

THE STATE OF AIRLINE SAFETY: FEDERAL OVERSIGHT OF COMMERCIAL AVIATION

HEARING

BEFORE THE

SUBCOMMITTEE ON AVIATION AND SPACE

OF THE

COMMITTEE ON COMMERCE,
SCIENCE, AND TRANSPORTATION
UNITED STATES SENATE

ONE HUNDRED SIXTEENTH CONGRESS

FIRST SESSION

MARCH 27, 2019

Printed for the use of the Committee on Commerce, Science, and Transportation



Available online: <http://www.govinfo.gov>

U.S. GOVERNMENT PUBLISHING OFFICE

WASHINGTON : 2023

42-445 PDF

SENATE COMMITTEE ON COMMERCE, SCIENCE, AND TRANSPORTATION

ONE HUNDRED SIXTEENTH CONGRESS

FIRST SESSION

ROGER WICKER, Mississippi, *Chairman*

JOHN THUNE, South Dakota	MARIA CANTWELL, Washington, <i>Ranking</i>
ROY BLUNT, Missouri	AMY KLOBUCHAR, Minnesota
TED CRUZ, Texas	RICHARD BLUMENTHAL, Connecticut
DEB FISCHER, Nebraska	BRIAN SCHATZ, Hawaii
JERRY MORAN, Kansas	EDWARD MARKEY, Massachusetts
DAN SULLIVAN, Alaska	TOM UDALL, New Mexico
CORY GARDNER, Colorado	GARY PETERS, Michigan
MARSHA BLACKBURN, Tennessee	TAMMY BALDWIN, Wisconsin
SHELLEY MOORE CAPITO, West Virginia	TAMMY DUCKWORTH, Illinois
MIKE LEE, Utah	JON TESTER, Montana
RON JOHNSON, Wisconsin	KYRSTEN SINEMA, Arizona
TODD YOUNG, Indiana	JACKY ROSEN, Nevada
RICK SCOTT, Florida	

JOHN KEAST, *Staff Director*

CRYSTAL TULLY, *Deputy Staff Director*

STEVEN WALL, *General Counsel*

KIM LIPSKY, *Democratic Staff Director*

CHRIS DAY, *Democratic Deputy Staff Director*

RENAE BLACK, *Senior Counsel*

SUBCOMMITTEE ON AVIATION AND SPACE

TED CRUZ, Texas, <i>Chairman</i>	KYRSTEN SINEMA, Arizona, <i>Ranking</i>
JOHN THUNE, South Dakota	BRIAN SCHATZ, Hawaii
ROY BLUNT, Missouri	TOM UDALL, New Mexico
JERRY MORAN, Kansas	GARY PETERS, Michigan
CORY GARDNER, Colorado	TAMMY DUCKWORTH, Illinois
MARSHA BLACKBURN, Tennessee	JON TESTER, Montana
SHELLEY MOORE CAPITO, West Virginia	JACKY ROSEN, Nevada
MIKE LEE, Utah	

CONTENTS

Hearing held on March 27, 2019	Page 1
Statement of Senator Cruz	1
Statement of Senator Sinema	2
Statement of Senator Wicker	3
Statement of Senator Cantwell	4
Statement of Senator Thune	37
Statement of Senator Klobuchar	39
Statement of Senator Moran	41
Statement of Senator Blumenthal	43
Statement of Senator Blunt	44
Statement of Senator Duckworth	47
Statement of Senator Moore Capito	49
Statement of Senator Markey	51
Statement of Senator Rosen	53
Statement of Senator Udall	56
Article dated June 15, 2018 from the <i>Seattle Times</i> entitled, “Trouble- some advanced engines for Boeing, Airbus jets have disrupted airlines and shaken travelers”	57
WITNESSES	
Hon. Daniel K. Elwell, Acting Administrator, Federal Aviation Administra- tion	6
Prepared statement	7
Hon. Robert L. Sumwalt III, Chairman, National Transportation Safety Board	11
Prepared statement	12
Hon. Calvin L. Scovel III, Inspector General, U.S. Department of Transpor- tation	19
Prepared statement	21
APPENDIX	
Response to written questions submitted to Hon. Daniel K. Elwell by:	
Hon. John Thune	73
Hon. Maria Cantwell	74
Hon. Amy Klobuchar	74
Hon. Tom Udall	74
Hon. Tammy Duckworth	76
Hon. Jon Tester	79
Response to written questions submitted to Hon. Calvin L. Scovel III by:	
Hon. John Thune	81
Hon. Maria Cantwell	81
Hon. Tammy Duckworth	82
Hon. Jon Tester	83

THE STATE OF AIRLINE SAFETY: FEDERAL OVERSIGHT OF COMMERCIAL AVIATION

WEDNESDAY, MARCH 27, 2019

U.S. SENATE,
SUBCOMMITTEE ON AVIATION AND SPACE,
COMMITTEE ON COMMERCE, SCIENCE, AND TRANSPORTATION,
Washington, DC.

The Subcommittee met, pursuant to notice, at 3:02 p.m. in room SH-216, Hart Senate Office Building, Hon. Ted Cruz, Chairman of the Subcommittee, presiding.

Present: Senators Cruz [presiding], Wicker, Thune, Blunt, Moran, Moore Capito, Sinema, Cantwell, Blumenthal, Markey, Duckworth, Klobuchar, Udall, and Rosen.

OPENING STATEMENT OF HON. TED CRUZ, U.S. SENATOR FROM TEXAS

Senator CRUZ. Well, good afternoon. The subcommittee will come to order.

Our hearing is entitled The State of Airline Safety: Federal Oversight of Commercial aviation. Welcome to each of the witnesses.

On March 10, 2019, Ethiopian Airlines Flight 302 departed Addis Ababa Airport with 157 souls onboard. Among them were parents and children, reverends and international aid workers, and college students with their entire lives ahead of them, but at 8:44 a.m., 6 minutes after takeoff, what should have been a routine two-hour flight turned into a tragedy. Flight 302 crashed, killing all 157 people.

Although devastating on its own, the tragedy of Flight 302 was compounded by the fact that something like this had happened less than six months earlier.

Lion Air Flight 610 had been in the air just 12 minutes before plunging into the Java Sea at 6:32 a.m. on October 29, 2018, killing all 189 people onboard.

The 346 men, women, and children lost in these tragic crashes came from 35 different countries, ranged in age from the elderly to the unborn, and had professions as diverse as their backgrounds, but they did have one thing in common. They were all traveling on a brand-new plane, a Boeing 737 Max.

It is truly unfortunate that today's hearing is necessary and I wish we didn't have to be here today, but our first priority in aviation must always be the safety of the flying public.

The fact of the matter is that these crashes and subsequent reports on how the 737 Max was approved have badly shaken consumer confidence.

In aviation, as in other industries, where a small mistake can have catastrophic consequences, trust is the currency of the realm. Trust of the flying public in the safety of the aircraft they step onto, trust of our international partners in the diligence and thoroughness of our regulatory bodies, and increasingly trust of our regulatory bodies in the quality and truthfulness of the data and certifications provided and performed by industry.

Not only have the recent crashes shaken the confidence of the public but the questions that have been raised in the aftermath about FAA's oversight of aircraft manufacturers, the certification process for planes, and the close relationship between industry and regulator threaten to erode trust in the entire system.

It is incumbent on us as legislators, as regulators, and as industry leaders to work to ensure that that does not occur.

Today's hearing takes the first step down that road by seeking to answer some fundamental questions.

First, we need to understand exactly what happened, both in these specific crashes and with the certification process for the Max aircraft, so that we can take action to keep something like these tragic crashes from occurring again.

Second, we need to look at the aviation safety space more broadly and identify where we can and should make improvements. We need to answer, at least begin to answer questions like is the FAA taking the right approach to the oversight and certification of aircraft manufacturing, operations, and repair, particularly with regard to designated authority.

Also answering how safe is commercial aviation, both in the United States and internationally, and how can we increase the level of safety even further, and how can we restore the confidence and trust of the flying public, both in the United States and internationally?

As our witnesses today will highlight in their testimony, commercial aviation in the United States today is as safe as it ever has been worldwide and particularly in the United States.

The likelihood of being in a fatal commercial plane crash is infinitesimally low and this is a record that we can and should be proud of, but this record is also exactly what makes the recent crashes and reports of lenient oversight by the FAA so frustrating.

As a nation, we have been on such a promising upward trend in safety that, although these crashes occurred in foreign countries, the questions that have been raised about the integrity of our regulatory processes strikes right to the heart of aviation safety here at home.

We need to do better and I firmly believe that we can. With that, I'll recognize the Ranking Member of the Aviation and Space Subcommittee, Senator Sinema.

**STATEMENT OF HON. KYRSTEN SINEMA,
U.S. SENATOR FROM ARIZONA**

Senator SINEMA. Well, thank you, Chairman Cruz, for holding this timely and important hearing.

I look forward to building a strong relationship and working closely with you on this and other issues in our Subcommittee's jurisdiction.

Thank you to our witnesses for joining us today.

The United States airspace and U.S. aviation are the safest in the world. The United States is the leader in aviation and aviation safety, thanks to the dedication of thousands of skilled individuals on the manufacturing floor, on the ground at airports, in control towers, and in the air.

Our safety also relies on the advocacy of concerned citizens, like the families of Continental Flight 3407, who tirelessly advocate for safer skies. Thank you for being here today and for your work on this important issue.

The aviation industry is a major economic driver. Safe, affordable, and convenient air travel is critical to the well-being of industry, job creation, and economic growth. The system is successful because it is safe and people know and trust that it is safe.

Tragedies, like the Ethiopian Airlines and Lion Air crashes are unimaginable in the U.S. and must remain so, but they and other recent incidents raise important questions about maintaining a safe national airspace system and U.S. leadership in aviation and safety.

It's imperative that we quickly fix any problems within FAA's oversight, evaluation, and approval processes to ensure safety in American skies, restore trust, and maintain U.S. global leadership in aviation and aviation safety.

Thank you, Mr. Chairman. I yield back.

Senator CRUZ. I now recognize the Chairman of the Full Committee, Senator Wicker.

**STATEMENT OF HON. ROGER WICKER,
U.S. SENATOR FROM MISSISSIPPI**

Senator WICKER. Thank you, Senator Cruz, and I want to thank Senator Cruz and Senator Sinema for holding this Subcommittee hearing on the timely subject of aviation safety.

As both the Chair and Ranking Member mentioned in their remarks, the remarkable safety record of U.S. passenger airline travel is a testament to decades of hard work and painful lessons learned by a great many stakeholders.

Today's hearing represents the beginning of this year's work in this area. The Committee intends to hold a second hearing on aviation safety to hear from non-government witnesses, including Boeing.

We understand that the investigations into the Ethiopian Airlines and Lion Air crashes are ongoing and may limit certain details from being discussed in this forum. However, our witnesses can cover a lot of information today, including addressing the FAA's response to these tragedies, the certification process, pilot training, and broader concerns about the increasing complexity and automation of aircraft systems.

The FAA has long been considered the gold standard internationally when it comes to safety. It is vital that we work with our partners throughout the world to promote safe air transportation. The committee will continue to discuss robust oversight to ensure the safety of our aviation system.

Thank you, Mr. Chairman.

Senator CRUZ. I now recognize the Ranking Member of the Full Committee, Senator Cantwell.

**STATEMENT OF HON. MARIA CANTWELL,
U.S. SENATOR FROM WASHINGTON**

Senator CANTWELL. Thank you, Mr. Chairman, and thank you for holding this important hearing today to discuss the paramount issue of aviation safety here in the United States and around the world.

I thank the witnesses for being here and their insights today and I, too, want to recognize the families of the Colgan Air Flight 3407 who are here today because it is their continued persistence about getting aviation right that is so admirable. I thank them and thank you all for being here.

The incidents that led us here today of the crash of Lion Air 610 last October and the Ethiopian Flight 302 are horrible human tragedies. I want to extend my deepest sympathies to the families and everyone impacted by this horrific incident.

These two accidents cost 346 lives, leaving behind countless individuals and loved ones who I know want to make sure this is never repeated.

The human toll is why we work every day to ensure that every possible step is taken to determine the causes that contributed to these incidents and through the crash investigations, other Federal investigations, and ongoing congressional oversight, I believe we all share the same goal, to make sure these accidents are never repeated.

It is critical that all those involved look at the causes of the accident and work so that everyone has the full picture of what happened.

Investigators in Indonesia and Ethiopia, with the help from NTSB and FAA and other international partners, are working through the evidence to determine the causes of these accidents and even though, as my colleagues have mentioned, global commercial aviation has experienced unprecedented periods of safety over the last decade, these two accidents are horrific reminders that we must remain vigilant in our oversight and focus on safety.

So I look forward to hearing the information from the witnesses that is available for us today and I also commend yesterday's Secretary Chao's indication that she will seek a previously authorized authority by the last 2018 FAA bill which authorizes the establishment of a special committee of aviation experts to review the recommendations on the Federal Aviation Administration procedure process.

So I look forward to their analysis as I do the analysis of all the investigations that are ongoing. Safety remains paramount and I look forward to working with all my colleagues on this very serious issue.

Senator CRUZ. Thank you.

I'll now introduce each of the witnesses. The first witness is Mr. Daniel K. Elwell, who is currently the Acting Administrator of the Federal Aviation Administration. Before becoming Acting Administrator, Mr. Elwell served as the Deputy Administrator of the FAA

from June 2017 to January 2018, and as a Senior Advisor to the Secretary of Transportation Elaine Chao prior to that.

Mr. Elwell began his career in aviation in the United States Air Force where he received his Bachelor of Science degree in International Affairs from the U.S. Air Force Academy. He achieved the rank of Lieutenant Colonel and retired from military service as a command pilot.

After retiring from the military, Mr. Elwell was a commercial pilot for 16 years with American Airlines, flying DC-10, MD-80, and Boeing 757-767 aircraft, and he then served at the FAA as Assistant Administrator for Policy, Planning, and Environment from 2006 to 2008.

From 2008 to 2013, Mr. Elwell served as Vice President of the Aerospace Industries Association and from 2013 to 2015 as Senior Vice President for Safety, Security, and Operations at Airlines for America.

Our second witness is the Honorable Robert Sumwalt. Following his nomination by President Trump and confirmation by the Senate, Robert L. Sumwalt was sworn in as Chairman of the National Transportation Safety Board on August 10, 2017.

Prior to joining the NTSB, Chairman Sumwalt was a pilot for more than 30 years, during which time he flew for commercial carriers that included Piedmont Airlines and U.S. Airways and accumulated over 14,000 flight hours.

He began his tenure at the NTSB in August 2006 when he was appointed to the Board by President George W. Bush and designated as Vice Chairman. In 2011, he was reappointed for an additional five-year term as a board member by President Obama.

Chairman Sumwalt earned his undergraduate degree from the University of South Carolina and a Master's of Aeronautical Science with Distinction from Embry-Riddle Aeronautical University.

He has been awarded an Honorary Doctor of Science degree from the University of South Carolina and an Honorary Doctorate from Embry-Riddle.

Our third witness is the Honorable Calvin Scovel. Mr. Scovel was sworn in as Inspector General of the Department of Transportation on October 26, 2006.

Prior to joining the DOT, he served 29 years of Active Duty service in the U.S. Marine Corps where he retired as a Brigadier General.

During his military career, he served as a senior judge on the U.S. Navy Marine Corps Court of Appeals and as an Assistant Judge Advocate General of the Navy for Military Justice and as a senior advisor for the 4th Marine Expeditionary Brigade.

His tenure as the DOT Inspector General has spanned the Administrations of three Presidents and four Secretaries of Transportation, during which time he has overseen audits and investigations dealing with all aspects of the Nation's transportation system.

Mr. Scovel received a law degree from Duke University, a Bachelor's degree from the University of North Carolina at Chapel Hill, a Master's degree from the Naval War College, and he is a recipient of the Secretary of Transportation's Gold Medal for Outstanding Achievement.

Administrator Elwell, we'll begin with your testimony.

**STATEMENT OF HON. DANIEL K. ELWELL, ACTING
ADMINISTRATOR, FEDERAL AVIATION ADMINISTRATION**

Mr. ELWELL. Chairman Cruz, Chairman Wicker, Ranking Member Sinema, Members of the Subcommittee, thank you for the opportunity to appear before you today.

On behalf of the U.S. Department of Transportation and the Federal Aviation Administration, I extend our deepest sympathy to the families of the passengers and the crews of Ethiopian Airlines 302 and Lion Air 610.

Safety is at the core of the FAA's mission. It is our first priority. We have worked tirelessly to take a more proactive data-driven approach to oversight that instills a safety above all else culture at the FAA and the aviation community we regulate.

This approach has made the U.S. aviation system the safest in the world. Since 1997, the risk of a fatal commercial aviation accident in the United States has been cut by 94 percent and in the past 10 years, we've experienced one commercial airline passenger fatality in the United States in over 90 million flights. That's a remarkable record, but we know we must never stop pursuing improvement. We must never become complacent because one fatality is one too many.

I speak to you today as both a former military and airline pilot and as a public servant who has dedicated his life to the pursuit of aviation safety. I am proud to lead the dedicated professionals of the FAA who share the same passion and sense of mission to make America's aviation system the safest.

Because we know our fact-based data-driven approach works, we have applied this guiding principle in our response to the recent Boeing 737 Max accidents.

I would like to provide you with an overview of the FAA's certification and oversight processes as well as our current actions with respect to the 737 Max and the next steps the FAA will take to foster safety enhancements here and abroad.

Safety is not just a set of programs that can be established or implemented. It is a way of living and working and it requires the open and transparent exchange of information. It takes collaboration, communication, and common safety objectives to allow the FAA and the aviation community to jointly identify system hazards and to implement safety solutions.

Decades of experience have proven that this approach yields knowledge that we would not otherwise obtain. FAA aircraft certification has always relied on the exchange of information and technical data with industry.

Some version of our certification process has been in place for over 60 years. This does not mean that the process remains static. To keep pace with technology and advances in safety, the general regulations have been modified more than 90 times. The rules applicable to large transport aircraft, like the 737 Max, have been amended more than 130 times.

The FAA focuses its efforts on those areas that present the highest risk within the system. Our certification processes are exten-

sive, well-established, and have consistently produced safe aircraft designs for decades.

Boeing first applied for an amended certificate for the 737 Max in January 2012. From initial application to final certification, it took about 5 years. The FAA was fully involved in the process, including participation in 133 of the 297 flight tests, some of which encompassed tests of the aircraft MCAS system which has been the subject of recent attention.

In the immediate aftermath of the Lion Air accident, the FAA issued an Emergency Airworthiness Directive that requires operators of the 737 Max to revise their flight manuals to reinforce to flight crews how to recognize and respond to uncommanded stabilizer trim movement.

The FAA continues to seek and evaluate any additional data that might help us understand the underlying factors that led to the recent 737 Max accidents.

We will take immediate and appropriate action based on the facts. U.S. and international operators of the 737 Max are relying on the FAA to get it right.

I want to assure you and everyone else that the FAA will go wherever the facts lead us in our pursuit of safety. The 737 Max will return to service for U.S. carriers only when the FAA's analysis of the facts and technical data indicate that it is appropriate to do so.

In our quest for continuous safety improvement, the FAA welcomes external review of our systems, processes, and recommendations. As recent events have reminded us, aviation safety has no borders or boundaries. The FAA is resolute in its commitment to maintaining the U.S. air transportation system as the gold standard of the world.

That concludes my statement. I'm ready to answer any questions. [The prepared statement of Mr. Elwell follows:]

PREPARED STATEMENT OF HON. DANIEL K. ELWELL, ACTING ADMINISTRATOR,
FEDERAL AVIATION ADMINISTRATION

Chairman Cruz, Ranking Member Sinema, Members of the Subcommittee:

Thank you for the opportunity to appear before you today to discuss the current state of aviation safety. On behalf of the United States Department of Transportation and the Federal Aviation Administration, we extend our deepest sympathy to the families of the victims of the recent Ethiopian Airlines accident, as well as the Lion Air accident.

Safety is the core of the Federal Aviation Administration's mission and our top priority. With the support of this Committee, we have worked tirelessly to take a more proactive, data-driven approach to oversight that instills a safety above all approach inside the FAA and within the aviation community that we regulate. The result of this approach is that the United States has the safest air transportation system in the world. Since 1997, the risk of a fatal commercial aviation accident in the United States has been cut by 95 percent. And in the past ten years, there has only been one commercial airline passenger fatality in the United States in over 90 million flights. But a healthy safety culture requires commitment to continuous improvement.

Our commitment to safety and fact-based, data-driven decision making has been the guiding principle in the FAA's response to the two fatal accidents involving the Boeing 737 MAX airplane outside the United States. Today, I would like to provide you with an overview of the FAA's certification and oversight processes, our current actions with respect to the 737 MAX, and the next steps that the FAA will take to foster safety enhancements here and abroad.

The FAA is a Data-Driven Agency Focused on Safety

As the aerospace system and its components become increasingly more complex, we know that our oversight approach needs to evolve to ensure that the FAA remains the global leader in achieving aviation safety. In order to maintain the safest air transportation system in the world, during the past two decades the FAA has been evolving from a prescriptive and more reactive approach for its safety oversight responsibilities to one that is performance-based, proactive, centered on managing risk, and focused on continuous improvement. A key part of this transition has been the adoption of safety management systems, or SMS, within the FAA. The evolution toward SMS began internally at the FAA more than 15 years ago, starting with the FAA's Air Traffic Organization and expanding across the FAA to include all of our lines of business. Consistent with recommendations of the International Civil Aviation Organization (ICAO), we have been working with industry towards implementation of SMS in various sectors. For example, as of March 9, 2018, scheduled commercial air carriers, regulated under 14 CFR part 121, are required to have an SMS.

Safety is not just a set of programs that can be "established" or "implemented." It is a way of living and working, and it requires the open and transparent exchange of information. We know that it takes collaboration, communication, and common safety objectives to allow the FAA and the aviation community to come together, to identify system hazards, and to implement safety solutions. This approach gives us knowledge that we would not otherwise have about events and risks. Sharing safety issues, trends, and lessons learned is critical to recognizing whatever might be emerging as a risk in the system. The more data we have, the more we can learn about the system, which in turn allows us to better manage and improve the system.

To be clear, the SMS approach does not diminish the FAA's role as a safety regulator. Any party that the FAA regulates remains responsible for compliance with the FAA's regulatory standards, and the FAA does not hesitate to take enforcement action when it is warranted.

Aircraft Certification

One of the FAA's core functions, aircraft certification, has always relied on the exchange of information and technical data. The FAA certifies the design of aircraft and components that are used in civil aviation operations. Some version of our certification process has been in place and served us well for over 60 years. This does not mean the process has remained static. To the contrary, since 1964, the regulations covering certification processes have been under constant review. As a result, the general regulations have been modified over 90 times, and the rules applicable to large transport aircraft, like the Boeing 737 MAX, have been amended over 130 times. The regulations and our policies have evolved in order to adapt to an ever-changing industry that uses global partnerships to develop new, more efficient, and safer aviation products and technologies.

The FAA focuses its efforts on areas that present the highest risk within the system. The FAA reviews the applicant's design descriptions and project plans, determines where FAA involvement will derive the most safety benefit, and coordinates its intentions with the applicant. When a particular decision or event is critical to the safety of the product or to the determination of compliance, the FAA is involved either directly or through the use of our designee system.

The designee program was originally authorized by Congress in 1958 and is critical to the success and effectiveness of the certification process. Under this program, the FAA may delegate a matter related to aircraft certification to a qualified private person. This is not self-certification; the FAA retains strict oversight authority. The program allows the FAA to leverage its resources through delegation. Last fall, Congress specifically directed the FAA to make full use of this authority in the FAA Reauthorization Act of 2018. In aircraft certification, both individual and organizational designees support the FAA. The FAA determines the level of involvement of the designees and the level of FAA participation needed based on many variables. These variables include the designee's understanding of the compliance policy; consideration of any novel or unusual certification areas; or instances where adequate standards may not be in place.

The Organization Designation Authorization (ODA) program is the means by which the FAA may authorize an organization to act as a representative of the FAA, allowing that organization to conduct inspections and tests and issue certificates on behalf of the FAA. Currently, there are 79 ODA holders. ODA certification processes allow an applicant greater flexibility and control over schedules than applicants whose projects are directly managed by the FAA. The FAA has a rigorous process for issuing an ODA. ODA holders must have demonstrated experience and expertise

in FAA certification processes, a qualified staff, and an FAA-approved procedures manual before they are appointed. The procedures manual defines an ODA holder's authority and limitations, and identifies the functions it may perform.

The FAA determines its level of involvement on a project-by-project basis. There are many issues that will always require direct FAA involvement, including equivalent level of safety determinations, and rulemakings required to approve special conditions. The FAA may choose to be involved in other project areas after considering factors such as our confidence in the applicant, the applicant's experience, the applicant's internal processes, and confidence in the designees.

Something that is not well understood about the certification process is that it is the applicant's responsibility to ensure that an aircraft conforms to FAA safety regulations. It is the applicant who is required to develop aircraft design plans and specifications, and perform the appropriate inspections and tests necessary to establish that an aircraft design complies with the regulations. The FAA is responsible for determining that the applicant has shown that the overall design meets the safety standards. We do that by reviewing data and by conducting risk-based evaluations of the applicant's work.

The FAA is directly involved in the testing and certification of new and novel features and technologies. When a new design, or a change to an existing design, of aircraft is being proposed, the designer must apply to the FAA for a design approval. While an applicant usually works on its design before discussing it with the FAA, we encourage collaborative discussions well in advance of presenting a formal application. Once an applicant approaches us, a series of meetings are held both to familiarize the FAA with the proposed design, and to familiarize the applicant with the certification requirements. A number of formal and informal meetings are held on issues ranging from technical to procedural. Once the application is made, issue papers are developed to provide a structured way of documenting the resolution of technical, regulatory, and administrative issues that are identified during the process.

Once the certification basis is established for a proposed design, the FAA and the applicant develop and agree to a certification plan and initial schedule. In order to receive a type certificate, the applicant must conduct an extensive series of tests and reviews to show that the product is compliant with existing standards and any special conditions, including lab tests, flight tests, and conformity inspections. These analyses, tests, and inspections happen at a component-level and an airplane-level, all of which are subject to FAA oversight. If the FAA finds that a proposed new type of aircraft complies with safety standards, it issues a type certificate. Or, in the case of a change to an existing aircraft design, the FAA issues an amended type certificate.

Facts Concerning the Boeing 737 MAX

The certification processes described above are extensive, well-established, and have consistently produced safe aircraft designs for decades. The Boeing Company has designed and built 14 variations of its original model 737 since the FAA issued the original type certificate in 1967. The FAA followed its standard procedures in determining that the 737 MAX project would qualify as an amended type certificate project, and identifying what items would be delegated to the Boeing ODA to approve and which would be retained by the FAA for approval. Boeing first applied for an amended type certificate for this aircraft in January 2012. As a result of regular meetings between the FAA and Boeing teams, the FAA determined in February 2012 that the project qualified as an amended type certificate project eligible for management by the Boeing ODA. The FAA was directly involved in the System Safety Review of the Maneuvering Characteristics Augmentation System (MCAS).

The process from initial application to final certification took five years; the FAA added the 737 MAX to the 737 type certificate in March 2017. The process included 297 certification flight tests, some of which encompassed tests of the MCAS functions. FAA engineers and flight test pilots were involved in the MCAS operational evaluation flight test. The certification process was detailed and thorough, but, as is the case with newly certified products, time yields more data to be applied for continued analysis and improvement. As we obtain pertinent information, identify potential risk, or learn of a system failure, we analyze it, we find ways to mitigate the risk, and we require operators to implement the mitigation. And that is what has happened in the case of the 737 MAX.

737 MAX Accidents and the Decision to Ground the Fleet

On October 29, 2018, a Boeing 737 MAX operated by Lion Air as flight JT610 crashed after taking off from Soekarno-Hatta Airport in Jakarta, Indonesia. Flight JT610 departed from Jakarta with an intended destination of Pangkal Pinang, Indo-

nesia. It departed Jakarta at 6:20 a.m. (local time), and crashed into the Java Sea approximately 13 minutes later. One hundred and eighty-four passengers and five crewmembers were on board. There were no survivors. An Indonesian-led investigation into the cause of this accident is ongoing, supported by the National Transportation Safety Board (NTSB), FAA, and Boeing.

On November 7, 2018, based on all available and relevant information, including evidence from the Lion Air accident investigation and analysis performed by Boeing, the FAA issued an Emergency Airworthiness Directive. The airworthiness directive requires operators of the 737 MAX to revise their flight manuals to reinforce to flight crews how to recognize and respond to uncommanded stabilizer trim movement and MCAS events. The FAA continued to evaluate the need for software and/or other design changes to the aircraft including operating procedures and training as additional information was received from the ongoing Lion Air accident investigation. On January 21, 2019, Boeing submitted a proposed MCAS software enhancement to the FAA for certification. To date, the FAA has tested this enhancement to the 737 MAX flight control system in both the simulator and the aircraft. The testing, which was conducted by FAA flight test engineers and flight test pilots, included aerodynamic stall situations and recovery procedures. The FAA's ongoing review of this software installation and training is an agency priority, as will be the roll-out of any software, training, or other measures to operators of the 737 MAX.

On March 10, 2019, Ethiopian Airlines flight ET302, also a Boeing 737 MAX, crashed at 8:44 a.m. (local time), six minutes after takeoff. The flight departed from Bole International Airport in Addis Ababa, Ethiopia with an intended destination of Nairobi, Kenya. The accident site is near Bishoftu, Ethiopia. One hundred and forty-nine passengers and eight crewmembers were on board. None survived. An Ethiopian-led investigation into the cause of this accident is ongoing, supported by the NTSB, FAA, and Boeing.

Following the second accident, the FAA gathered all of the data it had and continued to review information from the investigation as it became available. On March 11, 2019, the FAA issued a Continuous Airworthiness Notification to the International Community (CANIC) for 737 MAX operators. The CANIC included a list of all of the activities the FAA had completed in support of the continued operational safety of the 737 MAX fleet. These activities included the airworthiness directive issued on November 7, 2018, ongoing oversight of Boeing's flight control system enhancements, and updated training requirements and flight crew manuals.

After issuing the CANIC, the FAA continued to evaluate all available data and aggregate safety performance from operators and pilots of the 737 MAX, none of which provided any data to support grounding the aircraft. The FAA's initial review of flight safety data for U.S. operators showed no systemic performance issues and provided no basis to order grounding the aircraft. This review included analysis of recent Aviation Safety Reporting System reports that reference MCAS and/or controllability issues with the Boeing 737 MAX. In no case did the reporting party state that the problems experienced were due to the MCAS system. Also, at that time, other civil aviation authorities had not provided any data to the FAA that warranted action.

On March 13, 2019, however, the Ethiopian Airlines investigation developed new information from the wreckage concerning the aircraft's configuration just after takeoff that, taken together with newly refined data from satellite-based tracking of the aircraft's flight path, indicated some similarities between the Ethiopian Airlines and Lion Air accidents that warranted further investigation of the possibility of a shared cause that needed to be better understood and addressed. Accordingly, the FAA made the decision to ground all 737 MAX airplanes operated by U.S. airlines or in U.S. territory pending further investigation, including examination of information from the aircraft's flight data recorders and cockpit voice recorders.

Next Steps

The FAA will continue to support the ongoing Lion Air and Ethiopian Airlines accident investigations, review the evidence and data obtained, and take immediate and appropriate action based on the facts. U.S. and international operators of the 737 MAX are relying on the FAA to get it right. I want to assure this Committee and everyone else concerned that the FAA will go wherever the facts lead us, in the interest of safety. The 737 MAX will return to service for U.S. carriers and in U.S. airspace only when the FAA's analysis of the facts and technical data indicate that it is appropriate. In our quest for continuous safety improvement, the FAA welcomes external review of our systems, processes, and recommendations. We will work with the newly established Special Committee to Review FAA's Aircraft Certification Process, cooperate fully with the Inspector General's review, and continue

our work with the congressionally-mandated Safety Oversight and Certification Advisory Committee and ODA Expert Review Panel.

As recent events have reminded us, aviation does not have borders or boundaries. The FAA is focused on continuous safety improvement here at home and internationally through our ongoing engagement with other civil aviation authorities and industry stakeholders throughout the world. Aviation remains the safest mode of transportation globally, and we promote this level of safety by sharing issues, trends, and lessons learned throughout the world. The United States is the gold standard in aviation safety. The FAA is resolute in its commitment to maintaining that standard.

This concludes my prepared statement. I will be happy to answer your questions.

Senator CRUZ. Thank you.

Mr. Sumwalt.

**STATEMENT OF HON. ROBERT L. SUMWALT III, CHAIRMAN,
NATIONAL TRANSPORTATION SAFETY BOARD**

Mr. SUMWALT. Thank you, Chairman Wicker, Chairman Cruz, Ranking Member Cantwell, Ranking Member Sinema, and Members of the Subcommittee.

Thank you for allowing the NTSB to testify today about this very important topic.

As you are well aware, in the past five months, there have been two crashes involving the Boeing 737 Max and tragically these two accidents have claimed 346 lives.

My testimony this afternoon will focus on the NTSB's involvement with each of these crash investigations.

Now unlike the NTSB's involvement in domestic aviation accidents where we have the statutory responsibility to investigate each and every accident that occurs in this country, our involvement with international investigations is vastly different.

The NTSB's role in accidents outside the U.S. is governed by Annex 13 to the Convention on International Civil Aviation, to which 192 countries, including the U.S., are signatories.

Annex 13 states that a safety investigation is to be led by the country in which the accident occurs, known as the state of occurrence. Thus, the National Transportation Safety Committee of Indonesia is leading the investigation into last year's Lion Air crash, and likewise the Ethiopia Accident Investigation Bureau is leading the investigation into this month's Ethiopian Airlines crash.

When the accident involves a U.S.-operated or U.S.-registered aircraft or U.S.-designed or manufactured aircraft, as these aircraft were, the NTSB appoints an accredited representative. This is a highly skilled NTSB investigator whose purpose is to coordinate the input of all U.S. interests, including the NTSB, the FAA, and companies, such as manufacturers, and others that can provide technical assistance.

It's important to note that the state of occurrence leads the investigation and controls the release of information from that investigation, not the NTSB.

Although the state of occurrence is responsible for leading the investigation, NTSB participation in foreign accident investigations enables safety deficiencies to be promptly addressed by the FAA, the manufacturer, or the operator as well as through NTSB safety recommendations, when necessary.

Following last year's Lion Air crash, we immediately dispatched investigators to Indonesia to participate in the Indonesian Government's investigation. An NTSB investigator was stationed onboard one of the search vessels to help identify recovered aircraft components.

Once the cockpit voice recorder was recovered in January, we recalled four investigators who were furloughed during the partial government shutdown. Their role was to assist with the recorder download and analysis.

We responded immediately to the Ethiopian Airlines crash by sending a team of investigators to Ethiopia and once the recorders were sent to our aviation counterparts in France, the BEA, we dispatched investigators to France to assist with the recorder download and readout.

Because the U.S. is the state of design and certification of the Boeing 737, we are also examining the U.S. design certification process as part of our participation in these foreign-led investigations. As always, if we uncover safety deficiencies, we are poised to quickly issue safety recommendations.

Now here at home, the scheduled passenger airlines have displayed a remarkable safety record over the past decade but as we know too well at the NTSB, complacency is an unforgiving enemy.

My written testimony outlines other areas of NTSB aviation-related concerns which I've submitted for the record, and I'll be delighted to answer questions about those issues as well as the issue at hand.

Thank you very much.

[The prepared statement of Mr. Sumwalt follows:]

PREPARED STATEMENT OF HON. ROBERT L. SUMWALT III, CHAIRMAN,
NATIONAL TRANSPORTATION SAFETY BOARD

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

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

Our Office of Aviation Safety investigates all civil domestic air carrier, commuter, and air taxi accidents; general aviation accidents; and certain public-use aircraft accidents, amounting to approximately 1,400 investigations annually. We also participate in the investigation of major airline accidents in foreign countries that involve U.S. carriers, US-manufactured or -designed equipment, or US-registered aircraft.

This testimony will provide information regarding our role in international investigations and our current participation in both recent accidents involving Boeing 737 MAX 8 (MAX 8) aircraft in Indonesia and Ethiopia. I will also address the state of aviation safety from the NTSB's perspective based on our investigations, including a description of safety issues we have identified and recommendations we have made, as well as a description of the work we are doing with emerging transportation technologies in aviation.

Foreign Investigations of Boeing 737-MAX 8 Crashes

The NTSB participates in the investigation of aviation accidents and serious incidents outside the United States in accordance with the Chicago Convention of the International Civil Aviation Organization (ICAO) and the Standards and Rec-

ommended Practices (SARPS) provided in Annex 13 to the Convention.¹ If an accident or serious incident occurs in a foreign state involving a civil aircraft of U.S. Registry, a U.S. operator, or an aircraft of U.S. design or U.S. manufacture, where the foreign state is a signatory to the ICAO Convention, that state is responsible for the investigation and controls the release of all information regarding the investigation.

In accordance with the ICAO Annex 13 SARPS, upon receipt of a formal notification of the accident or serious incident that may involve significant issues, the NTSB may designate a U.S. Accredited Representative and appoint advisors to carry out the obligations, receive the investigative information and updates in accordance with the Annex, provide consultation, and receive safety recommendations from the state of occurrence. The advisors may include NTSB investigators with subject matter expertise, as well as others from U.S. manufacturers, operators, and the Federal Aviation Administration (FAA).

The key objectives of our participation in international aviation accident investigations are to:

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

Given the international nature of air transportation and the leading role the United States plays in developing aviation technologies, our participation in foreign investigations is essential to enhancing aviation safety worldwide. In 2018, we appointed Accredited Representatives to 324 international investigations and traveled to support work on 17 of these investigations.²

On October 29, 2018, a MAX 8, operated by Lion Air, crashed into the Java Sea shortly after takeoff from Soekarno-Hatta International Airport, in Jakarta, Indonesia. All 189 passengers and crew on board died. The National Transportation Safety Committee of Indonesia is leading the investigation and released a preliminary report on November 27, 2018.³ On March 10, 2019, a MAX 8, operated by Ethiopian Airlines, crashed after takeoff from Addis Ababa Bole International Airport in Ethiopia. All 157 passengers and crew, including 8 American citizens, died. The investigation is being led by the Ethiopia Accident Investigation Bureau.

Because the MAX 8 was designed and manufactured in the US, in accordance with ICAO Annex 13, the U.S. has a right to participate in both of these investigations. Accordingly, the NTSB appointed Accredited Representatives to assist both of the ongoing foreign investigations involving MAX 8 aircraft.

Following last year's Lion Air crash, the NTSB immediately dispatched investigators to Indonesia to participate in the Indonesian government's investigation. During the search for the critical "black boxes"—flight data recorder (FDR) and cockpit voice recorder (CVR)—an NTSB investigator was stationed onboard one of the search vessels. Once the CVR was recovered on January 14, 2019, NTSB recalled four investigators from furlough due to the partial government shutdown to assist with proper transcription of that recorder's content.⁴

In response to the Ethiopian Airlines crash, the NTSB also appointed an Accredited Representative, and dispatched him with a team of investigators to Ethiopia. Furthermore, we sent recorder, flight crew operations and human factors investigators to France once the recorders were sent to the Bureau d'Enquêtes et d'Analyses pour la Sécurité de l'Aviation Civile (BEA) for download and readout.

Also in accordance with ICAO Annex 13, technical advisors from the FAA, Boeing, and General Electric have accompanied NTSB investigators to the Lion Air and

¹ICAO is a UN specialized agency, which manages the administration and governance of the Convention on International Civil Aviation (Chicago Convention), (<https://www.icao.int/about-icao/Pages/default.aspx>).

²There were 202 accidents in 2018 where the NTSB appointed an Accredited Representative, 97 incidents, and 25 other safety-related occurrences. NTSB traveled in support of 8 of these accidents, 8 incidents, and one safety-related occurrence.

³National Transportation Safety Committee of Indonesia, *Preliminary Report No. KNKT.18.10.35.04*.

⁴Due to lapse of appropriations from December 22, 2018, through January 25, 2019, the NTSB furloughed all investigative staff. In accordance with provisions of the Anti-Deficiency Act (including sections 1341(a)(1)(B) and 1342 of Title 31, United States Code), allowable agency functions were limited to those where "failure to perform those functions would result in an imminent threat to the safety of human life or the protection of property." Due to the potential safety issues associated with the Lion Air crash, the NTSB responded by recalling from furlough four investigative staff to participate in the CVR readout.

Ethiopian Air accident sites to provide their specialized technical knowledge regarding the aircraft and its systems.

Although the NTSB is actively involved in these investigations, ICAO Annex 13 requires that, as the states of occurrence, Indonesia and Ethiopia are responsible for their respective investigations. As such, they control the release of all investigative information related to those accidents. Although the state of occurrence is responsible for leading the investigation, NTSB participation in foreign accident investigations enables safety deficiencies to be promptly addressed by the FAA, the manufacturer, or the operator, as well as through NTSB safety recommendations when necessary. As the state of design and certification of the aircraft involved in these accidents, we are examining the U.S. design certification process to ensure any deficiencies are captured and addressed, potentially up to and including NTSB safety recommendations.

Commercial Aviation Safety in the United States

For the last decade, the U.S. aviation system has experienced a record level of safety, and an overall decline in the number of US-registered civil aviation accidents.⁵ Aviation deaths in the United States decreased from 412 in 2016 to 350 in 2017. Nearly 94 percent of aviation fatalities (330 instances in 2017) occur in general aviation accidents, with the remainder primarily in Title 14 *Code of Federal Regulations (CFR)* Part 135 operations, which includes charters, air taxis, and air medical services flights. Until 2018, there had been no passenger fatalities as a result of accidents involving U.S. air carriers operating under the provisions of 14 *CFR* Part 121 since the crash of Colgan Air flight 3407 in 2009.⁶ Over the last several decades, significant advances in technology, important legislative and regulatory changes, and more comprehensive crew training have contributed to the current level of aviation safety. Following the Colgan Air crash, in 2010 Congress required FAA to make substantive regulatory changes addressing airline pilot fatigue, as well as airline pilot qualifications; FAA pilot records; airline flight crew and dispatcher training; FAA oversight and surveillance of air carriers; pilot mentoring, professional development and leadership; and flight crewmember pairing and crew resource management techniques.⁷ There are still provisions related to NTSB recommendations from our investigation of flight 3407 that have not been implemented, such as the creation of a pilot training records database. We continue to see accidents and incidents that remind us of the need to be ever-vigilant in improving safety.

Most Wanted List—Improve the Safety of Part 135 Aircraft Flight Operations

On February 4, 2019, we announced our Most Wanted List of Transportation Safety Improvements for 2019–2020.⁸ This list identifies 10 focus areas for transportation safety improvements based on safety issues identified through our investigations. Many of the issues on the Most Wanted List address multimodal challenges for improving safety, including many that have been identified in some of our aviation accident investigations, such as alcohol and other drug impairment, distraction, occupant protection, fatigue, medical fitness, and safe shipment of hazardous materials. One issue area is specific to aviation: improving the safety of Part 135 aircraft flight operations.

Regardless of the purpose of the flight or the type of aircraft, all passenger-carrying flights should be safe. However, currently, air medical service, air taxi, charter, and on-demand operators are not required to meet some of the same safety requirements as commercial airline operators. On March 12, 2019, the NTSB issued three new safety recommendations and reiterated six previous safety recommendations to the FAA as a result of the investigation of an accident that occurred on May 15, 2017, in Teterboro, New Jersey.⁹ In this accident, a Learjet 35A, operated by a Part 135 operator, departed controlled flight while on a circling approach to

⁵National Transportation Safety Board, 2017 preliminary aviation statistics. Accident data for calendar year 2018 are still being validated and have not yet been released.

⁶National Transportation Safety Board, *Loss of Control on Approach, Colgan Air, Inc., Operating as Continental Connection Flight 3407, Bombardier DHC 8 400, N200WQ*, Rpt. No. AAR–10/01 (Washington, DC: NTSB, 2012). In 2013, there were two fatal accidents involving non-scheduled cargo flights operating under Part 121—*National Air Cargo crash* after takeoff at Bagram Air Base, Afghanistan, and *United Parcel Service flight 1354* crash during approach in Birmingham, Alabama.

⁷The Airline Safety and Federal Aviation Administration Extension Act of 2010 (*Pub. L. 111–216*). Congressional Research Service, *Federal Civil Aviation Programs: In Brief*, R42781.

⁸National Transportation Safety Board, *2019–2020 Most Wanted List*.

⁹National Transportation Safety Board, *Departure From Controlled Flight, Trans-Pacific Air Charter, LLC, Learjet 35A, N452DA, Teterboro, New Jersey (Abstract)*, Rpt. No. AAR–19/02 (Washington, D.C.: NTSB, 2019)

Teterboro Airport, and impacted a commercial building and parking lot. The pilot-in-command and the second-in-command died; there were no passengers on the aircraft and no one on the ground was injured. While the aircraft was operating as a Part 91 positioning flight at the time of the accident, the accident raised concerns about the safety of Part 135 operations and the need for effective flight data monitoring (FDM) programs, safety management systems (SMS), procedures to identify pilots who do not comply with standard operating procedures, programs to address pilots with performance deficiencies, and the need for enhanced guidance for crew resource management training and leadership training for upgrading captains.

The safety issues identified in the Teterboro accident were not new; the NTSB previously identified these issues and made recommendations to address FDM equipment and programs and SMS as a result of the investigation of the November 10, 2015, crash of Execuflight flight 1526 in Akron, Ohio.¹⁰ The recommendations were reiterated following the October 26, 2016, crash of Ravn Connect flight 3153 in Togiak, Alaska, and we have again reiterated these important recommendations.¹¹ A list of the safety recommendations we have made regarding these operations is appended to this testimony. Implementation of these and other recommendations could prevent or mitigate many of the Part 135 crashes that the NTSB investigates, and that is why improving the safety of Part 135 aircraft operations is included on the Most Wanted List.

Most Wanted List—Reduce Fatigue-Related Accidents

Fatigue is a pervasive problem in transportation that degrades a person's ability to stay awake, alert, and attentive to the demands of safely controlling a vehicle, vessel, aircraft, or train. By including "Reduce Fatigue-Related Accidents" on our Most Wanted List, we are calling for a comprehensive approach to combatting fatigue in transportation, focusing on research, education, and training; technology; sleep disorder treatment; hours-of-service regulations; and on-and off-duty scheduling policies and practices.

Over the last 20 years, NTSB has investigated many air carrier accidents involving fatigued flight crews, including Colgan Air flight 3407. As a result of that investigation, we recommended that the FAA require operators to address fatigue risks associated with commuting.¹² The FAA's final rule for Fatigue Risk Management Plans for Part 121 Air Carriers did not address this recommendation. In 2006, we issued a safety recommendation to the FAA as a result of our investigation of the October 19, 2004 aviation crash in Kirksville, Missouri, to "Modify and simplify the flight crew hours-of-service regulations to take into consideration factors such as length of duty day, starting time, workload and other factors shown by recent research, scientific evidence, and current industry experience to affect crew alertness."¹³ On January 4, 2012, the FAA published a final rule which prescribed new flight-and duty-time regulations for all flight crewmembers and certificate holders conducting passenger operations under Part 121, but excluded operators who conduct cargo operations.¹⁴ The NTSB disagrees with this exclusion, as many of the fatigue-related accidents that we have investigated over the years involved cargo operators. We also believe that, because of the time of day that cargo operations typically occur, such operations are in greater need of these requirements. The NTSB believes that the FAA should include all Part 121, including cargo operations, under these requirements.

Current Part 121 Investigations

The NTSB is currently investigating two fatal accidents involving Part 121 operations.

¹⁰ National Transportation Safety Board, *Crash During Nonprecision Instrument Approach to Landing, Execuflight Flight 1526, British Aerospace HS 125-700A, N237WR*, Rpt. No. AAR 16/02 (Washington, D.C.: NTSB 2016).

¹¹ National Transportation Safety Board, *Collision with Terrain, Hageland Aviation Services, Inc., dba Ravn Connect Flight 3153, Cessna 208B, N208SD*, Rpt. No. AAR 18/02 (Washington, D.C.: NTSB 2018).

¹² National Transportation Safety Board, Safety Recommendation A-10-016.

¹³ National Transportation Safety Board, *Collision with Trees and Crash Short of the Runway, Corporate Airlines Flight 5966 BAE Systems BAE-J3201, N875JX Kirksville, Missouri*, Rpt. No. AAR-06/01 (Washington, D.C.: NTSB, 2006. *Safety Recommendation A-06-010*).

¹⁴ Federal Aviation Administration, *Flightcrew Member Duty and Rest Requirements*, 14 CFR Parts 117, 119, and 121.

SOUTHWEST FLIGHT 1380 ENGINE FAILURE—PHILADELPHIA, PENNSYLVANIA

On April 17, 2018, Southwest Airlines flight 1380, a Boeing 737–700, experienced a failure of the left engine after departing New York’s LaGuardia Airport.¹⁵ A fan blade in the left engine failed, which resulted in the loss of the engine inlet and cowling. Fragments from the cowling and engine inlet struck the fuselage and a window, causing a rapid depressurization. The crew conducted an emergency descent and diverted to Philadelphia International Airport. There were 144 passengers and five crewmembers onboard. One passenger was fatally injured and eight passengers had minor injuries.

On November 14, 2018, the NTSB held an investigative hearing to obtain more information regarding the engine fan blade design and development history, engine fan blade inspection methods and procedures, and engine fan blade containment design and certification criteria.¹⁶ The investigation into this accident is ongoing.

ATLAS AIR FLIGHT 3591 CRASH—BAYTOWN, TEXAS

On February 23, 2019, Atlas Air flight 3591, a Boeing 767–375BCF, entered a rapid descent from 6,000 feet and crashed into Trinity Bay, about 40 miles southeast of its intended destination, George Bush Intercontinental Airport, in Houston, Texas.¹⁷ The two pilots and one nonrevenue jumpseat pilot were killed, and the airplane was highly fragmented after impact. The flight was being operated as a Part 121 domestic cargo flight, which originated from Miami International Airport.

Based on data from the cockpit voice recorder, the flight data recorder, radar data, and other sources, the flight was normal from Miami to the Houston terminal area. As the flight approached Houston, the pilots were advised of an area of light to heavy precipitation along the flight route and that they could expect vectors around the weather. About one minute before the crash, data indicated some small vertical accelerations during descent. Shortly after, the engine thrust increased to maximum thrust, and the airplane pitched nose up. The airplane then pitched nose down over the next 18 seconds in response to nose-down elevator deflection. The stall warning (stick shaker) did not activate. Data indicated that the airplane entered a rapid descent, reaching an airspeed of about 430 knots. A security camera video captured the airplane in a steep, generally wings-level attitude until impact with the bay. The investigation into this accident is ongoing.

Emerging Transportation Technologies

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

Commercial Space

We have been involved in commercial space accident investigations for over 25 years, since leading the investigation of a procedural anomaly associated with the launch of an Orbital Sciences Corporation Pegasus expendable launch vehicle in 1993.¹⁸ Most recently, we led the investigation of the fatal in-flight breakup of SpaceShipTwo in October 2014.¹⁹ Foremost among the safety issues identified in the 2014 accident was the need to consider and protect against human error for safe manned spaceflight, which is the responsibility of designers, operators, and regulators. We made recommendations to the FAA and the commercial spaceflight industry to establish human factors guidance for commercial space operators and to strengthen the FAA’s evaluation process for experimental permit applications by promoting stronger collaboration between FAA technical staff and commercial space vehicle operators.

Our work in commercial space transportation supports our broader mission of improving transportation safety through investigating accidents and serious incidents, collaborating with others to conduct outreach and education related to commercial space vehicles, and developing and disseminating accident investigation techniques

¹⁵ National Transportation Safety Board, Southwest Airlines Engine Accident.

¹⁶ National Transportation Safety Board, Investigative Hearing: CFM International engine failure on Southwest Airlines flight 1380.

¹⁷ National Transportation Safety Board, Atlas Air #3591 crashed into Trinity Bay.

¹⁸ National Transportation Safety Board, *Commercial Space Launch Incident, Launch Procedure Anomaly, Orbital Sciences Corporation, Pegasus/SCD-1*, Rpt. No. SIR 93/02 (Washington, D.C.: NTSB 1993).

¹⁹ National Transportation Safety Board, *In-Flight Breakup During Test Flight, Scaled Composites SpaceShipTwo, N339SS, Near Koehn Dry Lake, California, October 31, 2014*, Rpt. No. AAR 15/02 (Washington, D.C.: NTSB 2015).

in commercial space within the international community. To develop and maintain the necessary investigative expertise and tools in this emerging segment of transportation, we are focused on training for NTSB staff and continuing outreach with commercial space stakeholders.

Unmanned Aircraft Systems

The growing number of UASs and reports of near-collisions with manned aircraft have raised safety concerns regarding UAS integration into the national airspace system. In August 2010, we revised our 14 *CFR* Part 830 regulations to indicate that accident and incident notification requirements also apply to unmanned aircraft.²⁰ An advisory to operators was released in July 2016 clarifying the reporting requirements (*i.e.*, if there is death or serious injury, the aircraft weighs more than 300 pounds and sustains substantial damage, or other specific serious incidents occur).²¹

On September 21, 2017, the pilot of a U.S. Army UH-60 helicopter reported an in-flight collision with a small UAS just east of Midland Beach, Staten Island, New York. The helicopter sustained damage to its main rotor blade, window frame, and transmission deck. We determined that the probable cause of the incident was the failure of the UAS pilot to see and avoid the helicopter due to his intentional flight beyond visual line of sight. Contributing to the incident was the UAS pilot's incomplete knowledge of regulations and safe operating practices.²² As the number and complexity of UAS operations continues to grow, it is inevitable that the number of NTSB UAS investigations will also increase.

We are also using UASs as an accident investigation tool in all modes. The NTSB appreciates this Committee's and Congress' support of a provision in our 2018 reauthorization that authorized the agency to acquire small UASs for investigative purposes.²³ UASs are rapidly becoming a standard tool in the domestic and international accident investigation community. Small UASs can be very rapidly deployed, which allows wreckage fields to be documented quickly and thoroughly when the accident area must be cleared expeditiously for safety or operational purposes. In addition, small UASs can access unique points of view useful to the investigator as well as areas otherwise inaccessible. Data collected is shared immediately, allowing investigators, managers, and support staff in distant locations instant access to accident site information in order to help focus the investigation on critical aspects of the accident.

Conclusion

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

APPENDIX TO NTSB CHAIRMAN SUMWALT'S TESTIMONY CONCERNING COMMERCIAL AVIATION SAFETY—RECOMMENDATIONS TO IMPROVE THE SAFETY OF PART 135 AIRCRAFT FLIGHT OPERATIONS

A-10-029 Open—Acceptable Alternate Response TO THE FEDERAL AVIATION ADMINISTRATION: Require Title 14 Code of Federal Regulations Part 121, 135, and 91K operators to (1) routinely download and analyze all available sources of safety information, as part of their flight operational quality assurance program, to identify deviations from established norms and procedures; (2) provide appropriate protections to ensure the confidentiality of the deidentified aggregate data; and (3) ensure that this information is used for safety-related and not punitive purposes.

A-13-012 Open—Acceptable Response TO THE FEDERAL AVIATION ADMINISTRATION: Require the installation of a crash-resistant flight recorder system on all newly manufactured turbine-powered, nonexperimental, nonrestricted-category aircraft that are not equipped with a flight data recorder and a cockpit voice recorder and are operating under Title 14 Code of Federal Regulations Parts 91, 121, or 135. The crash-resistant flight recorder system should record cockpit audio and images with a view of the cockpit environment to include as much of the outside view as possible, and parametric data per aircraft and system installation, all as specified

²⁰ 49 *CFR* § 830.2 (2010).

²¹ National Transportation Safety Board, *Advisory to Operators of Civil Unmanned Aircraft Systems in the United States*, July 29, 2016.

²² National Transportation Safety Board, *Inflight collision of UAS and helicopter*, Staten Island, NY.

²³ 49 USC § 1113(b)(1)(J) (2018).

in Technical Standard Order C197, "Information Collection and Monitoring Systems."

A-13-013 Open—Acceptable Response TO THE FEDERAL AVIATION ADMINISTRATION: Require all existing turbine-powered, nonexperimental, nonrestricted-category aircraft that are not equipped with a flight data recorder or cockpit voice recorder and are operating under Title 14 Code of Federal Regulations Parts 91, 121, or 135 to be retrofitted with a crash-resistant flight recorder system. The crash-resistant flight recorder system should record cockpit audio and images with a view of the cockpit environment to include as much of the outside view as possible, and parametric data per aircraft and system installation, all as specified in Technical Standard Order C197, "Information Collection and Monitoring Systems."

A-15-007 Open—Unacceptable Response TO THE FEDERAL AVIATION ADMINISTRATION: Require that all existing aircraft operated under Title 14 Code of Federal Regulations (CFR) Part 121 or 135 and currently required to have a cockpit voice recorder and a flight data recorder be retrofitted with a crash-protected cockpit image recording system compliant with Technical Standard Order TSOC176a, "Cockpit Image Recorder Equipment," TSO-C176a or equivalent. The cockpit image recorder should be equipped with an independent power source consistent with that required for cockpit voice recorders in 14 CFR 25.1457.

A-15-008 Open—Unacceptable Response TO THE FEDERAL AVIATION ADMINISTRATION: Require that all newly manufactured aircraft operated under Title 14 Code of Federal Regulations (CFR) Part 121 or 135 and required to have a cockpit voice recorder and a flight data recorder also be equipped with a crash-protected cockpit image recording system compliant with Technical Standard Order TSO-C176a, "Cockpit Image Recorder Equipment," or equivalent. The cockpit image recorder should be equipped with an independent power source consistent with that required for cockpit voice recorders in 14 CFR 25.1457.

A-16-034 Open—Acceptable Response TO THE FEDERAL AVIATION ADMINISTRATION: Require all Title 14 Code of Federal Regulations Part 135 operators to install flight data recording devices capable of supporting a flight data monitoring program.

A-16-035 Open—Acceptable Alternate Response TO THE FEDERAL AVIATION ADMINISTRATION: After the action in Safety Recommendation A-16-34 is completed, require all Title 14 Code of Federal Regulations Part 135 operators to establish a structured flight data monitoring program that reviews all available data sources to identify deviations from established norms and procedures and other potential safety issues.

A-16-036 Open—Acceptable Response TO THE FEDERAL AVIATION ADMINISTRATION: Require all Title 14 Code of Federal Regulations Part 135 operators to establish safety management system programs.

A-17-035 Open—Acceptable Response TO THE FEDERAL AVIATION ADMINISTRATION: Implement ways to provide effective terrain awareness and warning system (TAWS) protections while mitigating nuisance alerts for single-engine airplanes operated under Title 14 Code of Federal Regulations Part 135 that frequently operate at altitudes below their respective TAWS class design alerting threshold.

A-17-038 Open—Acceptable Response TO THE FEDERAL AVIATION ADMINISTRATION: Expand the application of Federal Aviation Administration Order 8900.1, volume 3, chapter 19, section 6, "Safety Assurance System: Flight Training Curriculum Segments," paragraphs 3-1251(B) and 3-1252, which address controlled flight into terrain-avoidance training programs for Title 14 Code of Federal Regulations (CFR) Part 135 helicopter operations, to all 14 CFR Part 135 operations.

A-18-013 Open—Acceptable Response TO THE FEDERAL AVIATION ADMINISTRATION: Although controlled flight into terrain (CFIT)-avoidance training programs are not required by Federal regulation for Title 14 Code of Federal Regulations Part 135 fixed-wing operations, work with Part 135 operators in Alaska to improve any voluntarily implemented training programs aimed at reducing the risk of CFIT accidents involving continuation of flight under visual flight rules (VFR) into instrument meteorological conditions, with special attention paid to the human factors issues identified in recent Alaska accident investigations, including, but not limited to, (1) the challenges of flying in mountainous terrain in Alaska and low-altitude VFR flight in an area subject to rapid changes in weather; and (2) limitations of the Alaska infrastructure, particularly weather observations, communications, and navigation aids.

A-18-014 Open—Acceptable Response TO THE FEDERAL AVIATION ADMINISTRATION: Work with Title 14 Code of Federal Regulations Part 135 certificate

holders that operate under visual flight rules in the aircraft's required terrain awareness and warning system (TAWS) class to (1) ensure that management and pilots are aware of the risks associated with distraction (from continuous nuisance alerts) and complacency (brought about by routine use of the terrain inhibit feature); (2) develop plans for mitigating those risks and minimizing nuisance alerts; and (3) develop procedures that specifically address when pilots should test, inhibit, and uninhibit the TAWS alerts, considering the operator's typical operations and the TAWS manufacturer's guidance.

A-18-017 Open—Await Response TO THE FEDERAL AVIATION ADMINISTRATION: Ensure that Alaska airports that are served by Title 14 Code of Federal Regulations (CFR) Part 135 operators and have instrument approaches are equipped with weather-reporting capabilities to enable instrument flight rules operations in accordance with 14 CFR 135.225(a).

A-19-007 Open—Await Response TO THE FEDERAL AVIATION ADMINISTRATION: Require all Title 14 Code of Federal Regulations Part 135 operators to establish programs for flight crewmembers who have demonstrated performance deficiencies or experienced failures during training and administer additional oversight and training to address and correct performance deficiencies.

A-19-008 Open—Await Response TO THE FEDERAL AVIATION ADMINISTRATION: Develop guidance for Title 14 Code of Federal Regulations Part 135 operators to help them create and implement effective crew resource management training programs.

Senator CRUZ. Thank you.
Mr. Scovel.

**STATEMENT OF HON. CALVIN L. SCOVEL III, INSPECTOR
GENERAL, U.S. DEPARTMENT OF TRANSPORTATION**

Mr. SCOVEL. Chairman Wicker, Ranking Member Cantwell, Chairman Cruz, Ranking Member Sinema, Members of the Subcommittee, thank you for inviting me to testify on the Federal Aviation Administration's Oversight of Commercial Aviation.

As you know, FAA is charged with safely overseeing the busiest and most complex aviation system in the world. Yet recent accidents highlight important concerns about FAA's safety oversight. Most notable are the two devastating crashes of Boeing 737 Max 8 aircraft in Indonesia and Ethiopia.

In addition, last April, a Southwest Airlines engine failure resulted in the first passenger fatality at a U.S. air carrier in over 9 years.

On behalf of the Office of Inspector General, we grieve the victims of these accidents and express our deep condolences to their families.

Secretary Elaine L. Chao, along with several Members of Congress, including Senator Blumenthal, recently requested that my office audit FAA's certification process for the Max 8 aircraft. We appreciate the Secretary's and your continued confidence in our independence and objectivity. We have already begun this work and will keep you informed on our results.

Today, my statement will focus on our recent and ongoing work related to a number of important aviation safety challenges.

First, FAA must take steps to reduce hazards associated with flight deck automation. Pilots now rely on automated flight systems as much as 90 percent of the time. While airlines have long used automation safely, FAA is responsible for ensuring air carriers meet requirements for these systems. This includes ensuring pilots are trained, tested, and proficient in the use of automation.

Notably, FAA now requires U.S. commercial pilots to be trained in how to respond to abnormal flight conditions, such as recovering from a stall or other unexpected event. Air carriers should have implemented these requirements earlier this month. Providing effective oversight of this training will be vital to maintain the margin of safety.

Second, FAA must remain vigilant as its systems and strategies for safety oversight evolve. Over the years, FAA has increasingly shifted toward working with industry to meet shared safety goals.

For example, FAA now delegates more of its aircraft certification to approved manufacturers through its congressionally authorized Organization Designation Authorization Program or ODA.

However, my office has identified weaknesses with FAA's oversight of ODA. For example, in 2015, we reported that its oversight was not based on risk. In response to our recommendations, FAA plans to revamp its ODA oversight process by the end of July 2019. Sustained management attention will remain essential to ensure that ODA companies comply with safety regulations.

In addition, FAA now requires air carriers to play a larger role in identifying and mitigating safety risks. For example, in 2015, FAA required U.S. commercial carriers to establish safety management systems to proactively manage risks.

However, recent events, including last year's Southwest engine failure, have raised concerns that FAA's oversight may not ensure that carriers meet their responsibilities under these systems.

FAA also introduced its new Compliance Program in 2015. The program calls for FAA to work with air carriers to address the root causes of safety violations rather than imposing enforcement actions. This is a significant change in the way FAA and the carriers conduct business.

As it works to leverage both collaboration and enforcement, FAA must be able to accurately assess whether an air carrier is willing and able to take timely corrective actions.

Finally, I want to note other critical safety areas that require FAA's attention. For example, FAA must continue its work to reduce safety risks in the air and on the ground at airports, including preventing near-misses on the runway.

In addition, FAA faces challenges in safely integrating unmanned aircraft systems in the same airspace as manned aircraft. Furthermore, FAA must protect its flight-critical and safety-critical IT systems from a growing number of cyber threats, and, last, FAA can do more to ensure essential aircraft parts, such as landing gear, meet safety standards by carefully implementing the Suspected Unapproved Parts program.

As always, my office remains committed to supporting FAA and the Secretary as they work to maintain aviation safety and protect the traveling public.

This concludes my prepared statement. I'd be happy to answer any questions you or members of the Subcommittee may have.

[The prepared statement of Mr. Scovel follows:]

PREPARED STATEMENT OF HON. CALVIN L. SCOVEL III, INSPECTOR GENERAL,
U.S. DEPARTMENT OF TRANSPORTATION

PERSPECTIVES ON OVERSEEING THE SAFETY
OF THE U.S. AIR TRANSPORTATION SYSTEM

Chairman Cruz, Ranking Member Sinema, and Members of the Subcommittee:

Thank you for inviting me to testify on the state of aviation safety and the Federal Aviation Administration's (FAA) oversight of commercial aviation. FAA is charged with safely overseeing the busiest and most complex air transportation system in the world, which carries over 2.5 million people on approximately 45,000 flights every day. However, recent events have brought new attention to FAA's safety oversight and its regulatory role. Most notable are the two fatal accidents involving Boeing 737 MAX 8 aircraft that occurred in October 2018 and earlier this month. The Office of Inspector General expresses our deepest condolences to the families of the victims of these accidents. A number of other incidents have also raised safety concerns. These include the April 2018 Southwest Airlines engine failure—which resulted in the first fatality at a U.S. commercial passenger air carrier¹ in over 9 years—and several safety incidents at airports, such as the near miss of an Air Canada Flight in San Francisco in July 2017.

As Secretary of Transportation Elaine L. Chao has stated, safety is and must remain the Department's top priority. Last week, Secretary Chao requested that our office audit the activities that resulted in the certification of the Boeing 737 MAX 8 aircraft. In addition, we have received requests from Congress to examine other related issues, including FAA's decision-making process that led to grounding the MAX 8 aircraft in the United States. My office has already begun this work and will keep you apprised of our results.

As the Nation's regulator of aviation safety, FAA is responsible for effectively overseeing a vast range of safety-critical areas. To its credit, FAA has taken steps in recent years to help its safety efforts keep pace with a rapidly evolving and diverse aviation industry. Yet, as my office's work has shown, both new and long-standing safety issues present significant challenges to FAA's oversight of the National Airspace System (NAS).

My testimony today will focus on FAA's efforts related to (1) reducing hazards associated with flight deck automation, (2) implementing FAA and industry's evolving safety oversight systems, and (3) addressing other safety-critical watch items.

Summary

Notwithstanding the Nation's safety record, important safety issues—both new and longstanding—need FAA's attention. First, with pilots relying on automated flight systems as much as 90 percent of the time, it is critical that FAA ensure that air carriers meet its requirements for these systems, including training pilots on how to respond to abnormal flight conditions when automation or other systems fail. Second, FAA faces new challenges as its systems and strategies for safety oversight evolve and air carriers take on a larger role in identifying and mitigating safety risks. To maintain the highest level of safety, FAA must implement effective risk-based oversight of organizations that perform certification work on the Agency's behalf, effectively leverage collaboration and enforcement, and maintain a strong safety culture. At the same time, our recent and ongoing work has also identified other watch areas that are essential to enhancing oversight of the NAS. These include reducing safety risks on the ground and in the air at airports, integrating Unmanned Aircraft Systems (UAS) in the same airspace as manned aircraft, protecting safety-critical information technology systems, and eliminating suspected unapproved parts from the aviation supply chain.

Strengthening FAA Oversight To Reduce Hazards Associated With Flight Deck Automation

Advances in aircraft automation have significantly contributed to safety and changed the way airline pilots perform their duties. Rather than manually flying an aircraft, pilots now monitor flight deck systems. Generally, new automation technologies are added to gain operational or efficiency advantages, such as reducing pilot workload, adding more capability, increasing fuel economy, and allowing access to airports surrounded by challenging terrain. FAA has estimated that automation

¹This was the first passenger fatality at a part 121 air carrier since February 12, 2009 (14 CFR Part 121, Operating Requirements: Domestic, Flag, and Supplemental Operations).

is used 90 percent of the time in flight.² Figure 1 below shows the advances in flight deck technology between the Boeing 737-200 (pictured left) and 737 MAX 8 aircraft (pictured right).

Figure 1. Evolution of Boeing 737 Flight Decks



Source: Copyright © Boeing

While airlines have long used automation safely, our 2016 report³ noted accidents in which pilots who typically fly with automation made errors when confronted with an unexpected event or transitioning to manual flying.⁴ As a result, reliance on automation is a growing concern among industry experts, who have questioned whether pilots receive enough training and experience to maintain manual flying proficiency. In addition, preliminary reports on the recent Boeing 737 MAX 8 accidents have suggested a possible link to one of the aircraft's automation systems, raising concerns about pilots' abilities to recognize and react to unexpected events.

As shown in table 1, pilots' use of automation may range from none to high. While no single level of automation is appropriate for all flight environments, pilots must understand automated systems and make appropriate decisions when encountering unusual situations, such as when automation fails or an emergency arises.

Table 1. Levels of Flight Deck Automation

Level	Auto-pilot ^a Engaged	Auto-throttle ^b Engaged	Overview
Full Auto-flight	X	X	The aircraft's control is fully automated based on information preprogrammed by the pilots.
Tactical Auto-flight	X	X	The aircraft's autopilot is engaged, but pilots can direct changes to heading, speed, and altitude using a control panel.
Manual		X	The pilot is manually controlling the aircraft based on guidance assistance from the preprogrammed flight directors. This is primarily used for takeoff, initial departure, and landings.
All Automation Off/ Full Manual			The pilot is manually controlling the aircraft without the assistance of flight directors. This would be used to avoid collisions with other aircraft or to recover from an undesired aircraft state such as a stall.

^aAuto-pilot helps automate the process of guiding and controlling an aircraft.

^bModern auto-throttles can control power from takeoff to touchdown. Source: OIG analysis of air carrier and manufacturer data.

²Estimates according to FAA senior officials, as noted in our 2016 report (see footnote 2).

³*Enhanced FAA Oversight Could Reduce Hazards Associated With Increased Use of Flight Deck Automation* (OIG Report No. AV2016013), January 7, 2016. Requested by the Ranking Members of the House Committee on Transportation and Infrastructure and its Subcommittee on Aviation. OIG reports as well as the current status of our recommendations are available at <http://www.oig.dot.gov/>.

⁴For example, in July 2013, Asiana Airlines Flight 214 crashed short of a runway at San Francisco International Airport. The National Transportation Safety Board determined that the crew did not appropriately understand the aircraft's automation systems, allowed airspeed to decay due to improper monitoring, and failed to perform a proper go-around response.

To promote safety and provide a basis for oversight while maintaining flexibility for different aircraft and systems, FAA has established certain requirements governing the use of flight deck automation during commercial operations. In particular, FAA developed limitations regarding minimum altitudes at which autopilot can be engaged and how automated systems within the cockpit are configured. For example, during takeoff and climb below 500 feet, FAA restricts the use of autopilot unless the carrier is granted explicit FAA authorization to use it sooner. Further, air carriers must obtain FAA authorization in order to use certain advanced flight procedures⁵ that rely on automation.

In addition, FAA requires that pilots be trained, tested, and proficient in all aircraft they operate, including any onboard automated flight deck systems. The Agency also now requires all part 121⁶ pilots to be trained in specific abnormal flight conditions, which include stall and upset recovery and loss of reliable airspeed (see table 2 for an overview of FAA's new requirements). These FAA requirements were based on accident investigations and National Transportation Safety Board (NTSB) recommendations. Air carriers had to comply with this rule by March 12, 2019.

Table 2. New Manual Flying Training Requirements for 2019

Training Maneuvers	Overview
Upset Prevention and Recovery	Aircraft upset is an unsafe condition that may result in loss of control (LOC). Training focuses on the pilot's manual handling skills to prevent upset, as well as training to recover from this condition.
Manually Controlled Arrival and Departure	Pilots will be both trained and evaluated on their ability to manually fly a departure sequence and arrival into an airport.
Slow Flight	Pilots will be trained to understand the performance of the aircraft and the way it handles at airspeeds just above the stall warning.
Loss of Reliable Airspeed	Training will focus on the recognition and appropriate response to an automation system malfunction that results in a loss of reliable airspeed, which increases risk of aircraft stall and/or upset.
Recovery From Stall/Stickpusher Activation	Training will provide pilots the knowledge and skills to avoid undesired aircraft conditions that increase the risk of encountering a stall or, if not avoided, to respond correctly and promptly.
Recovery From Bounced Landing	A poorly executed approach and touchdown can generate a shallow bounce (skip) or a high, hard bounce that can quickly develop into a hard landing accident.

Source: OIG analysis of FAA requirements

FAA requires these training maneuvers to be performed in flight simulators. However, the recent Boeing 737 MAX 8 accidents have raised questions about the availability and capabilities of these training simulators. For example, FAA determined training for the new Boeing MAX series could be completed in existing simulators. However, according to FAA, existing simulators do not fully replicate the 737 MAX aircraft, and no U.S. airline currently has a MAX simulator.

Overall, FAA has taken steps to emphasize the importance of pilots' manual flying and monitoring skills, as we recommended in 2016. Continued vigilance in these areas can help ensure that air carriers create and maintain a culture that emphasizes pilots' authority and manual flying skills.

Remaining Vigilant as FAA and Industry Safety Oversight Systems Evolve

In recent years, FAA has worked to revamp its strategy for overseeing the safety of the aviation industry. In particular, FAA has increasingly shifted to working with industry to meet shared safety goals, including delegating responsibilities for aircraft certification and requiring air carriers to proactively identify and mitigate their safety risks. Enhancing risk-based oversight, effectively leveraging industry collaboration and enforcement, and fostering a strong safety culture will remain key challenges for FAA as it works to implement its new oversight strategies and ensure the safety of the traveling public.

⁵ These include Area Navigation (known as RNAV), a method of flying in which aircraft use satellite signals to fly any desired flight path, as well as Required Navigation Performance (RNP) procedures, which add monitoring and alerting capabilities for pilots that allow aircraft to fly more precise flight paths.

⁶ 14 CFR Part 121, Operating Requirements: Domestic, Flag, and Supplemental Operations.

Enhancing FAA's Oversight of the Aircraft Certification Process

The U.S. civil aviation industry is vital to the Nation's economy and encompasses more than 230,000 aircraft, 1,600 approved manufacturers, and 5,200 aircraft operators, among others. Recognizing that it is not possible for FAA employees to oversee every facet of such a large industry, public law⁷ allows the Agency to delegate certain functions, such as approving new aircraft designs and certifying aircraft components, to private individuals or organizations. In 2009, FAA fully implemented the Organization Designation Authorization (ODA) program to standardize its oversight of organizations (*e.g.*, manufacturers) that are approved to perform certain functions on its behalf.

While delegation is an essential part of meeting FAA's certification goals, robust oversight is essential to ensure that ODA companies maintain high standards and comply with FAA safety regulations. However, our work over the years on the ODA program has identified management weaknesses with a number of FAA's oversight processes. To its credit, the Agency has taken action to improve its oversight in response to our recommendations. For example, our 2011 report⁸ identified inconsistencies in how FAA aircraft certification offices interpreted FAA's role and tracked ODA personnel. In particular, not all FAA offices consulted FAA's database to pre-screen performance histories of prospective ODA personnel. In addition, under ODA, FAA engineers have expanded enforcement responsibilities, but the Agency had not ensured that they were adequately trained to perform these duties. In response to our findings, FAA clarified guidance on tracking ODA employee performance history and improved its training and guidance for enforcement. As a result, FAA engineers responsible for overseeing ODA employees were better positioned to detect instances of regulatory noncompliance and take enforcement actions.

In 2015,⁹ we reported that FAA's oversight of ODA program controls was not systems- and risk-based,¹⁰ as recommended by an aviation rulemaking committee.¹¹ For example, FAA had not provided oversight teams with tools or guidance on data they should use to identify the highest-risk areas. Another gap in FAA's oversight pertained to companies that produce and supply components to other manufacturers. FAA performed oversight of only 4 percent of personnel conducting certification work on the Agency's behalf at suppliers in the period we reviewed.

In responding to our 2015 report, FAA recognized the need to improve its oversight of organizations performing certifications or other functions on its behalf. By July 2019, FAA plans to introduce a new process that represents a significant change in its oversight approach. For example, FAA's new process will include identifying system elements (such as training and company self-audit processes) and developing new evaluation criteria. While revamping FAA's oversight process will be an important step, continued management attention will be key to ensure the Agency identifies and monitors the highest-risk areas of aircraft certification.

Overseeing Air Carriers' New Systems for Managing Safety Risks

FAA's safety oversight strategy depends, in part, on air carriers' ability to identify hazards and implement corrective actions that mitigate risk. For example, in 2015, FAA established requirements¹² for U.S. part 121 air carriers to implement a formal, top-down approach to managing safety risks, known as a safety management system (SMS). Specifically, under SMS, air carriers must identify root causes for hazards and proactively manage risk to prevent accidents.

While air carriers were required to implement SMS by March 2018, recent events—including the April 2018 Southwest Airlines fatal engine failure—have raised concerns that FAA's oversight may not ensure air carriers sufficiently meet their risk-mitigation responsibilities. NTSB is currently investigating the accident,

⁷ 49 U.S.C. § 44702(d).

⁸ *FAA Needs To Strengthen Its Risk Assessment and Oversight Approach for Organization Designation Authorization and Risk-Based Resource Targeting Programs* (OIG Report No. AV2011136), June 29, 2011. Requested by Representative Daniel Lipinski.

⁹ *FAA Lacks an Effective Staffing Model and Risk-Based Oversight Process for Organization Designation Authorization* (OIG Report No. AV2016001), October 15, 2015. Requested by Representative Peter DeFazio.

¹⁰ Systems-based oversight shifts from focusing on individual project engineering work to holistically assessing whether ODA companies have the people, processes, procedures, and facilities in place to produce safe products. This allows FAA to focus its oversight on the highest-risk areas, such as new, innovative aircraft designs.

¹¹ The Aircraft Certification Process Review and Reform (ACPRR) Aviation Rulemaking Committee, a joint FAA and industry group, was formed in response to a congressional mandate to study the aircraft certification process.

¹² 14 CFR Part 5, Safety Management Systems. This requires part 121 carriers to implement SMS.

but its preliminary reports indicate similarities with a 2016 engine incident on a Southwest Airlines aircraft. We are currently assessing¹³ FAA's oversight of Southwest Airlines' systems for managing risk, including a focus on aircraft weight and balance issues that can affect critical phases of flight, as well as other matters. We expect to report on our findings later this year. Ultimately, while air carriers' SMS are an important part of maintaining the safety of the NAS, FAA must exercise appropriate regulatory oversight and intervene in a timely manner to ensure air carriers take sufficient actions to identify and reduce safety risks.

Effectively Leveraging Collaboration and Enforcement in FAA's New Air Carrier Safety Oversight Program

As FAA continues to move towards allowing air carriers to play a more collaborative role in safety oversight, strong management attention is critical to ensure the Agency's evolving strategy advances its safety goals. In particular, in 2015, FAA implemented a new "Compliance Philosophy" as part of its safety oversight strategy. The Compliance Program, as it is now known, is based on the premise that the greatest safety risk in the industry does not arise from a specific event or its outcome, but rather from an operator who is unwilling or unable to comply with rules and best practices for safety. The overarching goals of the new program are to achieve rapid compliance, eliminate a safety risk or deviation, and ensure positive and permanent changes.

FAA's Compliance Program emphasizes the Agency's preference for collaborating with air carriers through education and training instead of penalizing carriers as a means to address discrepancies. This program calls for FAA to work with air carriers to address the root causes of violations of safety regulations rather than to impose enforcement actions—a significant change in the way FAA and the airlines previously addressed compliance and safety issues. A key issue we will assess in upcoming audits is whether the Compliance Program is suitable for all air carriers, regardless of current working relationships or unique business models and operating environments.

An important component of the Compliance Program is working with carriers to identify the root cause of a violation. However, our ongoing audit¹⁴ related to Allegiant Airlines has highlighted the complex challenges FAA faces in implementing its new oversight approach and addressing the root cause of the air carrier's maintenance violations. Specifically, a longstanding maintenance issue at Allegiant Airlines resulted in a series of mid-air engine shutdowns, aborted takeoffs, and unscheduled landings. Our ongoing work focuses on the degree to which FAA's inspectors documented adjustments to their surveillance, effectively examined the root cause, or convinced the airline through collaboration to perform additional tests to operate at a higher level of safety. Overall, while FAA's Compliance Program offers a new strategy for addressing risk, such as potentially insufficient maintenance, the Agency's oversight must remain robust to ensure airlines implement effective corrective actions. A key challenge FAA faces moving forward is effectively leveraging both collaboration and enforcement and accurately assessing whether an air carrier is willing and able to correct its deficiencies.

Maintaining a Strong Safety Culture To Adequately Support FAA's Changing Oversight Methods

The success of FAA's evolving oversight methods depends on a strong safety culture within both the Agency and industry. According to FAA, a positive safety culture is one that is actively promoted by all levels of management and demonstrates a commitment to safety over competing goals and demands. Within such a culture, people acknowledge their accountability and act on their individual responsibility for safety.¹⁵

However, as early as 2015, FAA's Office of Audit and Evaluation cautioned about changes in airline safety culture and the potential impacts on safety and airline maintenance workforces. FAA guidance recognizes the impact that a single inspector can have on safety culture and establishes standards that require inspectors to act impartially and avoid the appearance of preferential treatment when they per-

¹³*Audit Initiated of FAA's Safety Oversight of Southwest Airlines*, June 20, 2018. Self-initiated.

¹⁴*Revised Notification—Review of FAA's Oversight of Air Carrier Maintenance Programs*, May 9, 2018. Requested by Representatives Peter DeFazio, Rick Larsen, Nita Lowey, David Price, Mike Quigley, Katherine Clark, Pete Aguilar, Jacky Rosen, and Cheri Bustos and Senator Bill Nelson.

¹⁵FAA Order 8000.369B, *Safety Management System*, March 18, 2016.

form their official duties. Nonetheless, our recent work¹⁶ identified concerns regarding an FAA inspector's oversight of American Airlines' flight test program, which is used to verify the airworthiness of aircraft following major repairs. We found that an inspector had developed a personal relationship with the head of the carrier's flight test program and appeared to give the carrier preferential treatment when safety concerns were raised. The inspector also worked with the carrier to suppress future complaints. Ensuring that FAA's inspector workforce meets standards of impartiality remains a key oversight challenge for the Agency to strengthen its safety culture and effectively identify and mitigate risks.

Addressing Other New and Longstanding Safety Challenges

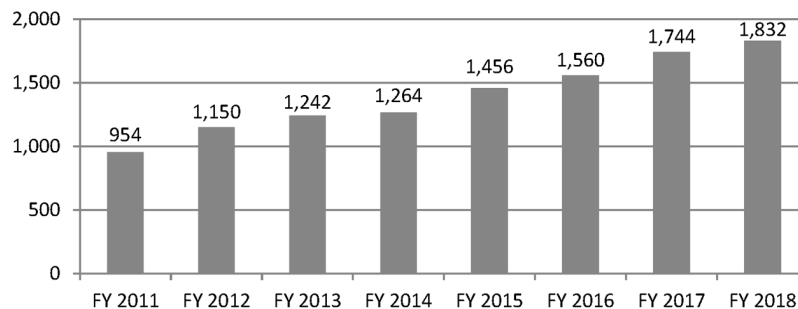
While working to address the urgent safety concerns highlighted by the recent Boeing 737 MAX 8 accidents, FAA must remain vigilant about other emerging and longstanding areas that are critical to maintaining the safety of the NAS. These include improving safety on the ground and in the air at airports, integrating UAS in the same airspace as manned aircraft, protecting flight-critical systems that directly affect the safety of aviation passengers from cyberattacks, and identifying and removing suspected unapproved parts from the aviation supply chain.

Reducing Runway Safety Risks at Airports

Incidents in which collisions between passenger aircraft were narrowly avoided at our Nation's major airports have renewed attention to runway safety. For example, in July 2017, a commercial pilot at the San Francisco International Airport attempted to land on a taxiway where four other aircraft were awaiting takeoff.¹⁷ Much of our work in this area has focused on FAA's efforts to reduce runway incursions—incidents involving unauthorized aircraft, vehicles, or people on a runway—which has been a longstanding challenge for FAA.

While FAA has undertaken a number of safety initiatives since 2007, reports of incursions have increased, with a 92-percent rise in total incursions reported between Fiscal Years 2011 and 2018 (see figure 2).¹⁸ In addition, while the number of serious runway incursions is relatively low, there have been several incidents where two aircraft have come within a few feet of colliding with each other, posing significant safety risks.

Figure 2. Total Number of Runway Incursions, Fiscal Years 2011–2018



Source: OIG analysis of FAA data

¹⁶ *FAA Has Not Fully Addressed Safety Concerns Regarding the American Airlines Flight Test Program* (OIG Report No. AV2018060), July 10, 2018. Self-initiated.

¹⁷ NTSB News Release, *Flight Crew Misidentifies Runway, Causes Taxiway Overflight*, September 25, 2018. NTSB determined an Air Canada flight crew's lack of awareness caused the overflight of the taxiway.

¹⁸ We have not analyzed how factors such as changes in operational levels and new reporting systems may have contributed to the increase in runway incursions.

Last year, we reported¹⁹ that FAA had completed 10 of the 22 runway safety initiatives recommended during a joint Government-industry forum,²⁰ including educating pilots on signs, markings, and other visual aids at airports with identified risk factors.²¹ However, the Agency faces challenges in fully implementing the initiatives still in progress, including dedicating funding and fully implementing new technologies,²² which could take years to complete. In addition, FAA did not establish quantifiable goals to measure the initiatives' effectiveness in reducing runway incursions. As a result, FAA will be limited in its ability to prioritize and adjust the initiatives based on their effectiveness. We made three recommendations, including updating target action dates for initiatives still in progress and developing metrics to measure their effectiveness. FAA plans to implement these recommendations by May 2019. Effectively analyzing data, identifying risks, and tracking mitigation actions will remain critical to reduce runway risks.

Strengthening Oversight of UAS in the NAS

The growing demand for UAS commercial operations—ranging from filmmaking and precision agriculture to package delivery—represents a substantial economic opportunity for the United States but also presents one of FAA's most significant safety challenges. Since initiating UAS registrations in December 2015, FAA has processed more than 1.1 million UAS registrations for commercial operators and hobbyists. Reports of UAS sightings by pilots and other sources have increased significantly in the past few years—from 238 in 2014 to more than 2,350 in 2018.

The Agency has taken many steps to accommodate UAS in the NAS, such as passing a rule²³ permitting small UAS (*i.e.*, under 55 lbs.) to fly commercially, with a number of operational restrictions.²⁴ However, much work remains to safely integrate UAS into the same airspace as manned aircraft. For example, FAA's rule allows commercial UAS operators to apply for a waiver to conduct higher-risk operations at night, over people, and/or beyond visual line of sight, if the Agency determines the proposed operations can be performed safely. Yet, as we reported last year,²⁵ our analysis of FAA inspections found multiple instances of commercial operators flying their UAS over people and in airspace with manned aircraft without authorization to do so, including over exhibitions and concerts and while performing building inspections.²⁶

Moreover, we found that FAA faces several challenges in developing a risk-based oversight system for commercial UAS operations. While the Agency had developed guidance for its inspectors in planning annual inspections of some UAS operators, FAA's UAS oversight was neither data-driven nor proactive and lacked key elements of a risk-based oversight system. For example, we reported that FAA's guidance did not include risk or operational factors (*e.g.*, operating location or frequency of operations) to consider when choosing operators for inspection. Furthermore, FAA had not yet collected sufficient inspection data to conduct a meaningful assessment of safety hazards and develop an overall, baseline risk profile of commercial UAS operating in the NAS. In response to our recommendations, FAA has recently required new, mandated inspections of UAS operators based on data. The Agency must continue to enhance its data collection and analysis to mitigate safety risks in this rapidly evolving industry.

Implementing Congressionally Mandated Aviation Cybersecurity Initiatives To Protect Safety-Critical Systems

Enhancing the safety and security of the NAS also depends on strengthening the Agency's ability to protect against a growing number of cybersecurity threats to

¹⁹ *FAA Faces Challenges in Implementing and Measuring the Effectiveness of Its 2015 Runway Safety Call to Action Initiatives* (OIG Report No. AV2018058), June 27, 2018. Self-initiated.

²⁰ FAA initiated a Call to Action forum in 2015 with representatives from industry, labor, and Government. The forum resulted in 22 initiatives intended to mitigate runway incursions and improve safety.

²¹ According to FAA, risk factors that contribute to runway incursions may include unclear taxiway markings, airport signage, and more complex issues such as the runway or taxiway layout.

²² For example, one initiative calls for testing and using new Next Generation Air Transportation System technologies for issuing taxi instructions, such as Data Communications.

²³ 14 CFR Part 107 (June 2016).

²⁴ The rule does not permit several potential UAS operations that are highly valued by industry but considered to be higher risk by FAA, such as operating a small UAS beyond line of sight or over people.

²⁵ *Opportunities Exist for FAA To Strengthen Its Review and Oversight Processes for Unmanned Aircraft System Waivers* (OIG Report No. AV2019005), November 7, 2018. Self-initiated.

²⁶ Our analysis of FAA's inspection record database shows no indication that formal enforcement actions were pursued for any of these specific incidents.

FAA’s safety-critical systems. Specifically, FAA operates a network of more than 300 information technology systems. This complex network has evolved over the years into an amalgam of diverse legacy radars and newer satellite-based systems for tracking aircraft, as well as a new initiative for controllers and pilots to share information through data link communications.

In 2016, the FAA Extension, Safety, and Security Act²⁷ directed FAA to establish a new “total systems” approach to enhance its ongoing cybersecurity efforts for securing the NAS, including aircraft systems. Our recent work²⁸ shows that FAA has taken initial steps to address the act’s requirements, such as completing a strategic plan with cybersecurity goals and objectives, developing a risk model to assess FAA operations, and establishing a research and development (R&D) plan to outline further cyber initiatives. However, FAA will be challenged to continue to implement the risk model across all of its lines of operations, establish priorities for its cyber R&D efforts, and coordinate ongoing efforts with other agencies (such as the Departments of Defense [DOD] and Homeland Security [DHS]) to maximize the Federal investment in cybersecurity research and implement corrective actions to protect the NAS. Accordingly, we will soon begin a review²⁹ of FAA’s role and authority in the Aviation Cybersecurity Initiative, a joint taskforce that includes DOD and DHS aimed at identifying and mitigating cyber vulnerabilities in the aviation industry.

Strengthening the Investigative Process and Proactively Removing Suspected Unapproved Parts From the Aviation Supply Chain

The safety of the NAS also depends on efforts by FAA and the aviation industry to ensure that U.S. aircraft are properly maintained and airworthy. A single passenger aircraft can contain as many as 400,000 parts, and FAA and the aviation industry are responsible for ensuring that all these parts meet established standards and are safe for use. Part of this responsibility is to detect and monitor for Suspected Unapproved Parts (SUPs)—aircraft parts that may have been manufactured without FAA approval, including counterfeit parts. However, our work has identified longstanding challenges with FAA’s processes for overseeing and reducing the risk of SUPs. For example, we reported in 2017³⁰ that FAA’s process for monitoring and investigating SUPs was not as effective as it could be because of record-keeping weaknesses and the lack of management controls to capture and accurately report the number of SUPs cases. As a result, FAA could not accurately account for the number of SUPs or track safety-related trends about the risks posed by unapproved parts.

Furthermore, FAA’s oversight of industry actions to remove unapproved parts was ineffective because the Agency did not confirm that operators took appropriate action to remove unapproved parts from their inventories. For example, an FAA inspector investigated a case to determine whether tens of thousands of privately owned commercial aircraft parts, which were for sale online, were unapproved. These included safety-critical parts, such as landing gear. However, the inspector did not physically account for the location and quantities of the parts but instead accepted a letter from the owner stating that he had removed the ad from his eBay site and had not sold any parts. FAA concurred with all 11 of our recommendations to strengthen its SUPs program and is working to complete actions to address the remaining three open recommendations by the end of May. Going forward, enhancing the margin of safety will require FAA’s sustained management attention to ensure that the hundreds of thousands of aircraft parts installed on airplanes are manufactured or repaired according to safety standards.

Conclusion

From certifying a new aircraft to aircraft maintenance to pilot training and beyond, aviation safety is a complex, wide-reaching effort with many moving parts. As the recent Boeing 737 MAX 8 and other accidents draw significant attention to FAA’s safety oversight, and as the aviation industry continues to evolve, FAA must ensure it can proactively adapt to new oversight challenges, while also addressing longstanding concerns in safety-critical areas. A strong commitment to risk-based oversight—built on the foundation of a rock-solid safety culture—will be vital to en-

²⁷ Pub. L. No. 114–190 (2016).

²⁸ *FAA Has Made Progress but Additional Actions Remain To Implement Congressionally Mandated Cyber Initiatives* (OIG Report No. AV2019021), March 20, 2019. Requested by the House Committee on Transportation and Infrastructure.

²⁹ This was requested by the Chairman of the House Committee on Transportation and Infrastructure.

³⁰ *Enhancements Are Needed to FAA’s Oversight of the Suspected Unapproved Parts Program* (OIG Report No. AV2017049), May 30, 2017. Requested by the Ranking Members of the House Committee on Transportation and Infrastructure and its Subcommittee on Aviation.

sure FAA continues to maintain one of the safest aviation systems in the world. As always, we remain committed to supporting FAA and the Secretary as they seek to uphold and enhance the safety of the NAS and protect the traveling public. We will continue to update you on our work on these and related matters.

This concludes my prepared statement. I would be happy to address any questions from you or Members of the Subcommittee at this time.

Senator CRUZ. Thank you, gentlemen. We appreciate your testimony.

Acting Administrator Elwell, although the investigations of both of these crashes are still ongoing, the investigators have gathered enough data to confirm similarities between the two crashes.

The most prominent link seems to be a new software unique to the Boeing 737 Max called the Maneuvering Characteristics Augmentation System, more commonly known as MCAS.

From the FAA's perspective, was there any information on this new MCAS System that was required to be included or was included in the "short self-administered online course" that pilots are required to go through before flying the Max?

Mr. ELWELL. Mr. Chairman, thank you for that question.

The MCAS System is indeed, as I mentioned, of great attention in both of these tragic accidents and the MCAS is actually a sub-device to a system called the Speed Trim System that is in the NG, a prior 737.

What the MCAS does is it—the 737 Max is a fly-by-wire aircraft. Fly-by-wire aircraft, the controls, the yoke, the controls, the flight controls needs to feel right to a pilot and so what the MCAS does is it gives inputs to the flight controls when necessary in a very thin envelope, thin piece of the flight envelope and certain regimes so that the pilots, the yoke feels exactly like it should, and in this case, the MCAS made the Max feel exactly like the NG to fly.

So for that reason, we gave it an amended type certificate because of its similarity to the NG, because of what the MCAS System aided the pilots in the feel and the flight of the airplane.

We have for a certification of this type a Flight Standardization Board comprised of pilots from Europe, Canada, the United States, who come together and fly the aircraft that is being amended, in this case 737 NG, and the new aircraft, and they fly it and are monitored by engineers and experts specifically to see if they have or notice differences in the flight characteristics, the handling characteristics of the new airplane because that would trigger us to need flight training for this new device.

Senator CRUZ. Administrator Elwell, let me try to refocus you back on the specific question I asked, which is, was there any information on the MCAS that was included in the short self-administered online course the pilots were required to go through?

Mr. ELWELL. There was not specific instruction on the MCAS to my knowledge specifically because it was not a system that went directly to what the pilots flew on the Max, the difference between the Max and the NG.

Senator CRUZ. Well, that might be true in ordinary circumstances, but as I understand it on previous versions of the 737, when the pilot pulled back on the yoke, it cutoff the electronic control of the stabilizers but with the MCAS, it did not, and presum-

ably pilots would not know this if it was not included in their training and they were not made aware of that, is that correct?

Mr. ELWELL. So, Senator, the MCAS gives input to the flight controls, as I said, in a very small flight envelope.

In this case we're talking about here, errant information to that system would make it give input where it's not needed and where it's not wanted and only in manual flight and pilots are trained when they get an input into their flight controls that they did not ask for, that is not appropriate for the regime of flight, then they go through procedures.

In this case, it's called runaway stabilizer trim procedure and that is what would be done in this instance. In normal operation for the MCAS, you would never——

Senator CRUZ. Did these pilots'——

Mr. ELWELL.—feel the input.

Senator CRUZ.—training or procedure let them know that pulling back the yoke would not disengage this system?

Mr. ELWELL. I'm not quite sure what you're referring to about pulling back the yoke and stopping it because that's not actually——

Senator CRUZ. So I'm reading a quote from the *New York Times* on February 3, 2019, where the *Times* reported “Older 737s had a way of addressing certain control problems with the stabilizers. Pulling back on the yoke or control column would cutoff electronic control of the stabilizers, allowing the pilots to control them manually,” and that was not true with the 737 Max.

Now is that correct factually? I'm relying on the *Times* reporting here.

Mr. ELWELL. So I don't believe that's correct. The same ways to deal with the MCAS inappropriate input is the same thing a pilot would do for runaway stab trim for an NG. It's the same input and the same procedure. In fact, the procedure for runaway stab trim does not change from the NG to the Max. It presents itself the same way and it's dealt with the same way.

Senator CRUZ. Now the MCAS System itself relied on angle of attack sensors that, as the *Washington Post* reported, “angle of attack sensors have been flagged as problems on more than 50 times on U.S. commercial airplanes over the past five years.”

How did the FAA come to the conclusion that it was appropriate to certify an anti-stall software system, the MCAS, that not only drew data from a sensor that had a history of problems but also that didn't have redundancy?

Mr. ELWELL. So the AOA vanes are an input to the MCAS System. The MCAS System is actually not an anti-stall system. It's not a system unto itself. It is a supplement to, as I said, the speed trim system that existed in the NG, does the same thing that the STS does in the NG.

I am not aware of AOAs being a problem, 50 malfunctions of an AOA or 50 maintenance procedures to an AOA across the gamut of flight where AOA vanes are in all the flights that use AOA. It is not in—you talk about numbers of hundreds of thousands of flights.

Senator CRUZ. Unless there is a system where the malfunction then causes the plane to crash, then that is a serious issue.

Mr. ELWELL. Well, sir, it is still yet to be determined if the malfunctioning of the AOA caused the crash. We actually don't know the cause of the crash. There's a lot more to find out through the investigation.

But I am confident in—well, I'm confident in the AOA vanes that are produced and put on airplanes and I'm confident in the MCAS System. Now where we need to go is we need to get all the information, all the data from the accident to determine the interaction between all of them, and it isn't just airframe or it isn't just the AOA. It isn't just the MCAS.

There's quite a few more factors in any investigation that we have to determine. We have to gather the data. We're a data-driven organization and we make our decisions based on the data collected. We still have a lot of data to collect, sir.

Senator CRUZ. Senator Sinema.

Senator SINEMA. Thank you, Mr. Chair.

My first question is for Mr. Elwell, but I welcome responses from any of our guests.

According to media reports, the initial failure classification for the MCAS enabled its safety evaluation to be delegated to Boeing and during—well, according to media reports, during testing, FAA did not completely and properly review technical documents provided by Boeing.

So how do we ensure that FAA can take over safety evaluation if issues are discovered during the testing and evaluation phase?

Mr. ELWELL. Thank you for that question, Senator.

What you're referring to is the Organizational Designation Authorization. In the course of a certification, such as an amended type cert that the 737 Max went through, the FAA determines what aspects of the delegation or what aspects of the certification can be delegated and usually those are normal well-known legacy-type systems, and in the case of the 737 Max, we, the FAA, retained MCAS for review at the beginning of the certification process.

As the process goes on, ODA is amended and is amended many times in the course of a certification as the FAA reviews and certifies the expertise of the manufacturer to take on more of the delegated authority under very strict review by the FAA and we at times in the course of a certification will find areas that we want to pay more attention to and we will retain those items.

So it is an active constantly changing dynamic in a certification and that's what happened during the certification of the Max.

Senator SINEMA. A second question then for you, Mr. Elwell.

So MCAS is new to the Boeing Max aircraft and I was wondering if you could talk to us about why the system was not included in pilot training materials and who makes the determination regarding what is included in pilot training materials?

Mr. ELWELL. So when we're doing a new certification, whether it's an amended or a new type, there's a Flight Standardization Board that is a group of experts and pilots and engineers whose responsibility it is to determine, and in this case an amended type certificate, if the handling characteristics of the new aircraft require flight training or if the differences between the new aircraft and the one that it's amending does not require flight training.

What the MCAS did was correct for some very slight modifications that the Max had. The Max has slightly larger diameter engines with not a whole lot of extra thrust, similar thrust, but because of the width of the engines, they had to go forward on the wing, and because of the diameter of the engines, the nose wheel had to be extended six inches.

These are not big changes as far as the FAA's concerned for an amended certificate, but what we need to do is put pilots in simulators and fly the aircraft that's being amended and the new aircraft and after many scenarios, flights in all regimes, sim flights in all regimes with these pilots, there was a consensus opinion from the pilots, European, Canadian, American pilots, that there was no market difference in the handling characteristics of these two aircraft and that is what we need to determine what kind of flight training or not is needed and there was, by the recommendation of the Flight Standardization Board—understand this is a Board that has been used dozens and dozens of times, and their unanimous opinion was flight training was not needed.

They didn't flight test the MCAS per se because, as I said, the MCAS is a device that is a supplement to another system that is designed, specifically designed for the yoke to feel correctly to the pilot in all regimes of flight.

Senator SINEMA. My last question is for each of the witnesses and I wonder if you have suggestions for legislative or regulatory changes that can ensure an aircraft is independently and appropriately evaluated for operational safety. Is there more we need to do?

Mr. SCOVEL. Thank you, Senator Sinema.

Yes, there may be. However, for me as Inspector General to offer suggestions today would be entirely premature.

As you know, Secretary Chao, Senator Blumenthal, and other congressional requesters have asked my office to start at the very beginning thinking of these as bookends. First, we want to look at the certification process.

I can outline very quickly for you what that will entail. We want to look at the key decisions made by FAA when certifying the airplane and the timeline. We want to determine when MCAS was added to the aircraft and why FAA approved it or the extent of FAA's involvement in Boeing's decision to approve it, how FAA reached the decision that pilots did not need additional training or that the details about the new system did not need to be included in the airplane's manual. That's the first bookend.

The second bookend in my view will be how FAA responded to the recent accidents and that's specifically Senator Blumenthal's question.

Clearly, confidence in FAA as the gold standard for aviation safety has been shaken. We can help provide information to the Secretary and to the Congress to determine how best to restore FAA to that position.

The second bookend we hope will shed some light on the obvious question as to why FAA was the last safety regulator to decide to ground the 737 Max.

Other safety regulators around the world decided that in their role as safety regulators they needed to drive risk to zero and they did that by grounding the aircraft.

Acting Administrator Elwell has testified that they were continuing the hunt for data in order to inform that decision. So that disparity, that apparent disparity in the safety regulator's role should be another question, I respectfully submit, for the Congress and the Secretary.

We hope to present information to all of you to help inform your decisionmaking.

Mr. SUMWALT. Ranking Member Sinema, thank you for your question.

The NTSB has looked at that issue as it relates to particular crashes. For example, coming out of the 2013 Asiana crash at San Francisco, we recommended that the FAA convene a special certification design review of how the Boeing 777 Automated Flight Control System controls air speed and we wanted the FAA to look at that and we've classified that recommendation as open alternate acceptable response.

Coming out of the 787 battery fire event that we investigated that same year, we talked about the use of engineering designees. Since 1999, we've issued eight recommendations to the FAA concerning the use of engineering designees. Three are still open. The remaining four have been closed acceptably.

We do want the FAA to provide certification to engineers with written guidance and training to address opportunities to improve the certification process outcomes and so that would be where we stand on that.

Senator SINEMA. Thank you. Thank you.

Senator CRUZ. Mr. Elwell, you told Senator Sinema that part of certification was based on pilots flying simulators in multiple different scenarios.

Did any of those scenarios include angle of attack sensors malfunctioning and reporting the wrong data to the MCAS System?

Mr. ELWELL. Sir, I can get an answer for you on that, but I don't believe so. I believe that they were all in the normal, the full range of the flight envelope for flight characteristics.

Again, the issue of an AOA vane giving the MCAS the wrong information causing it to give nose down input to the stabilizer trim presents as a scenario. All pilots are trained on it and familiar with it. It's called runaway stabilizer trim and the actions that they take to defeat it are the same as they would find in any other cause of a stab trim malfunction which would be the motor going off when it shouldn't. So it is indistinguishable to the pilot.

[Mr. Elwell's answer follows:]

The flight control system, of which the Maneuvering Characteristics Augmentation System (MCAS) is a part, was extensively tested, including in potential failure modes of MCAS and stalls.

Senator CRUZ. Chairman Wicker.

Chairman WICKER. Thank you, Senator Cruz.

Mr. Sumwalt, the Indonesian Civil Aviation Authority has issued a preliminary report. How long did that take after the Lion Air crash?

Mr. SUMWALT. The accident occurred, Senator, on October 29 and I believe the preliminary report was issued on November 27, so about 30 days.

Chairman WICKER. Do you think we can expect a preliminary report, then, from Ethiopia within about a month?

Mr. SUMWALT. I do. Our investigators are very engaged with the Ethiopian Government. We're working very closely with them, providing assistance in the development of a draft report, and we do expect it in the very near future.

Chairman WICKER. I assume you're getting all the cooperation you need from the Ethiopian Government—

Mr. SUMWALT. Yes, sir, we are.

Chairman WICKER.—and from the Indonesian Government?

Mr. SUMWALT. Absolutely.

Chairman WICKER. What do you know about the Lion Air crash that you don't know about the Ethiopian Air crash at this point?

Mr. SUMWALT. Well, I've read the Lion Air preliminary report that was issued in November. I will say a very ticklish issue is that there's a law, an actual law, 49 U.S.C. 1114 subsection f, that prohibits anyone from disclosing information concerning a foreign investigation unless that information has been cleared by the host country.

So I am not the one to speak about either of those two accidents.

Chairman WICKER. Mr. Scovel, are you going to have a recommendation about that law? Do you have an opinion about that law? Is it a problem?

Mr. SCOVEL. Conceivably, it might be. Certainly in the desire of the Congress and the Administration to foster transparency and determine the best route ahead. At this point, I certainly don't have a recommendation for you.

Chairman WICKER. OK. Well, if the witnesses would get back to us on that, we'd appreciate it. You have some time to consider that.

Now there was a nose-down input, Mr. Sumwalt. In other words, the pilots experienced the MCAS System kicking in and pushing the nose down. I understand it was some 21 times before the plane eventually crashed. Is that your understanding, sir?

Mr. SUMWALT. Which accident are you referring to?

Senator WICKER. Lion Air.

Mr. SUMWALT. I think that's about right, based on my read.

Chairman WICKER. Over what period of time would that have been?

Mr. SUMWALT. I'm not sure, sir.

Chairman WICKER. What should the pilots have done there?

Mr. SUMWALT. Well, I flew the 737 for 10 years and I do believe that there is a procedure, at least for the Flintstone version of the 737 I flew, a very old 737, but I do believe that the first thing you would do is oppose that motion by pulling the yoke back and that should engage a stab brake. Now apparently that feature is not on the Max—

Chairman WICKER. Mr. Elwell, what should they have done? What should the pilot have done, based on 21 times of the system kicking in and pushing the nose down?

Mr. ELWELL. Mr. Chairman, I did not fly the 737, so I can only speak to the airplane—all the different airplanes I flew, but—

Chairman WICKER. Oh, I'm actually asking about this aircraft. Do you know? If you don't know, that's fine.

Mr. ELWELL. Sir, I'll have to get back to you on the specifics. There is a non-normal checklist, an NNC on runway——

Chairman WICKER. I think that would be helpful for us to know, based on the expertise at this table, what should have occurred in the cockpit, based on that nose-down input?

Mr. Elwell, then discuss, if you don't mind, the point that Mr. Scovel mentioned and a lot of us have about the decision made by other countries initially to ground the aircraft, what data they had. Was this just an abundance of caution or was it based on facts that these agencies had that we didn't have here in the United States? Help us understand the decision there.

Mr. ELWELL. Yes, sir. It is a very important question.

The FAA, to make a decision to ground a fleet of aircraft, is going to do that on data-based information that we have to warrant grounding. I can't speak to the reasoning that the other nations took. I know that in communication with those countries, they, in our request of what data they might have, they did not have any data for us. In fact, there were several countries in communications with us who, after grounding the aircraft, asked us what data we had and what we might suggest for them for ungrounding when the time was right.

Chairman WICKER. Was your decision based on data or just——

Mr. ELWELL. Our decision——

Chairman WICKER.—what everybody else was doing? What was that data?

Mr. ELWELL. So on that Wednesday morning, mid-morning, we received data that gave us refined flight track. We had initial flight track data Monday that was unreliable and it was actually—we were not able to interpret it and to create a flight track.

That data was refined on Tuesday night into Wednesday by the company that actually produced the data or received the data through their satellite system and with the help of the NTSB and Boeing, that data was refined to the point where we could have a flight track, a 6-minute flight track of the Ethiopian Air flight, and we found information on the ground that corroborated for us in a briefing on Wednesday morning that the flight track of Ethiopian Airlines was very similar to the flight track of Lion Air and that data told us that there was very possibly a link between the two flights and when you have the possibility of a link between two accidents of the same type aircraft, it's prudent to ground them until you find what that link is, mitigate that link.

The important thing to know about using data, we may have been, I think someone said, the last country to ground the aircraft, but the United States and Canada were the first countries to ground the aircraft with data for cause and purpose and that's important because when you ground a fleet of aircraft for a reason, a definable reason, then you have something by which to unground them when you've mitigated that or you've solved it or you've found that link.

Chairman WICKER. Mr. Chairman, I know we're over, but Mr. Sumwalt seems to be nodding his head.

Are you in agreement with the approach that Mr. Elwell has outlined as having been taken by the FAA?

Mr. SUMWALT. Well, the NTSB was not involved in the grounding decision.

Chairman WICKER. Right.

Mr. SUMWALT. We supplied data that they could use to make that decision.

Chairman WICKER. Thank you. Thank you, Mr. Chair.

Senator CRUZ. Senator Cantwell.

Senator CANTWELL. Thank you, Mr. Chairman.

Administrator Elwell, did you say in answering an earlier question of Senator Sinema that the FAA retained the authority over the MCAS System, that it wasn't delegated?

Mr. ELWELL. I said that originally we retained it as a new system and then released it to the ODA, to the delegation designation.

Senator CANTWELL. So if someone is characterizing it as delegated, then it was delegated?

Mr. ELWELL. Right. So initially as a new system or a new device on the amended type certificate, we retained the oversight of that and then over time released that to the ODA when we had the comfort level and the oversight and we've examined it thoroughly and we were able to assure that the ODA members of Boeing had the expertise and the knowledge of the system to continue going forward.

Senator CANTWELL. And so that kind of information is something you can make available to members now or is that something that will be part of the investigation?

Mr. ELWELL. I'm sure, Senator, that we could get that information to you on exactly the timing and how that went, and, of course, in the investigations and the audits that are ongoing about the certification process here, this will all be very transparent and clear.

Senator CANTWELL. Well, I do think transparency is important.

Mr. ELWELL. Absolutely.

Senator CANTWELL. So I read statements where you're saying it wasn't delegated or I hear your answer here and then I read things in the press that say it was delegated and I think the public wants to understand the system and obviously Mr. Scovel and various IG reports is reviewing that and I appreciate those reports and that review.

As I mentioned in my opening statement, I appreciate Secretary Chao convening some experts of aviation analysis to also look at that system and review.

So, anyway, we'll look forward to getting that information from you on what that looked like as the FAA retains that oversight and then once they were certain then delegated. I'm not sure what they delegated but you will get that to us.

This larger question in my mind is Mr. Scovel also mentioned that pilots rely on automated flight systems, that the FAA ensure that carriers meet its requirements to train pilots on how to respond to abnormal flight conditions, and I think you also, Mr. Scovel, mentioned stall situations.

So how is the FAA making sure that that is achieved in particularly this area of human and machine interface? I think that the

public wants to understand, and I think it's probably across a lot of transportation sectors, want to understand what we're doing on testing to make sure that these safety factors of functionality are there, particularly when the functionality is between a machine and a human interface, how are we testing for that, and in this case, how were we testing?

Mr. ELWELL. Yes, Senator. The FAA is intensely interested in the interface between the pilot and the machine and over time that relationship has changed and as aircraft become more automated, we have this—clearly automation is one of the most important aspects for the amazing increase in improvement in safety we've seen over decades.

But automation brings with it certain challenges and as the IG has pointed out, if most of the time automation is on in an aircraft, there's always been this concern that, well, then pilot skills degrade.

So when I was flying in the airlines, we had within the airline itself, we had some rules about making sure that you hand flew frequently enough to keep that sharpness but certainly we look very, very closely at the training requirements and the human interface and what automation does, the safety benefits, and what the challenges are with it. So we watch that very closely.

Senator CANTWELL. And so you think there was enough of that training involved here?

Mr. ELWELL. Senator, I do, I do, because the MCAS, remember, the MCAS operates in manual mode. It's not automated. It's not during with autopilot on. It actually—as I said earlier, it makes the—its whole purpose is to give the pilot the proper feel with a fly by-wire yoke while he or she is flying.

So it interjects in manual mode. It does not interject in automatic mode, and as I said, when that MCAS is doing things that it's not supposed to do, pilots feel it. It presents itself as uncommanded pitch trim and pilots of large aircraft are trained from the beginning of their careers how to handle that.

Senator CANTWELL. Well, I mention this and I mentioned the Colgan Air families who are here because I think that's been their main mantra, that there wasn't enough training on that particular system or at least from a co-pilot perspective, and I think I saw that Captain Sully had also made similar comments recently.

We've had a lot of debate here about this as it relates to making sure that two pilots are, but I really do want to understand the FAA's role and certainly Mr. Scovel's review of that human-machine interface because my guess is we're going to continue to move forward but we have to get this right. We have to get this right.

So thank you, Mr. Chairman. I see my time has expired.

Senator CRUZ. Senator Thune.

**STATEMENT OF HON. JOHN THUNE,
U.S. SENATOR FROM SOUTH DAKOTA**

Senator THUNE. Thank you, Mr. Chairman.

Mr. Elwell, as you know, the FAA Reauthorization Act of 2018 contains several bipartisan provisions aimed at improving and modernizing FAA's aircraft certification process, to include the establishment of an organization designation authorization office

within FAA's Office of Aviation Safety designed to improve operational safety by strengthening oversight of ODA holders delegated to perform certain functions on behalf of FAA.

Could you provide a timeline on when you expect this office to be fully established?

Mr. ELWELL. Thank you for that question, Senator Thune.

Absolutely. In fact, we already established the new ODA Office, as you mentioned, prescribed in last year's FAA bill. On March 5, we created and stood up the office.

Senator THUNE. And as a followup, the FAA bill also established an expert review panel to survey ODA holders and evaluate the effectiveness of the ODA process.

You have an update on when you expect this review panel to be established?

Mr. ELWELL. I don't have it off the top of my head, Senator, but I will certainly get that information to you. It may already be in place, but I don't have that in my notes.

Senator THUNE. Thank you. That would be great if you could get us that information.

Boeing recently—I would direct this to you, Mr. Elwell, too. Boeing recently stated that the 737 Max Series aircraft was certified, and I quote, "Certified in accordance with the identical FAA requirements and processes that have governed certification of all previous new airplanes and derivatives."

Could you provide some examples of other aircraft models where the FAA has certified a variant aircraft in a manner similar to the process that was used for the 737 Max?

Mr. ELWELL. Well, Senator, the process to determine whether it is an amended type certificate or a new type is the same, regardless of the manufacturer, the type which you're amending, or making that determination, and it goes to the points I made earlier about flyability.

So, first and foremost, the criteria to examine as to whether there's a fundamental difference in the thrust, weight, flight characteristics of the applicant for an amended type. Those, as I said, are tried and true methods that we've used for decades on amended certificates.

I know sometimes, in my case when I flew the Super 80, we added to our fleet type the Super 80s from another airline in a merger. They had a different cockpit layout but the plane was fundamentally the same. There are a couple of different options but it handled the same.

So it was an amended type and we went through differences training because the flight deck had some different things in it that we needed to get used to, but that's the fundamental things that we look at.

Senator THUNE. You look at—so as a follow up, was there anything specific about the design of the 737 Max that differentiates the model certification process from some of those examples that you just mentioned?

Mr. ELWELL. Well, sir, the 737 Max is and required certainly an amended type certificate and again primarily because of the new modern complexities that it brought to the table. It did bring the

MCAS into the equation but the MCAS was a supplement or an addition to a system that already existed in the NG.

The engine position on the wing was different and it's what required actually—it's what necessitated the addition of MCAS and there was some differences in the screens, what was on the screens, but fundamentally the aircraft layout, the handling and the performance of the aircraft was the same, and thus the decision to make it an amended type certificate.

Senator THUNE. OK. Mr. Sumwalt, you mentioned in your testimony both the benefits and safety concerns related to the integration of UAFs in the Nation's airspace.

As you know, the FAA Reauthorization Act of 2018 included numerous provisions related to the safe operation of this emerging technology.

Are there any pending regulatory actions that the FAA in particular that you see as most important to ensuring the safe integration of drones into our airspace?

Mr. SUMWALT. Thank you for that question, Senator Thune.

As you're aware, the FAA recently enacted Part 107 to the Federal Aviation Regulations which imposes more regulatory requirements for drone operators and we see that as a positive.

Senator THUNE. OK. All right. Thank you. I see my time's expired, Mr. Chairman. Thank you all for your willingness to be here today and take questions.

Senator CRUZ. Senator Klobuchar.

**STATEMENT OF HON. AMY KLOBUCHAR,
U.S. SENATOR FROM MINNESOTA**

Senator KLOBUCHAR. Thank you very much, Mr. Chairman. Thank you to all of you.

The two tragic airplane crashes included, by the way, a beloved community member from St. Cloud, Minnesota, Mucaad Hussein, and I know his family is grief stricken, and following these crashes, as many of my colleagues have talked about, it is very important that we figure out our certification process and get it right so we can prevent similar tragedies in the future.

Mr. Elwell, I know you've been asked about this but let me try it a different way.

Are there any safety measures the FAA may have miscalculated when evaluating the safety features of the Boeing 737 Max?

Mr. ELWELL. Well, Senator Klobuchar, thank you for that question.

We certify aircraft in a way that we have refined, as I said, for large aircraft, large commercial aircraft. It has been refined 130 times, over 130 times since we started doing these.

In every certification we learn something new, from every IG audit, from every—

Senator KLOBUCHAR. Was this consistent with how you've done other certifications in other situations, the Boeing situation?

Mr. ELWELL. Yes, ma'am. This was an amended type certification that followed the procedures we use to determine and then to execute—

Senator KLOBUCHAR. But if you learn something else after this investigation or other things come out, you may change that process?

Mr. ELWELL. Absolutely. That's how we get better.

Senator KLOBUCHAR. And, Mr. Scovel, what is your office's timeline for this audit?

Mr. SCOVEL. Thanks, Senator.

We always shoot for 10 months. This is a very tall order for us, as I'm sure you can appreciate. We have a highly skilled team of aviation safety auditors who we'll turn to. If we can meet 10 months, I optimistically say great. It may well be some months after that. We will get to it as soon as we possibly can because we really truly appreciate your interest on all these matters.

Senator KLOBUCHAR. Thank you.

Mr. SCOVEL. Thanks.

Senator KLOBUCHAR. Mr. Elwell, back to you, according to a recent *New York Times* article, Boeing charged airlines extra for critical safety features. These were optional add-ons.

Following the crashes, does the FAA plan to update the requirements for aircraft safety features or take other action to mandate that these features are not optional?

Mr. ELWELL. Well, Senator Klobuchar, when we certify an aircraft, whether it's amended or a new type, critical safety features, that's an important term. If something is a critical safety feature on an aircraft, a passenger aircraft that we certify, it's not optional.

So critical safety features—

Senator KLOBUCHAR. I see.

Mr. ELWELL.—are part of the certification package and I think what you're referring to is AOA displays on the CRTs in the cockpit, and I can tell you as a pilot that's flown aircraft, several aircraft in the military and the civilian world, I had aircraft that had AOA displays in the cockpit and I had aircraft that didn't, and it all depends on what the rest of the display says.

In today's modern airplanes, and you've got 12-inch CRTs in the cockpit,—

Senator KLOBUCHAR. But is it possible this could be decided that these aren't just optional, that they should be mandatory if it's discovered after these investigations?

Mr. ELWELL. Absolutely.

Senator KLOBUCHAR. OK. And then do you know an estimate of how many safety features that the FAA lists as optional right now that detects sensor malfunctions or could you tell it to me later in writing?

Mr. ELWELL. I could tell it to you later, Senator Klobuchar.

Senator KLOBUCHAR. OK. All right. Chairman Sumwalt, what role does the U.S. play in setting international safety standards when it comes to training for foreign pilots?

I know you'd answered some questions about training for my colleagues, but do we have any role there? I'm just thinking because we had someone from Minnesota was killed.

Mr. SUMWALT. Sure. Senator Klobuchar, we are, as I've mentioned, we are member state to the International Civil Aviation Organization that sets recommended practices and standards and so it would be ICAO that would outline those international training

standards that other member states would be expected to comply with.

Senator KLOBUCHAR. And could you weigh in on those training standards?

Mr. SUMWALT. We could. The FAA is officially the U.S. representative to ICAO, but we work closely with them with our relationship with ICAO.

Senator KLOBUCHAR. I see. So you'd be involved in that, Mr. Elwell?

Mr. ELWELL. Yes, Senator, we would.

Senator KLOBUCHAR. OK. I'll follow up on that later.

One last question I had of you, Chairman Sumwalt. In your testimony, you highlighted reducing fatigue-related accidents as one of the NTSB's most wanted transportation safety improvements for 2019 to 2020.

As you know, I've led the Safe Skies Act, supported by Captain Sullenberger, among many, along with Senators Cantwell, Blumenthal, Markey, and Duckworth, to take the rest requirements that we put in place for passenger pilots and apply them to cargo pilots.

This is something unrelated to these two crashes but part of airline safety and something that I know the Colgan families have also supported. So could you comment on that?

Mr. SUMWALT. Absolutely. I want to thank you and Senator Blumenthal for your advocacy on that.

The NTSB does not agree that there should be a different standard for passenger-carrying airlines and cargo airlines with respect to the fatigue rules. The FAA, as you know, did enact a fatigue rule in 2012 for passenger carriers that did not relate to cargo carriers, and we disagree with that disconnect.

Senator KLOBUCHAR. OK. Well, I hope you win. So we're going to keep pushing for this bill.

Mr. SUMWALT. Thank you.

Senator KLOBUCHAR. Thank you.

Senator CRUZ. Senator Moran.

**STATEMENT OF HON. JERRY MORAN,
U.S. SENATOR FROM KANSAS**

Senator MORAN. Chairman, thank you very much. Thank you for conducting this hearing.

Press and media reports, Mr. Elwell, indicate that Boeing was implementing changes in the Max after the first crash and that is at least an explanation for why they may be close to having a "fix" for that Max.

Is there anything, a requirement that—first of all, is the FAA notified of that effort to make corrections to the Max after the first crash?

Mr. ELWELL. Senator, yes, the Boeing Company submitted an application for a software update to the MCAS, an MCAS software update after the Lion Air accident.

Senator MORAN. And is there a corresponding duty to warn either on the part of Boeing Corporation or the FAA either pilots or airlines, a duty to warn or a notification that there may be something wrong and a fix is on its way?

Mr. ELWELL. So nine days after the Lion Air accident, the FAA put out an Emergency Airworthiness Directive followed by a communiqué to all authorities around the world who fly the Max and what we pointed out was—back up a little bit.

The FAA's role, primary role in any accident investigation is for continual operational safety. In other words, if in the course of an accident something of immediate import is discovered, we don't wait for the end of the accident for the final report. We act immediately and in this case, the initial data suggested that a reminder was needed and that's what the Emergency AD was, a reminder was needed for pilots and operators of this aircraft to apply standard runaway stab trim procedures should this be encountered and that's what the Emergency AD was.

Now the software update that you're referring to is Boeing came to us with this and we talked to them about it. We accepted their application. They began work, but we determined that the issues that this software update was making, the things that it was improving upon for MCAS, did not warrant anything more than the announcement that this was in progress.

Senator MORAN. OK. Mr. Elwell, I'll stay with you for a moment longer.

I suppose that there's always a question of why we would have a private company certify their product. In this instance, it happens in the aviation world. It happens all the time.

What's the justification for that? We use ODAs, Organization Designation Authorizations, regularly. Would the FAA be able to certify aircraft without the use of that designation?

Mr. ELWELL. Senator Moran, that is a very important question, but let me go back to what you said in the question that we allow companies to certify their aircraft.

Senator MORAN. I know I misspoke in the way that you would phrase it and I understand the distinction. I'm not trying to discount the importance of an ODA.

In fact, I'm hoping that you'll confirm to me the importance with proper oversight, with FAA certification required, the actions that are taken by private companies to provide the information necessary to certify is important and how would we do this in aviation without that process?

Mr. ELWELL. So the concept of ODA, as I said, has been around for 60 years and some form of delegation has been around since the 1920s. It is part of the fabric of what we've used to become as safe as we are today, and I don't want to give the impression that ODA is some resource, a way for us to sort of stretch our resources.

We have very strict oversight on every participant in an ODA program and we make sure that they are experts in the field, that they have the appropriate understanding of FAA regs and manuals, they have professional integrity is checked, everything.

But to your point, if we had no ODA at all, it would be an estimation that would require roughly 10,000 more employees to do that role at the FAA and about \$1.8 billion for our Certification Office in the FAA.

Senator MORAN. How does that compare with—that process, that designation process compare to Europe and others across the globe when it comes to the use of that process?

Mr. ELWELL. So it's another excellent question. The European Aviation Safety Agency is the next, you know, biggest certification body in the world and they leverage ODA much more than we do. So it's used around the world.

Senator MORAN. So in this arena, there's nothing unusual to this process?

Mr. ELWELL. No.

Senator MORAN. It has been ongoing a long time and used globally, is that true?

Mr. ELWELL. Couldn't have said it better myself.

Senator MORAN. Thank you. Thank you, Mr. Chairman.

Senator CRUZ. Senator Blumenthal.

**STATEMENT OF HON. RICHARD BLUMENTHAL,
U.S. SENATOR FROM CONNECTICUT**

Senator BLUMENTHAL. Thanks, Mr. Chairman, and I want to thank the leadership of the Committee for having this hearing. Thank you for being here today, gentlemen, and I want to thank particularly the Inspector General, Calvin Scovel. We are lucky to have a professional of your caliber doing this investigation and I look forward to the results.

I've been deeply disappointed, in fact shocked, that in grounding these aircraft, American safety officials in effect lagged instead of led the world. The same information was available to our FAA as was accessible to every other country that grounded its airline days ahead of us and that put American passengers in peril.

But as important, maybe more so, is the system that led to in effect outsourcing safety to the manufacturers of these aircraft. Call it delegation or shifting, as you did. The fact is that the FAA decided to do safety on the cheap, which is neither cheap nor safe, and put the fox in charge of the henhouse. That was true of the 737 Max 8.

In its rush to produce that aircraft because of competition from Airbus, critical safety features were disregarded, and I'm going to be introducing legislation that will reform this system which is so fatally riddled with flaws. There needs to be rigorous reform so that the FAA is put back in charge of safety.

You said, Mr. Elwell, that the system is fact-based and data-driven. The FAA should have the facts and should be driving the data and making decisions. If the manufacturer has the facts and the data, not the FAA, if its employees chosen, hired, paid, fired by the manufacturer are the ones making these critical decisions and the FAA lacks all of the facts and data necessary to properly oversee them and overrule them, this system of oversight is failing.

I will tell you I read some of the pilot reports. They're public. NASA has them. They provided them to me. They are chilling. If I'd been a passenger on one of those planes and I knew about these incidents, I would have wanted a parachute.

Pilots of the airlines struggled to regain control of those aircraft in the same way that the pilots of the fatally crashed aircraft did. They succeeded, the others didn't.

So I look forward to your support for legislation that will fundamentally change this flawed system.

Mr. Elwell, have you reviewed those pilot reports?

Mr. ELWELL. Senator, thank you for your comments.

I reviewed the reports. There were——

Senator BLUMENTHAL. Did you review them at the time that they were received by NASA?

Mr. ELWELL. The reports—I did not personally. The reports were reviewed as they were written and received. There were 24 reports.

Senator BLUMENTHAL. Were they reported to you after the first crash because many of them followed the first crash?

Mr. ELWELL. The ASRS reports were reviewed and compared against the FDR data or FOQA data that we look at. ASRS reports are reports from pilots on experiences when they are on a trip. We take them very seriously. We review them. We have event review teams that sit down with the pilot and none of the 24 reports associated with the Max related to the MCAS or related to what the pilots experienced in either accident.

Senator BLUMENTHAL. Well, I am familiar with the reports that were given to me——

Mr. ELWELL. Yes, sir.

Senator BLUMENTHAL.—and my time is limited here. Let me just ask you. Were you contacted by anyone in the Administration before making your decision to ground those aircraft?

Mr. ELWELL. From the moment, Senator, of the Ethiopian accident until we grounded on Wednesday morning, I kept Secretary Chao and the President briefed and fully apprised on all of our activities, which included, I would add, a full——

Senator BLUMENTHAL. Did she order you to ground the aircraft?

Mr. ELWELL. I'm sorry?

Senator BLUMENTHAL. Did she order you or otherwise recommend what your decision should be in grounding the aircraft?

Mr. ELWELL. Senator, the decision to ground, to make an emergency grounding of a fleet of aircraft is vested in the FAA. I made that decision.

Senator BLUMENTHAL. And one last question. I don't know whether you've seen a ProPublica report. It's just come to my attention. I think it came out today, which reports your contacts with airlines.

Could you provide us copies of the e-mails between yourself and industry representatives and also a copy of your financial disclosure forms? I understand you had a consulting business while you were a part of the FAA, is that correct?

Mr. ELWELL. That's not correct, Senator. I'm happy to supply any and all communications.

Senator BLUMENTHAL. I want to give you a full opportunity to respond to the article that's just been provided to me, but it says that on those financial disclosure forms, you reported some income as a special government employee while you were a member of the FAA.

Mr. ELWELL. Happy to provide any and all information.

Senator BLUMENTHAL. Thank you. Thank you, Mr. Chairman.

Senator CRUZ. Senator Blunt.

**STATEMENT OF HON. ROY BLUNT,
U.S. SENATOR FROM MISSOURI**

Senator BLUNT. Thank you, Mr. Chairman.

So, Mr. Elwell, I think established in the questions with Senator Moran the long history of delegating certification. Let me ask a couple more questions about that.

The *Seattle Times* recently reported that FAA technical experts and safety engineers said in interviews that they were urged to delegate more responsibility to Boeing during the 737 Max certification process or to speed it up.

Does the FAA still retain the mandate to certify aviation technologies that are new or novel?

Mr. ELWELL. Yes, Senator, we do. That is our authority and it's our sole authority. We do not allow self-certification of any kind.

Senator BLUNT. Were there any deviations from that policy in regards to the Boeing 737 Max?

Mr. ELWELL. Sir, none of which I'm aware. We have a very good whistleblower program at the FAA. We encourage all levels of employees to report any activity that they find that doesn't go with our safety culture and I looked into this personally. There were no comments made by employees to our knowledge. I can't speak to the *Seattle Times* article.

Senator BLUNT. And it's your view that FAA managers did conduct the kind of reviews of that delegated authority that they're expected to conduct?

Mr. ELWELL. Absolutely. Yes, sir.

Senator BLUNT. Well, let's go back to the investigation going on right now. I think, Mr. Sumwalt, you said that—I think you said that we were cooperating closely with the investigation, the Ethiopian investigation.

Is that cooperating closely, is that the right phrase?

Mr. SUMWALT. Well, I'd actually say we're actively engaged. We have investigators on the ground in Ethiopia that are assisting and advising the Ethiopian Government as well as helping them to put together a draft interim report.

Senator BLUNT. Are they cooperating closely with you then?

Mr. SUMWALT. Yes, sir, they are.

Senator BLUNT. And are you getting access to all the information you'd like to have access to?

Mr. SUMWALT. At this time, we are.

Senator BLUNT. I know it's a much smaller agency than your agency in terms of budget and size and experience. How would you compare this investigation to other investigations you've been involved in and what are you doing to make up differences, if there are differences?

Mr. SUMWALT. Well, I don't want to sound like I'm bragging because I'm not. The NTSB has a lot of experience with investigating crashes. We've been in business for 52 years. So we have a lot of experience, but as an accredited representative to foreign investigations, we often find that other countries do not have the resources that we do. So we are very experienced with working with other countries, other states to help them, and I think that this investigation is going as it should.

The Ethiopians, again this is, like I wasn't bragging and this next statement is not a derogatory statement, they don't have the experience that we have because they haven't investigated the number of crashes that we have over the years. They're a relatively

new agency. So they are proceeding very deliberately and very cautiously.

Senator BLUNT. There was another comment made earlier about a prohibition unless information's been cleared by the host country. I believe the way I heard that, that was for you to share that information with others.

Does that suggest that there's information that's not being shared with you?

Mr. SUMWALT. I have no indication at all that the Ethiopians are not sharing with us the information that we need to make sure that we are aware of the safety-related information that we need to feed back to the FAA or feed back to Boeing to ensure continued airworthiness safety.

Senator BLUNT. And those earlier comments were about whether you could publicly share that information without the host government agreeing with that, is that right?

Mr. SUMWALT. That is correct. However, the law does further state that nothing in this subsection shall restrict the Board at any time from referring to a foreign accident investigation information in making safety recommendations.

So, in other words, if we identify safety-related information that we need to make a safety recommendation, then we can use that information, but we would always want to coordinate that ahead of time with the state of occurrence.

Senator BLUNT. So you don't feel unduly restricted by that prohibition of releasing information?

Mr. SUMWALT. I do not, but it is—and to be clear, as you've characterized it, it is for the public release of information is what the law is specifically calling for.

Senator BLUNT. That's helpful for me.

Mr. Scovel, do you want to comment on that?

Mr. SCOVEL. Thank you, Senator Blunt.

Not on that particular question. Thanks for recognizing my signal just for a moment. I may have information that may help you and the Committee in understanding the *Seattle Times* point that you mentioned in an earlier question, and I want to refer back to our 2015 Audit Report on ODA.

In the course of that work, we reviewed four ODA company self audits that identified employee concerns about undue pressure which could lead to rushing safety-critical tasks to meet production schedules.

Now I want to clarify these were not U.S. DOT Inspector General audits. These were company self audits that were required by FAA as part of its oversight process for ODA.

It's unclear to us what FAA may have known about those company self audits. As I mentioned, there were four of them. Two involved Boeing in fact, one in the Seattle area dating to 2013 and the other was from Boeing's Charleston, South Carolina, facility in 2014. The remaining two concerned Bell Helicopter, both in Ft. Worth, 2013 and 2014.

We didn't step into the shoes of the safety regulator. It's not in our lane to do that, but when we learned about the self audits, we determined that it would be appropriate for us to make a recommendation to FAA that they find the best way to use those com-

pany self audits in order to enhance their oversight of the companies' ODA processes.

Senator BLUNT. When would you have made that recommendation?

Mr. SCOVEL. That was in 2015, sir.

Senator BLUNT. Mr. Elwell, do you know what the follow up from the FAA was on that recommendation?

Mr. SCOVEL. I can help you on that, too, sir. I'll pass to my colleague to take an answer on that, but I also have what is the auditor's answer, as well.

Senator BLUNT. And what was it?

Mr. SCOVEL. We made the recommendation and FAA concurred. They took action to our satisfaction to address the recommendation, the intent behind it, and so we closed that recommendation.

What remains to be done, and this is the typical audit process, is to see how it's effectively implemented going forward. So when we close a recommendation, it means that the agency is poised to execute it but it may in some cases be a matter of years before we return to see the effectiveness of that implementation.

Senator BLUNT. Mr. Elwell, do you want to add anything?

Mr. ELWELL. I'd like to thank the Inspector General. We did an audit of our whistleblower program and so I need to go back and look at this self audit information that General Scovel's talking about and—

Senator BLUNT. Then you'll respond to the record with what you find?

Mr. ELWELL. Absolutely.

Senator BLUNT. Thank you.

Senator CRUZ. Senator Duckworth.

**STATEMENT OF HON. TAMMY DUCKWORTH,
U.S. SENATOR FROM ILLINOIS**

Senator DUCKWORTH. Thank you, Mr. Chairman.

And, Mr. Elwell, I want to touch on the training aspect of pilots in general of aircraft certified by the FAA and then also about the specific Max 8 aircraft.

Would it be a true statement to say that U.S. pilots properly trained would know how to respond to an uncommanded nose-down pitch rate on an aircraft with an automated—I'll give you an example. I flew the Blackhawk.

Mr. ELWELL. Yes, ma'am.

Senator DUCKWORTH. It went through a real problem in the beginning of its development and to this day, I know the procedure for uncommanded nose-down rate, right.

Mr. ELWELL. Mm-hmm.

Senator DUCKWORTH. So I know it by heart. I will always know it until the day I die.

Is that something that most pilots would be able to basically say what those steps or those memory items if they're properly trained under U.S. system?

Mr. ELWELL. Yes, Senator Duckworth, our American U.S.-trained pilots of large commercial aircraft know that procedure and if I might,—

Senator DUCKWORTH. Yes.

Mr. ELWELL.—I wanted to amplify what we were doing prior to the grounding on Wednesday, one of the things we were doing, I was doing, is talking to the heads of all of the pilot groups that flew the Max and asking did they have reservations about the Max.

This is in addition to data we got from 57—over 50,000 Max flights in North America, Canada and the U.S., and in those data reports, and those are data reports that are coming right off the airplanes, there was not a single case in North America of an MCAS malfunction or what we found happened in Lion Air, but that wasn't enough.

I called and talked to the presidents of the Southwest Airline Pilots Organization, ALPA, over 53,000 pilots, and APA, the American Airlines Pilots Group, and asked them what is your experience flying the Max? What are your pilots saying? They said to a person, to a group we are absolutely confident in the safety of this aircraft and our pilots' level of training in flying it.

If I hadn't had that information, the data, and the affidavits from those unions or from those pilot groups, I would not have been able—that's part of the data package I had to wait for the data from the accidents to justify a grounding.

Senator DUCKWORTH. Let me then ask you about—so we talked a bit about just responding to an uncommanded nose-down attitude. That aside, there's another procedure. My experience as a Blackhawk pilot, we have the stabilator that would slow down, killed a bunch of pilots, hurt a bunch of people, but the automatic control system, the basic procedure is reset. If it doesn't reset, turn it off, manual control, slow to zero at about 40 knots indicated airspeed. I know nothing you ever flew ever went as slow as 40 knots indicated airspeed as I did, slow and low pilots.

The question I have for you is, while the MCAS is not specifically referenced in the aircraft manual for the Max 8, the procedure to shut off stabilizer trim switches are in the manual as a response to this, is that correct, and this is something that American pilots would be trained on?

Mr. ELWELL. Yes, ma'am.

Senator DUCKWORTH. Is this something that FAA, through ICAO, would ensure that other pilots in other countries should also be trained on?

Mr. ELWELL. When we interact at ICAO, it is usually not to the specificity of a fleet type, but we do use our influence at ICAO and our influence at the International Civil Aviation Organization is substantial and we use it at any opportunity we get to raise the safety level around the world.

In fact, we don't have the final reports on either of these accidents, but I have already set in motion at the FAA activities to go to the Assembly and, as you know, I'm sure, ICAO meets every 3 years and we're already examining what we bring to the Assembly this year, our country, our pilots, to help raise the safety bar, which is, as you know, we're responsible for aviation safety in the United States, but there are no boundaries, there's no border. It's a global endeavor.

We care deeply about other countries and we have over a hundred technical assistance agreements around the world. We have 20 bilateral aviation safety agreements with 47 countries. We're

very, very passionate not just about safety in the U.S. but that every country raises their safety bar.

Senator DUCKWORTH. So are you saying that we need to look at strengthening the International Aviation Safety Assessment Program and do you plan on doing that in the next ICAO meeting?

Mr. ELWELL. The International Aviation Safety Assessment Program, I think, is sound. It's very good. The IASA that we do with countries around the world—because what we do is we evaluate the Civil Aviation Authority and a healthy Civil Aviation Authority tells you that that country has a good culture for everything—airports, pilots, airlines—but by working to help raise the standards overall, then when we do an IASA in a country and we do a rating, we'll be rating against higher standards and I think that that's appropriate and it's well worth our attention.

Senator DUCKWORTH. Thank you. I'm out of time, Mr. Chairman. Thank you.

Senator CRUZ. Senator Capito.

**STATEMENT OF HON. SHELLEY MOORE CAPITO,
U.S. SENATOR FROM WEST VIRGINIA**

Senator MOORE CAPITO. Thank you, Mr. Chairman. Thank all of you for being here.

Mr. Elwell, let me just make sure I understand exactly because some of the questioning from Senator Duckworth is similar to what I was going to ask you.

So the plane, the 737 Max 8 with MCAS, has been flying since 2017, is that correct?

Mr. ELWELL. Yes, ma'am.

Senator MOORE CAPITO. OK. And you said, and I have a report here that says, in the wake of the Airworthiness Directive and discovery of possible issue with MCAS on Boeing 737 Max, this is quoted from an article in *Bloomberg*, I believe, it says, "A number of pilot groups raised concerns over whether or not pilots had been sufficiently made aware of the system that is unique to that aircraft."

Did you just say that nobody had raised issues about this system previous to either one of these accidents or maybe in between the two of them?

Mr. ELWELL. Senator, what I was remarking upon is we look at the data that comes off aircraft that's called FOQA data and please don't ask me what the letters mean, but what that is, is data that literally comes off the flight data recorder. It's ones and zeroes that come off of aircraft and airlines get that data.

They use that data in their safety management systems and when we ask for that data and we ask for it to be filtered on certain parameters, they give that data to us and what I'm saying is there were no incidents on Max flights in North America. There was no incident of this happening.

Now when I say also that the pilot reports that Senator Blumenthal mentioned earlier, the ASRS or the NASA reports, I personally read—there were 24 of them. I read every one of them and I'm not the key expert in this determination, but they were all looked at and determined and I concurred none of them went to the

MCAS. None of them demonstrated an MCAS malfunction and that's what I meant.

Now what you're referring to——

Senator MOORE CAPITO. What am I referring to?

Mr. ELWELL. Senator, I believe what you're referring to is when the accident first happened, there were some pilots who said we would have liked to have read about that MCAS. We would liked to have known that. That wasn't in the manual. One of the things that we did in our Emergency AD was direct to have MCAS explained in the flight operating manual.

Senator MOORE CAPITO. OK. So that was in between the first accident and the second accident?

Mr. ELWELL. Yes, ma'am.

Senator MOORE CAPITO. OK. Then let me ask then you about the training then that occurred after that. It's given in a short self-administered online course. How does that work? Are you in a testing center? Are you on your own in your own laptop and you just check box, box, box? How's that administered? How is a self—I mean, we've all taken self-administered computer tests. How do you ensure that this is absorbed and that the person actually taking it is the person taking it?

Mr. ELWELL. Well, first of all, as a former pilot myself, I will tell you that when you go through differences training and that's what that is, differences training,——

Senator MOORE CAPITO. Mm-hmm.

Mr. ELWELL.—that isn't something you pencil with because it's the aircraft you fly.

Senator MOORE CAPITO. Right.

Mr. ELWELL. And our pilots in the United States are incredible professionals. Now they can do that. They can do that when they go to the Academy, when they go to the school——

Senator Moore Capito: Right.

Mr. ELWELL.—for their respective airline. They can do that in recurrent training. They can do it in initial training. I imagine, and although I can't tell you now if this is the case, that they could also do it on their computers at home, but all of that training has a test at the end, a quiz at the end to test for knowledge, and the important thing to note here is that the determination was made because of the flying characteristics of the Max versus the NG that this iPad training that you read about was what was needed by pilots to be able to fly the plane.

Senator MOORE CAPITO. So was that required then in between the two in the United States?

Mr. ELWELL. It was always required.

Senator MOORE CAPITO. It was always required.

Mr. ELWELL. Yes, ma'am.

Senator MOORE CAPITO. Let me ask you about another sort of thing that you've seen out in the press and I don't really have it specifically here and in terms of the fix to the airplane.

There are certain fixes that are going to be offered to certain airlines and there may be different pricing and how much is it going to be. There has been sort of a conflicting story in the media. How do you respond to that? Do you know anything about that?

Mr. ELWELL. So, Senator, I read those reports or I read those articles, and those I don't believe were characterized as fixes. Those are options.

When an airline or anybody purchases an airplane like anything else, there are options. As I was explaining before, if it is a safety-critical display in the cockpit and we certify it, it's required. It's not an option.

Senator MOORE CAPITO. Right.

Mr. ELWELL. So, you know, AOA displays, some airlines and some pilot training, the pilots and pilot training groups, for instance, the Navy, you know, love AOA displays in the cockpits. The Air Force not so much.

It is a matter of every piece of real estate in a cockpit is precious and you put one gauge up there, you're sacrificing another.

Senator MOORE CAPITO. Right.

Mr. ELWELL. These are important distinctions and in this case, those displays are not safety-critical because there are other ways for pilots to gauge their energy state and that's what an AOA gauge does. It tells you your energy state.

Senator MOORE CAPITO. Well, not understanding the technicalities of it, I would say that being a member of the general flying public, it's hard to believe that a safety item that could possibly be connected to taking down two jets and killing over 300 people would ever be characterized as any kind of an option.

Mr. ELWELL. Right.

Senator MOORE CAPITO. So I want you to have the chance to—and I understand it is more technically involved than what I'm representing, but that's how it's perceived to the flying public.

Thank you.

Mr. ELWELL. Thank you.

Senator CRUZ. Senator Markey.

**STATEMENT OF HON. EDWARD MARKEY,
U.S. SENATOR FROM MASSACHUSETTS**

Senator MARKEY. Thank you, Mr. Chairman.

Mr. Elwell, as the safety agency entrusted to provide the safest, most efficient aerospace system in the world, the FAA must ensure that aviation safety is not a luxury that can be bought and sold for an extra fee, but for Boeing, critical safety features that could have saved the lives of 346 souls on two of their 737 Max 8s were yet another profit center deemed optional, like premium seats or extra bathrooms or fancy lighting. That's wrong, just plain wrong, Mr. Elwell.

Boeing sold two safety features, the angle of attack indicator and the warning lights, to the airlines for an additional fee, not as a standard part of the aircraft. These features could have alerted the pilots and aviation mechanics that the doomed aircraft had faulty sensors which preliminary findings suggest are the cause of these two aviation disasters.

Let's be clear. In our automobiles, we don't pay more for seatbelts, for airbags, or in medicine for childproof caps. Those aren't optional. Those are all built-in as safety features to protect people, to protect families, and so should all critical safety features on aircraft.

Administrator Elwell, do you believe that Boeing's practice of selling the angle of attack indicator and warning lights as separate optional features may have contributed to the Lion Air and Ethiopian Airline crashes? Yes or no?

Mr. ELWELL. Well, Senator, thank you for that question.

The AOA indicator, the AOA vane is not an optional piece of equipment on the airplane. We look in the certification process that we've been using for decades that we've refined over 130 times is geared toward one thing, the safest possible—

Senator MARKEY. Should all of the safety features have been mandatory that could have alerted pilots and mechanics to issues with the sensors? Should they have been mandatory? Yes or no?

Mr. ELWELL. Senator, safety-critical pieces of equipment on an aircraft are mandatory. That's what certification does. If it's safety-critical,—

Senator MARKEY. So you don't think that they should have been mandatory? Is that what you're saying? Is that what you just said? They should not have been mandatory?

Mr. ELWELL. Sir, I'm saying that any—

Senator MARKEY. Yes or no? Should they have been mandatory? Yes or no?

Mr. ELWELL. Sir, the distinction between what goes in a flight deck and what stays out is a discussion and whether or not a display is safety-critical or not is a distinction that FAA is qualified to make.

Senator MARKEY. Do you believe that charging additional fees for these safety features and other safety features, like backup fire extinguishers in the cargo hold and oxygen masks for flight crews, may discourage airlines from equipping their airlines with important safety systems? Yes or no?

Mr. ELWELL. Well, Senator Markey, I find it hard to believe that a safety company like an airline would save a couple thousand dollars on an option that might improve safety on a—

Senator MARKEY. It may be hard for you to believe, but it's happening and as a result, the safety agency has a responsibility to make sure that an airline doesn't place—

Mr. ELWELL. Absolutely.

Senator MARKEY.—profit over people's safety. Do you agree with that?

Mr. ELWELL. Senator Markey, I would tell you that—

Senator MARKEY. Do you think the FAA has the responsibility to tell these airlines that they cannot change safety for profits when it's clear that that safety device plays a huge role in protecting the plane and its passengers? Yes or no?

Mr. ELWELL. Senator Markey, that is our fundamental responsibility.

Senator MARKEY. Yes or no? Should that be mandatory?

Mr. ELWELL. Senator Markey, the fundamental role of the FAA is to determine what the safety-critical aspects of every part on that airplane—

Senator MARKEY. Should the FAA ban the practice of airlines selling safety features ala carte to the airlines? Yes or no?

Mr. ELWELL. Senator Markey, I will tell you that if there is any manufacturer that sells a safety-critical part ala carte, we will not permit it.

Senator MARKEY. Well, if you change the rules so that they cannot do this, then that will be progress, but if business as usual continues, then passengers are going to continue to be vulnerable. So from my perspective, safety should never be ala carte. Safety should never be optional. Safety should always be mandatory and that's why I have sent a letter with 16 of my colleagues to Boeing demanding that they never again have any safety option as something that is discretionary with their own profit model.

It is absolutely unacceptable and it's unacceptable for the FAA to delegate to an airline what is safe, what is not, what they can afford, what they cannot. This should not be an option. Seatbelts, airbags, or whatever's in an airline should never be optional.

So my view is that until the FAA finally stands up and says that this is something that must change, then we are going to have problems, big problems, and that's why I'm introducing legislation with my colleagues to ensure that this never happens again and that when something is determined to be a safety feature that it no longer is an option for the airline to include it or else we will just continue to see continued repetition of what is happening because ultimately overconfidence breeds complacency and complacency breeds disaster.

We've seen it here and we'll see it again, unless we mandate safety as something which is not optional.

Thank you, Mr. Chairman.

Senator CRUZ. Senator Rosen.

**STATEMENT OF HON. JACKY ROSEN,
U.S. SENATOR FROM NEVADA**

Senator ROSEN. Thank you, Chairman Cruz, and thank you to all the witnesses for being here.

You know, I spent most of my career working as a computer programmer and systems analyst with the focus on software. In fact, in the 1980s, I worked for Hughes Aviation working out of the General Aviation Terminal in Las Vegas, helping them write programming that would assist in airplane maintenance and inventory.

So from that perspective, I am very concerned about what I've read and heard regarding the software for the 737 Max 8s and Max 9s. Pilots have told me that there's significantly more new software on these planes than usual and this is because planes don't actually fly like a 737 without the software. The physics of the plane is just a little bit different.

So, Mr. Scovel, let's talk a little bit about new certification. Is this really a 737 or does it require a new original certificate, and given that this plane, which is equipped with highly advanced software and is flying today in 2019, I just want to say today is 2019, is flying off an original certificate that was issued, and I'm sure you know this well, in 1967. The Beatles were the top of the charts in 1967, no cell phones, no technology, very different, so different kind of plane.

So do you think there could be some loopholes in the current certification system that makes it perhaps a little bit too easy for an

airplane manufacturer to continue to buy this or get a new original certificate?

I want to ask one other thing. If you can or supply this in writing, can you tell us how many derivative certificates have been issued for the 737 since it's originally been certified over 50 years ago? It kind of seems like we had a canoe in 1967 and today you're certifying the cruise ship. They're not the same.

Mr. SCOVEL. Thank you, Senator.

To your second question, I will defer to Mr. Elwell. I believe he and FAA are in a better position than I am or my office is to give you that particular number.

Senator ROSEN. You can supply that in writing.

Mr. SCOVEL. Yes, ma'am.

Senator ROSEN. That would be fine. Thank you.

Mr. SCOVEL. Be happy to.

Senator ROSEN. And then you can answer the first question about running off the 1967 certification.

Mr. SCOVEL. Right. I don't know the answer to your question. We have not completed that audit work yet. We can include it as a point that we will cover and we'd be happy to report back to you and the rest of Congress and the Secretary.

Senator ROSEN. Does it seem reasonable to think that you should have a new certification or some updates since 1967, except updates to the user manual, and that's fine. I'll look for that in writing.

I want to go on to enforcement versus compliance at the FAA. So some have argued that in recent years, the FAA's safety philosophy has moved from one of enforcement to one of compliance where, instead of penalizing safety violations without penalty, the agency has instead given industry the opportunity to correct the safety violations without penalty in order to comply with FAA regulations.

So, Mr. Elwell, would you say that this is an accurate characterization of the FAA's current approach?

Mr. ELWELL. Thank you, Senator Rosen.

Compliance is the end game, enforcement is a tool, and when we have a stakeholder in the system that is unwilling or unable to comply with our regulations, enforcement is aggressively——

Senator ROSEN. So would you say that this is the current approach, enforcement versus compliance? Yes or no? Do you think?

Mr. ELWELL. Senator Rosen, what I'm saying is that compliance is the end game and that's why it's called the Compliance Program because we have enforcement as a tool but we also work with people to fix their problems because it's much—we've found in our years of safety regulation that it is a much more productive model, and this is not something that we just changed a couple years ago. This is an organic development of our safety philosophy over decades, that when you work with somebody who has made an honest mistake to get——

Senator ROSEN. So we're going to say that's a no. So you're working on compliance. So if that's not the case and the FAA's robustly enforcing safety regulations, what steps can we now take to ensure that rules are in place to prevent this from happening again, and if proactive enforcement is paramount, why did it take the first

Max 8 crash for the FAA even to begin the process of requiring Boeing to make software changes to prevent these deadly malfunctions?

Mr. ELWELL. Senator Rosen, the process by which we improve safety is an oversight process that it is constantly refined, ongoing. It involves compliance activities and it involves enforcement.

What we have with Lion Air and Ethiopia are two tragic accidents, the reasons for which we still don't know.

You can be assured by the FAA and by me that when the results of these accidents come out, anything that we can change and make better, we will. That's what we do. That is the primary reason for our existence is to improve safety, but we have to get all the data. We have to get all of the results from the accident investigation. We don't know the cause, the primary causes of these accidents, but when we do, you have my assurance that we will take the action necessary that they don't happen again.

Senator ROSEN. Thank you. I have one last question about the software.

You mentioned that it masks, it masks the problem for the pilots, so that the pilots feel like the plane is flying the way it should. It'd be like if I was driving my car and a wheel flew off but my steering wheel still felt as if I had four wheels.

So why would you have software that would mask a problem like this? Can you explain?

Mr. ELWELL. Senator Rosen, thank you for asking that question because if that's the impression I gave on what MCAS does, then I'm sorry because that's not what it does. It doesn't mask a problem.

Senator ROSEN. Well, you said it makes the plane feel like it's flying to the pilot like it should.

Mr. ELWELL. Well, see, what fly-by-wire technology does and that's what the Max is, you know, when planes were first designed and flown, the yoke was connected to cables and pulleys and so you had direct interaction, physical interaction with the flight controls. Pilots had the feel, sort of like when you're driving your car, you turn the wheel.

Senator ROSEN. Right. So the instrument's telling you one thing and the feel's telling you another with the MCAS?

Mr. ELWELL. No, that's not quite how it works. What the MCAS does is it is a computer program that feeds information to the yoke so that the input the pilot makes to the yoke is proportional to what the flight controls do. It doesn't mask any problem. What it does is give the proper feel to a pilot because he doesn't have those cables and pulleys.

Senator ROSEN. So he would feel as if the nose were going down, going up, whatever he would feel?

Mr. ELWELL. He would feel it and in fact that is what happened and that's what happens if any computer or any device, even the pitch trim motor, does something to the nose of the airplane, the pilot's going to feel it.

Senator ROSEN. Would feel that in his——

Mr. ELWELL. Yes, yes, absolutely.

Senator ROSEN. Thank you very much. I appreciate it.

Senator CRUZ. Senator Udall.

**STATEMENT OF HON. TOM UDALL,
U.S. SENATOR FROM NEW MEXICO**

Senator UDALL. Thank you, Chairman Cruz and Ranking Member Sinema, for holding this important hearing, and I know you guys have been here for two hours. So I'll try to just get to the point here.

I first requested an aviation hearing on aviation safety last April when in Albuquerque we lost a shining light, a woman by the name of Jennifer Riordan. She was flying home from Philadelphia on a Southwest Airlines flight when a fan blade caused an engine to fail, you guys are nodding you understand this one, shattered a window and partially pulled Mrs. Riordan out of the plane.

This incident was shocking but it was not the first time this engine type failed, and I know that this is just a first of a series of conversations on how we can improve the oversight of the Federal Aviation Administration, including rethinking, if necessary, the airworthiness certification process.

Another important issue we must discuss is the integrity of the engines that are used. Many of us may not be aware but yesterday, Southwest Airlines 727 Max engine, a CFM Leap 1B, had an emergency landing during a flight to the Southern California Logistics Airport. This is at least the third Southwest Airlines that has had an emergency airline caused by engine troubles, all stemming from the same manufacturer of engines.

Mr. Chairman, I would seek unanimous consent to add an article on these engine troubles from the *Seattle Times* to the record.

Senator CRUZ. Without objection.

[*Seattle Times* newspaper article follows:]

The Seattle Times—Originally published June 15, 2018 at 6:00 am / Updated June 18, 2018 at 10:37 am

TRoublesome Advanced Engines for Boeing, Airbus Jets Have Disrupted Airlines and Shaken Travelers

By Dominic Gates—*Seattle Times* aerospace reporter



In 2014, Air New Zealand and Boeing showed off the first delivered 787-9 Dreamliner at Paine Field in Everett as finishing touches were put on the casing of a Rolls-Royce Trent 1000 engine. (Mike Siegel/The Seattle Times)

A slew of technical problems with the three latest-technology jet engines is widely disrupting operations at airlines, bleeding cash from the engine makers and grounding significant numbers of Airbus and Boeing jets.

A slew of technical problems with the three most advanced models of jet aircraft engines is widely disrupting operations at airlines, bleeding cash from the engine makers and grounding significant numbers of Airbus and Boeing jets.

The most difficult of the issues has this month left almost 50 Boeing 787 Dreamliners sold to some of the world's top airlines sitting powerless on the ground, waiting for engines before they can fly again.

And if the problem isn't contained, it could derail Boeing's plan to raise the 787 production rate next year.

British engine manufacturer Rolls-Royce has been inspecting its Trent 1000 engines on the Dreamliners for cracked turbine blades deep inside, and taking off those with cracks for repair.

The number discovered to have problems has "outstripped our ability to support the customers with spare engines," said Trent 1000 project director Gary Moore in an interview.

"We are causing a very disproportionate amount of disruption at this moment."

Steve Udvar-Hazy, chairman of Air Lease Corp. and a leading figure in the airline world, said disruption from the grounded jets is compounded by airlines having to reroute some of the Dreamliners they can still fly.

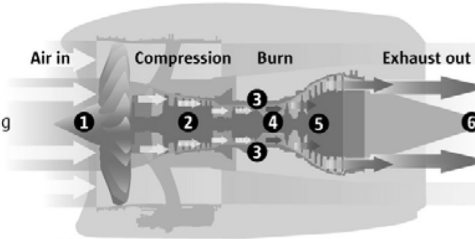
Flights across the Pacific, in particular, can no longer fly normal routes because, in case of an engine emergency, safety agencies now limit Dreamliners powered by one of the Trent 1000 engine models under scrutiny to *flying no more than 2.3 hours from the nearest airport*—down from 5.5 hours previously.

"It's having a huge impact. It affects a lot of the key 787 operators," said Udvar-Hazy. "There's a lot of scrambling going on."

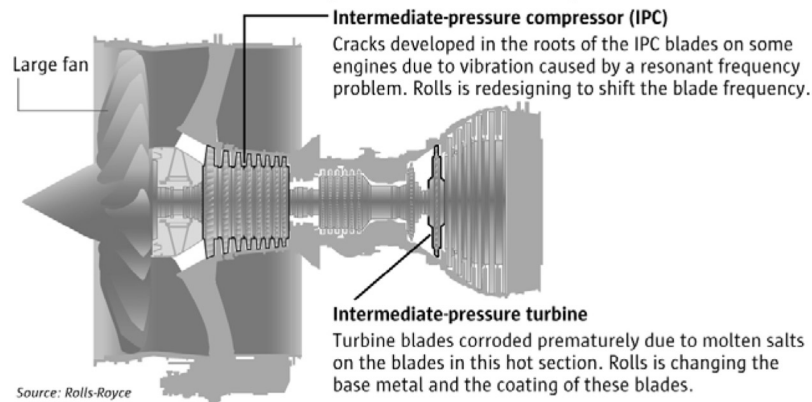
Trouble with new jet engines grounds planes

How a jet engine works

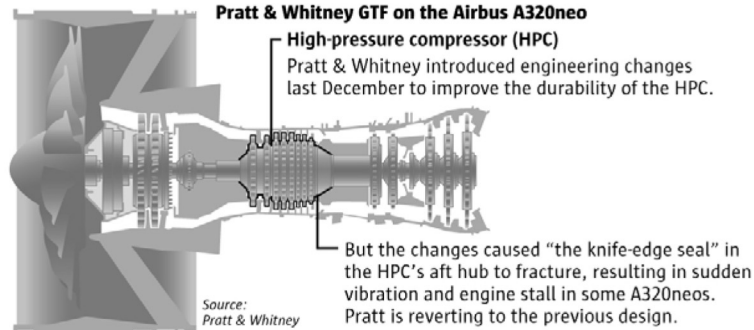
1. Large fan draws air in.
2. The air is compressed.
3. Compressed air is mixed with fuel.
4. Mixture is ignited and burned, creating hot, rapidly expanding exhaust.
5. Exhaust spins turbines that turn the large fan (1), repeating the process of drawing more air into the engine.
6. As the exhaust exits the engine, it generates thrust.



Rolls-Royce Trent 1000 on the Boeing 787



Pratt & Whitney GTF on the Airbus A320neo



Reporting by DOMINIC GATES, Graphic by MARK NOWLIN / THE SEATTLE TIMES

No quick fixes

The impact won't be short term.

Rolls is returning the repaired engines to airlines with only a temporary fix. A permanent modification won't be available until the end of the year at the earliest. "Those engines will have to come back to us when the final fix is available," said Moore.

Meanwhile, repeated technical problems with another engine—Pratt & Whitney's Geared Turbofan (GTF), the innovative new design that will power close to half of the Airbus A320neo fleet—have caused Pratt to fall way behind in deliveries, leaving engineless planes to stack up on the ground at Airbus factories.

At a gathering of the world's top airline executives in Sydney this month, Guillaume Faury, the new president of Airbus Commercial Aircraft, said that by the end of June the European jetmaker will have about 100 otherwise completed A320neos sitting grounded without engines outside its final-assembly plants in Toulouse, France, and Hamburg, Germany.

"We have an industrial crisis to manage," Faury told trade publication *Aviation Week*.

In comparison, the problems with the third engine—CFM International's LEAP engine, which powers the rest of the Airbus A320neos and all of Boeing's 737 MAXs—are less severe.

Boeing says it's been able to minimize the impact on MAX deliveries. But CFM had to remove dozens of LEAP engines from A320neos for repair, and LEAP deliveries to Airbus are running up to six weeks behind schedule.

Problems emerge late

These latest engines, all marvels of sophisticated engineering, incorporate significantly new technologies: new alloys in the Trent 1000, a gearbox to slow the fan speed in the GTF, ceramics in the hottest part of the LEAP.

All were certified as safe by the Federal Aviation Administration (FAA) and its European equivalent, the European Aviation Safety Agency (EASA).

And all three are powering the latest generation of fuel-efficient Airbus and Boeing aircraft where production rates are rising sharply to levels never before anticipated: heading up to 14 jets per month for the widebody 787, and to 60 jets per month and higher for the narrowbody 737 and A320 aircraft.

"The new technology aircraft bring tremendous economics and operating performance to the airlines, but they are only as good as the engines," said Udvar-Hazy. "We have never seen this unprecedented number of aircraft scheduled to be produced at the very time when we have all these engine issues."

Unfortunately, so-called "teething problems" with new technology may not show up until the engines have been used for several thousand hours in all kinds of climate conditions.

"The issue with engine certification is that's there's really no substitute for in-service experience," Hazy said.

FAA spokesman Les Dorr said the safety agency monitors newly certified engines after they enter service for issues "that were not evident in the certification phase."

Most Read Business Stories

- 1 Apple says it plans to turn Seattle into 'key engineering hub' with 2,000 new workers
- 2 Seattle is 'a notable exception' for stalled home prices
- 3 Sellers in Amazon's bookstore feel beaten up by counterfeit Wild West
- 4 Housing crunch sends bigger populations to smaller towns
- 5 Nintendo's Doug Bowser begins his reign, enjoying jokes about his namesake Mario nemesis

And when engine makers come up with fixes to such issues, they cannot be installed on airplanes until the FAA analyzes, tests and certifies the changes.

"Engine modifications undergo the same scrutiny. . . as original designs," Dorr said.

Airline trouble

The public's belief in airplane and jet-engine safety is understandably shaken by terrifying accidents such as the April engine explosion on a Southwest Airlines 737 that killed a female passenger when shrapnel from the engine shattered the window by her seat, depressurizing the plane and partially sucking her out of the aircraft.

Yet that was the first U.S. airline-passenger fatality due to an accident in more than nine years, and the first in Southwest's history. The engine that exploded, the

CFM-56, has been in service since 1997, has flown for some 350 million flight hours and has a reliability record second to none.

Statistically, flying is the safest form of modern travel.

Jet engines have become so immensely reliable that four-engine airliners are fading into the past. Planes with just two engines safely traverse vast expanses of oceans every day. If one engine fails in flight, those jets readily fly for hours on the remaining engine to the nearest airport.

And all the newest engines send critical performance data to the ground in real time while in the air, so any irregularities are quickly detected.

The latest engine issues have produced in-flight engine shutdowns and aborted take-offs but no incidents that put passengers at risk. So for the airlines, the risk is more to the reliable operation of the airplanes than their safety.

Still, even the potential for the flaws to affect both engines of a twin-engine plane while in flight was enough to spook safety regulators to issue directives restricting flights on both the Rolls and Pratt engines.

And the trouble created for the airlines, for Airbus and Boeing, and especially for the engine makers, is serious and very expensive.

To satisfy the safety regulators and mitigate the impact on airline operations, Rolls, Pratt and CFM are throwing engineering resources and money at the technical problems.

"It's a very painful thing for all of them," said Udvar-Hazy.

On Friday, Rolls updated its projection of the cost of dealing with the Trent engine crisis to a total of almost \$950 million.

787 engine flaw

The latest hit to Rolls came when it was still dealing with the fallout from an earlier Trent 1000 technical problem: corroded turbine blades in the hot rear section of the engine.

After redesigning those blades with a new base metal and a new coating, retrofitting the engines in service is still ongoing.

The more recent, and now more pressing, problem showed up when cracks were found in the roots of the blades of the Intermediate-Pressure Compressor (IPC), behind the fan at the front of the engine.



Technicians make adjustments to a Rolls-Royce. . . (Mike Siegel/The Seattle Times) More

Moore pointed to a design flaw: The vibrating frequency of the compressor blades of the engine at high thrust, magnifying the vibration to a level that over time caused the cracks to develop.

The immediate need was to inspect the susceptible engines—initially the “Package C” version of the Trent 1000, a total of 383 engines—and remove any with cracks for repair.

The problem intensified when fractured blades and excessive vibration led to several inflight engine shutdowns and aborted takeoffs.

In response, safety regulators gave Rolls until June 9 to complete an initial set of inspections on Package C engines that have clocked more than 300 flights, though all will have to be inspected eventually.

Two days after that deadline passed, Rolls announced that the problem had spread: It found cracks in the IPC blades in a small number of engines that are a different Trent 1000 variant, the “Package B” model.

That adds another 166 Dreamliner engines that must be inspected.

Intense response

Rolls must act fast or its rival GE, which also builds Dreamliner engines, will grab its market share.

Within a month of finding the original IPC problem, Rolls engineers developed and certified an ultrasonic inspection method to detect the invisible cracks in the interior of the blades without taking the engines off the wing.

It opened facilities in Singapore and the U.K. dedicated solely to those repairs—dismantling the engines, replacing the cracked blades, treating the remaining blades to close up any invisible micro-cracks, and applying a protective lubricant.

British Airways, Air New Zealand, Virgin Atlantic, Norwegian and LATAM Airlines of Chile were among the airlines forced to ground jets when engines were removed for repair with no replacements.

Willie Walsh, chief executive of British Airways parent IAG, said six of the airline's 26 Dreamliners are currently grounded, and he now expects he won't get all of those back in service until late July.

“I have no issue with Boeing, who have been proactive and supportive . . . I am however, very unhappy with Rolls-Royce,” Walsh said, via e-mail. “They have yet to give us confidence that they are on top of the problem.”

British Airways and Virgin Atlantic leased Airbus A330 aircraft to fill the schedule gap. Air New Zealand leased two Boeing 777s to fill in. Norwegian leased a four-engine Airbus A340 gas-guzzler to fly its Paris-Los Angeles route.

Rolls hopes by year end to certify a permanent fix—a redesigned blade with tolerances tweaked to shift its resonant frequency.

More on Aerospace

Bombardier sells CRJ jet program to Mitsubishi for \$550M

SpaceX launches hefty rocket with 24 satellites, experiments

‘I’m having a bad dream’: Air Canada reviews how crew left passenger on parked plane

The inside story of MCAS: How Boeing’s 737 MAX system gained power and lost safeguards / Times Watchdog

Trump shifts to talk of Air Force One

SpaceX, Boeing continue to struggle with spacecraft designs, as watchdog raises safety concerns

Moore said Rolls engineers are now testing the first modified hardware in a development engine at a facility in Derby, U.K., to verify that “we have moved the blade’s frequency to a point where I no longer have concerns.”

A second test engine will be used to confirm that the engine’s overall operation is unaffected by the change to the blades.

Next year, Rolls plans to gradually remove all those repaired engines once again to install the permanent modifications.

Meanwhile, Boeing deployed teams worldwide with Rolls-Royce to try to mitigate the disruption at affected airlines and tapped senior executive Keith Leverkuhn to work directly with Rolls.

“Keith and I talk every day,” said Moore.

Knife-edge seal

For Pratt & Whitney’s new GTF engine, *developed starting in the early 2000s at a cost of more than \$10 billion*, the advance worry was that it might run into trouble with the engine’s big technology innovation: the gearbox that allows the fan to run slower and more efficiently.

It turns out the gearbox has operated smoothly with no issues. However, the GTF did run into a rash of other “teething problems.”

Though Pratt developed fixes for all of them and the latest engines it’s building are up to date with those fixes, GTF production has been hampered and delayed, and deliveries to Airbus were interrupted.

Spokeswoman Jenny Dervin said the latest problem arose after a batch of engineering changes were introduced last December to improve the durability of the High Pressure Compressor (HPC).

Instead, the changes caused “the knife-edge seal” in the HPC’s aft hub to fracture, resulting in sudden vibration and engine stall in some A320neos. This led to several inflight engine shutdowns and aborted take-offs.

“By the end of January, we knew we’d have to recall the engines,” Dervin said.

Only 98 engines had been built with the defective seals—43 in service and another 55 still at the Airbus final assembly plants.

In February, EASA issued an airworthiness directive prohibiting airlines from flying any plane that had the defect on both engines. India’s air-safety regulator grounded planes having even one such engine.

By now, no GTF engines flying anywhere have the defective seal. For Pratt, what remains is to clear the backlog of engines to be delivered to Airbus.

Loss of a thin coating

For CFM’s LEAP engine, and specifically for Boeing’s 737 MAX, the introduction into service has been smoother. On the MAX and the Airbus A320neo, LEAP engines are now powering 342 aircraft with 56 airlines.

However, the LEAP was hit by one technical glitch related to a key innovation: a ceramic composite lining that shrouds the hottest part of the engine, the first rotor of the High-Pressure Turbine just aft of the fuel combustion chamber.

This ceramic material requires a thin protective coating. Rick Lowden, a research scientist at Oak Ridge National Laboratory, which developed the ceramic material, said that without such a coating, moisture in the gas emerging from the combustor will oxidize the ceramics and gradually “eat it away.”

CFM spokeswoman Jamie Jewell said engineers found a “premature loss” of this coating in service.

“This is not a safety or operational issue,” Jewell said, adding that the problem hasn’t caused any incidents during thousands of hours of engine tests and more than a million engine in-service flight hours.

To fix it, CFM designed a new coating. That’s being introduced into full-rate production for aircraft deliveries starting this month.

And about 60 LEAP engines were removed from A320neos for modification, none from 737 MAXs.

“Each of those removals were scheduled in advance and we are supporting the removals with around 70 spare engines,” Jewell said.

Boeing said that there have been some delays in delivery of MAX engines but so far no airplane deliveries are late.

Flying hotter, tighter and harder

Airlines today operate jet engines harder than ever before. They’re built to tighter tolerances and operate at higher pressures and hotter temperatures.

They fly many more flights and much longer flights than in the past.

Boeing projects that the 2016 worldwide airliner fleet of 23,500 jets will double in the next two decades, swelling the number of engines in the sky.

But near term, the plans by Airbus and Boeing to hike A320neo, 737 MAX and 787 production significantly in the next two years cannot happen until the engine makers sort out their problems and ramp up production.

To deliver the reliability airlines demand on the narrowbody jets, Pratt & Whitney and CFM must hope no further teething pains develop.

Rolls-Royce faces a more existential crisis.

It’s separately going through a drastic financial and corporate restructuring costing \$670 million and on Thursday announced layoffs of 4,600 employees over the next two years.

A Rolls nightmare would be if the same blade-durability problems show up later on the remaining variants of the Trent engine: the newest version for the 787 the Trent TEN, or the Trent XWB for the Airbus A350, or the Trent 7000 for the Airbus A330neo.

To survive, Rolls needs to convince airlines soon that the Trent’s technical problems are finally contained.

Senator UDALL. My first question will be to Mr. Scovel.

As you heard, a constituent of mine was killed last year in the Southwest Airlines accident because of a CFM engine failure. You have initiated an audit of the safety practices.

What is your timeline for completing this audit and will you include this most recent engine failure in your inquiry?

Mr. SCOVEL. Thank you, Senator.

For your first question, our timeline, we anticipate completing our review of Southwest Airlines maintenance practices by the end of this summer. We're looking not only at maintenance practices but also at certain operational issues to include and weight balance questions, and also a concern that was brought to our attention about Southwest's acquisition of a certain number of used aircraft and the fact that they may be flying in the United States reportedly without proper documentation. We don't know. That's one of the things that we need to look into to complete our audit.

Senator UDALL. And are you going to use the most recent engine failure in your inquiry?

Mr. SCOVEL. We'll see what we can derive from that. The one last night, sir, off the 737?

Senator UDALL. All three of the ones I mentioned.

Mr. SCOVEL. For the first two, yes and we'll see what information is available to us regarding the most recent one. Yes, sir.

Senator UDALL. Chairman Sumwalt, in your testimony, you referenced a Southwest Airlines accident that took the life of Ms. Riordan. I know the initial investigative hearing was held in November, but I'm concerned about the impact that the government shutdown may have had on the investigation. As you can imagine, the Riordan family is anxious to receive the information from the investigation.

Can you tell me when the final report will be ready?

Mr. SUMWALT. Yes, sir. Thank you for that question.

I was the board member on scene in Philadelphia. I'm very familiar with that tragic event. In November, we pointed out in the investigative hearing that we had some modeling and some structural analysis to do. We have completed that. We're in the process now of drafting the final report.

So the report will be completed later this year. I will say if we find any need for any urgent safety recommendations, we are postured to be able to do that.

Senator UDALL. Great. Thank you.

Mr. Scovel, one other question for you. As you know, Boeing is one of the largest, most powerful companies in the country, and a major government contractor with deep and wide connections in Washington. This plane was key to Boeing's future financial success. The company was locked in an intense competition with Airbus. Reporting has indicated that the FAA faced vigorous lobbying to approve the design and features of this plane so it could get it to market as soon as possible.

Political appointees were urging career staff to get the work done and a huge portion of that safety review work was taken on by Boeing itself so that it was self-certifying its own safety.

Given the size of Boeing and their political power, do you think the FAA is truly capable of regulating them in an independent way, and what changes need to be made in the relationship between this company and its regulator to ensure that the safety of the flying public remains the paramount interest, not the quarterly profits of this company?

Mr. SCOVEL. Senator, FAA has authority, complete authority currently to exercise responsibility over—

Senator UDALL. Are they too cozy? Are they too cozy? That's my pointed question right there with the industry.

Mr. SCOVEL. I don't have information yet to directly answer your question. The focus of the first part of our ongoing audit will be the certification process that FAA and Boeing employed to approve the 737 Max. We hope to have some information that'll inform your decisionmaking on that when we complete our audits.

Senator UDALL. Well, it is good. It's really important and in this age where we talk about captured regulators and things like that that you weigh in on these kinds of issues about are they truly capable of doing their job.

Thank you, and thank you for the courtesies, Mr. Chairman, for going over.

Senator CRUZ. Thank you, Senator Udall.

Mr. Ellwell, there were a couple of factual issues that came up during the course of the hearing that we're going to follow up with written questions and ask you to clarify.

One factual issue on which there was dispute, as you and I discussed, the New York Times and others have reported that on the earlier versions of the 737 when you pull back the yoke that it disengaged the stabilization system but that that did not happen on the 737 Max.

Your testimony to me, if I understood correctly, was that that was not correct, although I heard Chairman Sumwalt disagree on that point.

So we're going to ask you in writing to clarify how the system operates. I think it's important to have a shared set of—an agreed set of facts and to understand.

Likewise, when I asked you about the simulations that pilots did as part of the certification, I asked in particular if any of those simulations involved a faulty sensor producing faulty data and how to respond to it.

My recollection is you were not certain as to the answer of that. So I'm going you to go and verify and give us a clear answer to that.

[Mr. Ellwell's answer follows:]

The MCAS system is designed to assist pilots during manual operation. On earlier versions of the 737, and on the 737 MAX, pulling back on the yoke disables the speed trim system, but does not disable the MCAS on the 737 MAX.

Senator CRUZ. I want to read to you some portions of an article from Reuters from March 19, 2019, that purports to describe what happened on the Lion Air crash and Reuters reported, "The pilots of the doomed Lion Air Boeing 737 Max scrambled through a handbook to understand why the jet was lurching downwards in the final minutes before it hit the water, killing all 189 people onboard, three people with knowledge of the cockpit voice recorder contents said."

The article goes on to describe, "The captain was at the controls of Lion Air Flight JT610 when the nearly new jet took off from Jakarta and the first officer was handling the radio, according to preliminary report issued in November. Just two minutes into the

flight, the first officer reported a "flight control problem" to the air traffic control and said the pilots intended to maintain an altitude of 5,000 feet.

First officer did not specify the problem but one source said air-speed was mentioned on the cockpit voice recording and a second source said an indicator showed a problem on the captain's display but not on the first officer's. The captain asked the first officer to check the Quick Reference Handbook, which contains checklists for abnormal events, the first source said.

For the next nine minutes, the jet warned the pilot it was in a stall and pushed the nose down in response, the report showed. A stall is when the air flow over a plane's wing is too weak to generate lift and keep it flying.

The captain fought to climb but the computer still incorrectly sensing a stall continued to push the nose down using the plane's trim system. Normally trim adjusts an aircraft's control surfaces to ensure it flies straight and level.

They didn't seem to know that the trim was moving down, the third source said. They talked only about airspeed and altitude. That was the only thing they talked about."

Do you have any reason to doubt that account of what occurred in the final minutes of that flight?

Mr. ELWELL. Well, Senator, the information I have is that actually there has not been—and I would defer to Chairman Sumwalt on this, but—

Senator CRUZ. Please chime in, as well.

Mr. ELWELL.—that the cockpit voice recorder is not available to—I certainly haven't seen a readout and if I did, to Chairman Sumwalt's point earlier, I wouldn't be at the liberty to even talk about it.

But I would—and this actually is linked to what you said earlier about the confusion about whether the 737 Max, when you pull back, it stops, and I will admit to not having flown it and maybe not getting that right, but what certainly—and I will react to what you read, but I will qualify it by saying it is entirely possible that what was written is not accurate.

But I will tell you, as I said numerous times in this hearing, pilots of large aircraft are trained from day one when the pitch of the aircraft is doing something you're not telling it to do, you do run-away pitch trim checklist and in every plane I've ever flown, it's called the Memory Item. You're not fumbling through books. It's a time-critical procedure and you go to that. You do it in the sim when you fly. It's a memory item.

So some of what you read there, I can't tell you if that's accurate. I can't tell you if that's straight from the investigation or CVR. It disturbs me because it is not the way I was trained and what I would expect pilots to do in that situation.

Senator CRUZ. You have any explanation for why something like this might have happened, if the report is accurate?

Look, I'm not a pilot, but certainly the picture that is painted there of the pilot frantically looking through the checklist as the nose continues to adjust downward and as the pilot is unable to correct that problem, that is not an image that instills comfort or

confidence, and it does not suggest that the pilot is aware of how to correct for the system that is adjusting the nose downward.

Do you have any explanation in terms of the training that pilots undergo, how that would come to be?

Mr. ELWELL. Mr. Chairman, it would be inappropriate for me to comment any further on, first, an article whose veracity I can't ascertain right now, and I've no comment on—other than, yes, it sounds like a terrible situation, but I have no way of knowing that that account is accurate. So it would be inappropriate for me to comment on it.

Senator CRUZ. But there's nothing in the pilot training that the FAA required about the MCAS System and how to correct for it, is that accurate?

Mr. ELWELL. Senator, the MCAS is not something you fly. It's not something you would get in a simulator and fly the MCAS.

Senator CRUZ. I didn't say you'd fly the MCAS. I said there's nothing in the pilot training about the MCAS System adjusting the nose of the plane downward and how to compensate for that in the event of a malfunctioning sensor. Is that accurate that the training does not include that?

Mr. ELWELL. Senator, Senator, I would actually say that it is accounted for in the training and the accounting for that in the training is that that MCAS—inappropriate input of the MCAS is runaway pitch trim and runaway pitch trim is trained and trained and trained by every pilot who flies a large aircraft.

Senator CRUZ. Chairman Sumwalt, do you have any additional points on this line of inquiry?

Mr. SUMWALT. No, sir, I do not.

Senator CRUZ. OK. One final avenue of questions, Mr. Scovel.

I want to draw your attention to a June 22, 2012, memorandum from your office titled FAA Transport Airplane Directorate, Seattle, Washington. Are you familiar with this document?

Mr. SCOVEL. Yes, I am, Mr. Chairman.

Senator CRUZ. Good. The 2012 memorandum specifically states that your office's investigation "substantiated employee allegations that TAD," which is the FAA's Transport Airplane Directorate, "and FAA Headquarters managers have not always supported TAD employee efforts to hold Boeing accountable," and it further discusses TAD employee concerns that Boeing employees in the Boeing Certificate Office might have "delivery of airplanes as part of their performance standards."

The concerns described in that memo paint a troubling picture of agency capture. Do the concerns in the 2012 memo, do you still have those concerns, and do you see an ongoing pattern like that described in the 2012 memo?

Mr. SCOVEL. Mr. Chairman, I'm confident they fully describe my office's findings at the time in 2010, 2011, and early 2012, when we were doing the investigation work that led to that memorandum from the Office of Inspector General to FAA.

I don't know in 2019 whether those conditions still prevail.

Senator CRUZ. Well, this Subcommittee will eagerly await your investigation and assessment of that question because it is a critical question for evaluating ongoing safety.

Senator Blumenthal.

Senator BLUMENTHAL. Thanks, Mr. Chairman.

Let me just ask a few questions pursuing that same avenue, Inspector General Scovel.

I'm assuming that that issue of agency capture or improper influence will be part of the investigation you're doing in response to my request, correct?

Mr. SCOVEL. Yes, it certainly will be, and I should add we're always on the lookout for it. We've called it out in the past.

Senator BLUMENTHAL. That's your job.

Mr. SCOVEL. It is. We've done it several times with individual FAA employees in their roles as inspectors at Southwest, at American most recently, and in a report that we issued last summer, and in the 2012 report involving FAA employees at the FAA ODA Oversight Office in Seattle.

Senator BLUMENTHAL. So you'll be looking for any calls or contacts from Boeing or airlines or anyone else that may have impacted the FAA decisionmaking?

Mr. SCOVEL. It's part of the certification process and that's what you and the Secretary and others have requested. That's the mail we're going to answer, sir.

Senator BLUMENTHAL. Mr. Elwell, when we finished, we were talking about the decision to ground the airplanes, which you said was your own exclusively, correct? How did it happen then that it was announced by the President?

Mr. ELWELL. Senator Blumenthal, as I testified earlier, from the moment of the Ethiopian accident and I became first aware of it till I grounded the airplanes, I briefed and kept the Secretary and the President apprised of all of our actions, as I would always do with something this significant, and shortly after—leading up to and then shortly after making the decision to ground the aircraft, I again briefed the Secretary and the President and the President, it came to my attention, was very shortly thereafter going to an already-planned press event and as is his prerogative as Commander-in-Chief, he talked about the briefing that I gave and what my intentions were and it actually preceded the official announcement of the Emergency Order.

Senator BLUMENTHAL. So you briefed him——

Mr. ELWELL. So that was the timing.

Senator BLUMENTHAL. You briefed him directly?

Mr. ELWELL. I briefed the President and the Secretary on my decision and the data and the actions that led up to it.

Senator BLUMENTHAL. Had he contacted you or anyone else in the White House contacted you previously to that time?

Mr. ELWELL. I kept the White House or the President and the Secretary fully briefed and apprised of my actions leading up to the grounding.

Senator BLUMENTHAL. So between the time of the second crash and the announcement of your decision, there were contacts between you and the White House?

Mr. ELWELL. I briefed the Secretary and the President on the developments and kept them apprised.

Senator BLUMENTHAL. And they gave you their views as to whether the plane should be grounded?

Mr. ELWELL. Well, sir, I briefed them on where I was going with my data collection and my thinking right up until I grounded the aircraft.

Senator BLUMENTHAL. And let me repeat my question in case it wasn't clear.

Mr. ELWELL. Yes, sir.

Senator BLUMENTHAL. Did they indicate to you, did they express to you their views on whether that plane should be grounded?

Mr. ELWELL. Well, Secretary Chao never gave me any—told me to ground or anything like that and consistent with longstanding Executive Branch practice over many Administrations, I'm not going to go into details of conversations I had with the President.

Senator BLUMENTHAL. Well, what's your claim of the reason to refuse to answer that question?

Mr. ELWELL. Well,—

Senator BLUMENTHAL. Is that executive privilege? There is no executive privilege.

Mr. ELWELL. No, Senator. No, Senator. I'm just saying that consistent with longstanding Executive Branch practice, many, many Administrations, I'm not going to sit and get into details about my conversations with the President. It's a longstanding Executive Branch practice.

Senator BLUMENTHAL. Really?

Mr. ELWELL. Yes, sir.

Senator BLUMENTHAL. Well, are you telling me that you are not going to tell this committee what the President told you about grounding the aircraft before you made that decision?

Mr. ELWELL. Senator, I am just simply saying that I'm not going to get into details about conversations I had with the President. It's a longstanding Executive Branch practice.

Senator BLUMENTHAL. I'm not aware of that longstanding—is that grounded in law and, if so, what law?

Mr. ELWELL. Well, sir, I am not a lawyer, but I'm not going to talk about conversations that I had with the President.

Senator BLUMENTHAL. Well, I can't force you to. I don't think we can order you because we don't have that authority as of right now, but I'm going to pursue that issue.

Mr. ELWELL. Yes, sir.

Senator BLUMENTHAL. Let me ask you. Under the ODA, is there protection for whistleblowers if and when they come forward?

Mr. ELWELL. Sir, it is my understanding that there's protection for whistleblowers at all times, ODA or otherwise.

Senator BLUMENTHAL. Well, let me rephrase it. Is there protection for whistleblowers at Boeing? In other words, the Boeing employees who have responsibility, they're hired, fired, potentially disciplined, if they make decisions adverse to the company's interests?

Mr. ELWELL. Well, Senator Blumenthal, that is an excellent question, and I'm not sitting here knowing. I don't know Boeing's policies with regard to employee whistleblowers. There may in fact be in the agreement, the ODA Agreement that we have with the manufacturer a requirement for them to take on our whistleblower protections, but I will get back to you. I'm not sure sitting here.

Senator BLUMENTHAL. I appreciate your getting back to me. You're not aware of any protection for whistleblowers as you sit here?

Mr. ELWELL. I'm not aware that there is or there aren't, but I will get back to you, sir.

Senator BLUMENTHAL. Are you aware of any whistleblowers coming forward about the Boeing 737 Max 8?

Mr. ELWELL. I'm not aware of whistleblower complaints particularly to what was being discussed earlier about management pressure particularly. I've not gotten any from FAA employees. In fact, one charge that was in one article that it was claimed that FAA employees in Seattle were being rated against production rates and I did look into that to see if there was any evidence of that or any complaints in that area and the answer was no.

Senator BLUMENTHAL. Are you aware of any incentive bonuses or payments by Boeing for certification decisions?

Mr. ELWELL. You mean Boeing incentives to their employees?

Senator BLUMENTHAL. Well, they're the ones who are employed in this Certification Program, the ODA, right?

Mr. ELWELL. Correct. And I'm not aware of that.

Senator BLUMENTHAL. OK. I just have a couple more questions. I really appreciate it, Mr. Chairman.

You and I talked in a briefing that you were kind enough to provide some time ago and you indicated in response to one of my questions about the government shutdown that it was not in any way responsible for the delays in the development of new software for the MCAS System, correct?

Mr. ELWELL. Yes, sir.

Senator BLUMENTHAL. So you are saying that any reports of the impact of the government shutdown on any of the issues involved here is not true?

Mr. ELWELL. Well, Senator Blumenthal, I remember the question and we actually got the question. The reason I was able to answer you is because we had had that inquiry earlier and we checked and for the work that we had to do on the software update, we actually recalled the individuals. There was no delay in the certification or the work on that and because of our role of continuous operational safety, there was—the shutdown did not impact our examination or participation in continual operational safety post Lion Air.

Senator BLUMENTHAL. And I think you explained to me that the reason was that those employees were deemed to be essential to safety—

Mr. ELWELL. Yes, sir.

Senator BLUMENTHAL.—and therefore essential employees, as well.

Mr. ELWELL. Yes, sir.

Senator BLUMENTHAL. Just a couple more questions. On the issue of training, and I appreciate the courage and strength of the families coming to Congress and I'm struck by I guess the feeling I would have that the training here really could and should have been better for these pilots, and I know that the investigation will go into the technical issues, but as a passenger and a layman, my feeling was the training should have been better. Would you agree?

Mr. ELWELL. Senator Blumenthal, foreign accidents, as Chairman Sumwalt mentioned, bring with them investigative challenges. We are at the very earliest stage in the Ethiopian accident.

Our responsibility of continuous operational safety means that if anything comes out of these investigations that goes directly to training, we would know about it so that we could relay that information to the pilots and the system we oversee.

Of course, we don't oversee and regulate the training of foreign practices but we do audit the Civil Aviation Authorities of countries that fly to the U.S. and I believe that this is an area that we will look into very, very carefully because I believe we can use the FAA's credibility internationally and despite what you might read in the press, I believe that the FAA still is the gold standard, still has the credibility around the world to make change.

We fight for it all the time. Our goal is to raise the safety bar everywhere and that's what I'm going to try to do for the rest of my time in government service.

Senator BLUMENTHAL. Well, I'm hoping and I am going to take that answer as a yes because I think very unequivocally the training should have been better and I welcome steps to make sure it is better in the future. Thank you.

Senator CRUZ. And let me follow up on Senator Blumenthal's questions, both about training and whistleblowers. I want to ask in particular about a March 12 article in the *Dallas Morning News* that was entitled Several Boeing 737 Max 8 Pilots in the U.S. Complained About Suspected Safety Flaw, and the article begins by saying, "Pilots repeatedly voiced safety concerns about the Boeing 737 Max 8 fleet to Federal authorities with one captain calling the flight manual "inadequate and almost criminally insufficient" several months before Sunday's Ethiopian air crash that killed 157 people.

Are you familiar with these pilot complaints that are being referenced in the *Dallas Morning News* story?

Mr. ELWELL. Mr. Chairman, I am. That is a report, part of the group of 24 reports that I reviewed personally and that the FAA has reviewed. They are ASRS reports, otherwise known as NASA reports. They were the first foray in our efforts to have voluntary reporting and the history is important on voluntary reporting with regard to ASRS reports.

I wrote many of them in my time as a commercial airline pilot and the reason that they were in place is we wanted to see if pilots could make reports of mistakes that they've made in the field out in the system and be indemnified as long as it was an honest mistake. Could we gather enough data and information to make safety enhancements and make the system better? It's been one of the most successful programs that we've issued.

Now when I did them, I handwrote them. They weren't Flintstone but they were—I handwrote them. Now they're computer-entered and we looked at every one of those reports. Now I don't know if the one you just quoted went to an event review team, but when we find in these reports charges or problems that need to be addressed more robustly, that's what we have. We have an event review team. We bring the person who made the report

in with airline officials, with FAA officials, and we sit down and we review the report.

That particular report, as I said, there have been 57,000 flights since we introduced the Max in the U.S. and that, to my knowledge, is the only report of its kind from a pilot about the inadequacy of the manuals. Like anything, we do a risk-based analysis. We look at the body of reports and the body of data.

I will look into whether or not that individual and his complaint was addressed appropriately and get back to you.

Senator CRUZ. OK. I would very much appreciate that. I will say as someone who flies myself every week on commercial airlines and my family flies every week and millions of Americans fly regularly on these planes, we need the flying public to have confidence about safety and I'll also note in the state of Texas, tens of thousands, if not hundreds of thousands of jobs depend upon the aviation industry and so that confidence is critically important, and I have to say as a passenger, I would certainly find it troubling.

[Mr. Elwell's answer follows:]

ASRS report 1593017 notes that a Boeing 737 MAX Captain expressed concern that the flight manual did not fully describe the Maneuvering Characteristics Augmentation System (MCAS) and the Angle of Attack (AOA) system. Although we investigated this report and determined the assertions were not actionable, the certification of the MCAS software fix will include additional information on the MCAS function.

Senator CRUZ. This is according to the *Dallas Morning News*, a captain, if the captain is describing the training manual as "inadequate and almost criminally insufficient," that is a pretty serious charge and so I would appreciate your getting back with the basis of that.

Does that complaint that is referenced and those other complaints, does that trouble—I want to give Chairman Sumwalt and Mr. Scovel an opportunity to comment on that story and those allegations.

Mr. SUMWALT. Chairman Cruz, in a former life, I was a consultant to the NASA Aviation Safety Reporting System and one of the caveats that ASRS puts around their data is that they are unverified and that there are various reporting biases known and unknown. They put these caveats on every ASRS request.

If you were to request data, they would put those caveats there and it would not surprise me if, after the Lion Air crash, when pilots said, oh, my goodness, I never knew about this MCAS System and this really bothers me and I'm going to fill out the report.

So I think it's important to keep all of this in perspective. So that report in its own doesn't necessarily concern me, but what we do want to look at is to look at the training adequacy overall.

Senator CRUZ. Mr. Scovel.

Mr. SCOVEL. Thanks, and I appreciate the perspectives of both the Administrator and the Chairman.

We will be looking, as I mentioned at the very beginning of the hearing, into documentation, what was included in the manuals and the decisionmaking that went into that and beyond that to the actual training for pilots.

I am aware of the ASRS entry that you mentioned. My staff and I were reviewing that the other week. So we're factoring it into our questions.

Senator CRUZ. Are you able to shed any light on those complaints?

Mr. SCOVEL. I'm not.

Senator CRUZ. That one in particular certainly stands out.

Mr. SCOVEL. I'm not, but it does go to the question of what did they know and when did they know it. So this is after the Lion Air incident. Some things were bubbling up within ASRS, as both my colleagues have testified. Was that factored into FAA's decision-making going forward? We can consider all that fairly, I think.

Senator CRUZ. Well, I want to thank each of you for being here, for testifying on very short notice. These issues are of grave concerns to Americans across the country and to the Senate. So I appreciate your testimony.

The hearing record is going to remain open for two weeks and during that time, Senators are asked to submit any questions for the record and upon receipt, each of the witnesses are requested to submit your written answers to the Committee as soon as possible.

And with that, this hearing is adjourned.

[Whereupon, at 5:35 p.m., the hearing was adjourned.]

A P P E N D I X

RESPONSE TO WRITTEN QUESTIONS SUBMITTED BY HON. JOHN THUNE TO HON. DANIEL K. ELWELL

Question 1. Mr. Elwell, you mentioned in your testimony that in response to the October 29 Lion Air Crash, FAA issued an Emergency Airworthiness Directive on November 7 requiring 737 MAX operators to revise flight manuals to reinforce training on how to recognize and respond to stabilizer trim movement not initiated by the crew.

Could you describe current training procedures for recognition and response to these “runaway” stabilizer trim events on Boeing 737 models?

Answer. The procedure for runaway stabilizer trim directs the pilot to perform the following tasks:

1. Control Column, hold firmly
2. Disengage autopilot and control airplane pitch manually with control column and electric trim
3. Disengage autothrottle
4. If runaway trim continues, turn off both of the stab trim cutout switches
 - a. If runaway trim continues, grasp the trim wheel and perform stabilizer trim manually

This procedure is to be performed immediately by either memory or by quick reference checklist and as such training for this procedure is covered in initial ground training and on a recurrent basis thereafter. The training program is developed by the air carrier and approved by the FAA.

Question 2. How did the training procedures required by the Emergency Airworthiness Directive issued in November 2018 differ from the procedures described above?

Answer. The Emergency Airworthiness Directive issued on November 7, 2018, reinforced the application of existing flight crew procedures to be used in those circumstances when uncommanded stabilizer trim is encountered.

Question 3. Mr. Elwell, the notice of proposed rulemaking for Remote Identification of Unmanned Aircraft Systems was delayed from May 1 of this year to July 21. As you know, this rulemaking is a critical component of integrating unmanned aircraft systems into U.S. airspace.

Could you speak to how this delay might affect other pending regulatory actions related to UAS?

Answer. The FAA plans to finalize its policy concerning remote identification of small UAS—by way of rulemaking, standards development, or other activities that other Federal agencies may propose—prior to finalizing the proposed rule permitting operations of small UAS over people and operations at night, published in the Federal Register on February 13, 2019.

Question 4. As a follow-up, do you foresee any potential challenges related to this rulemaking that could cause further delays?

Answer. The remote identification of UAS is a complex issue. The rulemaking the FAA is developing must ensure that the safety and security of the National Airspace System is maintained, while proposing requirements for the identification of UAS that are technologically feasible and not cost prohibitive. This balancing requires consideration of the interests and concerns of many diverse stakeholders, including our Federal interagency security partners; State and local law enforcement; the development and production timelines of UAS manufacturers; UAS operators ranging from large industry to small businesses to recreational flyers, and more. We are working to ensure that the rule we propose addresses the concerns we have heard from our interagency security partners, while also reflecting the current and future state of UAS development, innovation, and industry/public adoption.

RESPONSE TO WRITTEN QUESTIONS SUBMITTED BY HON. MARIA CANTWELL TO
HON. DANIEL K. ELWELL

Question. Please provide additional detail on the work that FAA did on MCAS, and the work that was then delegated.

Answer. The FAA conducted several types of technical reviews associated with the Stabilizer Trim System (STS) and related Maneuvering Characteristics Augmentation System (MCAS) functionality. These included project scope reviews (known as familiarization), reviews of System Functionality and aspects of Software Development Assurance, and reviews of the System Safety Assessment (SSA) status for the STS.

These reviews allowed us to consider intended function, evaluate the related guidance material, and assess system failure conditions and appropriate crew actions. These reviews and further discussions with Boeing did not identify any unique or new/novel regulatory aspects, areas outside of ODA authorization, or other areas requiring FAA involvement. As a result, the FAA delegated the responsibility for determining MCAS regulatory compliance to the ODA.

Aggressive maneuvers (wind up turns) and full stalls were flown by FAA test pilots during FAA certification testing in simulators and in the aircraft. Several dozen FAA certification flights were flown by FAA test pilots in the aircraft between May 2016 and November 2016 to evaluate: Maneuvering Characteristics, Stall Characteristics, Stall Identification and various failure modes of the flight control system, including failures to the speed trim (MCAS) system. In all of these tests, MCAS was active and routinely performing its intended function.

RESPONSE TO WRITTEN QUESTION SUBMITTED BY HON. AMY KLOBUCHAR TO
HON. DANIEL K. ELWELL

Question. At the hearing, we discussed how the FAA allows manufacturers to sell certain safety features as optional add-ons to airlines for an additional charge. As you know, neither of the two Boeing 737 Max aircraft involved in the recent Ethiopian Airlines and Lion Air crashes had an angle of attack indicator or a disagree light. How many safety features listed by the FAA as “optional” detect sensor malfunctions like we saw in these recent crashes?

Answer. Required safety standards and features for large aircraft are established in 14 CFR part 25 (“Airworthiness Standards: Transport Category Airplanes”). Features required to meet those safety standards are mandatory on all FAA-certified aircraft, including the Boeing 737 MAX. There are no optional safety standards or features.

RESPONSE TO WRITTEN QUESTIONS SUBMITTED BY HON. TOM UDALL TO
HON. DANIEL K. ELWELL

Question 1. The Boeing 737 first made flight in 1967 and there have been a significant number of changes to the original configuration of the 737. Can you outline the number of different air craft certification configurations that Boeing has applied for?

Answer. Boeing has applied for 14 models of the 737.

- (1) 737-100 Series (1967)
- (2) 737-200 Series (1967)
- (3) 737-200C Series (1968)
- (4) 737-300 Series (1984)
- (5) 737-400 Series (1988)
- (6) 737-500 Series (1990)
- (7) 737-700 Series (1997)
- (8) 737-800 Series (1998)
- (9) 737-600 Series (1998)
- (10) 737-700C Series (2000)
- (11) 737-900 Series (2001)
- (12) 737-900ER Series (2007)
- (13) 737-8 MAX (March 2017)
- (14) 737-9 MAX (February 2018)

Question 2. Administrator Elwell, Mr. Scovel pointed out in his testimony that the 2015 DOT Inspector General report found that the QUOTE “FAA performed oversight of only 4 percent of personnel conduction certification work on the Agency’s behalf at suppliers in the period [it] reviewed.” It is my understanding that the FAA is revamping this process. But do you have the staffing necessary to increase the oversight necessary?

Answer. Yes. The FAA has the personnel necessary to perform the referenced oversight functions under current processes.

What are the FAA’s plans to increase training opportunities to ensure that staff with these responsibilities will have the expertise necessary to perform oversight of highly technical systems?

Answer. The FAA supports its technical staff through access to leading providers of training and through engagement opportunities with other technical experts, including standards bodies, industry associations, conferences, and universities. The FAA also has Chief Scientific and Technical Advisors (CSTA) who provide in-depth seminars and workshops for their individual areas of expertise. The CSTA program was established in 2002 to address rapid technological advances in aviation safety. CSTAs possess high levels of knowledge and skill in specialized disciplines. When needed, the CSTAs support FAA certification staff in evaluating complex technical issues.

Question 3. What are you doing to retain current employees?

Answer. Retaining employees when industry is doing well is a challenge. There are, however, many factors as to why employees may choose to stay with the agency. One of these factors is the clarity and importance of the mission. We also utilize internal and external resources to provide professional development and training opportunities. We have several programs to provide mentoring and temporary management assignments for employees actively seeking advancement.

Do you have resources to bring on additional staff?

Answer. The Aircraft Certification Service has the resources to hire sufficient staff under current processes.

And, if so, what are you doing by way of recruitment efforts to bring more of these employees on board?

Answer. The FAA is collaborating with academic partners to provide a focused curriculum related to aviation safety to facilitate job opportunities for qualified candidates. We participate in job fairs, seminars, and science and technology conferences. In addition, we support science, technology, engineering, and mathematics (STEM) activities across the Nation to promote aviation safety and certification professions.

Question 4. If you are able, please tell us the direct chain of reporting for the Boeing Max 800 process and if the managers who were responsible for this certification are still charged with these responsibilities.

Answer. The Boeing Aviation Safety Oversight Office, Boeing Certificate Management Office, Seattle Aircraft Evaluation Group, and Northwest Flight Test Section are the FAA offices responsible for the airplane level certification and production of the 737 MAX. The development of the certification basis for the 737 MAX, including any applicable regulation or policy developed during a certification project, *e.g.*, through issue papers, also involves the FAA Transport Standards Branch.

The office responsible for the oversight of the Boeing Organization Designation Authorization (ODA) and related certification projects is the Boeing Aviation Safety Oversight Office. There are three first line managers and one branch manager for the office. The 737 MAX certification was a 5-year project that started in 2012. Since 2012, we have had a number of changes in personnel, consistent with any large organization.

Question 5. It is important to receive clarification on some issues that circulated about the Boeing Max 8 jets. I will ask you a series of Yes/No questions. The *New York Times* reported on March 19th that senior FAA employees were unaware of the changes in the software that is in question. Can you confirm if this software was certified by the FAA?

Answer. Yes, the software described in the article was approved by the FAA.

Did any FAA employees sign off on training manuals?

Answer. Yes, the recommended training was approved by the FAA.

Question 6. Boeing has said the redundancy for the system in question were the pilots—even though many pilots were unaware of the changes made to the 737 Max. Given your experience as a pilot, are you aware of another example of any other component with critical safety mission not to have some kind of redundancy built-in?

Answer. In reference to system failures that can jeopardize controlled flight, there are single failures that require pilot response or action, including:

- Engine failure (at any time, but especially during takeoff ground roll)
- Landing gear failure to deploy
- Engine or cargo fire
- Failure of an air data computer
- Flight control surface jam
- Failure of certain components in flight control systems (actuator, control structural items such as a rod or actuator mount, cable break, etc.)

Question 7. Does FAA still maintain the others grounded “too early?”

Answer. The FAA made its grounding decision on March 13 based on refined satellite data and evidence found at the accident scene. This information solidified the similarities between the Lion Air and Ethiopian Airlines accidents. The FAA stands by its decision-making on grounding the 737 MAX.

Question 8. Is it appropriate for the POTUS and the CEO of Boeing to be discussing a matter like this vs leaving it up to the career expert?

Answer. The FAA’s primary focus is safety. We value and rely upon the advice of FAA career aviation safety experts.

- Were the same people who approved the design the ones deciding to ground?

Answer. The decision to ground the 737 MAX was made by me after receiving enhanced satellite data showing the flight path of Ethiopian Flight 302 and conferring with FAA safety experts. I was not with the FAA at the time the 737 MAX design was approved.

RESPONSE TO WRITTEN QUESTIONS SUBMITTED BY HON. TAMMY DUCKWORTH TO
HON. DANIEL K. ELWELL

Question 1. Please describe the Federal regulatory rules, process and procedures for addressing an aircraft design single-point-of-failure, including the threshold for grounding such aircraft.

Answer. 14 CFR §§ 25.1309, 25.671, and 25.901, advisory circulars, and other FAA guidance material prevent the FAA from approving proposed designs in which a single system failure (non-structural) would be catastrophic or prevent continued safe flight and landing. Beyond this, single system points-of-failure that are not catastrophic are governed by the reliability requirements of 14 CFR § 25.1309.

Manufacturers must show proposed airplane systems meet safety standards through a FAA hazard assessment and safety analysis. As part of this analysis, the manufacturer must show that “catastrophic” failure conditions are extremely improbable.

The FAA makes safety-based, data-driven decisions. In determining whether a condition discovered after certification is unsafe, we employ a standardized process called Monitor Safety/Analyze Data (MSAD) for determining mandatory design changes and appropriate timeframes to implement those changes based on risk exposure. The results of the risk assessments conducted under MSAD could lead to an aircraft grounding decision.

Question 2. What is the basis for certification by FAA of a derivative aircraft and how does FAA determine pilot training requirements for derivative aircraft?

Answer. The FAA decides whether to process an application as an amended type certificate (ATC) based on an evaluation of the airplane design changes in accordance with 14 CFR § 21.19, which describes changes requiring a new type certificate. The FAA evaluates the proposed design changes, considers the examples in the guidance material, and reviews determinations made on previous certification programs.

The FAA determines pilot training requirements for derivative aircraft using the Flight Standardization Board (FSB) in accordance with established processes outlined in FAA Order 8900.1 and FAA Advisory Circular (AC) 120–53B. Aircraft operational suitability is determined in accordance with FAA Order 8110.4C.

Question 3. For the purposes of FAA aircraft certification, who determines whether a design change is “significant” such that it would preclude the aircraft from a derivative certification? Please describe in detail precisely how FAA make this determination and what constitutes a requirement for a new type certificate?

Answer. The managing Aircraft Certification Office (ACO) determines if the proposed design is eligible for an amended type certificate (ATC) (derivative aircraft

certification) or if the proposed design changes require a new type certificate. The FAA decides to process an application as an ATC based on an evaluation of the proposed airplane design changes in accordance with 14 CFR § 21.19, which describes proposed changes that will require a new type certificate. Additionally, AC 21.101-1B, "Establishing the Certification Basis of Changed Aeronautical Products," provides examples of substantial design changes for transport airplanes.

The FAA evaluates the proposed design changes, considers the examples in the advisory circular, and reviews determinations made on previous certification programs in order to determine eligibility for an ATC.

Question 4. When a new system(s) for a derivative aircraft is disclosed to the FAA by an Original Equipment Manufacturer (OEM), how does the FAA evaluate that system(s) to determine changes to pilot training, aircraft and pilot manuals and handbooks, and the potential nullification of the derivative certification of the aircraft?

Answer. The OEM presents technical briefings on new systems to the FAA. The OEM proposes a pilot type rating determination and pilot training recommendations after formally identifying differences between the base aircraft (old) and candidate aircraft (new) using the process outlined in Advisory Circular (AC) 120-53B. The Flight Standardization Board then evaluates the proposed training in accordance with this AC (AC 120-53B).

Question 5. When a system is implemented on a derivative aircraft design with the intention of artificially retaining the handling qualities of the original design, what Federal requirements govern the publication and training of that system?

Answer. At all times, the aircraft must meet the existing design and performance requirements. The FAA evaluates handling qualities in accordance with AC 120-53B using the T2 Test (handling qualities comparison), between the base and candidate aircraft. Any additional training requirements are evaluated during T3 Test (differences) by the Flight Standardization Board.

Question 6. When the FAA certifies a derivative aircraft, which type certificated aircraft is considered as the baseline for design change comparisons? In the case of the Boeing 737 MAX, was it the most recent type certified aircraft like the 737 NG or the original type design?

Answer. When an applicant applies for an amended type certificate (ATC) of a previously certificated model, it is responsible for proposing the baseline. That baseline may or may not be the most recently certificated model of that aircraft. Since the baseline 737-800 model was introduced in 1998, many enhancements have been implemented in derivative models. In the case of the 737 MAX, the 737 NG was the baseline model.

Question 7. Are derivative aircraft required to comply with 14 CFR Part 25 regulations at the time the amended type certificate is awarded or at the time of the original type certificate?

Answer. Only the proposed design change and areas affected by the change must comply with the 14 CFR regulations in place at the time of application, in accordance with 14 CFR § 21.101 and FAA AC 21.101-1B. The applicant also can petition the FAA for an exemption or "equivalent level of safety determination" for particular requirements. These are addressed on a case-by-case basis.

Question 8. Please point to the safeguards that FAA has in place to ensure that external pressures, such as time or competition, do not play any role in the quality of the certification or evaluation of a derivative aircraft.

Answer. Through our public rulemaking process, the FAA prevents special interests from having undue influence in the development of standards and agency decisions regarding whether proposed designs meet those standards. Additionally, we have established processes for all FAA employees to elevate concerns if they feel that safety is being compromised. The FAA Office of Audit and Evaluation, established by Congress, provides a whistleblower hotline to report safety concerns. Complaints are investigated and responses to any findings are provided to this office. 14 CFR 183.57(c) and FAA Order 8100.15 place responsibility on the ODA holder to ensure that ODA unit members can perform their authorized functions without conflicting restraints or interference. ODA unit members also regularly interact with their FAA counterparts during certification projects and are able to communicate concerns directly. During regular FAA evaluations of ODAs, unit members are questioned about undue pressure and if they have the latitude to perform their duties appropriately.

The FAA may also suspend or terminate an ODA at any time. Some reasons why the FAA may suspend or terminate an ODA include:

- ODA holder fails to properly perform the duties granted in the authorization;

- ODA holder does not exercise the care or judgment required to properly exercise the ODA;
- ODA holder displays a lack of integrity;
- ODA holder qualifications lapse;
- ODA holder does not take corrective action as required by the FAA;
- ODA holder or ODA unit does not complete required FAA training;
- Misconduct including, but not limited to, carelessness, collusion, conflict of interest, compromise or any other act that would jeopardize the proper functioning of the delegated functions.

FAA Order 8100.15B, Ch. 7–2. ODA holders have limited administrative appeal rights within the FAA to appeal the suspension or termination of an ODA.

Question 9. Is FAA considering any changes to its existing certification process for aircraft currently in certification and for future designs?

Answer. Safety is the core of FAA’s mission and our top priority. We have a long-standing, well-established, data-driven certification process that consistently results in safe aircraft and we remain committed to our proven processes. We continue to evaluate the information we learn from the 737 MAX accident investigations to determine if certification process changes may be needed. The Department of Transportation’s Office of the Inspector General is conducting an audit of the FAA’s certification processes, and the Secretary of Transportation has established a Special Committee to Review FAA’s Aircraft Certification Process. We look forward to assessing any recommendations for improvements these activities may identify.

Question 10. Is the pitch stability of the Boeing 737 MAX series aircraft equal to the pitch stability of older models of the Boeing 737 aircraft?

Answer. The pitch stability and pitch maneuvering characteristics were flight tested and determined to meet part 25 requirements and equivalent to the previous 737 NG model.

Question 11. Did Boeing implement the Maneuvering Characteristics Augmentation System (MCAS) flight control law on the 737 MAX series to improve aircraft handling characteristics and achieve the pitch stability that FAA requires to certify an aircraft for use as a passenger aircraft? Did Boeing implement MCAS to allow pilots’ type certificate to transfer from 737 NG to 737 MAX aircraft? Please provide the Committee with any associated documentation for the purpose or justification for MCAS.

Answer. The purpose of MCAS is to make the 737 MAX compliant with FAA regulations on performance and handling characteristics, for example, maneuvering stability and aerodynamic stall characteristics. The MCAS provides performance and handling characteristics consistent with the predecessor Boeing 737 NG models. As part of the flight control system, MCAS was determined to be compliant with FAA regulations.

Question 12. During the certification process, did the FAA or Boeing under delegated authority, determine that it could not certify the Boeing 737 MAX series aircraft to be used as a passenger aircraft because of the lack of pitch stability?

Answer. No. The FAA flight tested the 737 MAX in all regimes of flight, including stalls, and no lack of pitch stability was found. If a lack of pitch stability was found, the FAA would have required Boeing to address the issue prior to the amended type certificate being issued.

Question 13. Did the FAA require Boeing to install an automated stability system in order to receive certification for the Boeing 737 MAX series to be used as a passenger aircraft?

Answer. The FAA did not require the installation of an automated stability system. Boeing, as the applicant, defines the scope of changes at the airplane level. The FAA through its Certification Basis determination concurred with the scope of the changes.

Question 14. When a pilot overrides the MCAS flight control law and manually controls the 737 MAX, does the pitch stability of the 737 MAX, while being manually operated, change to unsafe levels for a passenger aircraft?

Answer. An aircraft is required to be controllable in all regimes of flight. The MCAS operates as part of the flight control system, not independently. The MCAS function is active only during manual flight, when the flaps are up and the aircraft is at an elevated angle-of attack. Manual flight with MCAS active was extensively flight tested and found to be safe and compliant with part 25.

RESPONSE TO WRITTEN QUESTIONS SUBMITTED BY HON. JON TESTER TO
HON. DANIEL K. ELWELL

Safety Features as Options and Transparency

Question 1. Did FAA know which safety features on the 737 MAX were offered by Boeing as options versus as mandatory equipment?

Answer. Features and equipment that are required for safety are not optional on any aircraft the FAA certifies. 14 CFR part 25 “Airworthiness Standards: Transport Category Airplanes” contains the design standards.

Question 2. Does FAA know what the cost is to Boeing for AOA redundancy and pilot alert equipment? And what Boeing charges customers to install on the 737 MAX?

Answer. The FAA does not have information on pricing related to optional equipment on Boeing aircraft.

Question 3. Did FAA determine that any Boeing-designated “options” should to be installed as mandatory equipment? If yes, which equipment was switched to be mandatory standard equipment?

Answer. Required safety standards and features for large aircraft are established in 14 CFR part 25 (“Airworthiness Standards: Transport Category Airplanes”). Features required to meet those safety standards are mandatory on all FAA-certified aircraft, including the Boeing 737 MAX. There are no optional safety standards or features.

Question 4. Has FAA ever gone back to the manufacturer and required that equipment that the manufacturer identified as “optional” instead be included as standard for safety reasons? If so, what equipment for which plane?

Answer. The FAA has the statutory authority to promulgate new rules to mandate equipment enhancements and updates based on new data and operational experience. There are cases where optional equipment later became mandatory on transport category aircraft after specific safety benefits were established. For example, the FAA promulgated new rules to mandate new equipment including terrain awareness and warning systems (TAWS), enhanced ground proximity warning systems (EGPWS), and traffic collision avoidance systems (TCAS).

Question 5. Does FAA plan to require that AOA redundancy and pilot alert equipment be standard equipment? Why/why not?

Answer. We continue to evaluate the information we learn from the 737 MAX accident investigations to determine if certification process changes or specific equipment capabilities may be needed. The Department of Transportation’s Office of the Inspector General is conducting an audit of the FAA’s certification processes, and the Secretary of Transportation has established a Special Committee to Review FAA’s Aircraft Certification Process. We look forward to assessing any recommendations for improvements these activities may identify.

Question 6. Should air passengers know in advance which safety options airlines opt NOT to pay for on planes in their fleet? Why or Why not?

Answer. Features and equipment that are required for safety are not optional on any aircraft the FAA certifies. 14 CFR part 25 contains the design standards for transport category aircraft. This is a single level of safety, and the same requirements apply to all aircraft certified under part 25. The FAA does not regulate the cost of, or communicate to passengers on, optional equipment the operator has or has not chosen to install.

Pilot Training and Documentation

Question 7. On what basis did FAA determine that no additional training for the 737 MAX 8 was needed?

Answer. The FAA did require additional training for the 737 MAX 8. The FAA has processes and procedures to determine requirements for pilot training and type rating. During certification of the 737 MAX, the FAA followed its standard process in establishing a Flight Standardization Board (FSB) as the mechanism to evaluate manufacturer-proposed training for a new aircraft or type derivative. FSBs are chaired by FAA experts and utilize qualified pilots from the FAA, industry, and other aviation authorities to evaluate the aircraft. The FAA conducted this FSB as a joint evaluation with Transport Canada (TCCA), the European Aviation Safety Agency (EASA) and participation from U.S. operators. FSB pilots unanimously concluded that for the 737 MAX, additional computer-based training was necessary beyond the training required for a Boeing 737 NG pilot to fly the 737 MAX.

Instrumentation, Performance and Certification

Question 8. Did FAA know about the lack of simultaneous and cross-check readings of the AOA sensors on the 737-MAX 8, *i.e.*, the absence of displaying the readings of both sensors (versus just one at a time) and the lack of a “disagree light” being activated if the sensors are at odds with one another?

Answer. When the AOA indicator display is present on a 737 model, the left primary flight display (PFD) shows the left AOA reading, and the right PFD shows the right AOA reading. These readings do not display side-by-side on one display. It is important to note that AOA and other air data inputs (*i.e.*, airspeed and calculated Mach) are direct inputs to the MCAS flight control function within the flight control computers and not dependent on any display of information on the pilots’ PFDs. There is no regulatory requirement for the AOA indicators or the AOA disagree message.

Is that configuration consistent with current standards?

Answer. The AOA indicator display and AOA DISAGREE message were consistent with current standards.

Did anyone raise any concerns about this configuration?

Answer. FAA carefully considered the configuration before determining it met applicable standards.

Did FAA raise this point of vulnerability with Boeing? If no, why not?

Answer. There is no regulatory requirement for manufacturers to install an AOA disagree message because there are no pilot procedures associated with the display of the message.

Question 9. Who determined that the introduction of enlarged engines and their changed placement did not require a new certification for the aircraft? What were the factors/rationale justifying that decision?

Answer. The managing Aircraft Certification Office (ACO) followed FAA regulations and policy in making the determination that the proposed design was eligible for an Amended Type Certificate (ATC). The FAA issued an ATC based on the evaluation of the proposed airplane design changes in accordance with 14 CFR § 21.19, which describes changes requiring a new type certificate. Additionally, FAA Advisory Circular (AC) 21.101-1B, “Establishing the Certification Basis of Changed Aeronautical Products,” provides examples of substantial design changes for transport airplanes.

In making a determination of a proposed type certification, the FAA evaluates the proposed design changes, considers the examples in the advisory circular, and reviews determinations made on previous certification programs.

Question 10. FAA statements re: the functioning of MCAS appear to be conflicting. Can or cannot MCAS be disabled on the 737-MAXs?

Answer. MCAS is an integrated sub-system of the flight control system and cannot be disabled by itself. Automatic movement of the horizontal stabilizer—including that caused by MCAS—can be disabled through use of the STAB TRIM cut-off switches. When automatic movement of the horizontal stabilizer is disabled, MCAS cannot move the horizontal stabilizer. The pilot can still move the stabilizer manually, if necessary.

Question 11. How does FAA decide which systems are delegated to firms for certification?

Answer. The FAA determines the level of involvement during an Organization Designation Authorization (ODA) project based on many variables. These include the ODA’s performance and experience with the compliance requirements, consideration of any novel or unusual certification areas, or instances where adequate standards may not be in place.

Question 12. In the hearing, you testified that FAA managers did review the delegation of authority as required. Does that mean that the role of FAA managers is to review the delegation of authority OR do FAA managers review/verify that a firm’s certification decision is appropriate? If the latter, on what basis does the FAA make a determination that a certification done by a firm meets U.S. requirements?

Answer. The FAA reviews delegation of authority and appropriateness of certification decisions, including individual delegation decisions. This is accomplished in response to review of applicant certification proposals. The FAA responses are reviewed by management or by delegated staff on behalf of FAA management. The basis for ascertaining that the ODA makes certification decisions that meet FAA requirements is accomplished through approval of the ODA procedures and oversight of the ODA. FAA managers approve the ODA manual, which defines an ODA holder’s authority and limitations and identifies the functions it may perform. The FAA-approved ODA manual establishes criteria for FAA involvement on each certifi-

cation project. The FAA reviews the ODA's system for making decisions through oversight of system, personnel, procedures, activities and overall performance. FAA managers ensure the FAA's oversight program for the ODA is in place and is operating in accordance with FAA Order 8100.15. The ODA holder is responsible as the project applicant to show compliance to the airworthiness standards.

RESPONSE TO WRITTEN QUESTION SUBMITTED BY HON. JOHN THUNE TO
HON. CALVIN L. SCOVEL III

Question. Inspector General Scovel, the recent Federal Aviation Administration (FAA) Reauthorization Act of 2018 contained several bipartisan provisions aimed at improving and modernizing FAA's aircraft certification process. This included the establishment of an Organization Designation Authorization Office within FAA's Office of Aviation Safety, improving operational safety by strengthening oversight of ODA holders delegated to perform certain functions on behalf of the FAA.

Additionally, you mentioned in your testimony that FAA has taken several steps to improve certification oversight in response to recommendations made by the Department of Transportation Office of Inspector General (DOT OIG), some of which were due to be implemented earlier this year.

Beyond the work done in both the FAA Reauthorization and in response to recommendations made by DOT OIG, do you see a need for further action to be taken regarding FAA's aircraft certification process, and if so, what are those actions?

Answer. The actions FAA has already taken to address our prior recommendations are steps in the right direction. The key will be FAA's effective implementation of those recommendations and provisions of the FAA Reauthorization Act of 2018, which we will be reviewing during our audit of FAA's certification of the Boeing 737 MAX aircraft. We have just begun our latest audit work, and as such, it is too early to say what additional actions the FAA needs to take to improve its certification processes. We will keep the Committee apprised of our progress.

RESPONSE TO WRITTEN QUESTIONS SUBMITTED BY HON. MARIA CANTWELL TO
HON. CALVIN L. SCOVEL III

General Scovel, your office has examined the performance of the ODA system and other issues within the certification system many times. Several times, including in 2011 and 2015, your office issued recommendations to FAA on ways to improve the system.

Question 1. Did FAA adopt the recommendations from your office?

Answer. Yes. Overall, FAA has been responsive to and adopted our recommendations. However, one key recommendation—for FAA to implement a new, more systems-and risk-based oversight approach—remains open. The Agency expects to complete implementing our recommendation in July 2019.

Question 2. Overall, would you call the ODA system safe? Are there improvements that still need to be implemented?

Answer. Overall, the U.S. air transportation system is remarkably safe. However, recent events have raised concerns about FAA's oversight of the ODA program and its effectiveness. Improvements such as fully implementing our open recommendation will be a good start. We initiated an audit of FAA's certification of the Boeing 737 MAX on March 27, 2019. While our audit is still in the early stages, we plan to address this issue in our review. We will be available to provide your office with more substantive information once we have an opportunity to develop our observations and findings.

Question 3. What would happen if delegation ended—does FAA have the tools it would need to continue to carry out its certification responsibilities?

Answer. Currently there are about 80 companies with delegated authority. The practice of delegation has served the industry well for years. ODA offers the Agency the opportunity to leverage outside expertise that it might not otherwise have access to and make the best use of limited resources and expertise. According to FAA, if ODA did not exist, the Agency would have to hire roughly 10,000 more employees to fulfill its aircraft certification mission.

Question 4. Has your office compared the way the ODA system works with the way certification happens in Europe? Which system has a more rigorous degree of oversight agency involvement?

Answer. We have not conducted a comparative analysis of how FAA's ODA process compares to systems used in Europe.

RESPONSE TO WRITTEN QUESTIONS SUBMITTED BY HON. TAMMY DUCKWORTH TO
HON. CALVIN L. SCOVEL III

Question 1. Please describe the Federal regulatory rules, process and procedures for addressing an aircraft design single-point-of-failure, including the threshold for grounding such aircraft.

Answer. FAA is responsible for ensuring the safety of the traveling public, including eliminating single points of failure and grounding aircraft for safety reasons. We initiated an audit of FAA's certification of the Boeing 737 MAX on March 27, 2019. While our audit is still in the early stages, our ongoing work will shed additional light on the processes, policies, and procedures for addressing these issues.

Question 2. What is the basis for certification by FAA of a derivative aircraft and how does FAA determine pilot training requirements for derivative aircraft?

Answer. FAA is responsible for determining the classification and certification of derivative aircraft. Also, in conjunction with manufacturers, FAA determines training requirements for pilots. We will explore these issues in greater detail in our ongoing review of how the Boeing 737 MAX was certified.

Question 3. For the purposes of FAA aircraft certification, who determines whether a design change is "significant" such that it would preclude the aircraft from a derivative certification? Please describe in detail precisely how FAA make this determination and what constitutes a requirement for a new type certificate?

Answer. FAA has the ultimate authority to determine whether a design change is significant and whether it would preclude the aircraft from being certified as a derivative. This is an issue we will examine in our ongoing review of how the Boeing 737 MAX was certified. We will be available to provide your office with more substantive information once we have an opportunity to develop our observations and findings.

Question 4. When a new system(s) for a derivative aircraft is disclosed to the FAA by an Original Equipment Manufacturer (OEM), how does the FAA evaluate that system(s) to determine changes to pilot training, aircraft and pilot manuals and handbooks, and the potential nullification of the derivative certification of the aircraft?

Answer. FAA works closely with the aircraft manufacturer to determine changes to pilot training as well as manuals and handbooks. This is an important question that has been raised with the Boeing 737 MAX incidents. We will examine this and related issues in our ongoing review.

Question 5. When a system is implemented on a derivative aircraft design with the intention of artificially retaining the handling qualities of the original design, what Federal requirements govern the publication and training of that system?

Answer. We are in the early stages of our review of the certification of the Boeing 737 MAX, and as such, it is too early to say whether our review will address this issue. But please be assured that we will keep the Committee apprised of our progress.

Question 6. When the FAA certifies a derivative aircraft, which type certificated aircraft is considered as the baseline for design change comparisons? In the case of the Boeing 737 MAX, was it the most recent type certified aircraft like the 737 NG or the original type design?

Answer. FAA certifies derivative aircraft, but we have just begun our review of the 737 MAX certification. While our audit is still in the early stages, we plan to examine what make/model is considered as the "baseline" for the desired change and what other factors the Agency considers when making certification decisions for derivative aircraft.

Question 7. Are derivative aircraft required to comply with 14 CFR Part 25 regulations at the time the amended type certificate is awarded or at the time of the original type certificate?

Answer. This is an issue we will explore in detail in our ongoing audit of the Boeing 737 MAX certification.

Question 8. Please point to the safeguards that FAA has in place to ensure that external pressures, such as time or competition, do not play any role in the quality of the certification or evaluation of a derivative aircraft.

Answer. Safeguards against external pressures such as time and competition are important. FAA addresses this issue in its oversight procedures, but we do not know the effectiveness of any controls or safeguards in place. This is an issue we will explore in greater detail as we examine the certification of the Boeing 737 MAX.

Question 9. Is FAA considering any changes to its existing certification process for aircraft currently in certification and for future designs?

Answer. We are unaware of any changes FAA may be considering at this time. However, given the attention to this issue and the number of external reviews that are ongoing, there could be a number of changes to FAA's processes in the future.

Question 10. Is the pitch stability of the Boeing 737 MAX series aircraft equal to the pitch stability of older models of the Boeing 737 aircraft?

Answer. The issue of pitch stability is an important question in the recent 737 MAX accidents. Preliminary reports suggest that there may be a difference in stability compared to earlier models. This is an issue we will examine in our ongoing review of the 737 MAX certification.

Question 11. Did Boeing implement the Maneuvering Characteristics Augmentation System (MCAS) flight control law on the 737 MAX series to improve aircraft handling characteristics and achieve the pitch stability that FAA requires to certify an aircraft for use as a passenger aircraft? Did Boeing implement MCAS to allow pilots' type certificate to transfer from 737 NG to 737 MAX aircraft? Please provide the Committee with any associated documentation for the purpose or justification for MCAS.

Answer. Based on reports, it appears that Boeing implemented MCAS to improve aircraft handling characteristics and to address concerns about pitch stability to certify the aircraft. We will look into all the reasons Boeing implemented MCAS in our review of the 737 MAX certification.

Question 12. During the certification process, did the FAA or Boeing under delegated authority, determine that it could not certify the Boeing 737 MAX series aircraft to be used as a passenger aircraft because of the lack of pitch stability?

Answer. We have just begun our review of 737 MAX certification. We are aware of concerns regarding the pitch stability of the 737 MAX, and will examine these issues in greater detail during our review.

Question 13. Did the FAA require Boeing to install an automated stability system in order to receive certification for the Boeing 737 MAX series to be used as a passenger aircraft?

Answer. We do not know at this juncture exactly what FAA required Boeing to do, but we will determine whether FAA required Boeing to install an automated system to obtain certification.

Question 14. When a pilot overrides the MCAS flight control law and manually controls the 737 MAX, does the pitch stability of the 737 MAX, while being manually operated, change to unsafe levels for a passenger aircraft?

Answer. We are in the early stages of our review of the 737 MAX, but we will address the issue of whether or not the pilot can manually override MCAS. We recognize this is an important question in resolving problems with the Boeing 737 MAX.

RESPONSE TO WRITTEN QUESTIONS SUBMITTED BY HON. JON TESTER TO
HON. CALVIN L. SCOVILL III

Scope of OIG Review

Question 1. What factors will the OIG examine to determine if the FAA's relationship with Boeing was appropriate to fulfill its oversight role and responsibilities?

Answer. In addition to assembling a timeline of the Boeing 737 MAX certification, we will examine the ODA process, including the roles and responsibilities between FAA and Boeing and how key decisions were made.

Question 2. Is the OIG investigating if FAA allowed Boeing to take shortcuts to improve its competitiveness vis-à-vis international aircraft suppliers?

Answer. Our ongoing audit of FAA's certification of the Boeing 737 MAX will be reviewing all of the factors that went into the certification of the 737 MAX and will be alert for any factors that indicate shortcuts were taken.

Question 3. Is the OIG looking at the impact and implications of market competition on:

- a. Boeings' decision-making and production schedules of the 737-MAX 8?
- b. FAA's delegation of self-certification to Boeing?

Answer. Our current review is focused on building a timeline for the certification of the 737 MAX and delegated authority. We will examine any factors that may have influenced key decisions.

Question 4. Are reports that the number of aircrafts delivered is a factor in employees' performance reviews (and presumably bonus awards) true? If so, how will

you determine if that situation impacted the planes' safety-related systems and pilot training requirements?

Answer. We do not know whether the number of aircraft delivered was a factor in performance reviews at Boeing. This is an issue we will examine in our ongoing review of how the Boeing 737 MAX was certified. We will be available to provide your office with more substantive information once we have an opportunity to develop our observations and findings.

Instrumentation, Performance and Certification

Question 5. Did FAA know about the lack of simultaneous and cross-check readings of the AOA sensors on the 737-MAX 8, *i.e.*, the absence of displaying the readings of both sensors (versus just one at a time) and the lack of a "disagree light" being activated if the sensors are at odds with one another?

a. Is that configuration consistent with current standards?

b. Did anyone raise any concerns about this configuration?

c. Did FAA raise this point of vulnerability with Boeing? If no, why not?

Answer. We cannot say at this time what Boeing and FAA knew given that we are in the early stages of our review of the 737 MAX certification. The issues raised about instrumentation and warnings are important questions that we will explore in our review.

Question 6. Who determined that the introduction of enlarged engines and their changed placement did not require a new certification for the aircraft? What were the factors/rationale justifying that decision?

Answer. FAA is ultimately responsible for decisions about certification. We do not yet know the factors that drove these decisions. However, we will explore these questions in our review of the 737 MAX certification.

Question 7. FAA statements re: the functioning of MCAS appear to be conflicting. Can or cannot MCAS be disabled on the 737-MAXs?

Answer. After careful review and consideration, DOT-OIG believes FAA is most appropriately situated to provide a response to this question.

Question 8. How does FAA decide which systems are delegated to firms for certification?

Answer. FAA works closely with the manufacturer and decides what systems are delegated for certification. According to FAA, factors such as performance issues and areas critical to safety would lead to a higher level of FAA involvement and oversight.

Question 9. In the hearing, Acting Administrator Elwell testified that FAA managers did review the delegation of authority as required. Does that mean that the role of FAA managers is to review the delegation of authority OR do FAA managers review/verify that a firm's certification decision is appropriate? If the latter, on what basis does the FAA make a determination that a certification done by a firm meets U.S. requirements?

Answer. After careful review and consideration, DOT-OIG believes FAA is most appropriately situated to provide a response to this question.