Testimony of

The Honorable Robert L. Sumwalt, III
Chairman
National Transportation Safety Board

Before the

Subcommittee on Aviation
Committee on Transportation and Infrastructure
United States House of Representatives

— On —

Status of the Boeing 737 MAX

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NTSB | National Transportation Safety Board

An Independent Federal Agency

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

Congress established the NTSB in 1967 as an independent agency within the United States Department of Transportation (DOT) with a clearly defined mission to promote a higher level of safety in the transportation system. In 1974, Congress reestablished the NTSB as a separate entity outside of the DOT, reasoning that "no federal agency can properly perform such (investigatory) functions unless it is totally separate and independent from any other . . . agency of the United States."[1] Because the DOT has broad operational and regulatory responsibilities that affect the safety, adequacy, and efficiency of the transportation system, and transportation accidents may suggest deficiencies in that system, the NTSB's independence was deemed necessary for proper oversight.

The NTSB is 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 recommendations to federal, state, and local agencies, as well as other entities, aimed at improving safety, preventing future accidents and injuries, and saving lives. The NTSB is not a regulatory agency—we do not promulgate operating standards nor do we certificate organizations and individuals. The goal of our work is to foster safety improvements, through formal and informal safety recommendations, for the traveling public.

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 investigations of major airline accidents in foreign countries that involve US carriers, US-manufactured or -designed equipment, or US-registered aircraft.

For the last decade, the US aviation system has experienced a record level of safety, and the number of US-registered civil aviation accidents has declined overall.[2] 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 include charters, air taxis, and air medical services flights. Until 2018, there had been no passenger fatalities as a result of accidents involving US air carriers operating under the provisions of 14 *CFR* Part 121 since the crash of Colgan Air flight 3407 in 2009. Between February 2009, when Colgan Air crashed near Buffalo, New York, and April 2018, there were no passenger fatalities involving 14 *CFR* Part 121 US air carriers.[3] On April 17, 2018, a Boeing 737-700 experienced an engine failure at cruise

[1] Independent Safety Board Act of 1974 § 302, Pub. L. 93-633, 88 Stat. 2166–2173 (1975).
[2] National Transportation Safety Board, 2017 preliminary aviation statistics. Accident data for calendar year 2018 are still being validated and have not yet been released.
[3] National Transportation Safety Board, *Loss of Control on Approach, Colgan Air, Inc., Operating as Continental Connection Flight 3407, Bombardier DHC 8 400, N200WQ*, Rpt. No. AAR-10/01 (Washington, DC: NTSB, 2012). In 2013, there were two fatal accidents involving nonscheduled cargo flights operating under Part 121—National

altitude, resulting in damage to a cabin window and the partial ejection of a passenger, who subsequently died from her injuries.[4] Over the last several decades, significant advances in technology, important legislative and regulatory changes, and more comprehensive crew training have contributed to the current level of aviation safety. However, we continue to see accidents and incidents that remind us of the need to be ever vigilant.

This testimony will explain our role in international investigations and inform the subcommittee about our current participation in recent accidents involving Boeing 737 MAX 8 aircraft in Indonesia and Ethiopia.

NTSB's Role in Foreign Investigations

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 Recommended Practices (SARPS) provided in Annex 13 to the Convention.[5] If an accident or serious incident occurs in a foreign state involving a US-registered civil aircraft, US operator, or US-designed or manufactured aircraft, and 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.[6]

In accordance with the ICAO Annex 13 SARPS, upon receiving a formal notification of the accident or serious incident that may involve significant issues, the NTSB may designate the US Accredited Representative and appoint technical advisors to carry out the obligations, receive 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 US manufacturers, operators, and the Federal Aviation Administration (FAA).

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

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

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

Air Cargo crash after takeoff at Bagram Air Base, Afghanistan, and United Parcel Service flight 1354 crash during approach in Birmingham, Alabama.

[4] The Southwest Airlines flight 1380 investigation is ongoing. An investigative hearing was conducted on November 14, 2018.

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

[6] There are 193 Member States of ICAO, including both Indonesia and Ethiopia, (https://www.icao.int/MemberStates/Member%20States.English.pdf).

enhancing aviation safety worldwide. In 2018, we appointed accredited representatives to 324 international investigations, and traveled to support work on 17 of those investigations.[7]

Recent Boeing 737-MAX 8 Crashes

On October 29, 2018, a Boeing 737 MAX 8, operated by Lion Air, crashed into the Java Sea shortly after takeoff from Soekarno-Hatta International Airport, in Jakarta, Indonesia, killing all 189 passengers and crew on board. The Komite Nasional Keselamatan Transportasi (KNKT) of Indonesia, who is leading the investigation, released a preliminary report on the accident on November 27, 2018.[8] On March 10, 2019, a Boeing 737 MAX 8, operated by Ethiopian Airlines, crashed after takeoff from Addis Ababa Bole International Airport in Ethiopia, killing all 157 passengers and crew, including 8 American citizens. The investigation is being led by the Ethiopia Accident Investigation Bureau (AIB), which released a preliminary report on April 4, 2019.[9]

Because the MAX 8 was designed, certified, and manufactured in the United States, in accordance with ICAO Annex 13, the United States is afforded the right to participate in both investigations. Accordingly, the NTSB appointed accredited representatives to assist in both ongoing investigations.

Following last year's Lion Air crash, the NTSB immediately dispatched investigators to Indonesia to participate in the Indonesian government's investigation. An NTSB investigator was stationed onboard one of the search vessels during the search for the critical "black boxes"—the flight data recorder (FDR) and cockpit voice recorder (CVR). When the CVR was recovered on January 14, 2019, the NTSB recalled four investigators from furlough (due to the partial government shutdown) to assist with properly transcribing the recorder's content.[10]

In response to the Ethiopian Airlines crash, the NTSB also appointed an accredited representative, whom we dispatched to Ethiopia with a team of investigators. Once the recovered recorders were sent to the Bureau d'Enquêtes et d'Analyses pour la Sécurité de l'Aviation Civile, we sent recorder, flight crew operations, and human factors investigators to France to assist with downloading and reading out the recorders' contents.

In accordance with ICAO Annex 13, technical advisors from the FAA, Boeing, and General Electric have accompanied NTSB investigators to the Lion Air and Ethiopian Airlines accident sites to provide their specialized technical knowledge regarding the aircraft and its systems.

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[7] The NTSB appointed an accredited representative to 203 accidents, 97 incidents, and 24 other safety-related occurrences in 2018. NTSB traveled in support of 9 of these accidents and 8 of the incidents.

[8] Komite Nasional Keselamatan Transportasi, Preliminary Report No. KNKT.18.10.35.04.

[9] Ethiopia Accident Investigation Bureau, Report No. AI-01/19.

[10] Due to a lapse of appropriations from December 22, 2018, through January 25, 2019, the NTSB furloughed all investigative staff. In accordance with the 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 four investigative staff from furlough to participate in the CVR readout.

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 leading their respective investigations. As such, they control the release of all investigative information to the public related to those accidents. Annex 13 provides for other involved states to gain timely access to investigative information for the purposes of continued operational safety, however. As a result, NTSB participation in foreign accident investigations enables safety deficiencies to be promptly addressed by the FAA, the manufacturer, or the operator, as well as others deemed appropriate, and through NTSB safety recommendations, when needed. Because the United States is the state of design and certification of the aircraft involved in these accidents, we are examining relevant factors in the US design certification process to ensure any deficiencies are captured and addressed, including by NTSB safety recommendations, if necessary.

Summary of Lion Air 610 Preliminary Report

The FDR recovered from the Lion Air crash contained about 69 hours of data, covering the last 18 flights prior to the accident flight. The preliminary report released by the KNKT indicated that the left angle-of-attack (AOA) sensor[11] on the accident aircraft was replaced on October 27, 2018, due to an ongoing airspeed and altitude issue that had been reported by previous flight crews (there was a difference between the captain's and first officer's displayed airspeed and altitude). The aircraft's next flight -- which was also the flight prior to the accident flight -- occurred on October 28, 2018, from Ngurah Rai International Airport in Bali to Jakarta. On this flight, the FDR data indicate that the captain's AOA data was approximately 20 degrees higher than the first officer's AOA data, from airplane startup until the end of the flight. The FDR data also indicate that the captain's stick shaker activated immediately after rotation, followed by an airspeed and altitude miscompare warning.[12] As the airplane continued its climb after takeoff, the captain noticed that the stabilizer was automatically trimming in the airplane nose down (AND) direction. As a result, the captain engaged the automatic trim system cut-out switches and adjusted the stabilizers manually. The flight crew informed air traffic control (ATC) that they had an urgent situation and then conducted three different non-normal checklists. The flight crew elected to continue to their destination, Jakarta, and the remainder of the 96-minute flight was uneventful. After landing in Jakarta, the captain wrote up two issues in the maintenance logs: 1) there was a disagreement between the captain's and first officer's airspeed and altitude data, and 2) there was a fault in the elevator feel system. The maintenance personnel flushed the left pitot/static system and cleaned the electrical connector plug for the elevator feel computer. Both systems were then tested on the ground and no faults were noted.

The next day, October 29, 2018, Lion Air flight 610 departed from Jakarta. The FDR indicated that the captain's AOA data was about 20 degrees higher than the first officer's AOA data, from airplane startup until the end of the flight. The FDR data indicates that the captain's stick shaker activated immediately after rotation, followed by an airspeed and altitude miscompare warning. The first officer asked ATC to advise them of their airspeed and altitude, then indicted

[11] Angle of attack (AOA) is the angle between the relative wind and the wing chord line. The 737 MAX has two AOA sensors, one on each side of the forward fuselage, that measure the direction of airflow relative to the airplane during flight using a mechanical vane in each sensor.

[10] The stick shaker warns a pilot of an impending wing aerodynamic stall through vibrations on the control column, providing tactile and aural cues.

that they were experiencing a flight control problem and subsequently asked to return to the airport for landing. After the flaps were retracted, the data show that there was a 2.5-degree automatic AND stabilizer activation, followed by the flight crew commanding airplane nose up (ANU) stabilizer with ANU trim. The FDR data show that another automatic AND stabilizer activation occurred several seconds after the first, which was countered by the flight crew with ANU trim. The flight crew then extended the flaps, which stopped the automatic AND trim inputs. About 2 minutes later, the flight crew again retracted the flaps. There were then 25 automatic AND stabilizer activations that occurred until the end of the flight (approximately 6:20 minutes). The flight crew commanded ANU stabilizer trim after each of these automatic inputs. In the last 50 seconds, the ANU input by the crew was not sufficient to completely counter the AND inputs, and the stabilizer moved to almost the full AND position before the end of the data.

The captain of the accident flight had about 6,000 total flight hours, with about 5,100 hours on the Boing 737. The first officer had about 5,200 total flight hours, with about 4,300 hours in the Boeing 737. We do not have information regarding the number of flight hours in a Boeing 737 MAX.

Summary of Ethiopian Airlines 302 Preliminary Report

On March 10, 2019, Ethiopian Airlines flight 302 departed Addis Ababa. According to the preliminary report released by the AIB, the FDR data indicate that during startup, taxi, and takeoff ground roll, the captain's and first officer's AOA data was normal and identical. The throttle levers were set to takeoff and remained in the takeoff position for the entire flight. Several seconds after rotation, the captain's AOA data stepped up to about 75 degrees and his stick shaker activated, while the first officer's AOA data remained in the normal range throughout the flight. Concurrently, the flight crew received an airspeed and altitude disagree warning (the captain's airspeed and altitude values were lower than the first officer's values). Shortly after this, the flight crew also received an anti-ice warning. The captain then attempted to engage the autopilot three times; the autopilot engaged after the third attempt, as the airplane climbed through about 1,000 feet above the ground. The airplane continued to accelerate, and the flight crew retracted the flaps when the airspeed was about 240 knots. The flight crew then requested to maintain the runway heading (instead of turning on course), and reported that they were having flight control problems.

Shortly after the autopilot disengaged, an AND command moved the stabilizer approximately 2.5 degrees in the nose down direction (from 4.6 to 2.1 units), and the airplane momentarily descended as the Enhanced Ground Proximity Warning System (EGPWS) annunciation alerted. Approximately 3 seconds after the AND stabilizer movement stopped, the flight crew commanded ANU stabilizer input of about 0.3 degrees (from 2.1 to 2.4 units). Approximately 5 seconds after the end of the ANU stabilizer motion, a second automatic AND stabilizer command occurred, and the stabilizer moved about 2.0 degrees AND (from 2.4 to 0.4 units). The flight crew interrupted the automatic movement by commanding 1.9 degrees of ANU stabilizer trim (from 0.4 to 2.3 units). During this time, the captain asked the first officer to help him, and there were three EGPWS aural alerts. Shortly after, the first officer stated "stab trim cut-out" two times. The captain agreed and the first officer confirmed that the stabilizer trim cut-out switches were engaged. The FDR data indicates that, after that, there was another AND command

recorded without any corresponding movement of the stabilizer (which is consistent with the stabilizer cut-out switches being engaged). The first officer told ATC that the flight would like to level off at 14,000 feet, and that they were having flight control problems. For the next approximately 2.5 minutes, the stabilizer position moved about 0.2 degrees AND (from 2.3 to 2.1), and aft force continued to be applied to the control columns, which remained aft of the neutral position. During this time, the captain asked the first officer if the trim was functional. The first officer replied a short time later that the trim was not working but asked if he could try it manually. The captain told him to try. About 8 seconds later, the first officer replied that it was not working. About 32 seconds before the end of the recording, at approximately 13,400 feet, the flight crew commanded two ANU momentary electric trim inputs, and the stabilizer moved about 0.2 degrees ANU (from 2.1 to 2.3 units). Then, about 5 seconds after the last crew-commanded electric trim inputs, an automatic AND stabilizer command moved the stabilizer about 1.3 degrees (from 2.3 to 1.0) over approximately 5 seconds, and the airplane began to pitch nose down. The flight crew applied additional aft column force, but the airplane continued to pitch nose down, eventually reaching 40 degrees nose down. During the pitch over, the captain's airspeed increased to about 460 knots, and the first officer's airspeed reached about 500 knots; the captain's AOA data decreased and varied proportionally to the normal load factor.

The captain of the accident flight had about 8,100 total flight hours, which included about 1,400 hours in a Boeing 737 and about 100 hours in the Boeing 737 MAX. The first officer had about 360 total flight hours, including about 200 hours in the Boeing 737 with about 56 hours in a Boeing 737 MAX.

Conclusion

Thank you again for the opportunity to be here today to discuss the NTSB's role in international aviation accident investigations and to highlight our current participation in recent accidents involving Boeing 737 MAX 8 aircraft in Indonesia and Ethiopia. I will be happy to answer any questions.