AIRCRAFT SERIOUS INCIDENT FINAL REPORT

SI 02/22P

Air Accident Investigation Bureau (AAIB)

Ministry of Transport Malaysia

Boeing B737-800, Registration 9M-MLS

En-route KUL to TWU (Kuala Lumpur to Tawau)

on 03 April 2022

Air Accident Investigation Bureau
Ministry of Transport
No. 26 Jalan Tun Hussein, Precinct 4
Federal Government Administration Centre
62100 PUTRAJAYA
Phone: +603 8892 1072
Fax: +603 8888 0163
e-mail: AAIB@mot.gov.my
Website: http://www.mot.gov.my/en

Issued On 24 Nov 2023
MOT.(S).600-5/4/85

AIR ACCIDENT INVESTIGATION BUREAU (AAIB)
MALAYSIA

ACCIDENT REPORT NO.: SI 02/22

OPERATOR	**: MALAYSIAN AIRLINE BERHAD**
AIRCRAFT TYPE	**: BOEING B737-800**
NATIONALITY OF AIRCRAFT	**: MALAYSIA**
REGISTRATION	**: 9M-MLS**
PLACE OF OCCURRENC	**: EN-ROUTE KUL to TWU**
DATE AND TIME	**: 3 APRIL 2022 AT 1519 LT**

This report contains statement of facts which have been determined up to the time of issue. It must be regarded as tentative, and is subjected to alteration or correction if additional evidence becomes available.

This investigation is carried out to determine the circumstances and causes of the accident with a view to the preservation of life and the avoidance of accident or incident in the future. It is not the purpose to apportion blame or liability (Annex 13 to the Chicago Convention and Civil Aviation Regulations 2016).

All times in this report are Local Time (LT) unless stated otherwise. LT is UTC + 8 hours.

INTRODUCTION

The Air Accident Investigation Bureau of Malaysia

The Air Accident Investigation Bureau (AAIB) is the air accidents and serious incidents investigation authority in Malaysia and is responsible to the Minister of Transport. Its mission is to promote aviation safety by conducting independent and objective investigations into air accidents and serious incidents.

The AAIB conducts the investigations in accordance with Annex 13 to the Chicago Convention and Civil Aviation Regulations of Malaysia 2016.

According to ICAO Annex 13 paragraph 4.1, notification of the incident was sent on 15th April 2022 to the National Transport Safety Bureau (NTSB) of the United States of America as State of Manufacturer and Civil Aviation Authority Malaysia (CAAM).

In carrying out the investigations, the AAIB will adhere to ICAO's stated objective, which is as follows: *"The sole objective of the investigation of an accident or incident shall be the prevention of accident and incident. It is not the purpose of this activity to apportion blame or liability".*

Accordingly, it is inappropriate that AAIB reports should be used to assign fault or blame or determine liability since neither the investigation nor the reporting process has been undertaken for that purpose.

TABLE OF CONTENTS

GLOSSARY OF ABBREVIATIONS

A

AAIB	Air Accident Investigation Bureau
AAL	Above Aerodrome Level
AD	Aerodrome
ADIRU	Air Data Inertial Reference Unit
AFRS	Airport Fire Rescue Services
AIP	Aeronautical Information Publication
AP	Autopilot
APU	Auxiliary Power Unit
ATC	Air Traffic Control
ATCO	Air Traffic Control Officer
ATIS	Automated Terminal Information Service
ATPL	Airline Transport Pilot License
ATS	Air Traffic Services
AIS	Indicated Airspeed

C

CAA	Civil Aviation Authority
CAAM	Civil Aviation Authority of Malaysia
CAPT	Captain
CAR	Civil Aviation Regulations
CAS	Calibrated Air Speed
CAT	Category
CB	Circuit Breaker
CG	Centre of Gravity
CLB	Climb
CONFIG	Configuration
CPL	Commercial Pilot License
CRC	Continuous Repetitive Chime
CVR	Cockpit Voice Recorder
CSMM	Corporate Safety Management Manual

D

D1L	Door One Left
D1R	Door One Right
D2L	Door Two Left
D2R	Door Two Right
DAME	Designated Aviation Medical Examiner
DCA	Department of Civil Aviation

E

ECAM	Electronic Centralized Aircraft Monitor
ELAC	Elevator Aileron Computer
ESLD	ECAM System Logic Data
E/WD	Engine/Warning Display

F

FCOM	Flight Crew Operating Manual
FCTM	Flight Crew Techniques Manual
FDIMU	Flight Data Interface Management Unit
FDR	Flight Data Recorder
FFS	Full Flight Simulator
FIR	Flight Information Region
FL	Flight Level
FLX/MCT	Flex/Maximum Continuous Thrust
FO	First Officer
FOD	Flight Operations Directives
ft	Feet
FWC	Flight Warning Computer

G

GND	Ground
GS	Ground Speed

H

H	Hour(s)

HF	High Frequency
HDG	Heading
HSI	Horizontal Situation Indicator

I

ICAO	International Civil Aviation Organization
ICC	In-Charge Cabin Crew
IIC	Investigator-in-Charge
ILS	Instrument Landing System
IMC	Instrument Meteorological Condition

K

kg	Kilogram
kts	Knots
KUL	Kuala Lumpur International Airport
KIMAT	Waypoint SID KLIA

L

LAT	Latitude
LH	Left Hand
LONG	Longitude
LT	Local Time

M

m	Meters
MAB	Malaysia Airline Berhad
MAHB	Malaysia Airports Holdings Berhad
MCDU	Multipurpose Control and Display Unit
METAR	Meteorological Terminal Aviation Routine Weather Report
MHz	Mega Hertz
MLG	Main Landing Gear
MMO	Maximum Allowable Mach Number
MOC	Maintenance Operations Control
MOR	Mandatory Occurrence Report

MRO	Maintenance, Repair and Overhaul
MSN	Manufacturer Serial Number
MSL	Mean Sea Level

N

N/A	Not applicable
ND	Navigation Display
NM	Nautical Mile
NTSB	National Transport Safety Bureau

O

OM	Operations Manual
OR	Organisation Requirements

P

PIC	Pilot-in-Command
PF	Pilot Flying
PFD	Primary Flight Display
PFR	Post Flight Report
PM	Pilot Monitoring

Q

QAR	Quick Access Recorder
QNH	Standard Height Above MSL

R

RA	Radio Altimeter
RH	Right Hand
RWY	Runway

S

SID	Standard Instrument Departure
SOP	Standard Operating Procedures
STD	Standard Time of Departure

T

TLA	Thrust Lever Angle
TO	Take-off
TOGA	Take-Off – Go-Around
TWU	Tawau Airport

U

U/S	Unserviceable
UTC	Universal Time Coordinated
UPRT	Upset Preventive and Recovery Training
USA	United States of America

V

V1	Decision Speed
Vapp	Approach Speed
VHF	Very High Frequency
VPK	VOR Overhead Kuantan
VMO	Maximum Allowable Airspeed

W

WMKK	Kuala Lumpur International Airport
W/O	Workorder

SYNOPSIS

MH2664 (9M-MLS) was cruising at FL250, deviating approximately 30 NM right of VPK due to weather. While waiting for ATC clearance to climb, its autopilot tripped, and the aircraft pitched up unexpectedly. The Captain pushed the control column forward, where he realised the airspeed was decreasing. He glanced at the FO side, and his speed was increasing. There were IAS and ALT disagree indicators on the screens. This manoeuvre triggered the clacker sound. The Captain and FO cross-checked and concluded that the Captain's instrument was faulty. Immediately, the FO took over to fly manually.

After settling down, the aircraft system was back to normal. The autopilot and auto-throttle were re-engaged. The Captain carried out the non-normal checklist. While the Captain and FO were doing the non-normal checklist, the instrument discrepancies happened again for the second time. The Captain and FO managed to control the aircraft. However, the instrument discrepancies were faulty on the FO side, and the Captain pitot light was illuminated. The Captain and FO continued with the non-normal checklist and advised engineering regarding the issue. The engineers advised the Captain and FO to return to KUL.

From this event, two (2) of the cabin crew sustained light injuries, two (2) passengers suffered a slight burn on the arm from a hot drink, and one (1) passenger hit his shoulder at the service cart.

1.0 FACTUAL INFORMATION

1.1 History of the Flight

On the 03 April 2022, a Malaysia Airlines Boeing 737-800 bearing registration 9M-MLS operated a commercial flight MH 2664, scheduled to depart KUL for TWU. Total of two (2) flight crew and five (5) cabin crew operated the flight.

During departure, the Pilot in Command (PIC) acted as the Pilot Flying (PF) while the First Officer (FO) was the Pilot Monitoring (PM). The flight was the first sector of the day for the flight crew. Aircraft was dispatched with no defects related to the IAS disagree event. MH 2664 departed from runway 32L in KUL at 1449 LT and was cleared KIMAT 1D Standard Instrument Departure (SID).

There were some weather at the climb path, and the flight crew requested deviation to the right of the SID and airways. Aircraft was at FL250 and approaching abeam position VPK. At 1507 LT, the aircraft autopilot tripped, the aircraft pitched up by itself, and the PIC's side IAS reduced from 290 kts to 162 kts within 10 seconds.

PIC noticed the aircraft's behaviour and pushed the aircraft's nose forward to regain speed and prevent the aircraft from stalling. The highest recording vertical acceleration during the aircraft's pitch up was 1.78G, followed by a minimum of -0.15G during the pitch down.

FO noticed that his IAS was increasing, and there was an "IAS DISAGREE" at PIC's PFD and informed PIC. PIC also saw "IAS DISAGREE" and "ALT DISAGREE" at the PFD. PIC instructed FO to check FO's IAS. FO checked his IAS against the Standby Instrument and found the same speeds. This indicated that his IAS was reliable. He then informed Captain.

The lowest IAS was 140.5 kts, and the IAS remained below 176 kts throughout the descent. The lowest recorded altitude was 22,895 feet. The stick shaker was not triggered.

The Captain handed over controls to the FO. The FO pulled the aircraft to pitch up to return to FL250. The aircraft's speed exceeded its VMO/MMO and triggered the clacker sound. During the manoeuvre, the maximum recorded vertical acceleration was 1.77G. The aircraft exceeded FL250 momentarily before stabilising at FL250.

The FO, now as PF, engaged Autopilot (AP) B to reduce the workload on themselves. The Airspeed Unreliable on PIC's PFD was encountered when the aircraft was in clouds and IMC conditions.

The indications returned to normal when the aircraft was out of clouds. The Fasten Seatbelt Signs were OFF during the IAS DISAGREE encounter. It was switched ON after the recovery and left ON throughout the flight.

ATC KUL cleared MH 2664 climb to FL270. There was no query from ATC regarding the altitude lost. MH 2664 then was transferred to Singapore FIR and was cleared to climb to FL290.

The flight crew then wanted to do the Airspeed Unreliable Non-Normal Checklist. At approximately 1515 LT, as PIC was about to read the checklist, the FO's side IAS increased with a positive speed trend of between 10-20 kts.

"IAS DISAGREE" and "ALT DISAGREE" appeared on both PFDs. Both the flight crew checked the standby instrument and found that the PIC's IAS was the same as the Standby Instrument. The PIC took over controls and did the recall item, including disengaging and AP and ATHR. Altitude loss was approximately 800 feet.

The FO then carried out the Airspeed Unreliable Non-Normal Checklist. While conducting the checklist, aircraft indications were back to normal. AP 1 was engaged.

The FO noticed that the CAPT PITOT HEAT amber light was illuminated during the overhead scan. ,The FO did not see any anomaly after the first IAS Disagree during the overhead scan. Aircraft was in clear air (not in clouds) during the second Unreliable Airspeed, which happened at FO’s IAS.

The flight crew then contacted the MOC, informing them that they had two Unreliable Airspeed events. The MOC advised MH 2664 to return to KUL. Upon request, Singapore ATC then cleared MH 2664 to climb FL300 and turned towards KUL.

The PIC called the In-Charge Cabin Crew (ICC) to the flight deck to explain the situation and requested the ICC to conduct a cabin check. The PIC then announced informing passengers that the abrupt manoeuvre was due to a technical problem, and they decided to return to KUL for the safety of the flight.

The aircraft made several holding patterns to reduce the aircraft's landing weight. MH 2664 landed KUL safely on RWY 32L via the ILS approach at 1646 LT and reached the bay at 1654 LT.

The engineer then came to the flight deck to check the aircraft and informed the flight crew that one circuit breaker (CB) popped out. Both flight crews did not notice any Master Caution light illuminated throughout the flight.

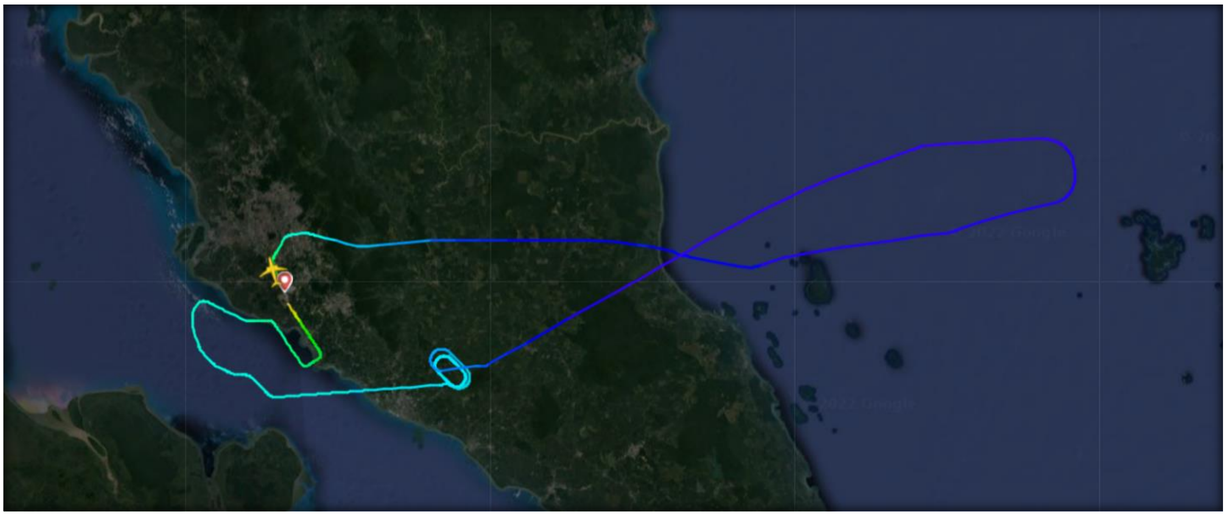
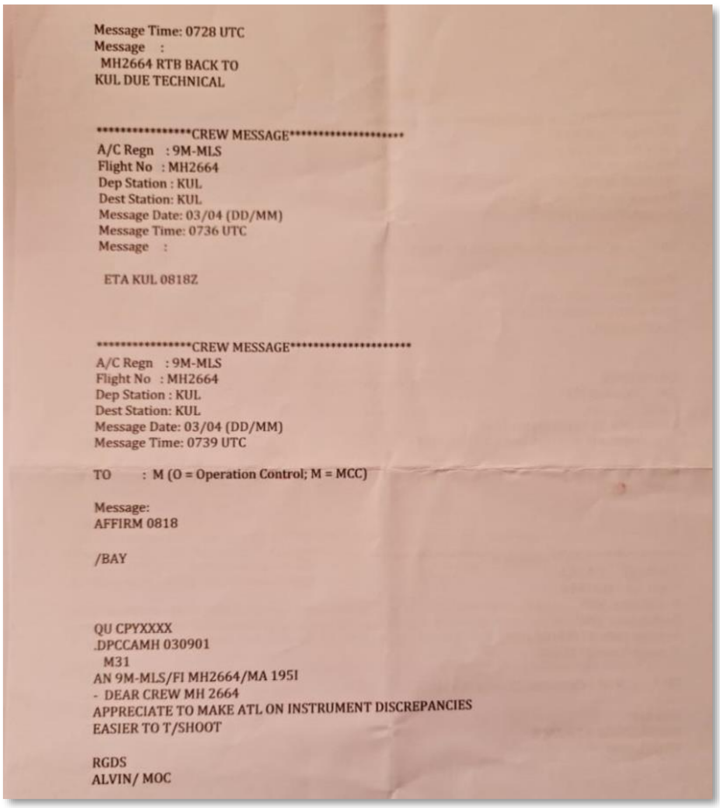


Figure 1: 9M-MLS flight path

*The flight path colours do not indicate anything significant to the event



Message Time: 0728 UTC
Message :
MH2664 RTB BACK TO
KUL DUE TECHNICAL

*****************CREW MESSAGE********************
A/C Regn : 9M-MLS
Flight No : MH2664
Dep Station : KUL
Dest Station: KUL
Message Date: 03/04 (DD/MM)
Message Time: 0736 UTC
Message :

ETA KUL 0818Z

*****************CREW MESSAGE*********************
A/C Regn : 9M-MLS
Flight No : MH2664
Dep Station : KUL
Dest Station: KUL
Message Date: 03/04 (DD/MM)
Message Time: 0739 UTC

TO : M (O = Operation Control; M = MCC)

Message:
AFFIRM 0818

/BAY

QU CPYXXXX
.DPCCAMH 030901
M31
AN 9M-MLS/FI MH2664/MA 195I
- DEAR CREW MH 2664
APPRECIATE TO MAKE ATL ON INSTRUMENT DISCREPANCIES
EASIER TO T/SHOOT

RGDS
ALVIN/ MOC

Figure 2: Text messages between MH 2664 (9M-MLS) and MOC

1.2 Injuries to Persons

Injuries	Crew	Passenger	Others
Fatal	Nil	Nil	Nil
Serious	Nil	Nil	Nil
Minor	2	2	Nil
None	5	125 + 1 (infant)	Nil

Figure 3: Injuries to persons

1.3 Damage to Aircraft

MH 2664 landed KUL at 1646 LT and reached the bay at 1654 LT. The aircraft was secured, and an initial assessment was carried out on the aircraft's condition and position by engineering personnel.

1.4 Other Damages

Nil

1.5 Personal Information

All crew had sufficient rest according to their roster analysis and did not experience any significant issues on the day of the flight

1.5.1 Pilot-in-Command (PIC/Capt)

Status	PIC/Capt
Nationality	Malaysian
Age	41 years old
Gender	Male
License Type	ATPL
License Validity	30/09/2022
Total Hours Operating on Type	1515:04
Total Flying Hours	6985:15
Medical Expiry Date	30/09/2022

Figure 4: Pilot-in-Command

1.5.2 Co-Pilot

Status	FO/Co-Pilot
Nationality	Malaysian
Age	39 years old
Gender	Male

License Type	ATPL
License Validity	31/08/2022
Total Hours Operating on Type	199:08
Total Flying Hours	2074:18
Medical Expiry Date	31/08/22

Figure 5: Co-Pilot

1.6 Aircraft Information

1.6.1 General

Aircraft Manufacturer	Boeing Company, United States of America
Aircraft Model / Type	B737-800
Aircraft MSN	39333
Date of Manufacture	17 Sep 2013
Aircraft Registration	9M-MLS
Certificate of Registration Issue / Expiry date	31 Dec 2019 / 08 Jan 2023
Certificate of Airworthiness Issue / Expiry date	16 Aug 2021 / 22 Sep 2022
Aircraft Owner	Qortuba Limited Maples Corporate Services Limited
Aircraft Operator	Malaysia Airlines Berhad
Total Flight Hours	22432 (as of 22nd Apr 2022)

Figure 6: Aircraft Information

1.6.2 Engine & APU

Engine Type	CFM56-7B26E	
Manufacturer	CFM	
Model	CFM56-7B	
	Engine No. 1	**Engine No. 2**
Serial No.	658248	658249
Time Since New	22432	22432
Cycle Since New	12466	12466

Figure 7: Engine information

APU	3800702-1
Serial No.	P-9576
Time Since New	21493
Cycle Since New	15448
APU cycle	653

Figure 8: APU information

1.6.3 Aircraft Load

Maximum Take-off Weight	79015 kg
Actual Take-off Weight	71690 kg
Maximum Landing Weight	66360 kg
Actual Landing Weight	65990 kg
Fuel on Departure	15213 kg

Figure 9: Aircraft load and balance

Aircraft load and balance did not indicate anything abnormal. The aircraft's weight and trim were within the normal parameters during the incident.

1.7 Meteorological Information

No significant weather was reported on the forecast enroute weather, but the Meteorological Chart supplied by Meteorological Office (dated 03 Apr 2022, 06 UTC) showed:

The pre-departure weather for MH2664 on the 03 April 2022 from the ATIS was wind 360/4 kts, visibility of more than 10 km, temperature 32c, and QHN of 1009. Initial departure on KIMAT 1D Standard Instrument Departure (SID). There was no severe weather or turbulence warning reported that day. However, the weather on the east coast and most of the South China. Sea enroute to Tawau will be cloudy from the prognostic chart.

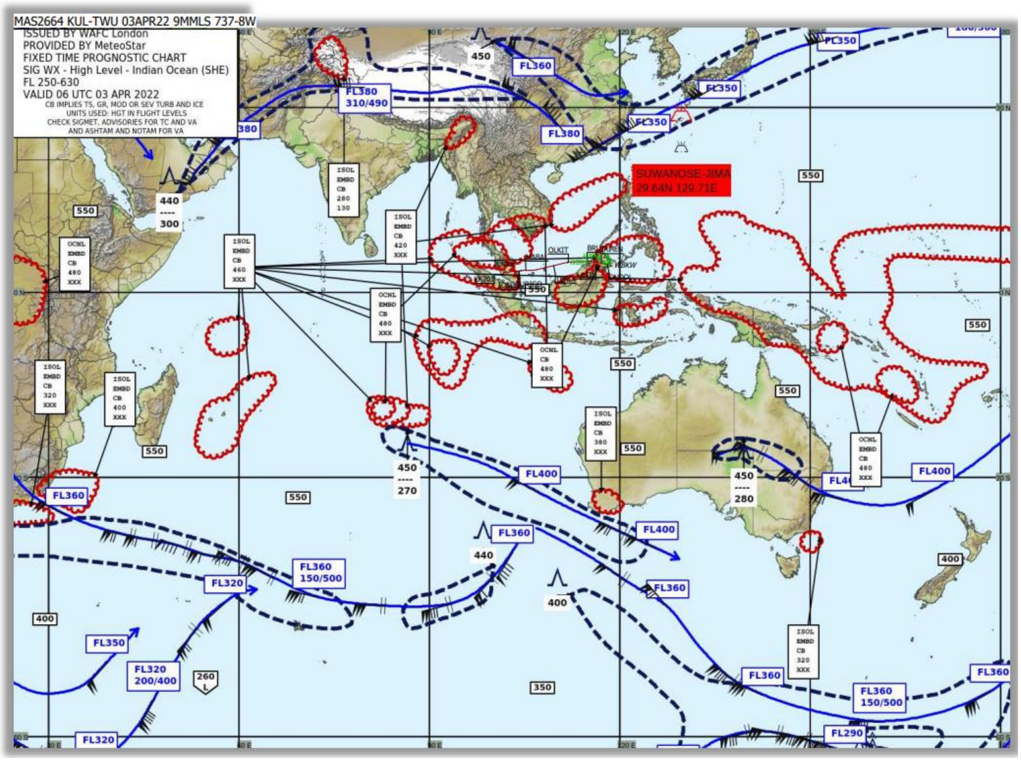


Figure 10: Weather forecast on departure for MH 2664 on the 03 April 2022

As per the satellite weather imagery, the weather pattern was more or less the same as what was forecasted. A weather deviation by the crew during enroute climb and early cruise can be expected. From the interview, the crew mentioned that there were some weather at the climb path and deviation was requested to the right of the SID and airways.

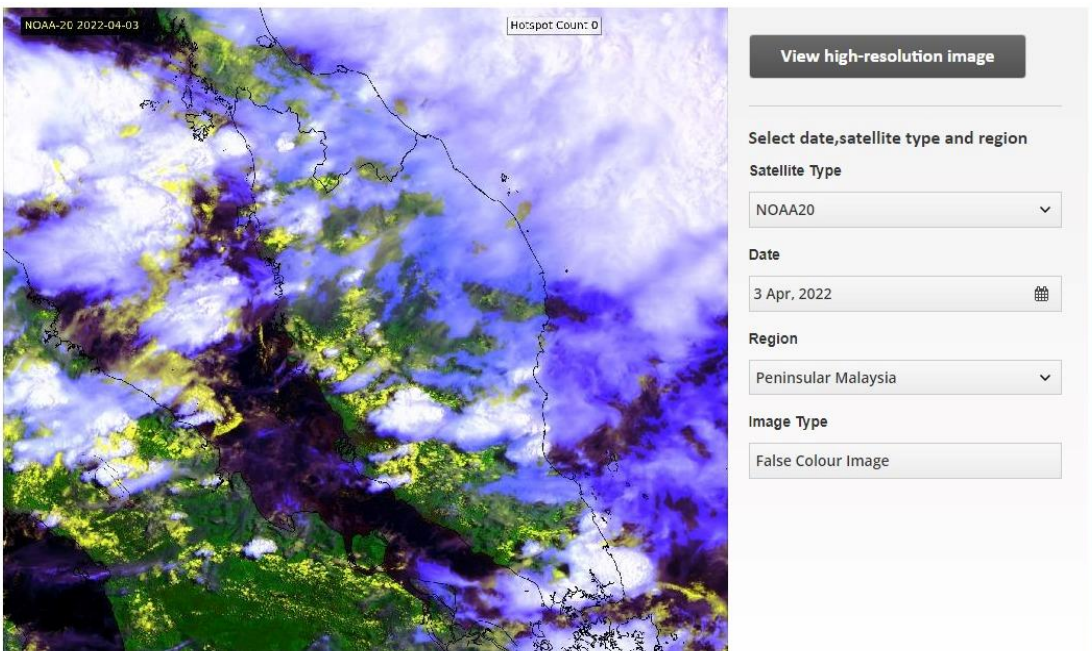


Figure 11: Satellite Weather Imagery on the 03 April 2022

1.8 Aid to Navigation

All navigation aids (ground-based navigation aids, onboard navigation aids, aerodrome visual ground aids) were operating normal.

1.9 Communication

Aircraft was employing VHF radio to communicate with the ATC. on frequency 128.125MHz until the point of incident.

1.10 Aerodrome Information

KL International Airport (KLIA), Sepang, is the main international airport in Malaysia. The airport is equipped with three runways: Runway 14L/32R (4,019m), 14R/32L (4,000m), 15/33 (3,960m) measuring 60m in width. All three runways can accommodate take-off and landing in both directions and equipped with ILS CAT 1 and RNAV (GNSS) approaches.

1.11 Flight Recorders

Only FDR data was made available by the airline for the investigation as data CVR recording during that event was no longer available.

1.12 Wreckage and Impact Information

Not Applicable

1.13 Medical and Pathological Information

All crew were fit for the flight, and the airline operator did not carry out any drugs and alcohol post occurrence as there were no suspicion of psych substance abuse. All crews' medical conditions have been reviewed by the Head Corporate Safety Oversight Malaysia Airlines Berhad.

1.14 Fire

There was no trace of fire found.

1.15 Survival Aspects

Two (2) cabin crew sustained a light injury from the witness interview, and two (2) passengers at seat no. (4B/D) suffered a slight burn on the arm from a hot drink, and one (1) passenger at seat no. (20C) hit his shoulder at the service cart.

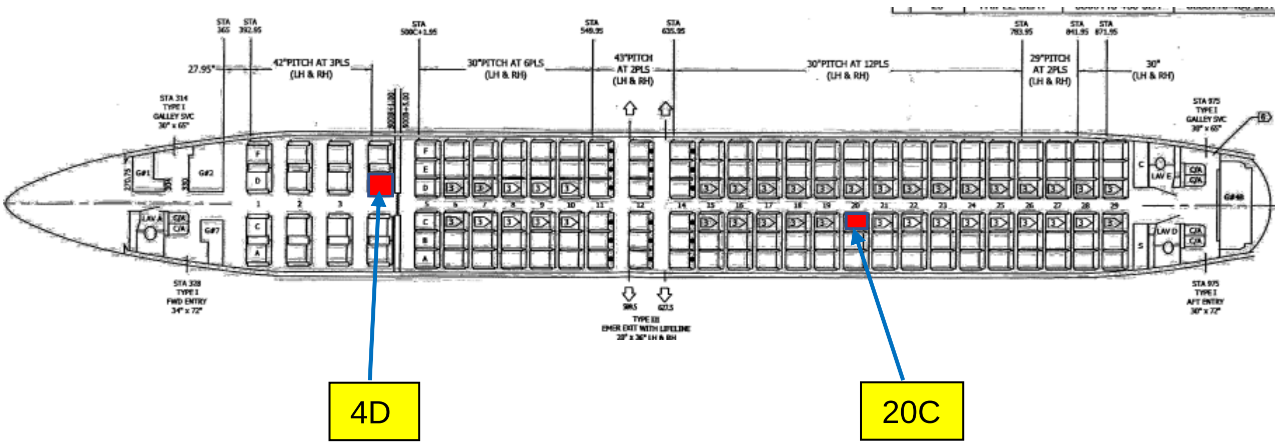


Figure 12: B737-800 Interior Arrangement

1.16 Test and Research

There are four (4) components that could contribute to the occurrence that were removed and sent for check at the Boeing facility namely: -

a. **Captain and FO Probes**. The Captain and FO probes were removed and sent for a check at Collins Product Improvement Laboratory (PIL) to ascertain the condition of the subject parts by conducting physical, electrical, and x-ray examinations. From the test report, both probes were externally in good condition.

Figure 13: Captain’s Probe

Figure 14: FO's probe

b. **Associated Relay and Circuit Breaker**. The associated Relay and Circuit Breaker were sent to the Boeing Company, Equipment Quality Analysis (EQA) facility in Seattle, Washington for examination.

In summary, an examination of the relay and circuit breaker was held at the Boeing EQA facility on October 25, 2022. Representatives of EQA and Boeing Air Safety Investigations (ASI) were present. Computed tomography (CT) X-ray examination revealed no anomalies in either the circuit breaker or relay. Operational checks of the electrical operation of both the circuit breaker and relay noted no anomalies.

c. **Air Data Module (ADM)**. This unit was sent to Thales AVS France SAS for repair. However, the ADM was scrapped, not repairable as per attached quote by Thales

Technical Informations

Visual inspection:
Missing fixing screws on the unit. BITE analysis detected: 1d75hc. No output signal.
Repair actions to be performed
No repair action taken: scrap on site .

Figure 15: ADM Technical Information

“The BITE code reported corresponds to an applied pressure of more than 1400hPa on the sensor. There can be several causes, but it usually doesn't happen during normal operations. Could be during aircraft testing/washing.”

In summary, the subject unit is deemed BER. On the possible root causes, Thales would recommend MAB to check with Boeing on the possible/known cases with other operators for similar events. However, the probe heating system do not go thru the ADM and did not contribute to the IAS Disagree event.

d. **P5-9 Panel**. The panel was inspected by Boeing Dallas Service Centre. However, the panel have been routed to the supplier, BAE Systems to perform the functional test per CMM 30-09-05. In summary, the P5-9 Panel passed final acceptance testing and approved for return to service.

In summary, no fault was detected on all the equipment tested above, and all the equipment related to the AIS Disagree and ALT Disagree was found to be working within the limit.

1.17 Organisational and Management Information

Operator	Malaysia Airlines Berhad
Address	Administration Building, South Support Zone, KLIA, 64000 SEPANG Selangior Darul Ehsan Malaysia
Air Traffic Service	CAAM

Figure 16: Organisational information

1.18 Additional Information

Nil

1.19 Useful or Effective Investigation Techniques

Three (3) domains of Aviation Safety were looked into while conducting the investigation, which were:

a. Safe Product
b. Safe Operations
c, Safe Air Transport System

2.0 ANALYSIS

2.1 Crew Resource Management (CRM)

During the first IAS DISAGREE event at 1507 LT, the PIC did not call out or crosscheck the speed difference with the FO. From the PIC recorded statement, it was found that the PIC made an abrupt movement by pushing the control column down when the PIC saw his speed trend going down and his active bar going up.

The PIC only communicated with the FO after the PIC glanced at the FO's instrument when the AIS Disagree alert and ALT Disagree alert came out and asking the FO to crosscheck his instrument.

In summary, the PIC reaction by pushing the control column down resulted the aircraft experiencing a sudden drop without communicating with the FO, which could have been avoided if proper CRM had been carried out.

2.2 Simulator Test

A simulation session was carried out on B737-800W Flight Simulation Training Device to simulate the occurrence of "IAS DISAGREE" and "ALT DISAGREE". The simulation was to observed how the system responded to the simulated occurrence.

From the FDR data, AAIB found that autopilot A was engaged at the time of the incident, and the physical input on the flight control column disconnected the autopilot, as shown in Figure 17.

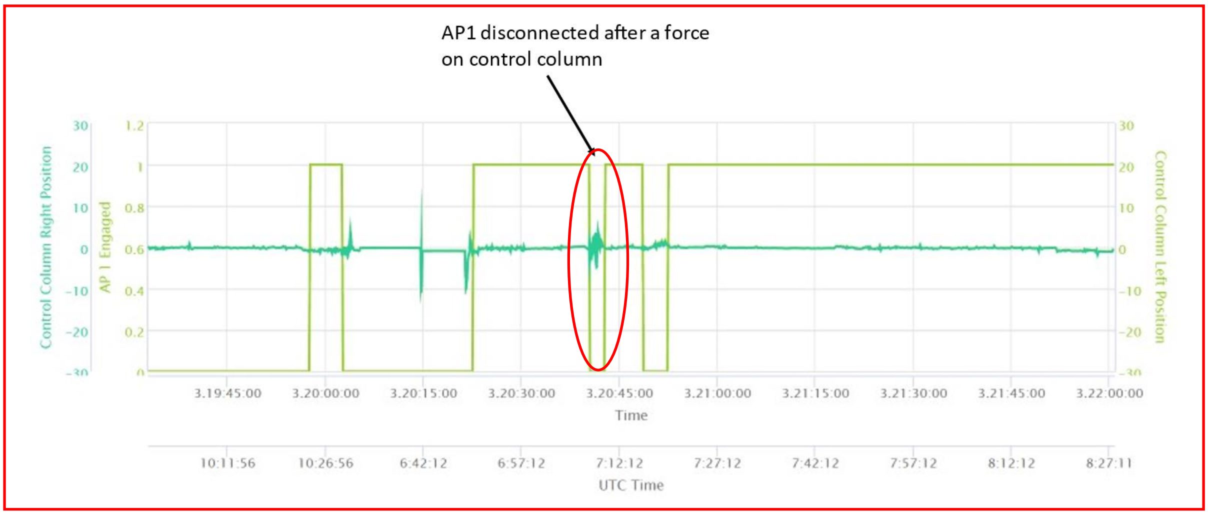


Figure 17: Autopilot disconnected - FDR data

However, from the interview with the flight crews, there was no input from them. AAIB Investigator have tested at the Simulator where a force has to be applied to the Control Column to turn off the autopilot. Refer to Figure 18, Master Caution light was active during the incident.

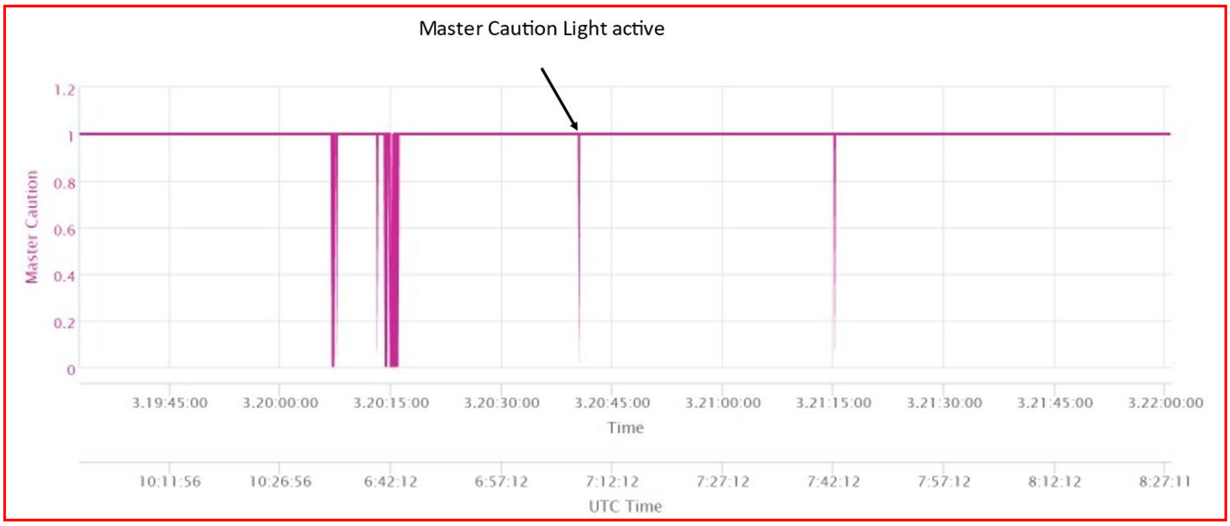


Figure 18: Master Caution Light – FDR data

In summary, A force is needed to deactivate the Autopilot. The physical input to the flight control column disconnected the Autopilot, and it has been tested at B737-800W Flight Simulation Training Device where the autopilot system has been disconnected with force to the control column. Master Caution was ON during occurrence as shown in Figure 18.

2.3 **Training syllabus** – Upset Prevention and Recovery Training (UPRT).

2.3.1 MAB has the UPRT training syllabus into four (4) Modules, as listed in Figure 19, Figure 20, Figure 21, and Figure 22. However, the training syllabus in all four (4) modules did not cover the “AIS Disagreed and ALT Disagreed” condition simultaneously.

2.3.2 UPRT - Module 1

1A	Low-altitude acceleration	To highlight the time taken to accelerate at low altitude to VMO
1B	High-altitude acceleration	To highlight the time taken to accelerate at high altitude to VMO
1C	High-altitude acceleration from very low speed	To highlight the time taken to accelerate at high altitude from below Green Dot
2	Roll demonstration with aileron only	To demonstrate the controllability in the roll axis
3	Handling characteristics with rudder	To demonstrate ineffective roll controllability through rudder
4	Effect of bank angle on pitch	To demonstrate how bank angle could be used to control pitch
5	Effect of stabilizer trim on pitch	To demonstrate powerful capabilities of the stabiliser on aircraft pitch
6	Effect of speed brakes on pitch attitude	To demonstrate sensitivity of pitch due to deployment of speed brakes
7A	Effect of thrust on pitch – LOW ALTITUDE	To demonstrate the effect of thrust on aircraft pitch at low altitudes
7B	Effect of thrust on pitch – HIGH ALTITUDE	To demonstrate the effect of thrust on aircraft pitch at low altitudes
8	Upset Pitch Altitude Indications	To show the extreme pitch indications on the PFD
9	Angle of Attack Awareness	To underscore the relationship between pitch attitude versus AoA
10	High Pitch/Low AoA & Low Pitch/High AoA	To underscore that Pitch and AoA are quite different

Figure 19: UPRT – Module 1

2.3.3 UPRT - Module 2

1A	Load Factor Awareness	Demonstrate PFD indications of local factor
1B	Load Factor Awareness – High Altitude	Demonstrate PFD indications of local factor
2	Unloading – ALTERNATE LAW	Demonstrate unloading in Alternate Law
3A	Hazardous Low-Speed at High Altitude (1 of 2)	Develop awareness of Capture Descent method to re-gain kinetic energy
3B	Hazardous Low-Speed at High Altitude (2 of 2)	Develop awareness of Drift-Down method to re-gain kinetic energy
4	First Actions Upon Stall Indication – Low Altitude	Recognising and unloading after a stall event
5	First Actions Upon Accelerated Stall – Low Altitude	To practice the first action following an accelerated stall, low altitude
6	Secondary Stall Demo – Low Altitude	Demonstrate the concept of the secondary stall
7	First Action Upon Stall Indication – High Altitude	Recognizing and unloading after a stall event at high altitude
8	First Action Upon Accelerated Stall – High Altitude	To practice unloading during a high-altitude accelerated stall
9	Secondary Stall Demo – High Altitude	Demonstrate the technique to safely recover from high-altitude stalls

Figure 20: UPRT – Module 2

2.3.4 UPRT - Module 3

3.1	Visual Circuit	Fully manually-flown circuit
3.2	Manual Go-Around	Practice fully manual go-around
3.3	Holding Pattern / S-Turn	Manually-flown holding pattern with alt changes
3.4	Changing Pitch; Constant AoA	Demonstrate that constant load factor can be achieved at different pitch angles
3.5	Review of Unloading	Demonstrate PFD indications of load factor
3.6	Introducing the UPRT Technique	Universal Stall or Upset Recovery Technique
3.7	Stall Recovery, Low-Level Clean	Low-level clean configuration stall
3.8	Stall Recovery, Landing Config.	Recovery from stall while configured for landing
3.9	Accelerated Stall on Approach	Recovery from stall during turn while configured for landing
3.10	Stall Recovery, Take-Off Config.	Recovery from stall following take off
3.11	High-Altitude Handling	Manually flying the aircraft in turns at high alt.

3.12	Stall Recovery, High-Level Clean	High-altitude clean configuration stall
3.13	Accelerated Stall Recovery, High Alt.	Recovery from accelerated stall, high-altitude

Figure 21: UPRT – Module 3

2.3.5 UPRT - Module 4

4.1	Nose-High Recovery Low Altitude	UA recovery, low-altitude
4.2	Nose-Low Recovery Low Altitude	UA Recovery
4.3	High Altitude High-Bank Recovery	UA high-altitude recovery
4.4	High Altitude Nose-Low Recovery	UA high-altitude recovery
4.5	Recovery from Automation-Induced Stall at High Altitude	High-altitude clean configuration stall, induced by improper use of automation
4.6	Stall Avoidance During High-Altitude TCAS Event	Avoidance of a high-altitude stall while receiving pull-up commands from TCAS
4.7	Nose-High Recovery Due to Trim	UA recovery
4.8	Nose-Low Recovery Due to Trim	UA recovery
4.9	Trim Runaway During Initial Climb	Low-energy trim runaway, requiring quick action
4.10	STARTLE: Recovery from mishandled upset, requiring stall recovery	Demonstration of an initially-mismanaged recovery, leading to stall during turn
4.11	Upset recovery in IMC	Recovery from upset with only PFD reference
4.12	Upset recovery with failed engine	Management of asymmetric thrust condition
4.13	Rudder trim event	Demonstration of dihedral and dihedral effect

Figure 22: UPRT – Module 4

2.4 Flight Crew Manning (pairing)

2.4.1 From the recording statements, the PIC hours on the aircraft type were about 1515 hours, and the FO hours on the aircraft type were approximately 190 hours. The flight crew pairing could contribute to the occurrence. With minimum flying hours on aircraft type, both flight crew should be paired with more experienced crew where CRM can be appropriately exercised call out or crosscheck between crews during the first IAS DISAGREE event at 1507 LT).

2.5 Capt. Pitot probe heating status was in OFF condition at the start of the engines and throughout the flight.

FDR data in Figure 23 shown that the Capt. Pitot probe heating status was in OFF condition at the start of the engines and throughout the flight. The heating status in OFF condition is equivalent to no heating being applied. When the aircraft flew through clouds at 25000 ft, it was possible that the ice would have gradually built up on the Capt. Pitot probe. The blockage had resulted from losing heating on the Capt. Pitot probe where the aircraft flies through an icing condition. The ice build-up on the probe would have caused the discrepancy in the Capt. IAS indication

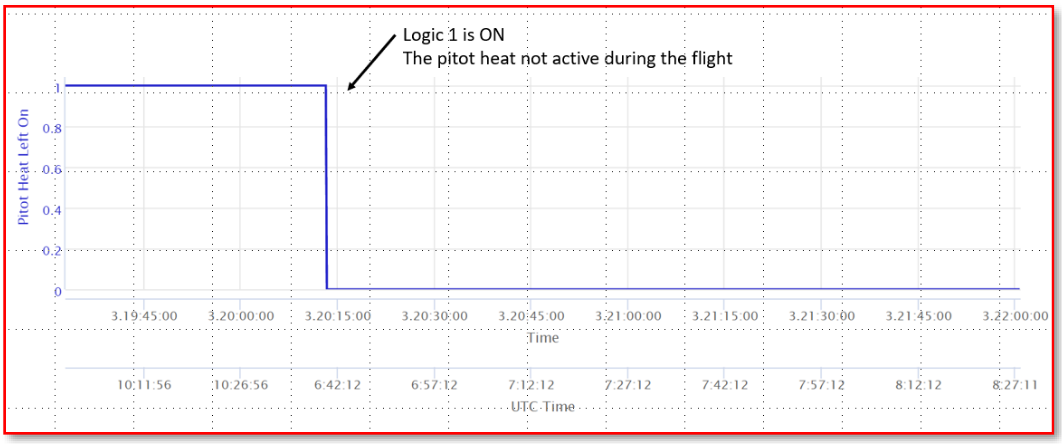


Figure 23: Capt. Pitot probe heating status

3.0 CONCLUSIONS

3.1 Findings

3.1.1 The Captain and FO were rated on aircraft type.

3.1.2 The Captain and FO have enough rest prior to the scheduled flight.

3.1.3 The aircraft was airworthy when despatched for the flight.

3.1.4 The maintenance records indicated that the aircraft was equipped and maintained in accordance with the approved procedures.

3.1.5 The Captain and FO reported no abnormalities on the aircraft prior to departure.

3.1.6 Aircraft load and balance did not indicate anything abnormal. The aircraft's weight and trim were within the normal parameters during the incident.

3.1.7 The Captain and FO were issued with the standard pre-flight documents including the weather forecast enroute to Tawau.

3.1.8 Capt. pitot probe heating status was in OFF condition throughout the flight.

3.1.9 There was a possibility of human error involvement where the CB was overlooked and not pushed in by the flight crew during visual inspection prior to departure.

3.1.10 Master Caution warning was ON during the occurrence.

3.1.11 There was a force to Control Column that disconnected the AP1.

3.1.12 CRM was not carried out effectively and accordingly by the flight crew.

3.1.13 Flight crew pairing could contribute to the occurrence. Both flight crew should be paired with more experienced crew where CRM can be appropriately exercised.

3.2 Causes/Contributing Factor/Probable Causes

3.2.1 As mentioned in para 1.19 Useful or Effective Investigation Techniques, AAIB will look into the three (3) domains of Aviation Safety while conducting the investigation. Three domains of Aviation Safety were:

a. Safe Product

b. Safe Operations

c. Safe Air Transport System

3.2.1.1 **Safe Product**

- All four (4) components associated with the occurrence have been removed and sent to the authorised facility to check on their serviceability.
- As a result, all components were found to be working as per normal.

3.2.1.2 **Safe Operation**

- No maintenance issue linked to the event was identified.
- There was a force to the Control Column that disconnected the AP1.
- CRM was not carried out effectively and accordingly. The PIC made an abrupt movement by pushing the control column down.
- Flight crew pairing could have contributed to the occurrence.

3.2.1.3 **Safe Air Transport System**

- The meteorological information provided by meteorological office was correct.
- All navigation aids were operating normal.
- MOC had respond to the occurrence appropriately.

3.2.2 There was a possibility of human error involvement where the popped CB was overlooked and not pushed in during visual inspection prior to departure by flight crew.

3.2.3 As mentioned by the FO, weather conditions require them to avoid the clouds during their flight enroute to Tawau. FDR data shows that Pitot Heat Left was off throughout the flight, as shown in (Figure 24), and the aircraft flew through clouds at 25000 ft. Due to that, it was possible that the ice would have gradually built up on the Capt. Pitot probe. The blockage had resulted from losing heating on the Capt. Pitot probe that flies through an icing condition. The ice build-up on the probe would have caused the discrepancy in the Capt. IAS indication.

The drop in the Capt. IAS indication, compared to F/O IAS, would have triggered the Master Caution warning as shown in Figure 25.

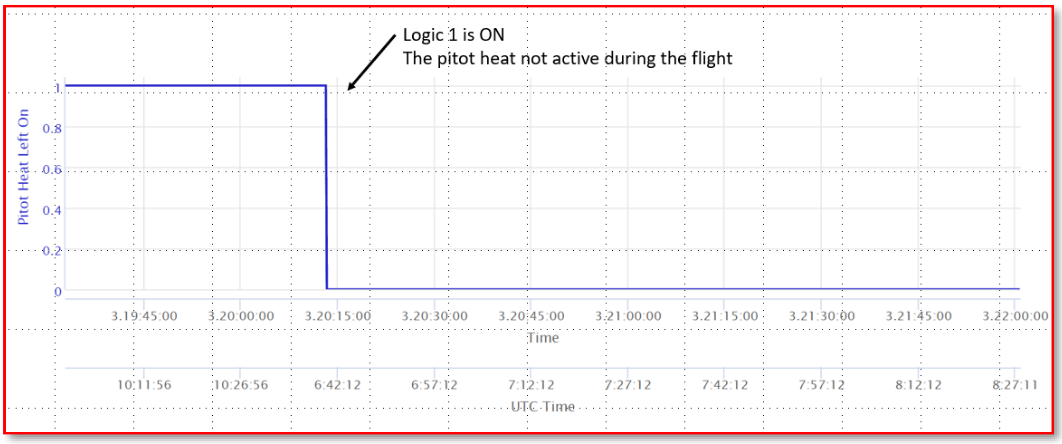


Figure 24: Pitot Heat Left was off throughout the flight FDR data

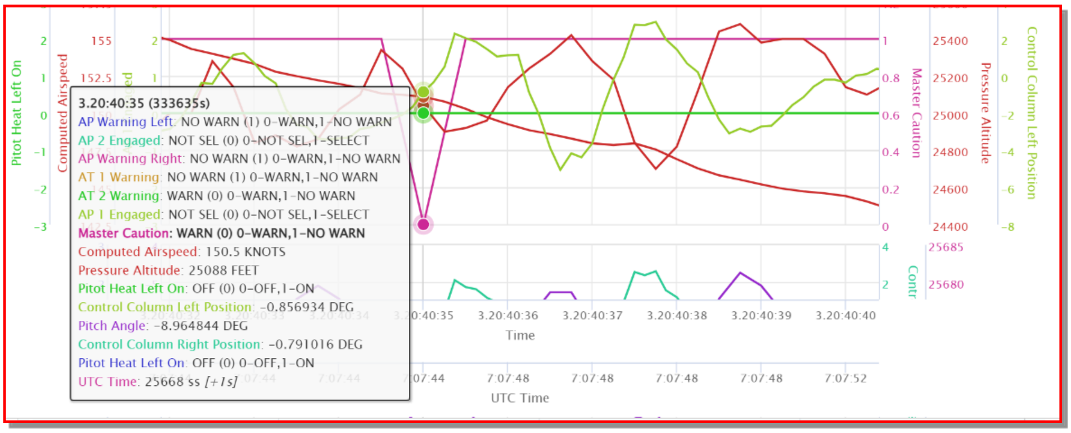


Figure 25: Master Caution warning – FDR data

3.2.4 From the FDR data as shown in Figure 26, the flight crew's abrupt flight control movement was suspected to be present during the IAS disagreement event.

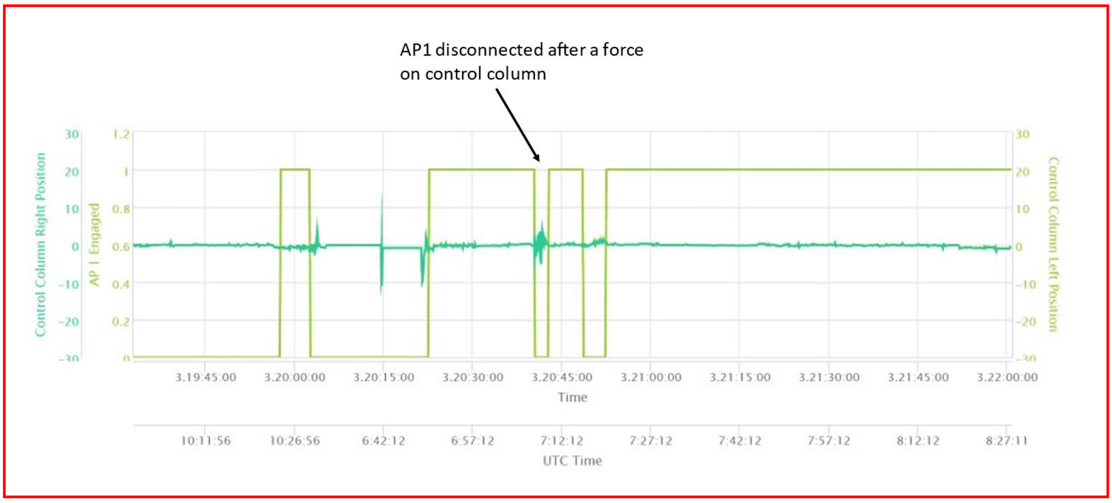


Figure 26: AP1 disconnected – FDR data

4.0 SAFETY RECOMMENDATIONS

4.1 The MAB is to carry out the following safety recommendations:

4.1.1 To enhance the UPRT Training Module by introducing the IAS Disagreed and ALT Disagree in the training syllabus.

4.1.2 To impound both Flight Recorders (FDR and CVR) for further investigation if MAB suspected occurrences that AAIB might investigate.

4.1.3 Refer to AAIB on the Flight Recorders status of any occurrences.

4.1.4 To conduct a thorough visual inspection by both PIC and FO diligently prior to take-off to avoid any CB pop up prior to departure as shown in Figure 27.

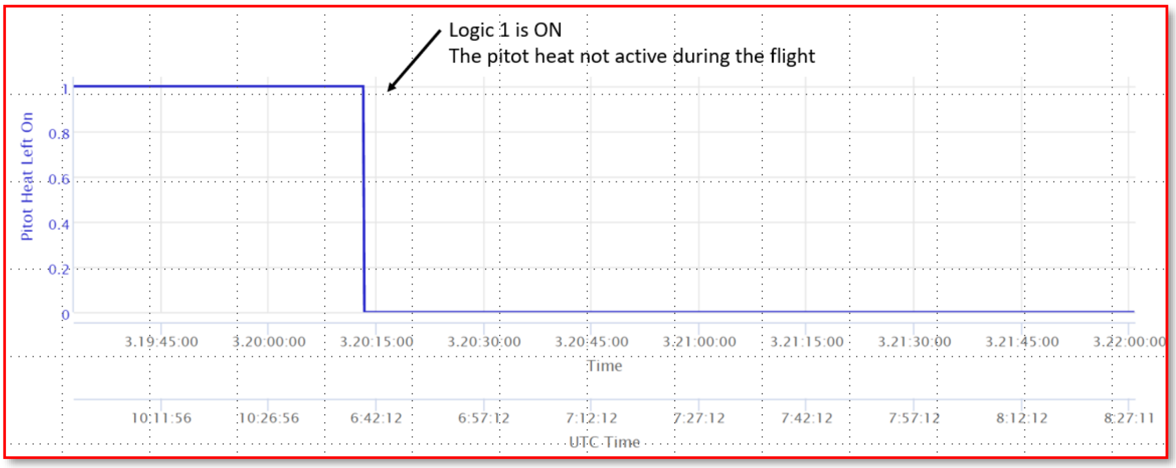


Figure 27: Pitot Heat Left was off throughout the flight FDR data

4.1.5 To be alert with Master Caution awareness

INVESTIGATOR IN-CHARGE

Air Accident Investigation Bureau

Ministry of Transport

Malaysia