July 5, 2022

BY FEDEX & EMAIL

The Honorable Jennifer L. Homendy
Chair, National Transportation Safety Board
490 L'Enfant Plaza East, SW
Washington, DC 20594

Re: Lion Air Flight 610 and Ethiopian Airlines Flight 302 Accident Investigations

Dear Ms. Homendy,

My name is Ed Pierson. I am the Boeing whistleblower that testified before Congress as part of the investigations into the two Boeing 737 MAX tragedies. Since the Lion Air disaster, I have done extensive research trying to answer a fundamental question that has been gnawing at me—why did the AOA Sensors fail? Last week I came upon a piece of information that actually startled me, something that has apparently been overlooked up to this point.

I have had concerns all along regarding the possibility that electrical installation and testing problems at the 737 Factory in Renton, Washington played pivotal roles in the crashes. This latest information when combined with other facts is so concerning that it warrants urgent action.

As you know, the JT610 investigation concludes a replacement sensor was miscalibrated and improperly installed. Although the ET302 final report has yet to be published, some aviation experts suggest the sensor was damaged due to a bird strike. Experts further state that no evidence can be traced back to manufacturing and the technical cause of the crashes (MCAS) has already been found and fixed. I agree MCAS and the lack of pilot training played major roles in these preventable tragedies. However, please allow me to suggest a different, even more alarming scenario that needs to be investigated.

The *NTSB's System Safety and Certification Specialist's Report* is dated August 21, 2019. This report was made public on June 3, 2021. The following paragraph found on pg. 23 describes an engineering design error made by Boeing in their initial System Safety Assessment (SSA). Boeing corrected the error after the ET302 crash. This fault analysis correction supports my initial finding—that both airplanes had electrical defects that could have caused their AOA sensors to fail, sending faulty data triggering both crashes. This fault type is considered "extremely improbable," but it appears this is exactly what may have happened.

"In 2019, Boeing advised the NTSB of an error in this fault tree in that the above two conditions should not have been combined with an AND gate. In a June 28, 2019, revision to the SSA, "Erroneous AOA-L data from Captain's side" is revised to show three separate conditions combined with on OR gate, ***meaning any one by itself could result in erroneous AOA data****:*

- *Erroneous AOA-L Sensor*
- *Incorrect AOA output from ADIRU-L output*
- ***Loss of Power to AOA-L Heater****"*

On Dec 10, 2018, U.S. accident investigators traveled to a Collins Aerospace facility in Minnesota to test the "removed AOA Sensor." This was the original Boeing-installed and tested sensor. In Minnesota, the sensor was subjected to several tests and the results were not good. In fact one sensor component failed every test including the Vane Travel Test, the Resolver Accuracy Test, and the Resolver Accuracy Test with Operation of the Heater Element.

From the JT610 Final Aircraft Accident Investigation Report

"Examination of the AOA Sensor revealed an intermittent open circuit in the resolver #2 coil wiring. At temperatures above approximately 60°C, the resolver functioned normally, but did not function below that temperature."

"A resolver accuracy test was repeated on the AOA Sensor per the test procedure with the additional requirement to operate the internal heaters."

"The first two measurements taken on Resolver 2 showed that the values were unstable similar to values observed in previous resolver accuracy testing. Once the unit warmed up with the heater operation the unit resolver 2 output stabilized and was within the CMM performance requirements. The remaining Resolver 2 values were found within limits. The first two measurements were re-taken and were found within limits. ***The vane and case heaters were turned off and the values for Resolver 2 went unstable..."***

Six months later, on June 5-6, 2019, the "removed AOA Sensor" from the Lion Air airplane is finally subjected to additional testing in Blacksburg, Virginia. This belated testing uncovers a serious production quality defect. More excerpts from the JT610 accident report:

"*Using CT Scans, physical examinations, and Scanning Electron Microscope (*SEM*) imaging, the open circuit was found to be a broken magnet wire on the rotor coil.* ***A loose loop in the coil of the magnet wire had been epoxied between two different insulators on the rotor with different coefficients of thermal expansion for each insulator.*** *As the rotor was exposed to cyclic differences in operating temperature over time, it is likely that the difference in the expansion rates of the two insulators induced a localized stress in the coil wire that led to a fatigue break in the wire that was open or closed dependent on temperature.*"

"*Because of the trapped magnet wire attached to two different CTE materials, the thermal cycling of the resolver over time due to the operational environment of the AOA on the aircraft mechanically "worked" the confined magnet wire into a fatigue failure mode. The magnet wire exhibits a series of ridges or "beach marks" that are indicative of multiple crack growth cycles (i.e. fatigue) before ultimately breaking and arcing multiple times as evidenced in the SEM images.*"

The flight control problems that occurred in the weeks prior to the crash were associated with this factory installed sensor—not the reportedly miscalibrated sensor installed by Lion Air the day prior.

From the ET302 Aircraft Accident Investigation Bureau Interim Report

Ten seconds after takeoff the left and right recorded AOA values began deviating. The left AOA Sensor value reaches 74.5 degrees. 4 seconds later the cockpit voice recorder transcript states:

> ***"At 5:38:48 Anti-ice was annunciated, by a master caution. The F/O called out "Master caution/anti ice" and the captain acknowledged the master caution"***

The accident report goes on to say:

> *"AOA vane heating belongs to the anti-ice protection. In case of a fault of the vane heating, the following systems activate:*
> *- the master caution triggers (master caution light illuminates)*
> *- the ANTI-ICE light (right system annunciator) switches on*
> *- The [L/R] ALPHA VANE message illuminates (on the Probe heat panel of overhead panel)"*

"The vane heating monitoring is based on current detection circuit. After the current drops, there is a delay of 3 to 5 s before the light "[L/R] Alpha Vane" illuminates and the master caution triggers."

Additional Relevant Information

A partial list of electrical installation and testing problems that were occurring in the 737 Factory:

- chronically late deliveries of electrical parts (engines, power panels, connectors, and wire bundles)
- fatigued employees and a shortage of trained electricians, mechanics, and quality inspectors
- insufficient amount of electrical test equipment
- huge backlog of electrical installation and testing jobs (more than ten times normal amount)
- electrical installation and testing jobs being worked out of sequence of the approved production plan
- numerous reports of electrical system test failures (circuitry, bonding, grounding, pull tests, etc.)
- installation work not in compliance with Electrical Wiring Interconnect System (EWIS) standards
- extensive rework and retesting of production milestones (Power On, Oil On, HIRF, HIBLOW, CSMS)

A partial list of production quality defects and workmanship errors that surfaced after the crashes:

- Installing defective slat tracks on the wings
- Leaving Foreign Object Debris (FOD) inside wing fuel tanks
- Installing unapproved Heads-Up Guidance System (HUD) Displays
- Grinding down wiring protection around engines (adding vulnerability to lightning strikes)
- Improperly installing fuel sealant
- Installing a refueling panel that does not indicate an automatic shutoff system failure
- Installing defective stab trim motors that move the horizontal stabilizer
- Faulty electronic flow control of air conditioning packs that vent air into the cargo hold
- Electrical bonding and grounding defects

Note 1: A Boeing factory manager told me on Jul 29, 2021, that SAT production records showed both airplanes had electrical defects as they were being built in the factory and even after they rolled out.
Note 2: Southwest removed two faulty AOA Sensors on new MAX airplanes three weeks prior to JT610.

Clearly both brand-new airplanes had electrical defects not attributable to MCAS. The FAA's 20-month comprehensive recertification process did not address this fact. Nor did the FAA admit their failure to provide effective production oversight at the factory that has resulted in all of these production quality defects. Instead the FAA focused on MCAS. **As a result, 737 MAX airplanes that are currently in-service around the world, may have similar electrical defects.** Of course these kinds of imbedded hazards pose other risks and can affect a wide range of flight safety systems beyond MCAS. We are seeing signs of EWIS defects in a disturbing number of system failures in FAA and NASA malfunction reports (stab trim motors, trim switches, autopilot, autothrottle, FMC, anti-ice, IAS & ALT alerts, maintenance alerts, etc.).

While I maintain the stance there are widespread issues with Boeing production and FAA oversight in general that need to be closely examined and fixed, this specific issue is tantamount because it is an immediate threat to the safety of every 737 MAX airplane. Within your Accredited Representative role, I implore the NTSB assist the JT610 and ET302 accident investigation teams in investigating these electrical defects on both airplanes and assess potential risks to other airplanes. I have cc'd the IICs on this letter. For more information, please see the attached report, *Boeing 737 MAX—Still Not Fixed*.

Sincerely,

Ed Pierson

cc: Bruce Landsberg, Michael Graham, Thomas Chapman, Dana Schulze, Eric Havian, Chris McLamb, Nurchahyo Utomo, Amdye Ayalew, Michael Stumo (contact for JT610 & ET302 victim families)