Crash: Lion B38M near Jakarta on Oct 29th 2018, aircraft lost height and crashed into Java Sea, wrong AoA data

By Simon Hradecky, created Wednesday, Nov 28th 2018 15:32Z, last updated Wednesday, Nov 28th 2018 15:55Z

Following the release of the preliminary report on Nov 28th 2018 The Aviation Herald issued a number of questions to the FAA (see below) and received the following reply, the spokesman explaining "We aren''t going to answer your specific questions because the investigation is ongoing":

The Federal Aviation Administration continues to participate in the Indonesian government's investigation into the crash of Lion Air Flight 610. The FAA issued an Emergency Airworthiness Directive (AD) on Nov. 7 ordering operators to revise the airplane flight manual (AFM) to give the flight crew horizontal stabilizer trim procedures to follow under certain conditions. The agency will take further action if findings from the accident investigation warrant.

The Aviation Herald had submitted following questions (two questions were forgotten but in the light of the reply above it can be assumed they would not have been addressed too):

With respect to the certification of the 737 MAX aircraft, in particular the MCAS system, I'd like to raise following questions:

- when was the certificate for the 737 MAX 8 requested, and when was the certification issued?

- what risk assessments were done within the certification procedures, in particular again with respect to the AoAs and MCAS?

- were the ADR (Air Data Reference) algorithms reviewed with respect to AoA?

- was the risk assessed that one of the AoA sensors could be damaged by a bird strike, hail strike or similiar and could show a substantially too high angle of attack?

- did the certification deem not necessary that an "AoA Disagree" message was to be introduced?

- Why was the MCAS permitted to operate on the base of a single AoA value showing too high angle of attacks? Why does the MCAS not consider the other AoA value?

- Was the risk assessed according to Boeing's last sentence in the notice to operators: "If the original elevated AOA condition persists, the MCAS function commands another incremental stabilizer nose down command according to current aircraft Mach number at actuation.", in particular what possibilities existed for that conditions to persist?

- what should the system response have been in case the AoA values disagree? How would the systems determine which value is plausible and which is erroneous? Is there any such check at all? Would MCAS not need to be prohibited if left and right AoA disagree?

*- considering the scenario that happened to Airbus twice (the **crash in Perignan** and the **Lufthansa A321 near Bilbao losing 4000 feet**), that at least two AoA sensors froze in same positions during climb, was the risk of such a scenario on the 737s assessed, too?*

- Did the certification consider a massive change in the function of the AoA when MCAS (as actor in the flight controls) was introduced in addition to stick shaker (monitoring only)?

- What is the reasoning behind the certification permitting to allow a system modify the aircraft's equilibrium (via trim) in manual flight in a way that the trim could run to the mechanical stop and thus overpower the elevator?

- Was the AoA input to the MCAS (or in general) ever being cross checked, e.g. by taking into account altitude, IAS, vertical speed to compute TAS via altitude, density and IAS and the angle of the airflow by computing the angle of the flight trajectory with TAS and vertical speed? Could such an crosschecking algorithm not even detect if two or more AoA sensors were frozen/faulty?

- is the FAA going to review the certification of the 737 MAX family (and perhaps previous 737 versions) following the findings by the KNKT so far?

*- Russia's MAK revoked the certificate of airworthiness for the entire 737 family (from 737-100 to 737-900) three years ago claiming they found an issue in the pitch/altitude control system of the aircraft (suggesting that at least the **Tatarstan crash in Kazan** as well as the**Flydubai crash in Rostov** may have been the result of that weakness) but did not receive a satisfactory response by the FAA and Boeing, also see **News: Russia suspends airworthiness certification for Boeing 737s, but does not prohibit operation of 737s**. What was the issue they found?*

The questions we forgot to add:

- How the certification deal with spurious faults and spurious functions, in particular during maintenance? The maintenance manuals define a test to be run, then list maintenance steps one by one, the test is to be repeated after each step. If the system is found to be working during the test the maintenance task aborts with the message "You have solved the issue", which may trigger a wrong analysis and premature end of troubleshooting without removing the fault if the test apparently works correctly by random chance.

- Why do the FIM procedures for airspeed disagree, altitude disagree, feel difference light, inexplicable stick shaker activation etc. not reference the possibility of an AoA issue although AoA has a crucial influence onto all these error conditions, thus not guiding the AME to verify proper action of this input in each of these error conditions?

By Simon Hradecky, created Wednesday, Nov 28th 2018 08:27Z, last updated Wednesday, Nov 28th 2018 17:37Z

On Nov 28th 2018 Indonesia's KNKT (also known as NTSC) released their **preliminary report** (**alternatively via AVH** due to congestion at KNKT website) releasing following findings so far (editorial note: a reader made us aware that the fault code 34-21123 identified by maintenance in the tech log refers to the left hand AoA sensor, hence the left hand AoA

sensor was replaced):

According to factual information during the investigation, the KNKT identified findings as follows:

- On 28 October 2018, a Boeing 737-8 (MAX) aircraft registered PK-LQP was operated as a scheduled passenger flight from Denpasar to Jakarta. Prior to the flight, the Angle of Attack (AoA) sensor had been replaced and tested.

- The DFDR showed the stick shaker activated during the rotation and remained active throughout the flight. About 400 feet, the PIC noticed on the Primary Flight Display (PFD) that the IAS DISAGREE warning appeared.

- The PIC cross checked both PFDs with the standby instrument and determined that the left PFD had the problem. The flight was handled by the SIC.

- The PIC noticed that as soon the SIC stopped trim input, the aircraft was automatically trimming aircraft nose down (AND). After three automatic AND trim occurrences, the SIC commented that the control column was too heavy to hold back. The PIC moved the STAB TRIM switches to CUT OUT.

- The pilot performed three Non-Normal Checklists (NNCs) consisting of Airspeed Unreliable, ALT DISAGREE, and Runaway Stabilizer. None of the NNCs performed contained the instruction "Plan to land at the nearest suitable airport".

- After parking in Jakarta, the PIC informed the engineer about the aircraft problem and entered IAS (Indicated Air Speed) and ALT (altitude) Disagree and FEEL DIFF PRESS (Feel Differential Pressure) light problem on the Aircraft Flight Maintenance Log (AFML).

- The PIC also reported the flight condition through the electronic reporting system of the company A-SHOR.

- The engineer performed flushing the left Pitot Air Data Module (ADM) and static ADM to rectify the IAS and ALT disagree followed by operation test on ground and found satisfied. The Feel Differential Pressure was rectified by performed cleaned electrical connector plug of elevator feel computer. The test on ground found the problem had been solved.

- At 2320 UTC, (29 October 2018, 0620 LT) the aircraft departed from Jakarta using runway 25L and intended destination Pangkal Pinang. The DFDR recorded a difference between left and right Angle of Attack (AoA) of about 20° and continued until the end of recording. During rotation the left control column stick shaker activated and continued for most of the flight.

- According to the weight and balance sheet, on board the aircraft were two pilots, five flight attendants and 181 passengers consisted of 178 adult, one child and two infants. The voyage report showed that the number of flight attendant on board was six flight attendants.

- During the flight the LNI610 SIC asked the TE controller to confirm the altitude of the aircraft and later also asked the speed as shown on the TE controller radar display. The LNI610 SIC reported experienced „flight control problem".

- After the flaps retracted, the FDR recorded automatic aircraft nose down (AND) trim active for 10 seconds followed by flight crew commanded aircraft nose up (ANU) trim. The flaps extended to 5 and the automatic AND trim stopped.

- At 23:25:18 UTC, the flaps retracted to 0 and several seconds later, the automatic AND trim and flight crew commanded ANU trim recorded began again and continued for the remainder of the flight.

- The LNI610 PIC advised the controller that the altitude of the aircraft could not be determined due to all aircraft instruments indicating different altitudes and requested to the controller to block altitude 3,000 feet above and below for traffic avoidance.

- The flight crew and the flight attendants held valid licenses and medical certificates and certified to operate B737.

- The Aircraft Flight Maintenance Log (AFML) recorded that since 26 October 2018 until the occurrence date, several problems occurred related to airspeed and altitude flag appeared on Captain (left) Primary Flight Display (PFD) three times, SPEED TRIM FAIL light illumination and MACH TRIM FAIL light illumination two times and IAS (Indicated Airspeed) and ALT (Altitude) Disagree shown on the flight Denpasar to Jakarta the day before the accident flight.

The KNKT already released two safety recommendations to LionAir basically stating, the aircraft was not airworthy on the flight from Denpasar to Jakarta, the flight should not have continued to Jakarta:

04.O-2018-35.1

Refer to the CASR Part 91.7 Civil Aircraft Airworthiness and the Operation Manual part A subchapter 1.4.2, the pilot in command shall discontinue the flight when un-airworthy mechanical, electrical, or structural conditions occur.

The flight from Denpasar to Jakarta experienced stick shaker activation during the takeoff rotation and remained active throughout the flight. This condition is considered as un-airworthy condition and the flight shall not be continued.

KNKT recommend ensuring the implementation of the Operation Manual part A subchapter 1.4.2 in order to improve the safety culture and to enable the pilot to make proper decision to continue the flight.

04.O-2018-35.2

According to the weight and balance sheet, on board the aircraft were two pilots, five flight attendants and 181 passengers consisted of 178 adult, one child and two infants. The voyage report showed that the number of flight attendant on board was six flight attendants. This indicated that the weight and balance sheet did not contain actual information.

KNKT recommend ensuring all the operation documents are properly filled and documented.

The KNKT summarized the events on the last completed flight from Denpasar to Jakarta,

which according to the safety recommendations was already flown with the aircraft in an "un-airworthy condition":

On 28 October 2018, a Boeing 737-8 (MAX) aircraft registered PK-LQP was being operated by PT. Lion Mentari Airlines (Lion Air) as a scheduled passenger flight from I Gusti Ngurah Rai International Airport (WADD), Denpasar to Jakarta as LNI043. During pre-flight check, the PIC discussed with the engineer of the maintenance actions that had been performed including replacement of the AoA sensor and had been tested accordingly.

The aircraft departed at 1420 UTC (2220 LT) at night time, the DFDR showed the stick shaker activated during the rotation and remained active throughout the flight. About 400 feet, the PIC noticed on the PFD the IAS DISAGREE warning appeared. The PIC handed over control to the SIC and cross checked the PFDs with the standby instrument and determined that the left PFD had the problem. The PIC noticed the aircraft was automatically trimming AND. The PIC moved the STAB TRIM switches to CUT OUT and the SIC continued the flight with manual trim without auto-pilot until the end of the flight.

The PIC declared "PAN PAN" to the Denpasar Approach controller due to instrument failure and requested to maintain runway heading. The PIC performed three Non-Normal Checklists and none contained the instruction "Plan to land at the nearest suitable airport".

The remainder of the flight was uneventful and the aircraft landed Jakarta about 1556 UTC. After parking, the PIC informed the engineer about the aircraft problem and entered IAS and ALT Disagree and FEEL DIFF PRESS problem on the AFML.

The engineer performed flushing the left Pitot Air Data Module (ADM) and static ADM to rectify the IAS and ALT disagree followed by operation test on ground and found satisfied. The Feel Differential Pressure was rectified by performed cleaned electrical connector plug of elevator feel computer. The test on ground found the problem had been solved.

The KNKT then summarized the accident flight:

At 2320 UTC, (0620 on 29 October 2018 LT), the aircraft departed from Jakarta with intended destination of Pangkal Pinang. The DFDR recorded a difference between left and right AoA of about 20° and continued until the end of recording. During rotation the left control column stick shaker activated and continued for most of the flight.

During the flight the SIC asked the controller to confirm the altitude of the aircraft and later also asked the speed as shown on the controller radar display. The SIC reported experienced „flight control problem".

After the flaps retracted, the DFDR recorded automatic AND trim active followed by flight crew commanded ANU trim. The automatic AND trim stopped when the flaps extended. When the flaps retracted to 0, the automatic AND trim and flight crew commanded ANU trim began again and continued for the remainder of the flight. At 23:31:54 UTC, the DFDR stopped recording.

Until the publishing of this Preliminary Report, the CVR has not been recovered, the search for CVR is continuing. The investigation will perform several tests including the test of the AoA sensor and the aircraft simulator exercises in the Boeing engineering simulator. The

investigation has received the QAR data for flight for analysis.

The KNKT reported that a tug boat found first floating debris at position N5.8156 E107.1231 about 35 minutes after the flight data recorder stopped recording.

The aircraft was flown by a captain (31, ATPL, 6,028 hours total, 5,176 hours on type) and a first officer (41, CPL, 5,174 hours total, 4,286 hours on type).

The occurrence aircraft had flown 895 hours and 433 cycles since new.

On Oct 26th 2018 following a flight from Tianjin Binhai to Manado the crew noted following faults: "Speed and Altitude Flag show on Captain Primary Flight Display (no speed and altitude indication)" and "Maintenance light illuminate after landing", maintenance performed following actions for the first tech log entry: "Performed check Onboard Maintenance Function (OMF), found maintenance message 27-31000. Refer to Interactive Fault Isolation Manual (IFIM) 27-31000, performed Stall Management and Yaw Damper (SMYD) number 1 system test carried out, result normal." and for the second note: "Performed check OMF, found message 27-31-000. Performed erase maintenance message check out maintenance light goes off."

On Oct 27th 2018 following a flight from Manado to Denpasar the flight crew noted following faults in the tech log:

- Speed and Altitude Flag show on Captain Primary Flight Display (no speed and altitude indication)
- SPEED TRIM FAIL light illuminate and MACH TRIM FAIL light illuminate
- Auto-throttle Arm disconnect, during aircraft takeoff roll

Maintenance actioned for all log entries: "Refer to IFIM task 27-32-00-810-816 rev October 2018. Perform check OMF status found message “STALL WARNING SYS L”. initial evaluation performed SMYD number 1 self-test result failed message 27-31-12 (AD data invalid) and 27-31015 (ADIRU data invalid). Check OMF existing fault (34) found message 34-21107 (AIR DATA SIGNAL INVALID) and 34-21123 (AOA SIGNAL OUT OF RANGE). BITE ADIRS L via CDU found message 34-21023 (AOA SIGNAL FAIL). Reset CB ADIRU L AC and DC and ADIRU L carried out. System test pass. DFCS BITE result PASS. Erase status message carried out and check message not active." In addition maintenance decided: "For troubleshooting due to repetitive problem perform replaced angle of attack sensor in accordance with Aircraft Maintenance Manual (AMM) Task 34-21-05-000-001 and task 34-21-05-400-801 carried out. Installation test and heater system test result good." (Editorial note: the text does not identify directly, whether left or right hand AoA was replaced, the AMM tasks are generic for both left and right hand AoA sensor thus also not permitting to identify which AoA sensor was replaced, thanks to a friendly followup by a licensed aircraft maintenance engineer, a second AME made us aware however, that the error code 34-21123 refers to the left hand AoA sensor only).

On Oct 28th 2018 following the flight Denpasar to Jakarta the crew noted in the tech log of the aircraft:

- IAS and ALT Disagree shown after take off
- feel diff press light illuminate

Maintenance wrote down as maintenance activity for the first entry: "(Refer to IFIM task 34-20-00-810-801 REV 15 June 2018). Performed flushing Left Pitot Air Data Module (ADM) and static ADM. Operation test on ground found satisfied." and for the second entry: "Refer IFIM 27-31-00-810-803 Rev 15 June 2018, performed cleaned electrical connector plug of elevator feel computer carried out. test on ground found OK."

The preliminary report confirms (and contains also) the FDR graphs already shown to Indonesia's parliament and previously published by the AVH.

The KNKT reports that they have obtained the AoA Sensor that was replaced in Denpasar, the sensor will "undergo further testing and analysis under the supervision of the KNKT."

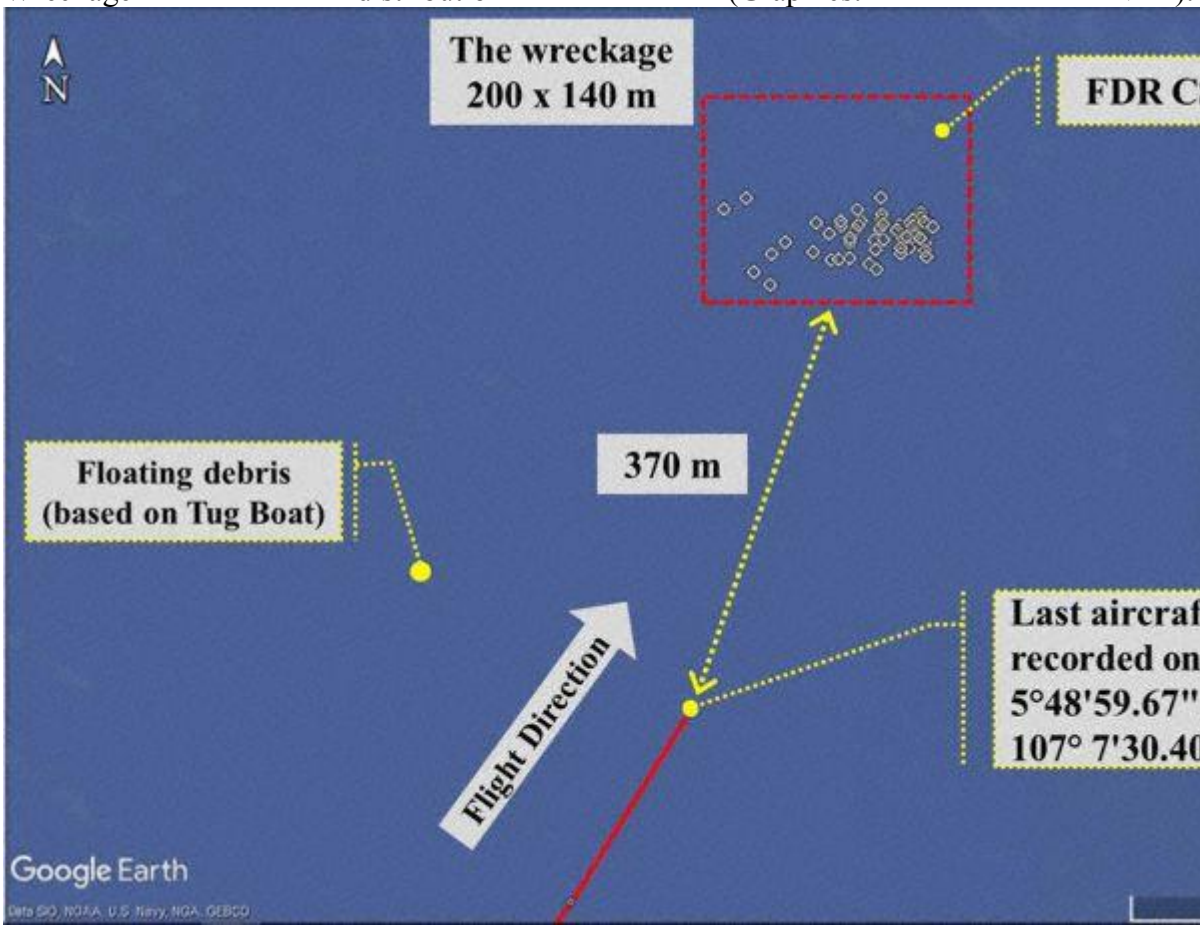
As result of the investigation so far Boeing issued their Operator's Manual Bulletin and the FAA subsequently their Emergency Airworthiness Directive (already reported previously).

On Nov 10th 2018 Boeing sent out multi-operator messages informing operators about the MCAS (Maneouvering Characteristics Augementation System) stating:

A pitch augmentation system function called 'Maneuvering Characteristics Augmentation System' (MCAS) is implemented on the 737-8, -9 (MAX) to enhance pitch characteristics with flaps UP and at elevated angles of attack. The MCAS function commands nose down stabilizer to enhance pitch characteristics during steep turns with elevated load factors and dunng flaps up flight at airspeeds approaching stall. MCAS is activated without pilot input and only operates in manual, flaps up flight. The system is designed to allow the flight crew to use column tnm switch or stabilizer aisle stand cutout switches to override MCAS input. The function is commanded by the Flight Control computer using Input data from sensors and other airplane systems.

The MCAS function becomes active when the airplane Angle of Attack exceeds a threshold based on airspeed and altitude. Stabilizer Incremental commands are limited to 2.5 degrees and are provided at a rate of 0.27 degrees per second. The magnitude of the stabilizer Input is lower at high Mach number and greater at low Mach numbers. The function Is reset once angle of attack falls below the Angle of Attack threshold or if manual stabilizer commands are provided by the flight crew. If the original elevated AOA condition persists, the MCAS function commands another incremental stabilizer nose down command according to current aircraft Mach number at actuation.

Wreckage distribution (Graphics: KNKT):



By Simon Hradecky, created Monday, Oct 29th 2018 03:16Z, last updated Wednesday, Nov 28th 2018 08:28Z

A Lionair Boeing 737-800 MAX, registration PK-LQP performing flight JT-610 from Jakarta to Pangkal Pinang (Indonesia) with 181 passengers and 8 crew, was climbing out of Jakarta when the aircraft reached a maximum altitude of about 5400 feet, then lost height, radar contact was lost about 35nm northeast of Jakarta over the Java Sea at 06:33L (23:33Z Oct 28th). Rescue services are on their way to the suspected crash site, first ships have reached the crash site and located oil slicks as well as debris from the aircraft including mobile phones and first body parts. Later the day 6 bodies were recovered. Authorities state there is no hope for survivors. On Nov 1st 2018 one of the blackboxes was recovered. On Nov 3rd 2018 one of the divers involved in the recovery of bodies died in action.

Indonesian Authorities reported it is certain the aircraft crashed north of the Karawang area in the waters of the Java Sea. First ships have reached the crash site, water depth at the site is about 30-35 meters. At the surface there were oil slicks as well as debris from the aircraft. No survivors or bodies have been found so far.

Indonesia's Ministry of Transport reported a tug boat saw an aircraft crash into the Java sea. Radar contact with the aircraft carrying 178 passengers, 2 babies and one infant as well as two pilots and five flight attendants was lost at position S5.8156 E107.1231. The accident aircraft was registered on Aug 15th 2018 and received its certificate of airworthiness also on Aug 15th 2018. Indonesia's BASARNAS are in charge of the rescue and recovery operation and are sending their units to the suspected crash site.

On Oct 30th 2018 the Ministry reported that an unscheduled inspection of Lionair aircraft has been conducted and indicated there will be sanctions. The nature of the sanctions is being coordinated with the KNKT. A first instruction to inspect all aircraft have already been issued to Lionair.

On Oct 31st 2018 the Ministry advised that the technical director of LionAir has been suspended for 120 days (not fired as a number of media reported).

Indonesia's Civil Aviation Authority reported the aircraft requested to return to Jakarta.

Basarnas reports there are currently attempts to dive to the aircraft in the waters about 30-35 meters deep. First debris has been collected from the water surface including mobile phones and first body parts. The crash site is located less than 2nm from the last known radar position. No ELT signal was received. Underwater equipment has been moved to the crash site, divers are attempting to locate the victims and the blackboxes. Later the day six bodies were recovered. The position of the blackboxes was detected (editorial note: obviously via pingers), the blackboxes have not yet been recovered.

Early Oct 30th 2018 Basarnas reported there were 181 passengers, 2 pilots and 6 cabin crew on board. Speed boats delivered 4 body bags with body parts collected from the water surface as well as debris including identities as well as belongings of passengers to the command post. The main wreckage however has not yet been located. A remotely operated underwater vehicle (ROV) has been deployed to the crash site. Lighting equipment has been dispatched to the crash site in order to enable a 24 hours continuous search.

In the evening of Oct 30th 2018 Basarnas reported a total of 34 ships and 837 personnel are engaged in the search for the fuselage and black boxes, which has been expanded to cover 400 square nautical miles. 26 body bags have been taken to the command post, 24 are already on their way to hospital for identification.

On Oct 31st 2018 Basarnas reported that multiple large objects, size undetermined, have been located on the sea floor. At this point it can not be ascertained these objects belong to JT-610. Divers have been dispatched. TNI (Indonesia's Army) advises that a large piece of 22 meters length is believed to be part of the fuselage.

On Nov 1st 2018 Basarnas reported one of the black boxes was recovered. The black box has been handed over to KNKT for further processing and read out. The box was located at position S5.8128 E107.1269, 400 meters northeast of the last known radar position of the aircraft. A second pinger signal was located from about position S5.8133 E107.1271.

On Nov 3rd 2018 Indonesia's Navy reported a volunteer diver recovering body parts died, probably because of decompression. The diver had served in AirAsia Indonesia's crash QZ-8501 four years ago, see **Crash: Indonesia Asia A320 over Java Sea on Dec 28th 2014, aircraft lost height and impacted waters, loss of rudder travel limiter due to maintenance**, and in Palu after the September 2018 earthquake and tsunami.

On Nov 3rd 2018 Basarnas reported 73 body bags have been taken to the command post so far. The largest part recovered so far, part of the landing gear, as well as other debris collected so far were handed over to KNKT. The locator ping signal, believed to originate from the CVR, had died down, possibly the CVR is covered by mud or water currents in the area move

the pinger, more sensitive specialist equipment is being brought in to find the pings again. Search and recovery operations are continuing within a 500 meter radius around the location where the first black box was found.

On Nov 4th 2018 Basarnas reported the second weak ping signal has been successfully re-detected, the source appears to be buried in mud below about 1 meter of aircraft debris about 50 meters off the center of the main search area. The box itself has not yet been found. 104 body bags have been taken to the command post so far. The search operation has been extended for an additional 3 days.

On Nov 8th 2018 Basarnas reported the search for the CVR is still ongoing with the ROV, scan side sonar, ping locator and multi beam echo sounders deployed. Basarnas wrote: "As explained earlier, the ping locator could detect the black box's signal, but it was weak. The signal source is difficult to ascertain its position considering the sea floor is mud with a depth of more than 1 meter." Up to Nov 7th 2018 20:00L 187 body bags were collected and taken to the command post and further to the hospital for identification.

On Nov 10th 2018 Basarnas announced that the search for bodies has ended, the search has been downgraded to monitoring. 196 body bags have been taken to the command post and further to the hospital for identification, 77 victims have been identified so far. The search for the CVR continues. The CVR is described as critical to understand the events on board of the flight, the KNKT indicates the currently understand about 70-80 percent of what happened, the CVR would help to understand 100%.

The airline reported the aircraft encountered a technical problem, the crew was about to return to Jakarta. There had also been a technical problem on the previous flight, this problem however was fixed (editorial note: the aircraft remained on the ground in Jakarta over night for 8 hours prior to the accident flight, there is a write up circulating in the Internet only claiming the aircraft had experienced unreliable airspeed and altitude on the previous flight, the captain's instruments were identified faulty, control was handed to the first officer and the flight continued to destination below RVSM airspace - we removed this write up repeatedly from our reader comment board because of its unverified nature and because it supposedly contains names of flight crew). The captain had accumulated 6,000 hours of total flight experience, the first officer 5,000 hours.

On Oct 30th 2018 the airline indicated they are going to accept whatever sanctions will be issued including a grounding. As of current inspections of all aircraft under supervision by the Ministry are underway.

On Oct 31st 2018 the airline stated they have dismissed the technical director and assigned a new technical director.

On Nov 1st 2018 the airline confirmed one of their maintenance engineers was on board of the aircraft during the accident flight. This was an "anticipatory measure" in the event of technical problems with the new aircraft. As such, "the presence of the technician has nothing to do with the condition of the aircraft before taking off."

Indonesia's KNKT (aka NTSC) reported the crew requested to return to Jakarta shortly after takeoff, when the aircraft climbed through 2000-3000 feet MSL about 3 minutes after takeoff, the request was granted by ATC. The KNKT is still looking into the causes of the request to

return. About 8 minutes later radar contact was lost. The blackboxes are at an estimated depth of 30 meters, attempts to reach and recover the black boxes are underway.

Late Oct 30th 2018 the KNKT reported in a press conference that they have listened to the ATC audio recordings and heard the request to return. However, The KNKT will first compare with the black boxes and verify that the recording matches what happened to the aircraft before releasing such information.

On Oct 31st 2018 the KNKT reported in a press conference, they are about 70% certain the pings being received since Oct 29th come from the aircraft's black boxes. The location appears to be within 3 kilometers of the current search area. Resources are being deployed to examine and retrieve the source of the pings.

On Nov 2nd 2018 the KNKT reported the black box recovered on Nov 1st 2018 was the Crash Surviveable Memory Unit (CSMU) of the flight data recorder storing 25 hours of flight data. However, as the flight data recorder has been split, additional work is needed to read the data out. The unit is being cleaned and recovered at the KNKT recorder lab in Jakarta.

On Nov 4th 2018 the KNKT reported the FDR has been successfully read out. It contained 1800 parameters spanning 19 flights including the accident flight. Analysis of the data has begun. The KNKT is committed to release preliminary findings as soon as possible.

On Nov 5th 2018 the KNKT reported the ping signal from the CVR has not been received for two days now. There are other means to find the CVR however. A first assessment of the FDR data revealed that during last 4 flights (including the accident flight) there was damage to the airspeed indicator.

On Nov 8th 2018 the KNKT reported an angle of attack sensor had been replaced on Oct 28th 2018 following the flight JT-775 from Manado to Denpasar (the aircraft completed the subsequent flight JT-43 to Jakarta and suffered the crash the next flight JT-610). The aircraft subsequently flew to Jakarta, the crew however reported there were still problems. The search for the CVR is hampered by thick mud.

On Nov 22nd 2018 the KNKT gave a presentation to Indonesia's Parliament about the findings so far. The KNKT told the parliament that the FDR contained 1790 parameters spanning 19 flights. The last two flights, the flight from Denpasar to Jakarta as well as the accident flight, were showing the same issue, the right hand speed (first officer's IAS) signficantly higher than the left hand speed (captain's speed). The captain's AoA indicated about 20 degrees higher than the first officer's AoA. As result the left stick shaker activated immediately after takeoff and operated, with a brief period where it stopped during a descent shortly after takeoff, continuosly throughout the flight. When the aircraft levelled off at 5000 feet automatic nose down trim inputs occurred which were countered by manual trim up inputs by the crew. The nose down trim inputs were created by the Maneouvering Characteristics Augmentation System (MCAS), a tool which will lower the nose of the aircraft to prevent a stall. Until the end of the flight the automatic nose down trim inputs were countered by manual nose up trim inputs by the crew. During the end of the recording the automatic nose down trim inputs increased, the pilots still trimmed nose up however shorter. Overall the stabilizer trim position moves increasingly towards nose down until it was no longer possible to counter the pitch down moment via the yoke. Throughout the flight there had been no problems with the engines. On the previous flight from Denpasar to Jakarta the same problem existed, the

automatic trim inputs however did not occur. The crew must have done something preventing the MCAS system producing the nose down trim inputs. Following the presentation the KNKT released **first information in Indonesian** including some FDR graphics.

AirNav Indonesia, ATC provider, reported the crew requested to return to Jakarta, however, did not declare emergency. The aircraft did not turn following the clearance to return, radar contact was lost subsequently.

Boeing reported Indonesia's Ministry of Transport has confirmed the wreckage of the 737 MAX 8 has been located conducting flight JT-610. Boeing is saddened by the loss of flight JT-610 and expresses condolences to the families. Boeing stands ready to provide technical assistance to the accident investigation.

On Nov 7th 2018 Boeing issued an Operations Manual Bulletin (OMB) to all Boeing 737 MAX Operators stating that the investigation into the crash of PK-LQP found one of the Angle of Attack Sensors had provided incorrect readings, which could cause the aircraft's trim system to uncommandedly trim nose down in order to avoid a stall during manual flight. The OMB directs "operators to existing flight crew procedures to address circumstances where there is erroneous input from an AOA sensor." The OMB reiterates the Stabilizer Runaway non-normal checklist.

The flight Crew Operations Manual Bulletin TBC-19 reads:

The Indonesian National Transportation Safety Committee has indicated that Lion Air flight 610 experienced erroneous AOA data. Boeing would like to call attention to an AOA failure condition that can occur ***during manual flight only.***

This bulletin directs flight crews to existing procedures to address this condition. In the event of erroneous AOA data, the pitch trim system can trim the stabilizer nose down in increments lasting up to 10 seconds. The nose down stabilizer trim movement can be stopped and reversed with the use of the electric stabilizer trim switches but may restart 5 seconds after the electric stabilizer trim switches are released. Repetitive cycles of uncommanded nose down stabilizer continue to occur unless the stabilizer trim system is deactivated through use of both STAB TRIM CUTOUT switches in accordance with the existing procedures in the Runaway Stabilizer NNC. It is possible for the stabilizer to reach the nose down limit unless the system inputs are counteracted completely by pilot trim inputs and both STAB TRIM CUTOUT switches are moved to CUTOUT.

Additionally, pilots are reminded that an erroneous AOA can cause some or all of the following indications and effects:

- *Continuous or intermittent stick shaker on the affected side only.*
- *Minimum speed bar (red and black) on the affected side only.*
- *Increasing nose down control forces.*
- *Inability to engage autopilot.*
- *Automatic disengagement of autopilot.*
- *IAS DISAGREE alert.*
- *ALT DISAGREE alert.*
- *AOA DISAGREE alert (if the AOA indicator option is installed)*
- *FEEL DIFF PRESS light.*

In the event an uncommanded nose down stabilizer trim is experienced on the 737 - 8 / - 9, in conjunction with one or more of the above indications or effects, do the Runaway Stabilizer NNC ensuring that the STAB TRIM CUTOUT switches are set to CUTOUT and stay in the CUTOUT position for the remainder of the flight.

Late Nov 7th 2018 the FAA released **Emergency Airworthiness Directive (EAD) 2018-23-51** concerning all Boeing 737 Max aircraft reading:

This emergency AD was prompted by analysis performed by the manufacturer showing that if an erroneously high single angle of attack (AOA) sensor input is received by the flight control system, there is a potential for repeated nose-down trim commands of the horizontal stabilizer. This condition, if not addressed, could cause the flight crew to have difficulty controlling the airplane, and lead to excessive nose-down attitude, significant altitude loss, and possible impact with terrain.

The EAD requires operators to update the procedures in the Aircraft Flight Manuals within 3 days according to Boeing's Service Bulletin (see the text above), however, includes the possiblity the trim could move even after the cutout switches were set to cutout. The text of the proedure for a Runaway Stabilizer mandated reads:

Disengage autopilot and control airplane pitch attitude with control column and main electric trim as required. If relaxing the column causes the trim to move, set stabilizer trim switches to CUTOUT. If runaway continues, hold the stabilizer trim wheel against rotation and trim the airplane manually.

Note: The 737 - 8 /- 9 uses a Flight Control Computer command of pitch trim to improve longitudinal handling characteristics. In the event of erroneous Angle of Attack (AOA) input, the pitch trim system can trim the stabilizer nose down in increments lasting up to 10 seconds.

In the event an uncommanded nose down stabilizer trim is experienced on the 737 - 8 / - 9, in conjunction with one or more of the indications or effects listed below, do the existing AFM Runaway Stabilizer procedure above, ensuring that the STAB TRIM CUTOUT switches are set to CUTOUT and stay in the CUTOUT position for the remainder of the flight.

An erroneous AOA input can cause some or all of the following indications and effects:

- *Continuous or intermittent stick shaker on the affected side only.*
- *Minimum speed bar (red and black) on the affected side only.*
- *Increasing nose down control forces.*
- *IAS DISAGREE alert.*
- *ALT DISAGREE alert.*
- *AOA DISAGREE alert (if the option is installed).*
- *FEEL DIFF PRESS light.*
- *Autopilot may disengage.*
- *Inability to engage autopilot.*

Initially, higher control forces may be needed to overcome any stabilizer nose down trim already applied. Electric stabilizer trim can be used to neutralize control column pitch forces before moving the STAB TRIM CUTOUT switches to CUTOUT. Manual stabilizer trim can

be used before and after the STAB TRIM CUTOUT switches are moved to CUTOUT.

On Oct 31st 2018 a local fisherman reported they (he and his friends) were out on the Java Sea to fish for shrimps when they observed a white airplane with an orange pattern in some distance, the aircraft was flying unusually low. The aircraft appeared to roll in for a turn when it shook and swooped sharply and impacted the waters of the sea. Immediately after a sound of thunder or explosion occurred. They were afraid of approaching the source of the sound and decided to return to the coast which was about 3 hours away. After arriving at the coast they saw the coast was crowded with many residents looking out over the waters, there were emergency vehicles and policemen in the crowd. They talked to a policeman and told him about their observation, police asked them to show them the crash site. After a trip of about 3 hours back to the location they found debris, body parts and oil slicks on the surface of the water. Soon after many more ships arrived at the scene.

On Nov 5th 2018, following the KNKT release confirming airspeed indicator problems during the last 4 flights of the aircraft, a tweet posted on Oct 29th 2018 at 07:07Z by Razaan Botutihe gained sufficient weight to be rated as factual. The tweet states concerning flight JT-43 from Denpasar (Indonesia) to Jakarta, the last flight the aircraft completed: "Airspeed unreliable and alt disagree shown after take off. STS was also running to the wrong direction, suspected because of speed difference. Identified that CAPT instrument was unreliable and handover control to FO. Continue NNC of Airspeed Unreliable and ALT disagree." (Editorial Notes: STS: speed trim system. As far as is known so far the accident crew managed to control the aircraft for 12 minutes from takeoff to maintaining 5000 feet at about 290-310 knots over ground between 5000 and 5400 feet, which suggests they were flying on pitch and power for that time, it thus appears something beyond unreliable airspeed and altitude must have contributed to the loss of control in minute 13.) In addition three different versions of a maintenance logbook were leaked to the Internet, after a closer look they all appeared to show the same log book at different point in time. Apart from the remark of unreliable airspeed and altitude, which prompted the flushing of the captain's static ports, an entry for elevator feel computer light illuminated was written down by the flight crew of JT-93 (presumably a typo and believed to be JT-43), maintenance opened and cleaned a cannon plug connector for the elevator feel computer, checks by the Aviation Herald with AMEs and related Maintenance Manuals confirmed the log book appeared authentic, the maintenance activity concerning that plug however could not have changed the forces on the pitch control of the yoke, only the status and error messages concerning the system could have been affected by the maintenance activity. The elevator feel computer has its own static and dynamic ports positioned at the tail of the aircraft, is purely mechanical with no electronic components except for some status monitoring, depends on hydraulic systems A and B available and does not depend on the instrumentation/Air Data References used for pilot instrumentation.

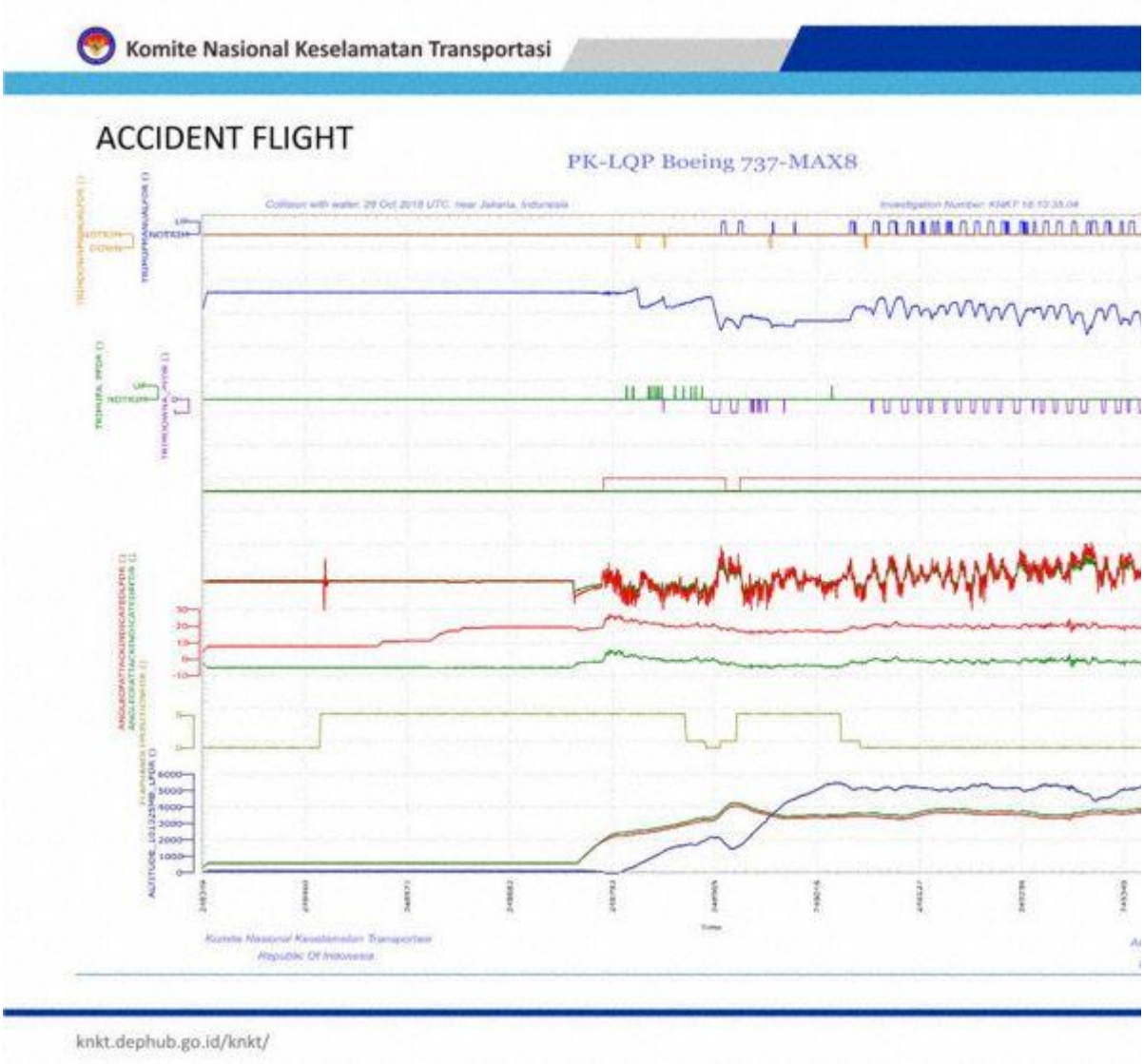
According to ADS-B data transmitted by the aircraft's transponder the aircraft departed Jakarta's runway 25L at 06:21L (23:21Z Oct 28th), never climbed above 5400 feet remaining between 5200 and 5400 feet for about 6 minutes before losing altitude and disappearing from radar about 12 minutes after departure at about 06:33L (23:33Z) about 35nm northeast of Jakarta's International Airport.

Metars:

WIII	290130Z	VRB04KT	8000	SCT020	29/25	Q1011	NOSIG=
WIII	290100Z	VRB03KT	8000	SCT020	28/25	Q1011	NOSIG=
WIII	290030Z	VRB03KT	8000	SCT020	27/25	Q1011	NOSIG=

WIII	**290000Z**	**VRB03KT**	**8000**	**SCT020**	**27/25**	**Q1011**	**NOSIG=**
WIII	**282330Z**	**16003KT**	**8000**	**SCT020**	**27/25**	**Q1010**	**NOSIG=**
WIII	**282300Z**	**VRB02KT**	**8000**	**BKN022**	**26/25**	**Q1009**	**NOSIG=**
WIII	282230Z	VRB04KT	8000	SCT020	26/25	Q1009	NOSIG=
WIII	282200Z	VRB04KT	9000	SCT020	26/25	Q1009	NOSIG=
WIII	282130Z	17004KT	9000	SCT020	26/25	Q1009	NOSIG=
WIII	282100Z	13004KT	9000	SCT020	26/25	Q1009	NOSIG=
WIII	282030Z	VRB02KT	9000	SCT020	26/25	Q1009	NOSIG=
WIII	282000Z	16002KT	9000	SCT020	26/25	Q1009	NOSIG=

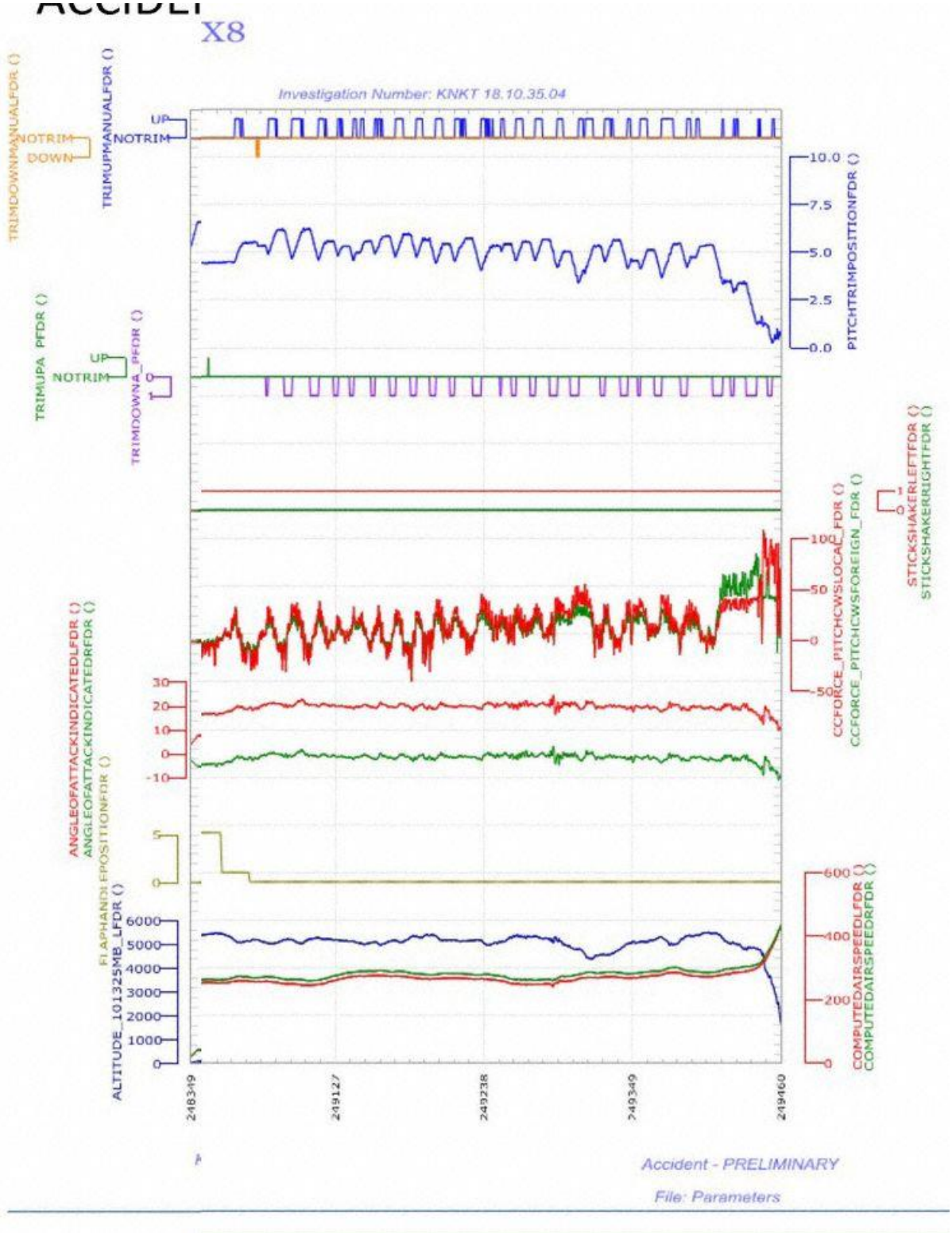
The FDR data released by KNKT on Nov 23rd 2018 (Graphics: KNKT):



Detail of FDR data, left scale stitched to detail of crash sequence (Graphics: AVH/KNKT):

Accident

X8


Investigation Number: KNKT 18.10.35.04
TRIMDOWNMANUALFDR ()
NOTRIM
DOWN
TRIMUPMANUALFDR ()
UP
NOTRIM
PITCHTRIMPOSITIONFDR ()
10.0
7.5
5.0
2.5
0.0
TRIMUPA PFDR ()
UP
NOTRIM
TRIMDOWNA_PFDR ()
0
1
STICKSHAKERLEFTFDR ()
STICKSHAKERRIGHTFDR ()
CCFORCE_PITCHCWSLOCAL_FDR ()
CCFORCE_PITCHCWSFOREIGN_FDR ()
100
50
0
-50
ANGLEOFATTACKINDICATEDLFDR ()
ANGLEOFATTACKINDICATEDRFDR ()
30
20
10
0
-10
FLAPHANDLEPOSITIONFDR ()
5
0
ALTITUDE_101325MB_LFDR ()
6000
5000
4000
3000
2000
1000
0
COMPUTEDAIRSPEEDLFDR ()
COMPUTEDAIRSPEEDRFDR ()
600
400
200
0
248349
249127
249238
249349
249460
Accident - PRELIMINARY
File: Parameters

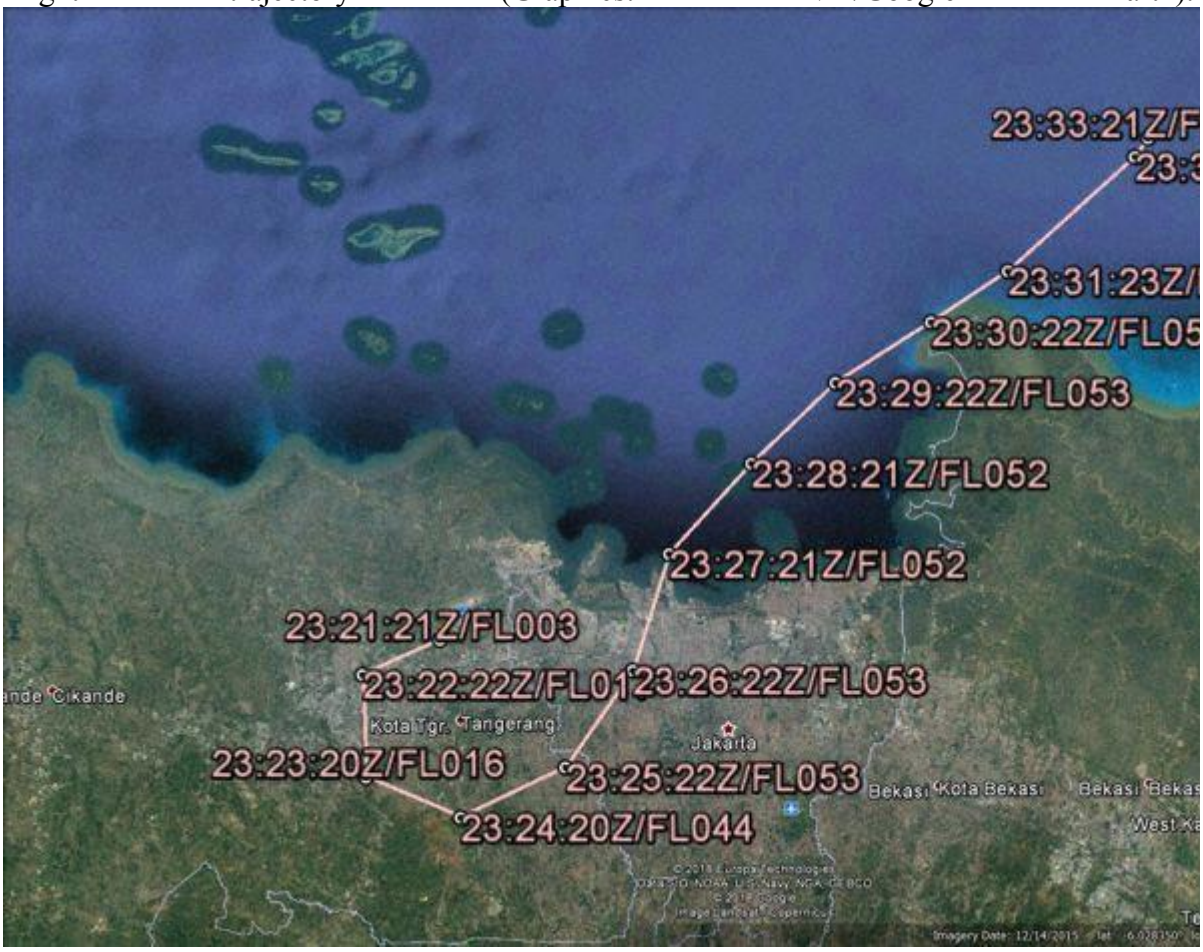
The largest part recovered so far, Nov 3rd 2018 (Photo: Basarnas):

The black box found on Nov 1st 2018 (Photo: Basarnas):

Debris in the water (Photo: Basarnas):

Part of recovered debris (Photo: Basarnas):

Flight trajectory (Graphics: AVH/Google Earth):



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