Safety on call

Behind the scenes with air safety investigators

BY MEGAN HILFER AND ED MUIR, BOEING WRITERS

Boeing teams inspire lasting aviation safety innovation

Eric East got the late-morning call about a Boeing cargo jet.

The National Transportation Safety Board (NTSB) said the airplane had gone down in a swampy area near Houston. Within 24 hours, East and a team of other Boeing technical experts from Washington state were on scene to provide assistance to the NTSB.

"Nothing is more important than the safety of everyone who flies on our airplanes," said East, a Boeing Associate Technical Fellow and senior air safety investigator. "From the moment we get the call, the devastating impact of these accidents is always on our minds."

ON SITE
Alongside NTSB members and a Texas game warden, Boeing air safety investigator Eric East (right) searches near Houston for recorders from a cargo jet crash. Pinger locator equipment enables him to listen for the underwater locator beacons.

PHOTO: NTSB

PHOTO: BOEING

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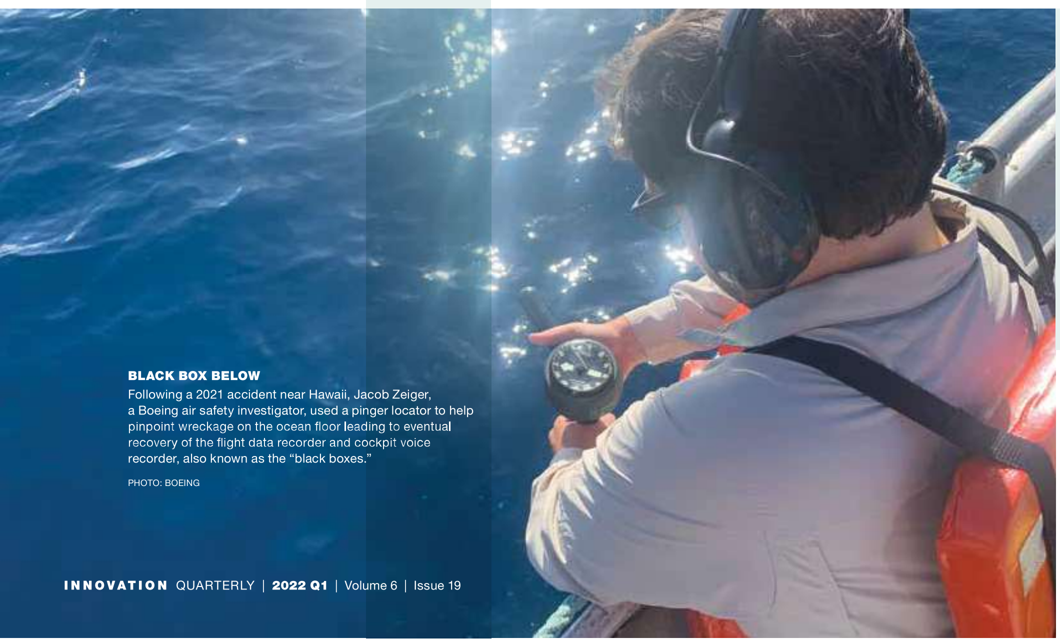
ERIC EAST,
BOEING SENIOR AIR
SAFETY INVESTIGATOR

They quickly went to work in an airboat and began to search the muddy waters for the flight data recorder and cockpit voice recorder underwater locator beacons in the wreckage field around the crash scene. More technical experts joined the investigation. Thousands of pieces of debris were recovered and reconstructed by the investigation team over the next several months.

"It's more than recovering physical pieces of the airplane. Investigators take a holistic approach to help determine exactly what happened," East said. The Boeing Air Safety Investigation (ASI) team and the Boeing technical experts who support it play a critical role to advance aviation safety.

When an incident or accident occurs involving a Boeing airplane anywhere in the world, Boeing's ASI team is always ready to respond.



BLACK BOX BELOW

Following a 2021 accident near Hawaii, Jacob Zeiger, a Boeing air safety investigator, used a pinger locator to help pinpoint wreckage on the ocean floor leading to eventual recovery of the flight data recorder and cockpit voice recorder, also known as the "black boxes."

PHOTO: BOEING

Poised and Ready

Following an airplane accident or incident, an investigation led by the relevant country's accident investigation authority will likely be launched. Boeing stands ready to provide technical advisers to the NTSB, the U.S. agency that leads domestic investigations and represents the state (or country) of manufacture and design when a Boeing airplane is involved in an incident or accident elsewhere.

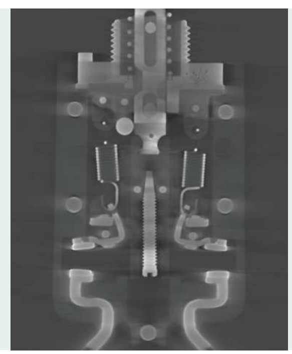
The NTSB is responsible for gathering and analyzing evidence to determine the cause and for issuing safety recommendations. The agency works with the airplane, engine and other component manufacturers who provide the technical expertise related to the design and operation of their products.

Under the protocols governed by the International Civil Aviation Organization, Boeing's support of an investigation focuses on data and technical expertise, including information specific to the airplane, such as its systems, controls and operating procedures, and access to resources, such as labs, specialized equipment and technical experts.

The data gathered helps ensure the continued airworthiness of the existing fleet by identifying if there are potential product safety issues. However, the investigations may also reveal findings that help inform future designs and safety enhancements while uncovering lessons learned that benefit the broader aviation industry.

A government investigation can take anywhere from months to a few years to complete, culminating with a final report that provides context, identifies contributing factors and often provides recommendations to improve safety.

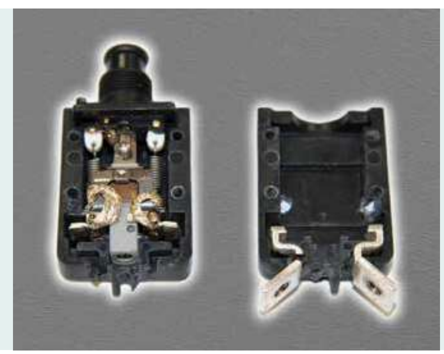
The ultimate mission for all: to determine cause, prevent recurrence and make improvements.



PRESERVATION OF EVIDENCE

Boeing assists investigation authorities in examination of components such as this circuit breaker. The Boeing Equipment Quality Analysis Lab uses nondestructive techniques such as computed tomography scanning and digital X-rays, capturing perishable evidence.

PHOTO: BOEING



VERIFICATION

Highly skilled Boeing personnel can help identify potential anomalies before disassembly or sectioning of components for evidence collection, providing further insight and focus to the investigation.

PHOTO: BOEING

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Team Tasks

As the airplane manufacturer, Boeing dedicates technical expertise and its unique resources and capabilities to aid from the initial wreckage recovery through the entire investigation. ASI leads the Boeing technical team comprising experts who bring their deep knowledge and experience in the design, build, test, certification and in-service support of Boeing products and services:

Jay Shoji, a Boeing Associate Technical Fellow, is part of a small group of structural analysis engineers who may be called upon by ASI to help identify aircraft parts on scene.

Shoji may be required to travel to an accident site as quickly as possible and has a "go bag" packed in case of emergency.

Once Shoji and others gather as many aircraft parts as possible, he sometimes works with the NTSB team to "reconstruct" the airplane. The investigative team would lay out the debris in a nearby warehouse or other space to try to piece it together like a jigsaw puzzle; this process can take weeks.

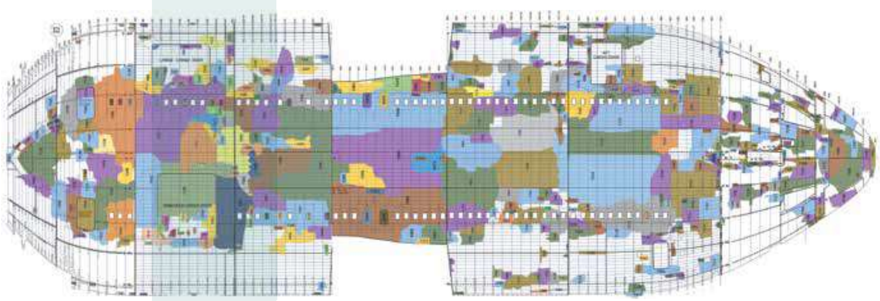
The team looks for signs of damage on the debris. Are the aircraft pieces blackened, which may point to a fire or explosion? How expansive is the debris field? In an accident where the wreckage is unrecoverable, would the maintenance logs and other records indicate something meaningful about the aircraft's history?

"Most accidents have no structural cause," Shoji said. "So most often, the investigation team essentially performs a forensic investigation, piecing together physical clues to determine the sequence of events. However, if there is an indication of a potential structures contribution to the accident, we'll look for structural anomalies, for clues to what may have caused the accident."

RECONSTRUCTION

This digital reconstruction of a fuselage was created by Boeing structures and liaison engineers for an NTSB investigation. It can help determine if structural anomalies were present and whether the airplane was intact during the accident as well as reveal the overall accident sequence.

GRAPHIC: BOEING



SIMULATING SAFETY

Using actual flight data, technical experts can run flight scenarios using Boeing's engineering flight simulators to provide investigators insight into both airplane performance and human factors.

PHOTO: BOB FERGUSON/BOEING

PHOTO: BOEING

Scott Lunde works in the Aerodynamics Stability & Control Post-Certification Support group. The group analyzes flight recorder data to help confirm expected airplane performance and identify contributing factors to in-service incidents or accidents on Boeing commercial airplanes.

Once his team receives the data from an accident investigation, members create working plots, analyze the data and coordinate with other Boeing subject matter experts to help understand the data. They then share this analysis with ASI and the NTSB to support the ongoing investigation, all with the goal of identifying potential causes and contributing factors.

"Our team has developed a number of analysis methods over the past 25-plus years that help us to understand the event," Lunde said. "These include data plotting techniques, methods of calculating information not captured by the recorder, the use of desktop simulation to evaluate expected airplane performance, animations to visualize the airplane, and piloted simulator cab sessions to investigate event timing and crew resource management."

PHOTO: BOEING

Vic Riley, a human factors engineer and Boeing Associate Technical Fellow, supports the investigation by helping analyze flight deck and other data to determine how pilots behaved in the time leading up to an incident.

He asks key questions: What were their expectations and habits, and how could those have contributed to the way they reacted? What did they pay attention to? How did they communicate with each other? In short, did pilots act as they would be expected to under the circumstances? And if they didn't, why not?

"The pilot is the most complex and least deterministic part of the airplane," said Riley.

PHOTO: BOEING

“We realize what we’re doing is very important. We hope our work means a similar accident doesn’t happen again.”

STEVE CHISHOLM, BOEING MECHANICAL AND STRUCTURAL FUNCTIONAL CHIEF ENGINEER

Steve Chisholm is a mechanical and structural functional chief engineer. When Chisholm was a Boeing Associate Technical Fellow, he consulted with ASI on several airplane accidents. Among those, he spent the most time working on a 747 that went down in the waters off Long Island, New York, in 1996.

In the year following that crash, Chisholm spent five to six months in New York, working seven-day weeks, 14- to 16-hour days, helping piece together what happened. Among issues unique to that investigation, the FBI and CIA personnel on scene did not allow pictures to be taken while they investigated whether the crash was the result of a crime, so Chisholm drew sketches of the debris field.

As Chisholm and other investigators physically reconstructed the aircraft at a hangar on Long Island, they attempted to solve the riddle of sequencing — the potential order of how things happened — which was a new way to approach crash investigations.

He and his team aimed to determine the direction of a fracture or source of fire on a wing or segment of fuselage. After establishing the direction, the team worked backward toward the source of the fracture, which eventually led them to an issue with the center fuel tank.

Chisholm also helped propose and implement process improvements in investigations. For instance, ASI team members now take blood-borne pathogen training courses, which used to be available only to first responders. Chisholm says more mental health services are provided for investigators now as well.

“We realize what we’re doing is very important,” Chisholm said. “We hope our work means a similar accident doesn’t happen again.” **IQ**

Lasting Change

Following the tragedy of airplane accidents, regulators and other officials often reexamine protocols and safety regulations, which can lead to important safety changes. Due to the international and domestic protocols in place, the company is limited as to what it can share publicly during an investigation. One exception is when product safety issues are uncovered during the course of an investigation that are important to share with the entire fleet for continued airworthiness.

Here are several examples of investigations that helped inspire aviation safety innovation and shape procedural and technology improvements in place today:

- **March 27, 1977, 5:06 p.m. Western European Time, Tenerife Airport, Canary Islands**
  Miscommunication between air traffic control and the flight deck resulted in forming the standardized communication practices now used worldwide.
- **Aug. 12, 1985, 6:56 p.m. Japan Standard Time, Mount Osutaka, Japan**
  Catastrophic depressurization at 24,000 feet drove critical changes in airplane design and repair protocols.
- **July 19, 1989, 3:16 p.m. Central Daylight Time, Sioux City, Iowa**
  In-flight disintegration of an engine fan disk led to extensive modifications of hydraulic control systems.
- **Dec. 20, 1995, 9:41 p.m. Eastern Standard Time, Cali, Colombia**
  A mountainside collision resulted in enhanced terrain-awareness warning systems found on all commercial airplanes today.
- **Jan. 31, 2000, 4:19 p.m. Pacific Standard Time, north of Anacapa Island, California**
  In-flight failure of a horizontal stabilizer assembly led to revised maintenance-testing procedures and increased regulatory oversight of maintenance.

What’s Next

Aviation safety is a journey of continuous improvement.

Each accident is tragic and an opportunity to evaluate if there are steps we can take to enhance safety. We will always remember those who lost their lives as well as their families. We will honor them by holding close the hard lessons learned from our journey. We have and will continue to institute lasting changes that continue to increase the level of safety in air travel.

For Boeing, that journey is illustrated by steady progress with the implementation of an enterprise Safety Management System (SMS). The SMS is an industry-proven approach to managing safety risk and ensuring the effectiveness of safety risk controls.

Boeing’s SMS will incorporate data from regulators; customers; employee reporting; and existing production, compliance, quality and safety processes. Ultimately, the intent is to bring the right data into the right forums to make data-driven, risk-based decisions that help prevent accidents and protect people.

As part of a robust SMS in place, Boeing needs a strong ASI team. And investigators such as Eric East and his colleagues are always ready for the call.