments, disaster relief organizations, and transportation carriers to meet the needs of family members and survivors following major aviation and rail accidents. Division staff also serve as the primary source of investigative information for family members and survivors for any accident investigated by the NTSB.[15]

To support both our investigative and family assistance efforts at major accidents, we maintain formal agreements with the American Red Cross; the US Departments of Homeland Security, Defense, Health and Human Services, and State; and the Federal Bureau of Investigation.

During 2021, division staff participated in five launches and provided nonlaunch family assistance support for an additional 713 investigations in all modes of transportation. We also supported seven Board meetings, interacting with 2,921 victims and family members.

Staff engaged with family members associated with 65 different accidents, on average, each week; these encounters ranged from a single phone call or e-mail to several hours of work over multiple days with numerous family members from a single accident.

In addition, staff interfaced with 281 federal, state, and local agencies; transportation industry organizations; and other nongovernmental organizations that have a role in family assistance operations, with an average of 22 engagements per week requiring either travel or remote interaction. We also supported a total of 65 advocacy and outreach events.

[15] In 1996, Congress enacted the Aviation Disaster Family Assistance Act (Title 49 *United States Code* [*U.S.C.*] sections 1136 and 41113), charging the NTSB with assisting victims of aviation disasters and their families, and coordinating with federal agencies, domestic air carriers, and state and local authorities to ensure that the fundamental concerns of families are met. In 1997, the Foreign Air Carrier Family Support Act (Title 49 *U.S.C.* section 41313) required foreign air carriers operating flights to and from the United States to meet similar victim assistance standards as their US counterparts. The Rail Safety Improvement Act of 2008 (Title 49 *U.S.C.* sections 1139 and 24316) gave similar responsibilities to the NTSB, Amtrak, and other interstate and intercity high-speed passenger rail operators following rail passenger accidents. Finally, in 2018, Congress further expanded the Board's responsibilities to provide information regarding NTSB investigative processes and products to the families of individuals involved in any accident investigated by the NTSB to the maximum extent practicable in advance of the media (Title 49 *U.S.C.* section 1140).

Office of Administrative Law Judges

Table 20. Office of Administrative Law Judges Statistics

Total Cases Received	272
Total Cases Closed	237
Emergency Cases Received	112
Emergency Cases Closed	101
Challenges to Emergency Determinations	24
Hearings Held	18
Board Opinions and Orders	9

The NTSB serves as the court of appeals for pilots, aircraft mechanics, air traffic controllers, air carriers, repair facilities, and any other individual or entity against whom the FAA has taken a certificate action, and for mariners against whom the US Coast Guard has taken a certificate action.

The judges within the agency's Office of Administrative Law Judges hear and consider the cases of, and issue initial decisions on, administrative appeals of FAA aviation enforcement actions. Under the Equal Access to Justice Act, the judges also adjudicate claims from certificate holders for legal fees and expenses incurred in defending against FAA certificate actions and adjudicate appeals from civil penalty actions assessed against any individual by the FAA. The certificate holder, the person being assessed, or the FAA may appeal an administrative law judge's decision. The Board's review of such an appeal is based on the record of the proceeding, which includes the transcript of the hearing testimony, exhibits, the judge's decision, and appeal briefs submitted by the parties. Marine certificate actions are heard first by US Coast Guard administrative law judges and may be appealed to the vice commandant of the Coast Guard. The vice commandant's ruling may then be appealed to the NTSB.

The office currently has four judges, two of whom were hired in 2021. Two judges are assigned to NTSB headquarters in Washington, DC, one to the circuit that includes Denver, Colorado, and one to the circuit that includes San Antonio, Texas. In the past, our judges held hearings in their circuits, but the pandemic required a transition to virtual hearings. Emergency and nonemergency hearings were held virtually, enabling the judges ultimately to dispose of 54 percent of the 2021 caseload by year's end.

Training Center

Table 21. Training Center Statistics

Courses, Programs, Seminars Offered (Total)	223
Workforce Development Courses	211
Total Attendance	6,083
NTSB Participants	5,485
External Participants	598
International Participants (Representing 32 Countries)	90
Participants from Other Federal Agencies	261

The NTSB Training Center, located in Ashburn, Virginia, provides training opportunities for NTSB employees and others from the transportation community to improve attendees' knowledge of accident investigation techniques and their ability to respond to transportation disasters.

The program includes courses that focus on key competencies to enhance safety through objective investigations in all modes of transportation, as well as specialized topics in cognitive interviewing techniques, human fatigue factors, communications following a transportation disaster, and coordinating family assistance.

The Training Center promotes safe transportation by ensuring and improving the quality of accident investigation through critical thought, instruction, and research. In every course, instructors communicate lessons learned, foster the exchange of new ideas and new experiences, advocate for operational excellence, and provide a modern platform for accident reconstruction and evaluation.

Our high-quality training resources are also used to facilitate family assistance programs, to ensure that NTSB investigators and party representatives can work effectively to investigate accidents, and to support other federal agencies and transportation entities in conducting incident investigations and safety analyses.

The Training Center's workforce development curriculum offers NTSB employees access to courses focused on career development and management, leadership, and other mission-critical and support skills. Vacant seats are offered to other small federal agencies on a reciprocal basis to maximize training opportunities and knowledge management for the federal workforce, and to provide the best stewardship of taxpayers' training dollars.

Training Center Offerings

In 2021, the Training Center continued to evaluate courses, further refine offerings, and improve instruction in all areas of investigative and mission-support training as well as workforce development. Staff regularly conducted needs analyses and assessments to ensure that course offerings remained responsive to the NTSB's changing needs and priorities. All NTSB investigators and on-scene support personnel were trained in the National Incident Management and Incident Command Systems and Emergency Management protocols, to maximize our ability to work effectively with other agencies during the on-scene phase of investigations.

As telework became the norm in 2020, the Training Center adapted, moving over 90 percent of our courses to a virtual platform without negatively affecting course content. This adaptation to virtual learning continued throughout 2021 and especially benefitted the 25 percent of NTSB employees living outside the Washington, DC, metropolitan area who, in the past, have occasionally been unable to attend in-person training due to limits on travel funds or the time needed for travel.

A new series of instructor-led courses in supervisory competencies emphasizing performance management (particularly in a telework environment) and novel issues related to the pandemic received high marks from supervisors. The Training Center also continued to offer a course in refresher training for experienced supervisors, as well as executive coaching.

Transportation Community and Partnerships

Furthering the Training Center's commitment to meeting the needs of those in other areas of government, the transportation safety community, and transportation safety investigators worldwide, the division continues to build upon alliances with private organizations and federal agencies. For example, staff partnered with the US Coast Guard to conduct four courses in 2021 exclusively to train its aviation and marine safety operations personnel to investigate mishaps involving Coast Guard assets and personnel. Other NTSB accident investigation courses were attended by employees from other federal agencies and investigators from other countries. The Training Center also conducted courses exclusively for 143 employees of Blue Origin, Delta Airlines, and Norfolk & Southern Railroad.

Figure 30. In 2021, the NTSB announced its decision to deconstruct the TWA flight 800 wreckage as the agency prepares for the expiration of the lease for its Ashburn, Virginia, Training Center.

As of December 31, 2021, the Training Center's laboratory area contained the reconstruction of TWA flight 800, as well as other wreckage and materials, enabling participants to gain hands-on experience with real-world examples during investigative courses. During 2021, the NTSB created a digital virtualization of the TWA flight 800 wreckage to highlight the transformative developments in investigative techniques and technologies that have occurred over the past quarter-century since our investigation of the inflight breakup of that aircraft. This digital reconstruction will enable the Training Center to resume more interactive viewing and discussions with students about the TWA flight 800 investigative case study, which exemplifies the in-depth investigative testing and analysis underlying today's complex accident investigations. This will be particularly important going forward, as the Ashburn facility is scheduled for closure in December 2022, necessitating the deconstruction of the wreckage.