AIRCRAFT ACCIDENT
PRELIMINARY REPORT
A 05/23
Air Accident Investigation Bureau (AAIB)
Ministry of Transport Malaysia

Accident Involving Fixed Wing Aircraft Hawker Beechcraft 390 Premier 1, Registration N28JV, at Elmina, Shah Alam, Selangor on 17 August 2023

Air Accident Investigation Bureau
Ministry of Transport
No.26, Jalan Tun Hussein, Precinct 4
Federal Government Administrative 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 15 September 2023
MOT.(S).600-5/4/99

AIR ACCIDENT INVESTIGATION BUREAU (AAIB) MALAYSIA

REPORT NO: A 05/23

OPERATOR	**: JET VALET SDN BHD**
AIRCRAFT TYPE	**: HAWKER BEECHCRAFT 390 PREMIER 1**
STATE OF REGISTRATION	**: UNITED STATES OF AMERICA**
REGISTRATION	**: N28JV**
PLACE OF OCCURRENCE	**: ELMINA, SHAH ALAM, SELANGOR**
DATE AND TIME	**: 17 AUGUST 2023 AT 1451 LT (0651 UTC)**

This report contains statement of facts which have been determined up to the time of issue. It must be regarded as tentative, and is subject 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 of this investigation to apportion blame or liability (Annex 13 to the Chicago Convention and Civil Aviation Regulations 2016).

INTRODUCTION

The Air Accident Investigation Bureau of Malaysia

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

AAIB also conducts investigation into incidents when the occurrence shows evidence to have safety concerns.

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

In carrying out 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.

AIRCRAFT ACCIDENT/SERIOUS INCIDENT REPORT

Aircraft Type	**: HAWKER BEECHCRAFT**
Model	**: BEECHCRAFT 390 PREMIER 1**
Owner	**: KOPERASI AMANAH PELABURAN BERHAD (KAPB)**
Nationality	**: MALAYSIA**
Year of Manufacture	**: 2004**
Aircraft Registration	**: N28JV**
Serial Number	**: RB-97**
State of Registration	**: UNITED STATES OF AMERICA**
Place and State of Occurrence	**: ELMINA, SHAH ALAM, SELANGOR**
Date and Time of Occurrence	**: 17 AUGUST 2023 at 1451 LT (0651 UTC)**

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

TABLE OF CONTENTS

SYNOPSIS

On 17 August 2023, at about 1408 LT, a Hawker Beechcraft Model 390, Premier 1, call sign N28JV, operated by Jet Valet Sdn Bhd departed Langkawi International Airport (WMKL), Langkawi, Kedah to Sultan Abdul Aziz Shah Airport (WMSA), Subang, Selangor. At about 1449 LT, N28JV impacted the ground while manoeuvring for landing at the Sultan Abdul Aziz Shah Airport (WMSA), Subang, Selangor. The airplane was destroyed following the ground impact and subsequent fire. The eight (8) occupants and two (2) ground bystanders were fatally injured.

A Mandatory Occurrence Report (MOR) was submitted by the Civil Aviation Authority of Malaysia (CAAM) Subang to the Air Accident Investigation Bureau, Malaysia (AAIB) as notification of the incident.

1.0 FACTUAL INFORMATION

1.1 History of the Flight

According to ADS-B data[1], N28JV departed WMKL with 8 persons on board at about 1408 LT to WMSA. At about 1447 LT N28JV contacted the WMSA tower controller requesting to land. At 1448:39 LT, N28JV was cleared to land on runway 15. The flight acknowledged the clearance at 1448:45 LT. No further radio transmission was heard from the flight. ADS-B data indicated that after 1447:24 LT and at 2,600 feet, the airplane began a speed reduction and descent. At about 1449:06 LT and at 1,025 feet, the airplane began a right turn that continued until about 1449:14 LT at an indicated height of 550 feet. That was the last recorded data transmission from the accident flight, which was in the vicinity of the accident location. The ground speed during the right turn was indicated between 146 and 154 knots. The aircraft crashed at Persiaran Elmina, Elmina, Shah Alam.

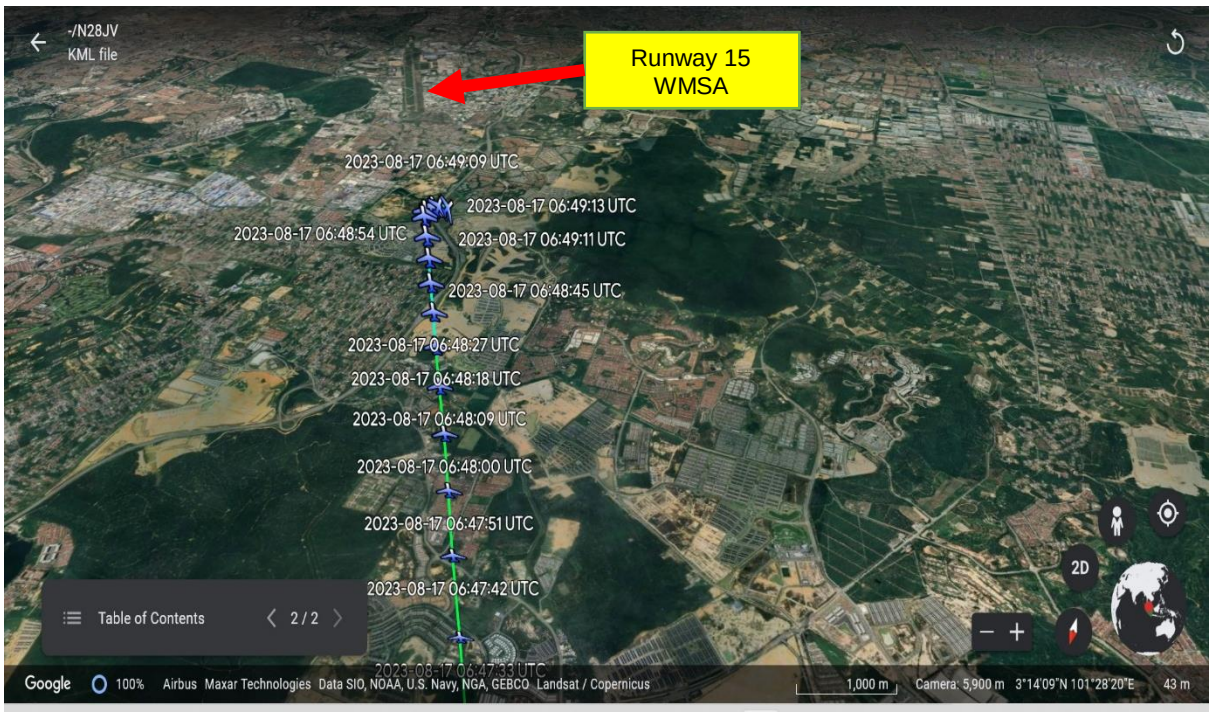

Figure 1: N28JV Flight Path on Final Runway 15

[1] Source: ADS-B Exchange - track aircraft live (adsbexchange.com)

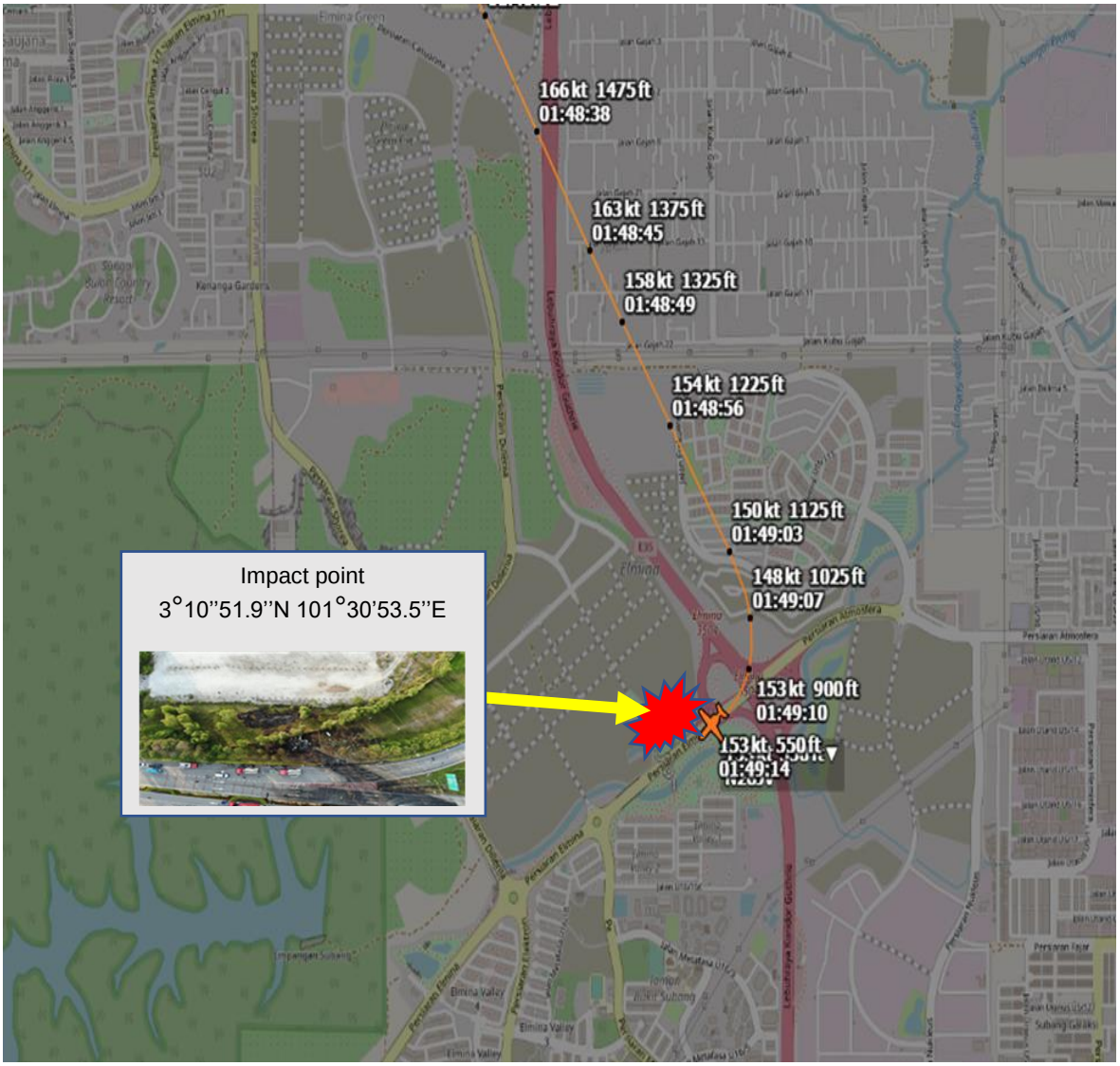

Figure 2: N28JV Impact Point[2]

1.2 Injuries to Persons

Injuries	Crew	Passengers	Others	Total
Fatal	2	6	2	**10**
Serious	Nil	Nil	Nil	**Nil**
Minor/None	Nil	Nil	Nil	**Nil**

Table 1: Injuries to Persons

[2] Times in UTC-5 (US EST).

1.3 Damage to Aircraft

The airplane was destroyed following the ground impact and subsequent fire.

1.4 Other Damage

One car, Nissan Almera registration number WC 1687 U and one motorcycle, Honda RS-X registration number KFK 2150 were destroyed in this accident. There was some damage to public road surface and infrastructure at and near the impact point.

1.5 Personnel Information

1.5.1 Pilot-in-Command (PIC)

Nationality		Malaysian
Age		41
Gender		Male
License Type		ATPL
License Expiry		Issued on 14 March 2023 Expires on 29 February 2024
Medical Expiry		Issued on 24 March 2023 Expires on 29 February 2024
Aircraft Rating		Airplane Multi Engine Land, RA-390S
Instructor Rating		N/A
Flying Hours	Total Hours	6275.39
	Total on Type	36.72

Table 2: Personnel Information – Pilot-in-Command

1.5.2 Second-in-Command (SIC)

Nationality		Malaysian
Age		44
Gender		Male
License Type		Temporary Airman Certificate (ATP AMEL)
License Expiry		Issued on 27 July 2023 Expires on 30 November 2023
Medical Expiry		Issued on 24 July 2023
Aircraft Rating		Airplane Multi Engine Land (Nil rating on RA-390S)
Instructor Rating		N/A
Flying Hours	Total Hours	9298.40
	Total on Type	3.15

Table 3: Personnel Information – Second-in-Command

1.6 Aircraft Information

The airplane was manufactured in 2004 and was registered as N6197F. It was subsequently exported to and registered with the United Kingdom as G-FRYL and deregistered in the United States. In April of 2023, the airplane was deregistered in the United Kingdom and registered in the United States as N28JV. It was issued a Standard Airworthiness Certificate with the FAA on 10 May 2023. ADS-B data revealed that the accident airplane arrived in Malaysia on 16 May 2023 after departing Germany on 10 May 2023.

According to the Pilot's Operating Manual, the airplane was a Hawker Beechcraft Model 390 Premier 1. It was 46 feet (14.02 meters) long, had a span of 44 feet 6 inches (13.56 meters), and a height of 15 feet 3.6 inches (4.66 meters). It was a metal and

carbon fibre composite, low wing airplane powered by two (2) Williams-Rolls FJ44-2A turbofan engines each capable of producing 2,300 pounds of thrust. It was also equipped with retractable tricycle landing gear.

The fuselage was a carbon fibre/reinforced epoxy honeycomb monocoque construction. Aluminium alloy was used for the wing. The composite structure consisting graphite plies and honeycomb core was used for the vertical stabiliser skin and horizontal stabiliser structure.

Dual mechanical controls with three-axis electrical trim operated the ailerons, rudder, and elevator. The spoilers were electronically controlled and hydraulically actuated. The single slotted fowler flaps were electrically controlled and driven.

Aircraft Type	Hawker Beechcraft 390 Premier 1
Manufacturer	Raytheon Aircraft Company
Year of Manufacture	2004
Owner	Koperasi Amanah Pelaburan Berhad (KAPB)
Registration No.	N28JV
Aircraft Serial No.	RB-97
Certificate of Airworthiness Issue / Expiry date	Issued on 10 May 2023 / 17 Apr 2024
Certificate of Registration Issue / Expiry date	Issued on 3 May 2023 / 31 May 2030
Total Flight Hours	3142.90

Table 4: Aircraft Data

1.7 Meteorological Information

The incident happened in day time. The weather was fine, with visibility reported as more than 10 kilometres, and wind was variable (VRB) at 05 knots.

METAR WMSA 170500Z VRB04KT 9999 FEW018 30/24 Q1012=
METAR WMSA 170600Z VRB05KT 9999 FEW018 30/24 Q1011=
METAR WMSA 170700Z 24004KT 160V300 9999 FEW017CB 31/23 Q1010=
METAR WMSA 170800Z 25006KT 210V300 9999 FEW017CB 32/23 Q1009=

1.8 Aids to Navigation

ILS for Runway 15 was declared unserviceable (U/S) from 1 Jan 2023 UFN due to replacement works (AIP SUP 05/23 effective from 9 Feb 2023). The available instrument approach for inbound aircraft was NDB RWY 15. Other navigation aids were operating normally.

1.9 Communications

All ATC communications frequencies were operating normally.

1.10 Aerodrome Information

Airfield	WMSA – Sultan Abdul Aziz Shah Airport
Runway	15 / 33
Length	3782 m
Width	45 m
ICAO Designator	WMSA
IATA Designator	SZB
Elevation	21.5 m

Table 5: Sultan Abdul Aziz Shah Airport (WMSA) Aerodrome Information

1.11 Flight Recorders

1.11.1 Flight Recorder Installed

The aircraft was equipped with a L3Harris F2100 Cockpit Voice Recorder (CVR). The CVR can record 30 minutes of high-quality 4-channel voice data. There was no Flight Data Recorder (FDR) installed in the aircraft. Apart from the CVR, there was no other flight recorder or any other types of non-volatile memory (NVM) storage media recovered from the aircraft wreckage.

1.11.2 Search and Recovery of CVR

The CVR was recovered relatively promptly during the search and recovery operation following the accident. The on-site search team was cleared by the police forensics team to start the search for the CVR at about 2030 LT. A damaged CVR was found underneath the main aircraft wreckage at about 2150 LT, 17 Aug 2023.

The recovered CVR was secured and packed, and was in secure custody of the AAIB team until the CVR was handed over to the AAIB Flight Recorder Laboratory at the Science and Technology Research Institute for Defence (STRIDE), Kajang, Selangor at about 0900 LT, 18 Aug 2023.

1.11.3 CVR Data Recovery

The recovered CVR was cleaned up at the AAIB Flight Recorder Laboratory upon receipt of the recorder on 18 Aug 2023. Details of the recovered CVR were identified as follows:

a. CVR manufacturer: L3Harris (formerly known as L3 Communications).
b. CVR type: FA2100.
c. CVR part number: 2100-1010-51.
d. Serial number: 000229957.

An initial damage assessment confirmed that the CVR was damaged to an extent that it was not possible for the recorder to be processed with the existing equipment and capabilities at the AAIB laboratory[3].

The Transport Safety Investigation Bureau (TSIB) Singapore offered technical assistance for the CVR data recovery. A TSIB Accredited Representative (AR) was appointed and dispatched to Malaysia on 18 Aug 2023 to provide technical assistance.

On 19 Aug 23, the damaged CVR was disassembled to be assessed further at the AAIB Flight Recorder Laboratory. Visual inspection (Figure 3) indicated that the CVR was exposed to elevated temperature of the post-crash fire. Parts of the external paint coating had liberated from metal surface of the Crash Survivable Memory Unit (CSMU). The front face connector had also melted.

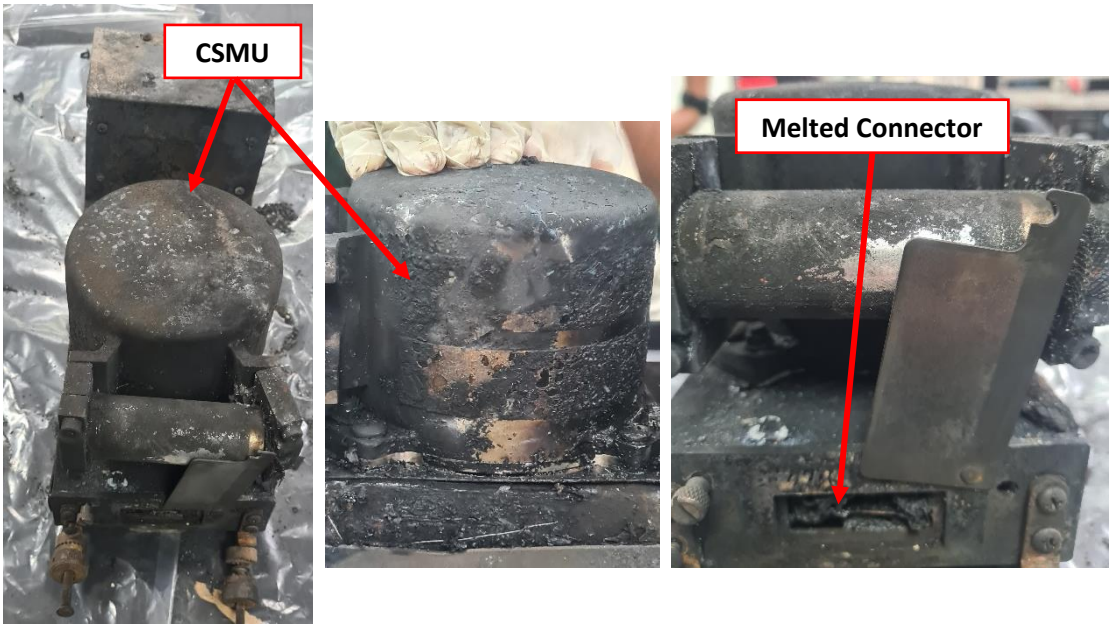

Figure 3: (Left): Overall view of CVR. (Centre): View of CMSU with bare metal surface visible, absent of paint coating. (Right): Front face connector melted.

[3] The AAIB Flight Recorder Laboratory does not have the equipment and capability to process damaged L3Harris flight recorders. In this case, the facility does not have the L3Harris FA2100 Accident Investigator's Kit (AIK) to process the damaged CVR (L3Harris FA2100), that include a L3Harris Golden Chassis, cable spares, Readout Support Equipment (ROSE) software and other repair kit stores.

The CSMU was then removed from the CVR chassis. It was observed that the exposed portion of the ribbon cable connecting the memory storage module[4] exhibited signs of thermal stress (Figure 4). Visual examination of the circuit board within the CVR chassis indicated that it was exposed to elevated temperature which was sufficient to cause the solder joints to melt, as several integrated circuit (IC) chips were not in their original position.

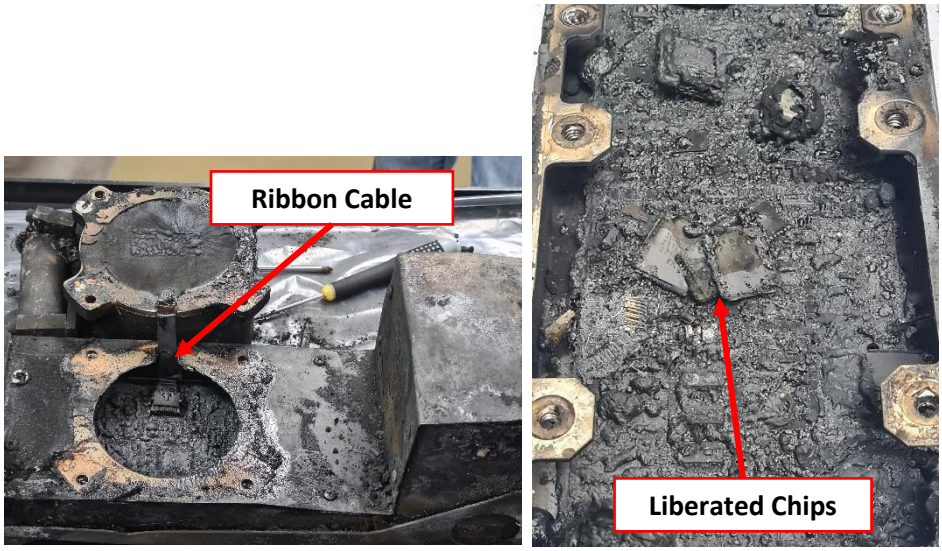

Figure 4: (Left) CSMU separated from CVR chassis.
(Right) Several IC chips liberated from their solder joints.

The CSMU base plate was removed and the internal area of the CSMU appeared to be in good condition with the thermal absorption material still in its original state[5] (Figure 5). The portion of the ribbon cable housed within the CSMU appeared to be undamaged.

[4] The memory storage module aka 'puck' is a cylindrical metal container housed within the CMSU that contains an assembly of printed circuit boards and memory chips.

[5] Had the internal of the CSMU been exposed to elevated temperature for a prolonged duration, the thermal absorption material would have melted into semi-liquid state, absorbing the thermal energy to reduce amount of heat transfer to the memory puck.

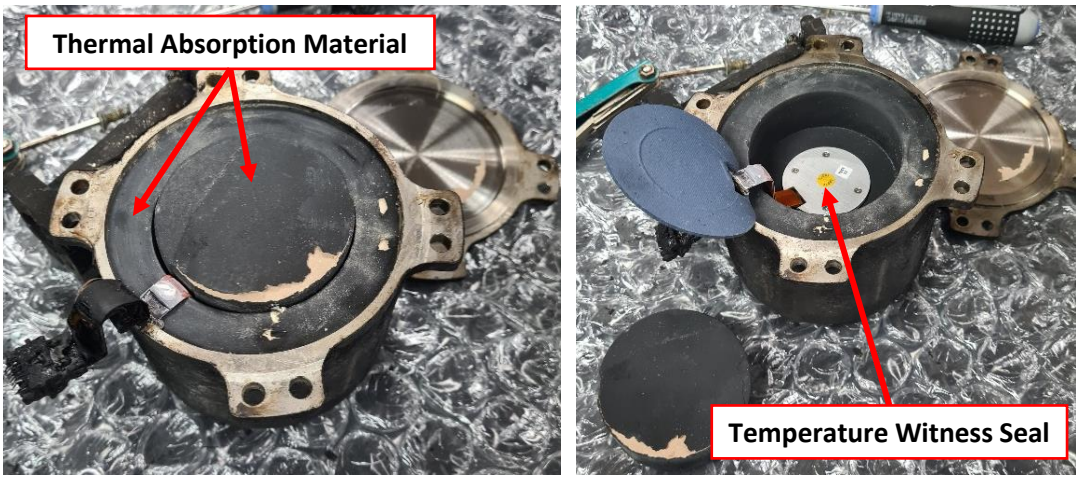

Figure 5: (Left): Thermal absorption material condition.
(Right): View of memory storage module exposed.

The CSMU's memory storage module was extracted and the temperature witness seal was in its original yellow colour[6]. According to the manufacturer's procedures, if the temperature witness seal had turned black, the manufacturer should be contacted for assistance to extract the stored data.

As the temperature witness seal indicated that the memory storage unit was not exposed to high temperature, it was possible to perform recovery of the data following the manufacturer's Accident Investigator's Kit (AIK) recovery procedures. As the TSIB's flight recorder laboratory in Singapore possesses the capability as well as the necessary AIK equipment and spare parts, it was decided to perform the memory storage module recovery in the TSIB's recorder laboratory, as it presented highest chance of recovering the stored data as soon as possible.

The damaged CVR data recovery effort was conducted in TSIB's flight recorder laboratory in Singapore from 20 to 22 Aug 2023. This data downloading effort was unsuccessful due to technical issues. Subsequently, on 28 August 2023, the effort at the L3Harris Technologies facility at St. Petersburg, Florida, USA to download the

[6] In the event that the memory storage module was exposed to elevated temperature for a sufficiently long duration, the temperature witness seal will change to black colour.

stored data from the accident CVR was successfully completed. The two (2) CVR data download efforts are summarised in Appendix A.

1.11.4 CVR Audio Files Download

The audio data from the accident CVR was fully downloaded by the L3Harris facility in St. Petersburg, Florida on 28 Aug 2023. There were no anomalies observed during the download process. The following data files were downloaded and converted to respective wav format files in the following order:

a. CH1 (N28JV H1.wav): 29,119 kilobytes (KB); Length: 31 min, 3.576 sec. Left/Right Crew Chief and Rear Intercom Communication Unit (ICU).

b. CH2 (N28JV H2.wav): 29,119 kilobytes (KB); Length: 31 min, 3.576 sec. Left Seat Intercom Communication System (ICS).

c. CH3 (N28JV H3.wav): 29,119 kilobytes (KB); Length: 31 min, 3.576 sec. Right Seat ICS.

d. HQC (N28JV H4.wav): 58,237 kilobytes (KB); Length: 31 min, 3.576 sec. High Quality Cockpit Area Microphone (HQC).

* Note: CH=Channel; HQC=High Quality Channel

1.11.5 CVR Recording Transcript

Initial transcription of the CVR recording has been completed and analysis of the audio files is in progress at the time of issue of this Preliminary Report. Transcripts from the cockpit voice recording shall be included in the Final Report only when essential to the analyses and understanding of the accident.

1.12 Wreckage and Impact Information

The aerial photo of the crash site (impact point position – 3°10''51.9''N 101°30'53.5''E) in Figure 6 below provides a general illustration of the site; consisting of the initial location of impact on the ground, the location of the main wreckage and the location of the right engine. Area 1 (the red line circle) is the initial ground impact point. Area 2 (the red line circle) shows the main wreckage, and Area 3 (the red line circle) indicates the location of the right engine. The yellow line illustrates the aircraft debris distribution area.

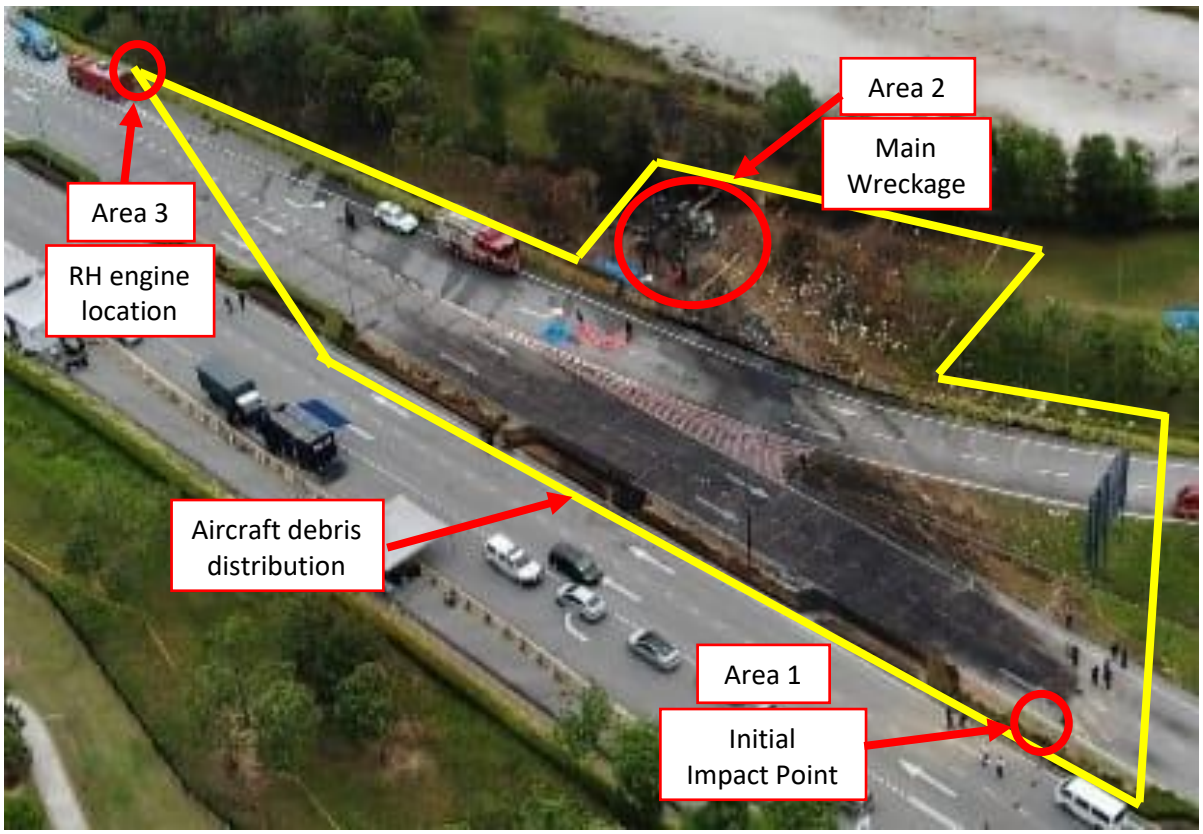

Figure 6: General Map of Wreckage and Impact Information

1.12.1 Engines

Visual inspection observed that the right and left engines had broken into three (3) and four (4) distinct segments respectively; the fan, fan case assembly, Intermediate Pressure (IP) compressor section and the High-Pressure Compressor/Hot Section.

The starter, Hydromechanical Unit (HMU) and gearbox had all detached from both of the right and left engines. Both of the engines, had no evidences of blade liberation such as case dents or perforations at the compressor sections. The fan shroud also did not exhibit any evidence of blade liberation such as case dents or perforations. There was no evidence of foreign object ingestion, bird feathers or matter to any of the engine components.

1.12.2 Cockpit Section

The cockpit was highly fragmented. The landing gear handle was found in the down position but the handle was damaged. The lift dump handle was damaged and found in an intermediate position (normal range is either retracted or extended).

1.12.3 Aileron System

The aileron system from the control column to the left and right ailerons were examined, except for the aft sector and the left wing inboard sector. These components could not be definitively identified due to wreckage fragmentation. The breaks in the cables had ends that had a splayed, broom straw appearance consistent with tension overload. All remaining control sectors and their associated fittings were either intact or exhibited damage consistent with overload. Both the left and right aileron trim actuators were extended approximately 1.9 inches. This corresponds to approximately 6 degrees aileron trim trailing edge tab up.

1.12.4 Rudder System

The rudder cables from middle fuselage to the rudder were examined. Most breaks in the cable had ends that had a splayed, broom straw appearance consistent with tension overload. One break in a ’right rudder’ cable was retained for further examination. The rudder cables from middle fuselage to the rudder pedals could not be definitively identified due to wreckage fragmentation. Flight control cables of various lengths were found that exhibited breaks consistent with tension overload but these cables could not be positively identified as rudder or elevator cables.

1.12.5 Elevator System

The elevator cables from the cockpit to the elevator were examined. Most breaks in the cable had ends that had a splayed, broom straw appearance consistent with tension overload. One break in an elevator cable was retained for further examination.

1.12.6 Spoilers

The right lift dump actuator was found in an extended position while the left lift dump actuator was found in the retracted position. The down-lock striker on the right lift dump panel was bent from impact. Both the left and right middle and outboard spoilers were in the stowed position. The Hydraulic Spoiler Control Module (HSCM) was impact and thermally damaged. It was retained for further examination. The Spoiler Control Unit (SCU) was thermally damaged. The lift dump actuators, the roll control actuators and the pull (blow) down actuators have been removed for further examination.

1.12.7 Flap System

The eight (8) flap actuators were found at the wreckage site. Six (6) of the eight (8) actuators were easily measured. Two (2) actuators were separated from their control rods. By examining their control rods and the end of the ball screw, the position of the flaps was determined. The flap actuators were all in the ‘DOWN’ position (fully extended). Where each actuator was installed on the aircraft could not be definitively identified due to the fragmentation of the wreckage.

1.12.8 Landing Gear System

The left and right main Landing Gear assemblies remained intact, remained attached to their respective wing attachment and exhibited heat/thermal and impact damage. The left and right main landing gear actuators remained attached to their respective gear and wing. However, the right main landing gear actuator piston was impact separated. The left and right main landing gear actuators were found in the full extended/down position. The nose gear was separated from its attachment point. The

lower strut was separated from the upper trunnion. The nose gear assembly exhibited impact damage.

1.13 Medical and Pathological Information

A total of 10 victims were fatally injured in this air accident. They were 1 PIC, 1 SIC, 6 passengers onboard, 1 motorcyclist on ground and 1 motorist on ground.

1.13.1 On-Site Investigation

After the collision, the site was covered with fire. The medical forensic team entered to the crash site to carry out a pathological investigation after the area was declared safe. The position of bodies, body parts and biological tissues at the site were duly marked and documented before being extricated. Due to the poor illumination at night time during the search and recovery operation at the accident site, the retrieval of biological tissues continued into following two (2) days during day times. All biological tissues were transported to the Medical Forensic Department, Hospital Tengku Ampuan Rahimah, Klang for further identification and post-mortem investigation.

The distance between the first impact of the aircraft on the ground and the furthermost body found was approximately 100 metres. The main wreckage came to rest about 73 metres from the first impact of the aircraft on the ground. Massive post-crash fire engulfed the aircraft immediately after the collision.

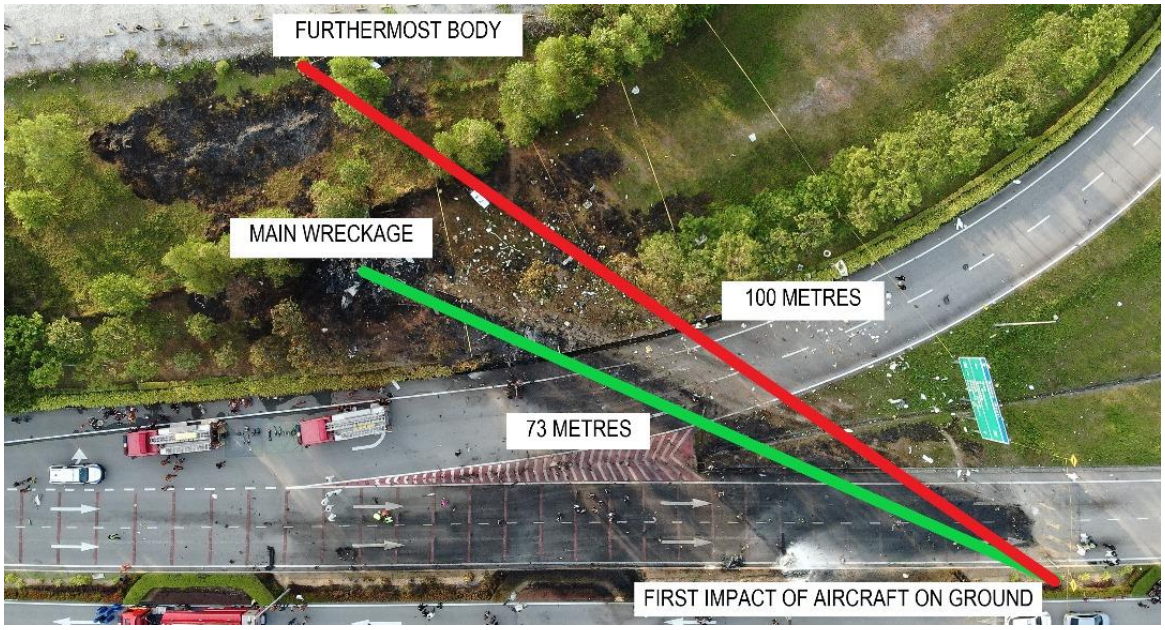

Figure 7: Distance between first impact and wreckage and furthermost body

1.13.2 Off-site Investigation

All victims had been successfully identified via primary criteria, (i.e. DNA analysis, Odontology comparison and finger print) and secondary criteria (i.e. body features, clothing and birth mark recognisable by family members).

1.13.3 Cause of Death (Official post-mortem reports were pending at the time of issue of this report)

The PIC and SIC succumbed to multiple injuries. Evidences indicated that both of the pilots did not suffer from cockpit incapacitation. Hence, the hypothesis of medical causative and contributing factors to this accident may be discounted.

1.13.4 Toxicology Information

Pending result from the laboratory.

1.13.5 Medical Fitness Status of PIC

On witness account, the PIC was reported to be well the night before the accident. The witness also said that the PIC had a good rest before the flight departing from Langkawi.

1.13.6 Licensing Medical Information from Aviation Authorities

Both the PIC and SIC held valid medical certificate from the Federal Aviation Administration (FAA) and the Civil Aviation Authority of Malaysia (CAAM).

The PIC successfully gained First Class Medical Certificate from FAA with limitation "Must use corrective lenses to meet vision standards at all required distances" on 24 March 2023. He concurrently held CAAM Medical Certificate valid from 6 December 2022 till 31 December 2023 with limitation "VDL – Valid only with correction for defective distant vision". Review of the Medical Certificate and supporting documentation indicated that the PIC reported no significant medical concerns and the attending Designated Medical Examiner (DME) identified no significant conditions on physical examination. Based on available history and physical examinations, this pilot had no known medical conditions that could pose significant hazards to flight safety.

The SIC successfully gained First Class Medical Certificate from FAA on 24 July 2023 with limitation "Must use corrective lenses to meet vision standards at all required distances". He concurrently held CAAM Medical Certificate valid from 15 September 2022 till 30 September 2023 with limitation "VDL – Valid only with correction for defective distant vision". Review of the Medical Certificate and supporting documentation indicated that the SIC reported no significant medical concerns and the attending DME identified no significant conditions on physical examination. Based on available history and physical examinations, this pilot had no known medical conditions that could pose significant hazards to flight safety.

1.14 Fire

The high energy collision of the aircraft on the ground and flammable fuel in the tank ignited catastrophic fire. The fire engulfed the entire fuselage, aircraft occupants as well as the collateral motorist and motorcyclist on the ground. Several remains were severely charred (pending confirmation of number from the post-mortem report).

1.15 Survival Aspects

There were no survivors in this catastrophic accident.

1.15.1 Crash dynamic and injuries

According to the visual and field analysis, the aircraft right wing tip firstly impacted on the solid ground and immediately followed by the nose at high energy. The short duration acceleration (0.1-0.5 seconds) typically observed in high energy collision led to fatal injuries of the aircraft occupants. This level impact forces, collision pattern and magnitude were beyond the limit of human tolerance indicating that this was not a survivable accident.

1.15.2 Analysis of Aircraft Crashworthiness and Post-Crash Survivability

Crash survivability and the human tolerance to impact was analysed using the reference tool C.R.E.E.P (Container, Restrain, Environment, Energy Absorption, Post-crash factors). Assessment of the factors below determined causes of injuries and survivability of the occupants.

1.15.3 Container

Container refers to the space occupied by the aircrew, it encompassed both the cockpit and cabin spaces. The container should be robust to withstand deformation as reduction of this occupiable space is likely to cause injury or death.

The aircraft container was shattered due to the high energy impact and post-crash fire. This disintegration of the container failed to prevent intrusion of outside objects. Therefore, occupants sustained fatal injuries.

Figure 8: Container was shattered. Survivability was almost impossible.

1.15.4 Restrain

Restraint system kept the individual within their workspace, so that control of the aircraft and equipment was maintained. The restrain system was also designed to attenuate the crash dynamic and to restrict movement of the occupant to avoid impact with aircraft structures. Unfortunately, the restrain system analysis was not applicable as the occupants would have not survived the initial impact. Moreover, the fire has consumed the restrain system rendering lack of evidence on the function of the restrain system.

1.15.5 Environment

It refers to the volume space of the container. If the container maintained its integrity, the aircraft occupants still could be injured by contact collision with cabin structures. Brace position reduced the strike envelop of the body, protects head and vital parts

from missile injury and stabilize occupants. Survivability of this element was not applicable, as the energy environment involved was lethal.

1.15.6 Energy absorption

This crumple zone crushed and deformed in a controlled manner during the impact, increasing the stopping distance. This crushing and deforming ultimately reduced the accelerations acting on the occupants. In this accident, the impact forces were beyond the limit of the aircraft structure could withstand. Therefore, the aircraft disintegrated and excessive energy was transmitted to cabin occupants.

1.15.7 Post-crash factor

This referred to everything which can affect cabin occupants after the immediate impact event and should encompassed all of the hazards present at the crash. Should occupants survived previous factors of the analysis, it was very unlikely they could survive the fire erupted which consumed the whole remnant.

1.16 Tests and Research

1.16.1 Mechanical Functionality Test

Identified relevant mechanical parts and components of the recovered Flight Control Surfaces were sent to the NTSB laboratory (and OEM facilities, if necessary) in the United States for further inspection and examination (metallurgical and mechanical tests), in order to determine the functionality and status/conditions of the relevant parts and components. The list of the items sent to the NTSB laboratory are as follows:

No.	Descriptions	P/No.	S/No.	Qty
1.	LH Aileron Trim Actuator	390-381009-0009	080	1
2.	RH Aileron Trim Actuator	390-381009-0008	67	1
3.	LH Pull Down Actuator	390-381010-0001	0202	1

4.	RH Pull Down Actuator	390-381010-0001	0197	1
5.	LH Lift Dump Actuator	390-381008-0001	0216	1
6.	RH Lift Dump Actuator	390-381008-0001	648	1
7.	LH Roll Control Actuator	390-381007-0003	0214R	1
8.	RH Roll Control Actuator	390-381007-0003	0252	1
9.	Lift Dump Switch/ Panel	Unknown	Unknown	1
10.	RH Rudder Cable & Elevator Cable	Unknown	Unknown	1
11.	Spoiler Hydraulic Control Module	Unknown	Unknown	1
12.	Annunciator Panel	Unknown	Unknown	1

Table 6: List of Aircraft Parts and Components Sent to NTSB Laboratory

1.17 Organisational and Management Information

Jet Valet Sdn Bhd was formed in 2021 and is a subsidiary of Koperasi Amanah Pelaburan Berhad. It began as a way to provide "*easy travel and additional benefits to the cooperative's member in the membership program."* Jet Valet Sdn Bhd operates three (3) different types of airplanes, the Premier 1 (N28JV), Hawker Beechcraft 4000 (N35JV), and a Gulfstream IV (N729TY), and is situated in Sultan Abdul Aziz Shah Airport, Subang Selangor.

The Aerodrome Operator for Sultan Abdul Aziz Shah Airport (WMSA) is Malaysia Airports Sdn Bhd (MASB). MASB is licensed by the Ministry of Transport Malaysia to operate, manage, and maintain all airports in Malaysia except Kuala Lumpur International Airport (KLIA).

1.18 Additional Information

Nil.

1.19 Useful or Effective Investigation Techniques

1.19.1 Cockpit Voice Recorder (CVR) Data Recovery Process

Visual inspection found that the Cockpit Voice Recorder (CVR) was exposed to elevated temperature of the post-crash fire. The Crash Survivable Memory Unit (CSMU) was removed from the CVR chassis. The CSMU's memory storage module (memory puck) was extracted and sent initially to the TSIB Singapore flight recorder laboratory before being sent to the L3Harris accident investigation laboratory in the U.S. The CVR audio data was successfully recovered in the L3Harris facility.

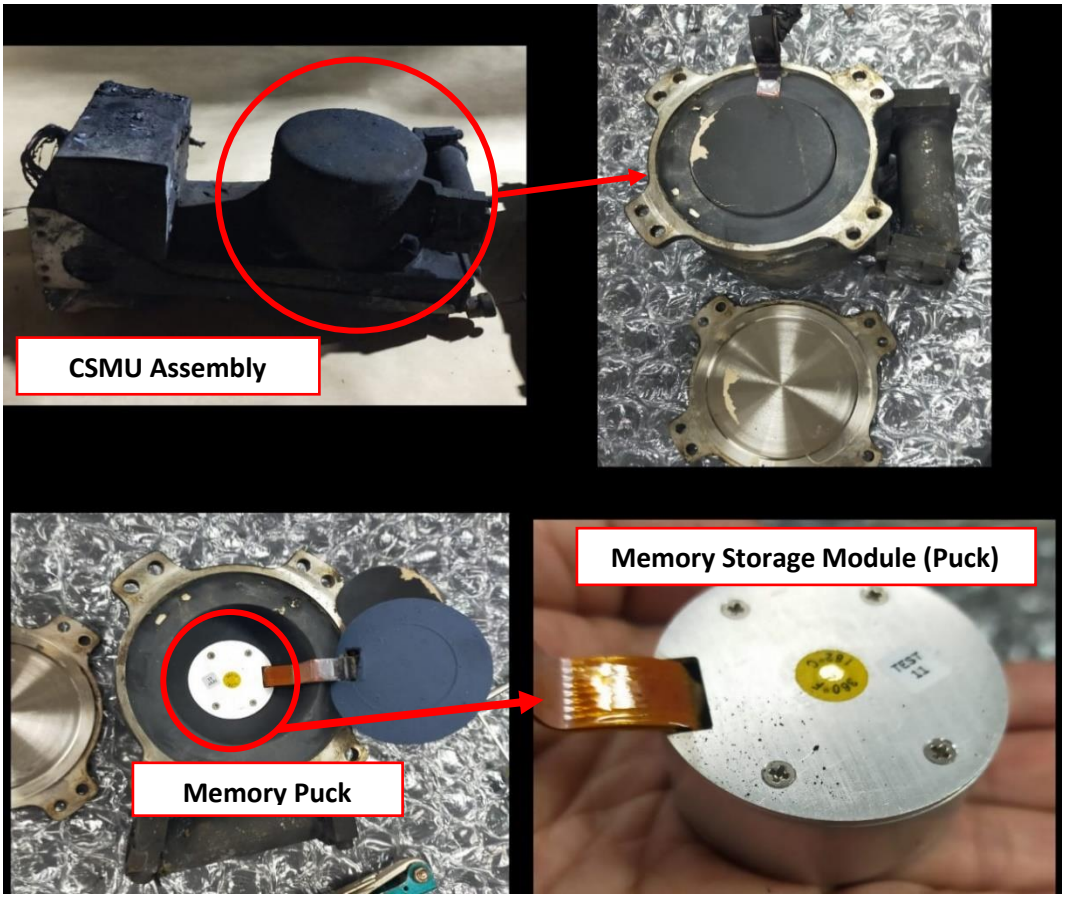

Figure 9: Condition of the Recovered CVR Memory Module (Puck)

1.19.2 Aircraft Parts/Components and Power Plants Identification

A basic 'reconstruction method' of the airplane wreckage was used to identify the airplane parts, components and power plants assembly for further investigation.

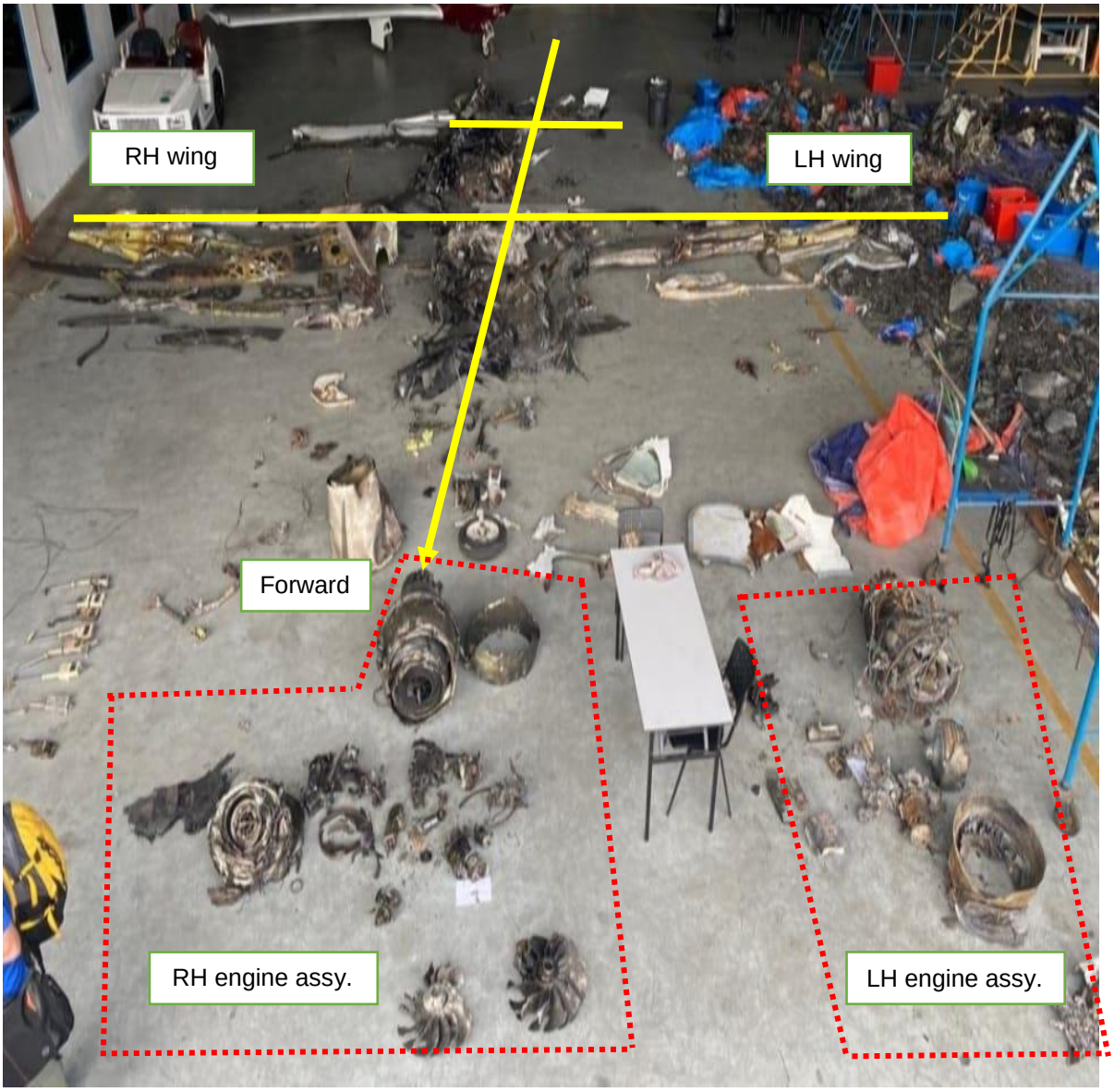

Figure 10: Layout of the Aircraft Wreckage

2.0 Analysis

To be included in the Final Report.

3.0 Conclusion

3.1 Findings

The preliminary findings of the investigation are as follows:

3.1.1 The PIC was licensed and qualified for the flight in accordance with existing regulations.

3.1.2 The aircraft had a valid Certificate of Airworthiness and had been maintained in compliance with the regulations.

3.1.3 The incident happened in day time with reported clear visibility and fine meteorological conditions.

3.1.4 There was no evidence of incapacitation or physiological factors that affected the flight crew performance.

3.1.5 The accident was not survivable due to the magnitude of the deceleration force and the post-crash fire.

3.1.6 (Additional findings to be included in the Final Report.)

3.2 Causes/Contributing Factors

To be included in the Final Report.

* Note: Initial analysis of the recovered CVR recording has provided critical leads to uncovering the cause of the accident, with a focus on the aircraft flight control systems. Results from the pending inspection and examination of the related aircraft parts and components at the NTSB and OEM laboratories are necessary to provide collaborative and/or conclusive evidence in establishing the cause of the accident.

4.0 Safety Recommendations

To be included in the Final Report.

5.0 APPENDICES

A	CVR Data Recovery Process	A-1 to A-6
B	Aircraft Damage Assessment	B-1 To B-23

INVESTIGATOR IN-CHARGE

Air Accident Investigation Bureau

Ministry of Transport

Malaysia

- End -

Appendix A

CVR Data Recovery Process

1.1 CVR Data Recovery at TSIB Flight Recorder Facility, Singapore

The recovery of data from the CVR memory storage module at the TSIB's flight recorder laboratory commenced on 20 Aug 23. The recovery process was performed based on the L3Harris's FA2100 Accident Investigation Procedure FA2100 Rev. F and L3's Accident Investigators Training material 165E1436-22 (dated 18 Jun 12).

During the disassembly process, the internal and each layer of the memory puck appeared to be in good condition. The part number of the damaged ribbon cable was determined to be 024-E1575-00, which is used for a memory storage module that operates at 5V (Figure 1).

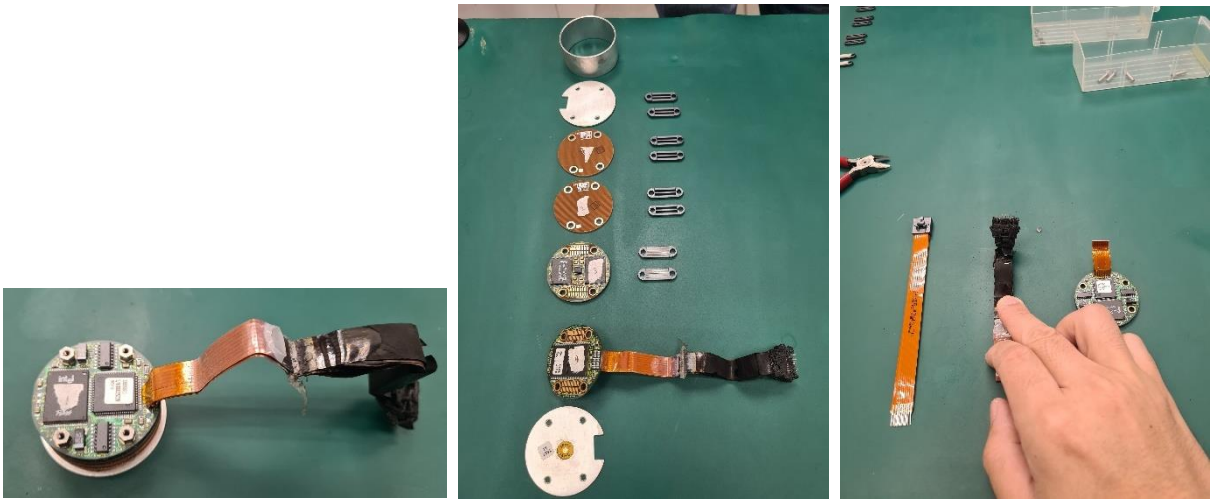

Figure 1: (Left): View of memory puck with base cover removed, showing the memory PCB. (Centre): Each layer of the memory puck removed. (Right): Verification of the replacement cable to be used.

A new ribbon cable was successfully attached. The memory storage module was reassembled and electrical checks were performed. Based on the electrical checks conducted, it was determined that it was safe to apply electrical power to the memory storage module to attempt downloading the stored data.

The Golden Chassis was reprogrammed successfully with the 2100-1010-XX AIK firmware and the memory storage module was connected to it. Upon initial introduction of electrical power to the Golden Chassis with the accident memory storage module, the voltage and current readings were stable at 28V DC and 0.34A, indicating that there was no electrical short circuit.

In the L3Harris's Readout Support Equipment (ROSE) software, the "Test Flight Recorder" function was selected to determine if ROSE was able to communicate with the Golden Chassis and the memory storage module. An error was encountered indicating that the Golden Chassis was not connected to ROSE (Figure 2).

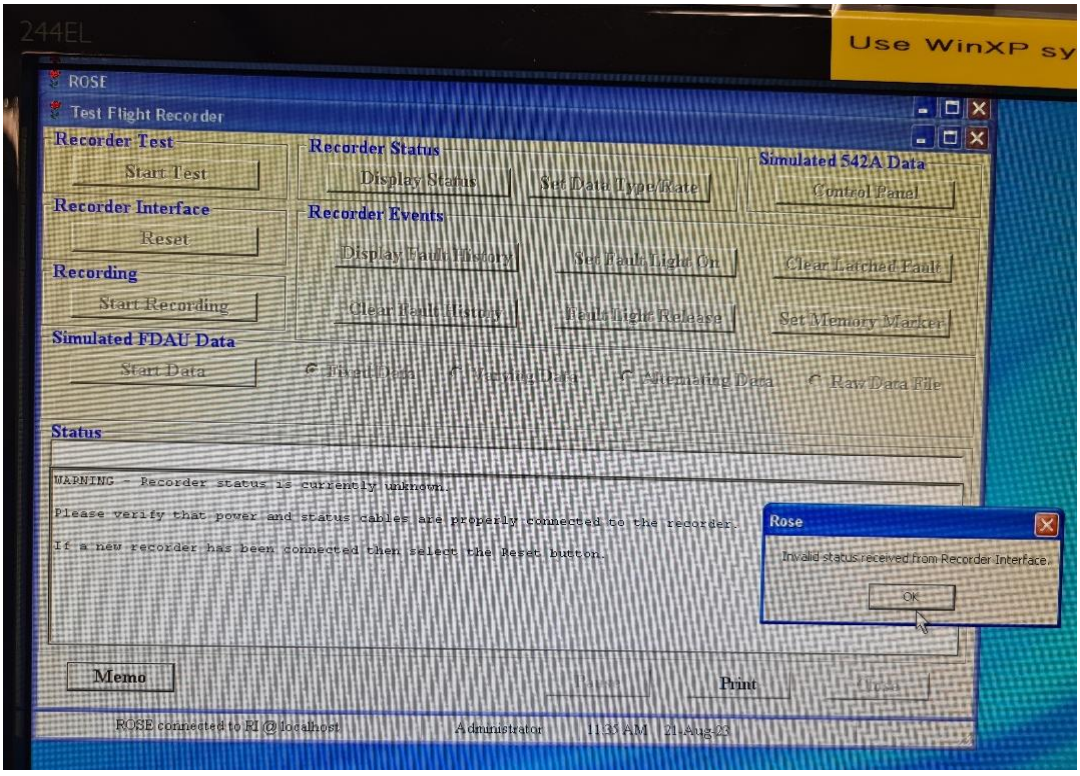

Figure 2: Error encountered in ROSE.

Further attempts were made to connect the Golden Chassis to ROSE, which include restarting the download computer several times, disassemble and reassembly of the memory storage module and replacement of the ribbon cable. However, the repeated attempts encountered the same error in Figure 2.

During the subsequent troubleshooting, it was determined that it was highly probable that the issue was in the AIK firmware used to program the Golden Chassis. The L3Harris representative for accident investigation was contacted to enquire about the issue. Over the rest of day and the next day on 22 Aug 23, further troubleshooting by TSIB and L3Harris followed by the reprogramming of TSIB's Golden Chassis with an updated AIK firmware finally enabled successfully communication with ROSE using the production CVR 5V CSMU.

Once the download process using the new AIK Firmware was successful, it was agreed that another attempt to recover data from the accident memory storage module should be performed. After unpacking the memory storage module, a contact on the ribbon cable was observed to have detached from the solder attachment point and some debris were observed on the PCB.

Rework on the loose contact point and cleaning of the PCB of the memory storage module were performed. The following resistance checks failed to return satisfactory results. The ribbon cable was then replaced with a fresh cable. However, this measure also failed to achieve satisfactory resistance check values.

At this point, it was decided to perform the CVR data recovery at the L3Harris' facility in the USA in view of the several considerations, that include depleting spare ribbon cables at the TSIB's facility, changes in resistance check values of the reassembled memory storage module, risk of heat damage to the PCB with continuous soldering of the crimped contacts, and the availability of additional equipment and resources at the L3Harris facility should more complex recovery process is required.

1.2 CVR Data Recovery at L3Harris, St. Petersburg, Florida, USA

The data recovery from CVR memory storage module (Figure 3) at the L3Harris Technologies facility in St Petersburg, Florida was conducted on 28 Aug 2023.

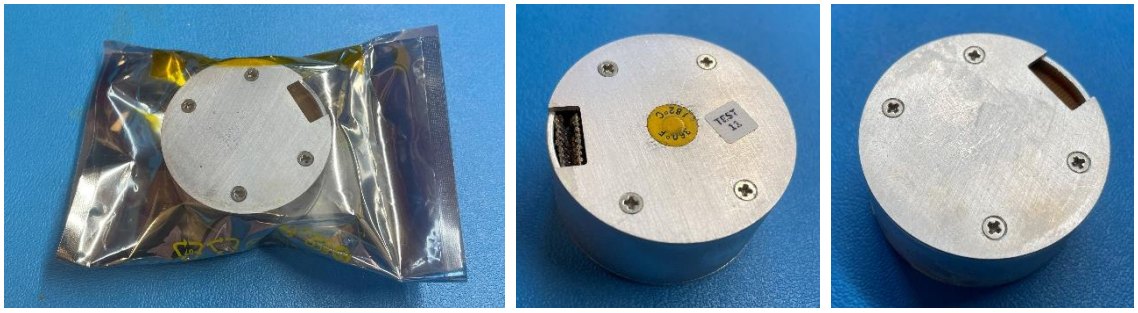

Figure 3: (Left): CVR memory module handed over to L3Harris.
(Centre): Front side. (Right): Back side.

Disassembly of the memory module (Figure 4), including removal of the remaining cable assembly components (Figure 5) was uneventful. Safe-to-power measurements performed after the cable remnants removal was within specification.

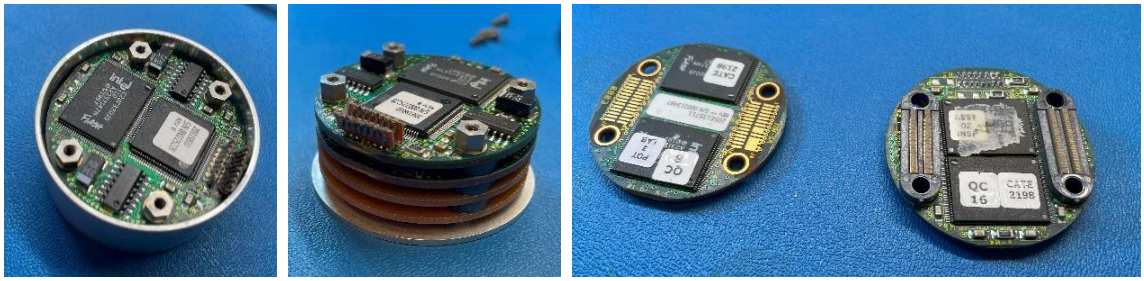

Figure 4: Dissemble of the memory module.

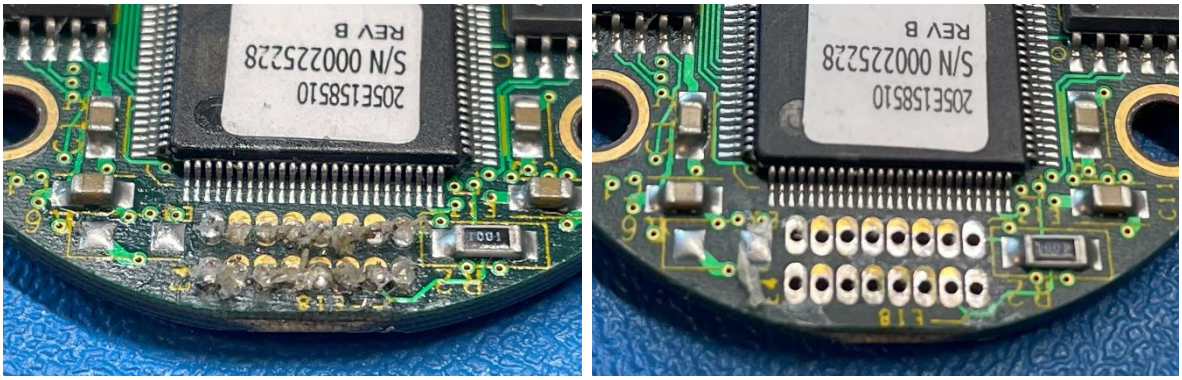

Figure 5: Removal of the remaining cable assembly. (Left): Before. (Right): After.

Reinstallation of a new cable assembly (Figure 6) was likewise uneventful. Post-installation and reassembly safe-to-power testing were successful (Table 1).

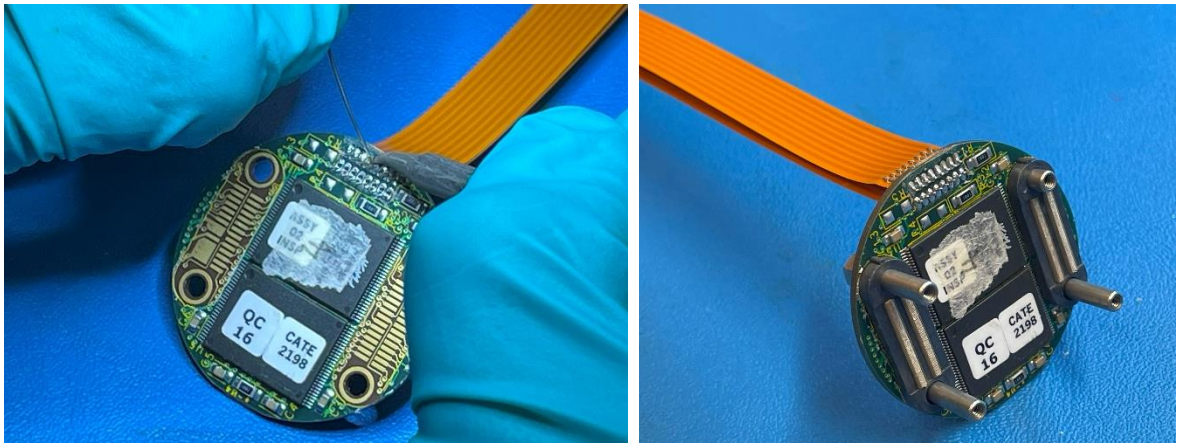

Figure 6: Reinstallation of a new cable assembly.

Between Pins			
From (Red Lead)	To (Black Lead)	Expected	Measured
E3	E5	open	OPEN
E5	E7	3.686k	3.695k
E7	E9	2M	1.539M
E9	E11	open	OPEN
E11	E13	open	OPEN
E13	E15	6.06k	6.09k
E15	E17	6.06k	6.09k
E4	E6	0	0.5Ω
E6	E8	0	0.6Ω
E8	E10	2M	1.545M
E10	E12	open	OPEN
E12	E14	open	OPEN
E14	E16	6.06k	6.09k
E16	E18	6.06k	6.09k
E3	E4	open	OPEN
E5	E6	600	608Ω
E7	E8	3.09k	3.098k
E9	E10	open	OPEN
E11	E12	open	OPEN
E13	E14	935	936Ω
E15	E16	884	893Ω
E17	E18	936	942Ω

Pinout	
Pin	Signal
E3	MIC_RESET_L
E4	GND
E5	VCC
E6	GND
E7	VPP
E8	GND
E9	HS_MSG_MI_LO
E10	HS_MSG_MI_HI
E11	HS_FS_MI_HI
E12	HS_FS_MI_LO
E13	HS_FS_AP_HI
E14	HS_FS_AP_LO
E15	HS_CLK_AP_HI
E16	HS_CLK_AP_LO
E17	HS_MSG_AP_HI
E18	HS_MSG_AP_LO

Table 1: Final safe-to-power measurements taken after new cable rebuild.

The FA2100 Accident Investigator's Kit (AIK) Golden Chassis was inspected and a known good "golden" CSMU was used to demonstrate functionality of the AIK. After the golden CSMU was downloaded, the accident memory module (with replacement

cable) was installed and downloaded (Figure 6). The download and subsequent data reconstruction/decompression was uneventful.

Figure 7: Accident memory module (with replacement cable) installed to (Left) and downloaded with the FA2100 AIK Golden Chassis (Right).

The downloaded audio files were then provided to the AAIB/TSIB/NTSB team for their analysis. The team reviewed the audio files retrieved, concluding that the files were complete and that the accident CVR data recovery was successful.

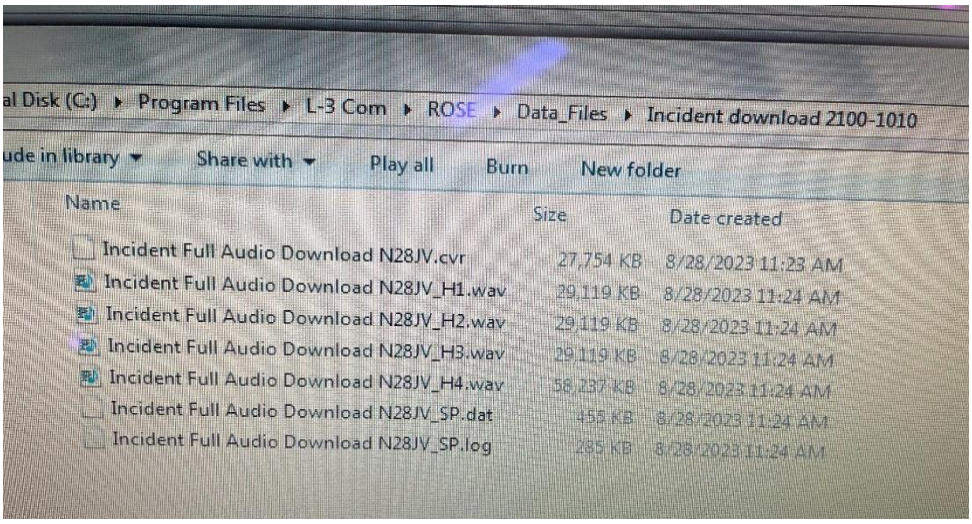

Figure 8: (Left): Complete and successful accident CVR data recovery.

- End -

Appendix B

AIRCRAFT DAMAGE ASSESSMENT

1.0 Examination Details

1.1 Structures

The majority of the airplane was consumed by fire. Both wings and the vertical stabiliser structure had detached from the airframe. All four (4) corners of the airplane along with remnants of all flight controls, flaps, and spoiler surfaces were located. There was no evidence of feathers or bird debris on any of the airframe structure.

1.1.1 Accident Site

Note: By the time of the investigation group's arrival, some of the wreckage had been removed from the initial impact point along the "Persiaran Elmina" highway and moved to a field adjacent to the main wreckage. The road surface with the impact scar marks was then repaved.

The first identified point of impact was characterized by a 5-ft-long ground scar, on a heading of 260 °, in the centre median of the highway about 3 miles northwest of the approach end of SZB airport Runway 15. Fragments of the green navigation light lens were located within the disruption.

Debris consisting of the right engine, right wing fragments, cabin contents and skins continued across the paved highway and into a tree-lined grass area to the west. The main wreckage came to rest about 240 ft west of the initial impact, next to a stand of four (4) felled trees. The grass and surrounding vegetation were burnt.

Within the main wreckage area, the cabin had come to rest on a reciprocal heading from the debris and was resting against the left engine and a crushed automobile. The left wing remained partially attached to the cabin and was pointing in a north direction.

The vertical stabiliser assembly was about 10 ft to the west of the cabin, and the left and right main landing gear remained with the main wreckage and attached to their respective wing attachment. The trunnion/upper section of the nose landing gear was found in the main wreckage. The nose gear piston/wheel was found in the immediate vicinity of the main wreckage. (Figure 1)**.**

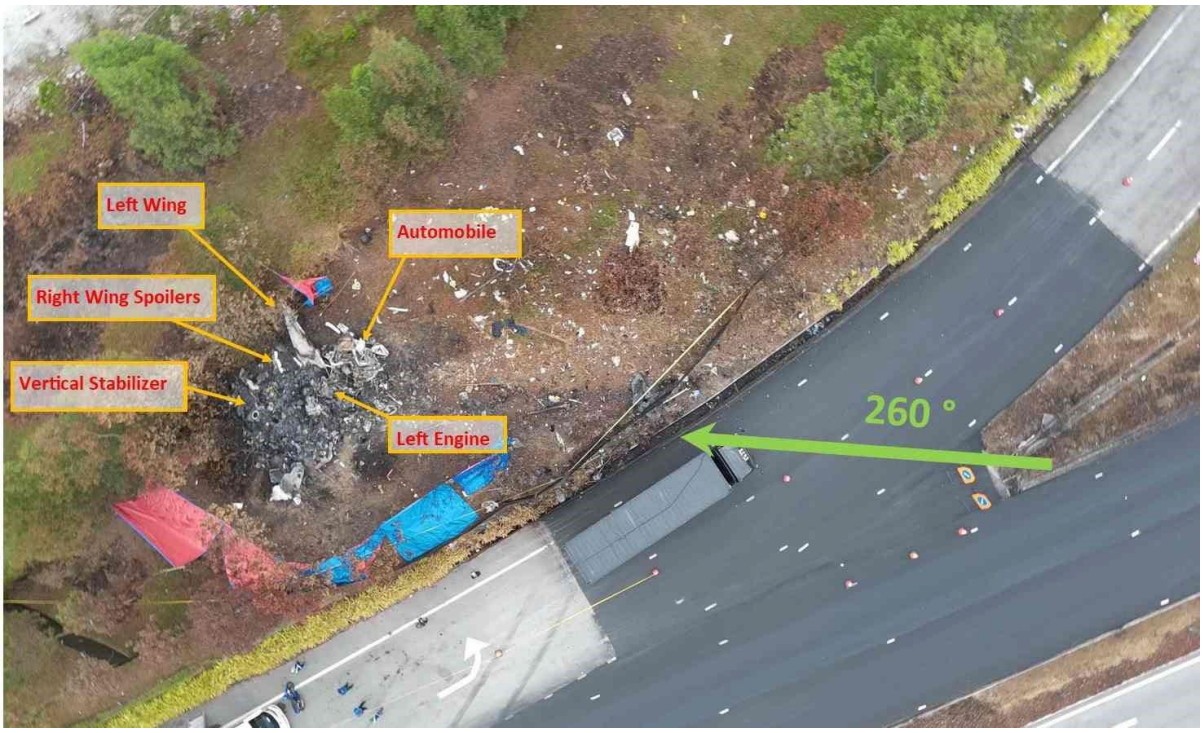

Figure 1. Accident Site.

1.1.2 Right Wing

The right wing (Figure 2) had fragmented, and its skins were distributed through the debris field. One of the wing spars was located principally intact and bent slightly aft, the remaining spars were fragmented with eight distinct sections identified.

Figure 2. Right Wing.

The aileron remained attached to the wingtip by all of its hinges, the trim tab and actuator remained attached to the aileron. The inboard flap sustained thermal damage to about 70% of its surface. The flap remained attached to its tracks, which had detached from the aft spar. The outboard flap had broken in half about midspan. The outboard track had detached from the aft wing spar and remained attached to the flap.

The inboard lift dump surface was bent on the inboard side and remained attached by its actuators. The inboard spoiler remained attached to its intermediate spar by all hinges, the outboard spoiler had broken into two (2) pieces, and remained partially attached by the actuators.

The fuel filler cap was not located, however the filler neck exhibited jagged tearing deformation to its locking tab consistent with the cap being installed at impact.

1.1.3 Left Wing

The left wing exhibited leading edge crush damage starting at the root and progressively moving aft and through the intermediate spars as it continued to the aft

spar at the tip. The wing sustained thermal damage to most of its skin surface, bubbling and darkening the paint. (Figure 3) The inboard section of the leading edge was crushed aft to the wing forward spar and upward to the wing top skin. It also exhibited diagonal scratches in and aft/upward direction.

Figure 3. Left Wing.

The aileron had broken into three (3) sections, which the centre section remained attached to the wing by its push/pull rod. The trim tab remained attached to the inboard section of the aileron.

The outboard spoiler remained attached by its hinges and actuators, the inboard spoiler sustained thermal damage consuming its inboard section, but it remained attached by its outboard hinges and actuators. The lift dump surface was burnt but remained attached by its hinges.

The fuel cap was installed at the filler neck.

The inboard flap had completely detached but remained connected to its inboard track. The outboard flap had broken in half, and remained attached to its outboard track, which had detached from the wing.

1.1.4 Vertical and Horizonal Stabiliser

The vertical stabiliser skins sustained thermal damage consuming the resin and leaving only fabric remnants. The top rudder hinge and bell-crank rudder assembly remained attached to the vertical stabiliser aft spar, and remnants of burnt rudder skin were located.

Remnants of the horizontal stabiliser remained attached to the centre box section. The bolts that attach the box to the vertical stabiliser were still in place, along with the fibre remnants of the vertical stabiliser.

The left horizontal stabiliser sustained thermal damage consuming the resin and leaving only fabric remnants of the skin. The stainless steel leading edge sustained crush damage and remained attached to the skin remnants. The left elevator had detached and fragmented with the centre and tip section located. The outboard hinge remained attached to the control surface

.

The right horizontal stabiliser had broken in half about midspan, and the stainless steel leading edge had detached and crushed aft. The inboard section of the elevator was located, along with its inboard hinge and trim tab, both of which remained attached.

1.1.5 Cabin

Fragments of the windshield screens were located, along with a fractured single tempered pane. The main cabin door had broken into three (3) segments, and the external latch was in the locked position. The entire cockpit was fragmented, and fire consumed, destroying all avionics equipment and electrical wiring. The escape hatch door was fragmented into several sections.

1.2 Engines

1.2.1 Right Engine (SN: 105102)

The engine had broken into three (3) distinct segments; the fan, fan case assembly with Intermediate Pressure (IP) blades, and the High-Pressure Compressor and Hot Section. The starter, Hydromechanical Unit (HMU) and gearbox had all detached.

The Low Pressure (LP) shaft remained partially attached to the fan (Figure 4), which had separated from the engine. Remnants of the spinner were still in place. The LP shaft had separated aft of the 1.5 bearing retainer and exhibited twisting in the opposite direction of rotation and deformation with 45° sheer lips at the separation area.

Figure 4. Right Engine Fan.

Two (2) adjacent fan blades had broken off about one inch from the root, and another blade had broken off about one inch from the root. All blades sustained significant leading edge and tip gouges, nicks, and abrasions, and embedment of asphalt material. The three (3) separated blades all exhibited similar separation features of

even grainy dull striations. The fan shroud did not exhibit any evidence of blade liberation such as case dents or perforations.

The fan case and IPC rotor assembly had detached. The inter-stage assembly group which had separated, was found fragmented. On the front side, the fan stator was retained within the engine inlet case but most blades where crushed and torn away from the fan stator centre body. The urethane segment of the hub had partially melted.

The aft fan hub and LP shaft remained within the assembly, and the hub was continuous to the aft side.

The Intermediate Pressure Compressor (IPC) rotor hub was torn away from its hub. An approximate 180° radial segment of the first stage blades were separated at their roots. All blades appeared bent, opposite the direction of rotation. The forward side of the number one bearing was exposed due to the IPC rotor hub separation, and a single ball bearing was observed.

The second stage blades remained attached to the hub and all exhibited varying degrees of leading edge tears and tip damage. The IP one and two (2) stators appeared to be in place, but were bent and crushed, with no blade loss to the observable sections. The third stage stator was largely intact and the IP rotor could be seen through the rear of the assembly; all blades were observed to be detached at the root.

The 1.5 bearing housing was partially bent, and the bearing was not located, although the inner cage remained in place.

The number one bearing remained in place and did not show any evidence of discoloration or heat distress. About 3 inches of the LP shaft was protruding from the assembly; the shaft exhibited torsional damage with 45° sheer lips at the separation area.

The engine control unit harnesses remained partially attached to the engine but was severed in multiple locations.

Within the aft assembly, the High-Pressure Compressor (HPC) was intact but the outboard sections of the tips at the main, large, and small splitter stages were bent 90° up to 3/8 inch from the tips. The entire assembly was coated in a greasy dark film, and the inner case had evidence of rotational blade contact. None of the blades exhibited dents or dings that would have indicated an upstream blade liberation or FOD event. (According to Williams, the dark oil was likely a result of the inter-stage oil tank rupturing during impact while the inner HPC stage was still spinning).

The LP shaft was protruding about 4 inches, and had twisted and separated, such that the normally straight serial number was beginning to spiral (Figure 5).

Figure 5. Right Engine LP Shaft.

On the aft side of the inter-stage, remnants of the casing remained attached to the diffuser.

The exhaust mixer assembly was crushed and coated in dark oily coke-like deposits. There was no evidence of blade uncontainment such as dents in an outward direction. From the aft end of the engine, viewed through the mixer, the 2nd stage LP turbine

blades appeared intact and but appeared to have sustained crush damage. The first stage LP blades could not be observed, and the case could not be removed due to the damage sustained, however there was no damage to the rear housing/mixer that would have indicated 1st stage LP blade liberation. The diffuser outer case showed no outward dents or any other signs of High-Pressure Turbine (HPT) damage that would have indicated HPT blade or disk liberation (Figure 6).

Figure 6. Right Engine Diffuser Case.

The lubricant oil cooler had broken away, its mounting pad remained attached, but the bolts were not located. The oil filter had burnt, but the element was free of debris. The lubricant and scavenge pump remained attached to the remnants of the gearbox casing, the scavenge chip collector was free of metallic debris. The starter gear shaft crown gear remained intact and undamaged; the airframe starter shaft had separated from the starter but remained attached to its drive gear, which appeared clean and undamaged. A section of the inter-stage assembly had detached from the gearbox mount. The hydraulic pump remained attached to sections of the gearbox assembly.

The gearbox magnetic chip collector was documented as being installed in the collector fitting at the accident site. However, it was not observed in the fitting after the wreckage had been relocated to the hangar.

Removal of the hydraulic pump revealed that the shear coupling was intact, and the input shaft could be rotated smoothly by hand force.

The Hydromechanical Unit (HMU) had completely detached from the airframe. Fuel was observed to flow from the inlet fitting, which had broken away. The HMU fuel pump input drive shaft remained attached, the throttle control arm remained attached and could be moved by hand force, and the cut-off detent was felt. The Engine Control Unit (ECU) harness had pulled away from its connector.

There was no evidence of foreign object ingestion, bird feathers or matter to any of the engine components.

1.2.2 Left Engine (SN: 105103)

The engine had broken into four (4) distinct segments; the fan, fan case, Intermediate Pressure (IP) compressor section, and the high-pressure compressor/hot section. The starter, HMU and gearbox had all detached.

The fan had detached, but the fan nut and locking plate were in place; none of the blades had been liberated, but all exhibited significant leading edge gouges, and tip separation along with embedment of mud material (Figure 7). The blades were covered in black soot.

Figure 7. Left Engine Fan.

The fan case and insert had detached and were crushed and distorted, with about a 20° arc of the melted shroud remaining. A crushed 30° arc of remnants of the fan stator remained attached.

The LP shaft had twisted away from the aft fan hub in the opposite direction of rotation and remained attached to IP rotor. About 45% of the 1st stage IP rotor blades had detached at their roots. The IP stage 1 and 2 stators were largely intact along with the 2nd stage rotor.

The third stage stator was largely intact and the IP rotor could be seen through the rear of the assembly, with blades observed to be detached at the root.

The 1.5 bearing housing exhibited an indentation next to the bearing, the outer cage of which was not located, although the inner cage remained in place.

The number one bearing remained in place. About 2 inches of the Low Pressure (LP) shaft was protruding from the assembly, and its inner core was full of mud.

Number 2 bearing and 1st reduction bevel gear assembly remained in position, and the LP shaft remained in position and had twisted and separated, such that the shaft was twisting in the opposite direction of rotation (Figure 8).

Figure 8. Left Engine LP Shaft.

On the aft side of the inter-stage, remnants of the casing remained attached to the diffuser.

The exhaust mixer assembly was intact and sustained thermal damage with rust coloured deposits to its external surface. There was no evidence of blade uncontainment such as outward pointing dents, the LP trip pass-through had been torn and elongated.

From the aft end of the engine, viewed through the mixer, the 2nd stage LP turbine blades appeared intact and undamaged. The first stage LP blades could not be observed, and the case could not be removed due to the damage sustained, however there was no damage to the rear housing mixer assembly that would have indicated 1st stage LP blade liberation. The diffuser outer case showed no outward dents or any other signs of HPT damage that would have indicated HPT Blade or disk liberation (Figure 9).

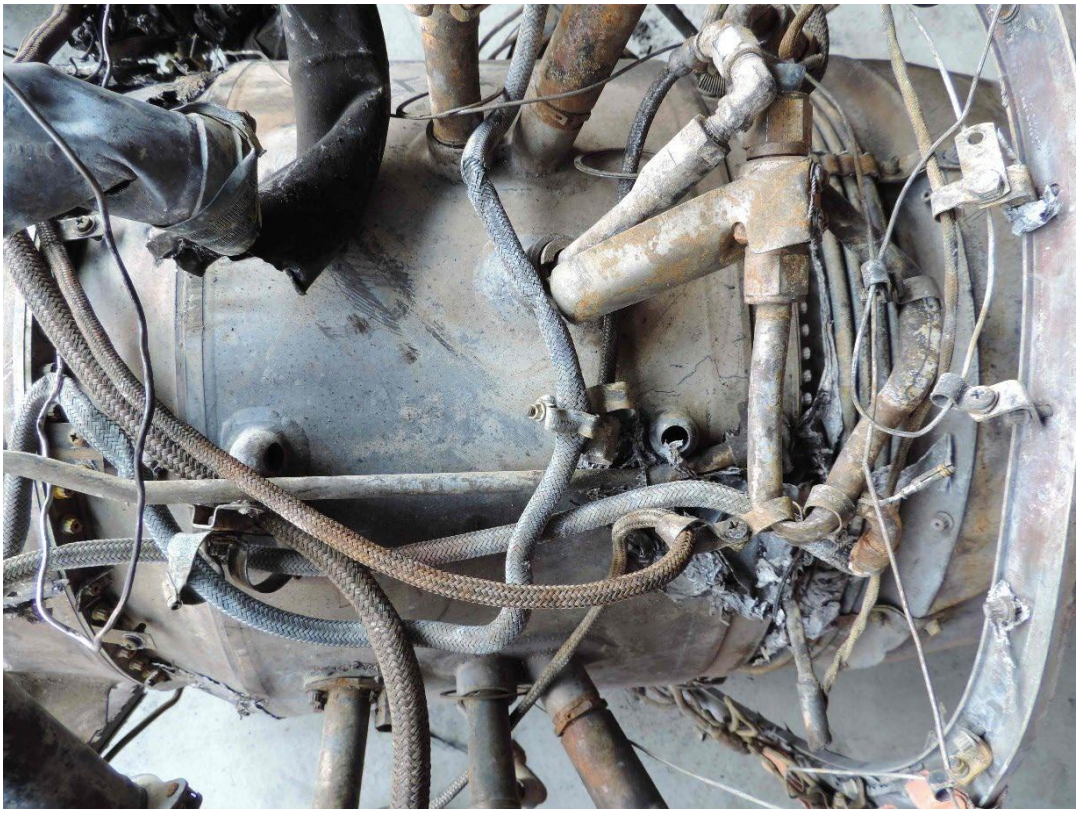

Figure 9. Left engine diffuser case.

The accessories were liberated and sustained thermal damage. The starter, lubricant pump, and hydraulic pump remained attached as an assembly to a remnant of the gearbox casing.

The magnetic chip collectors for the gearbox, lube, and scavenge assemblies were not observed at the accident site or the hangar.

The HMU and fuel pump remnants were partially consumed, the fuel pump input driveshaft remained intact, and the lubricant oil cooler had broken away from its fitting. The fuel and oil filters had sustained thermal damage but were free of debris.

The Engine Control Unit (ECU) sustained thermal damage, preventing a recovery of any non-volatile memory.

There was no evidence of foreign object ingestion, bird feathers or matter to any of the engine components.

1.3 Cockpit

The cockpit was highly fragmented. The cockpit controls were examined. The landing gear handle was found in the down position but the handle was damaged. (Figure 10) The lift dump handle was damaged and found in an intermediate position (normal range is retracted or extended) (Figure 11).

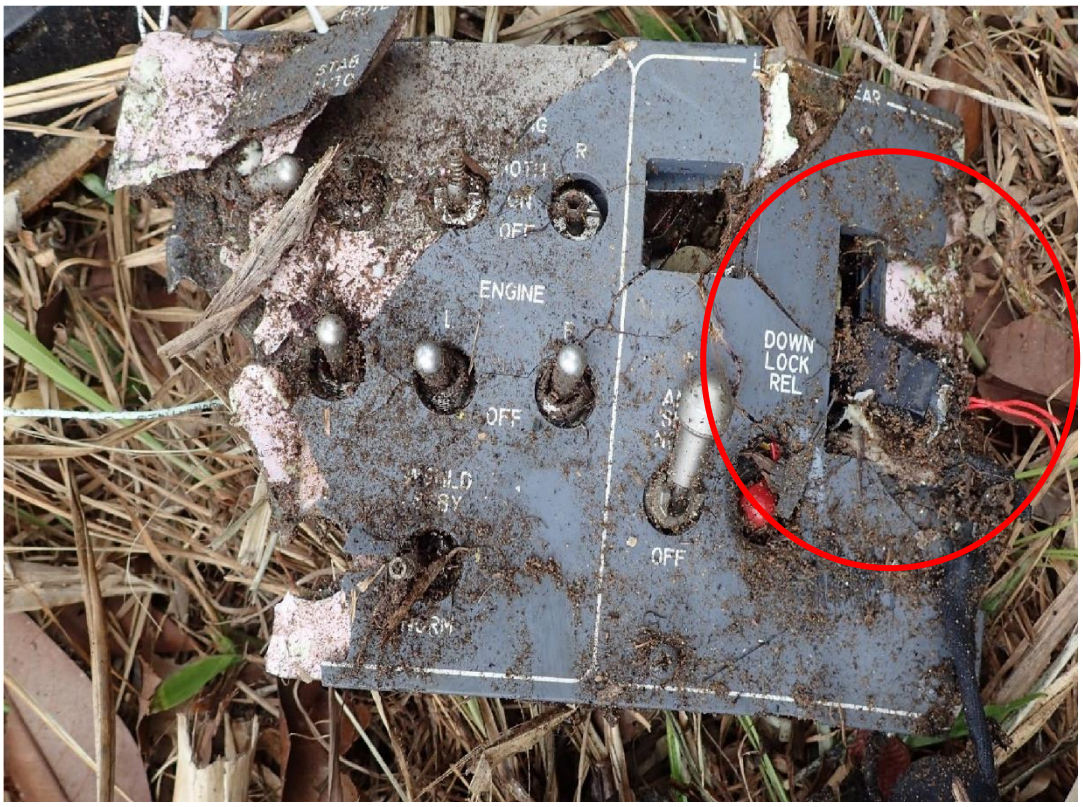

Figure 10. Landing Gear Handle.

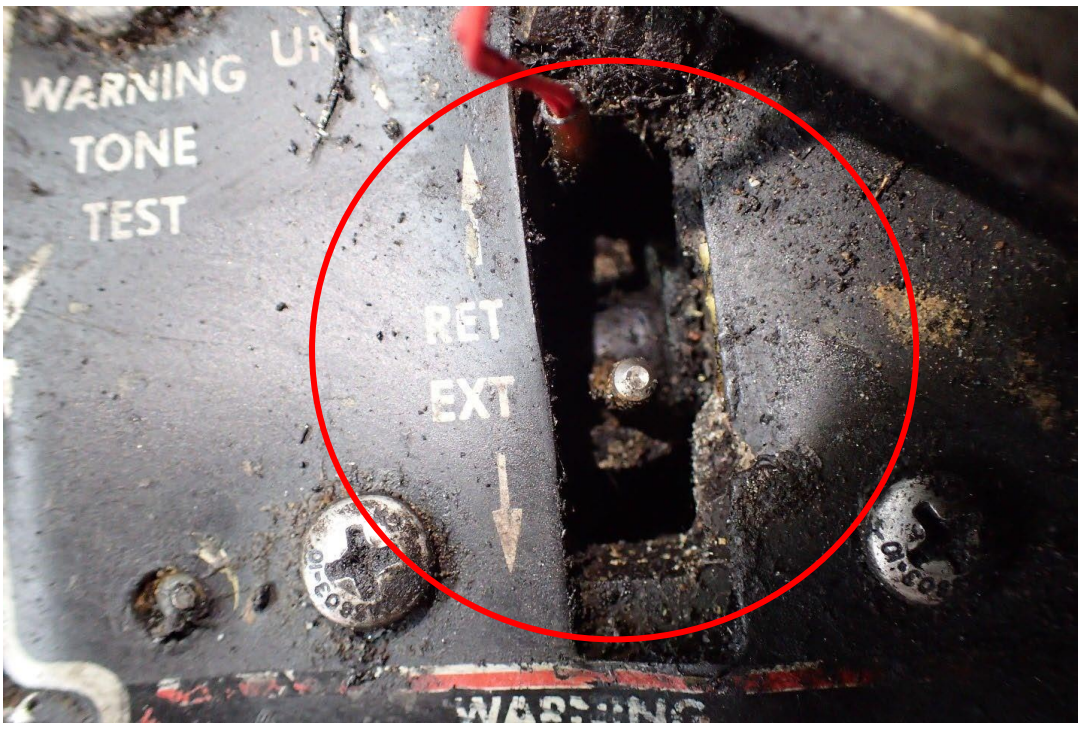

Figure 11. Lift Dump Handle.

1.4 Aileron System Examination

The aileron system was retrieved from the wreckage and examined. The aileron system from the control column to the left and right ailerons were recovered and examined except for the aft sector and the left wing inboard sector (Figure 12). These components could not be definitively identified due to wreckage fragmentation. The breaks in the cables had ends that had a splayed, broom straw appearance consistent with tension overload. All remaining control sectors and their associated fittings were either intact or exhibited damage consistent with overload.

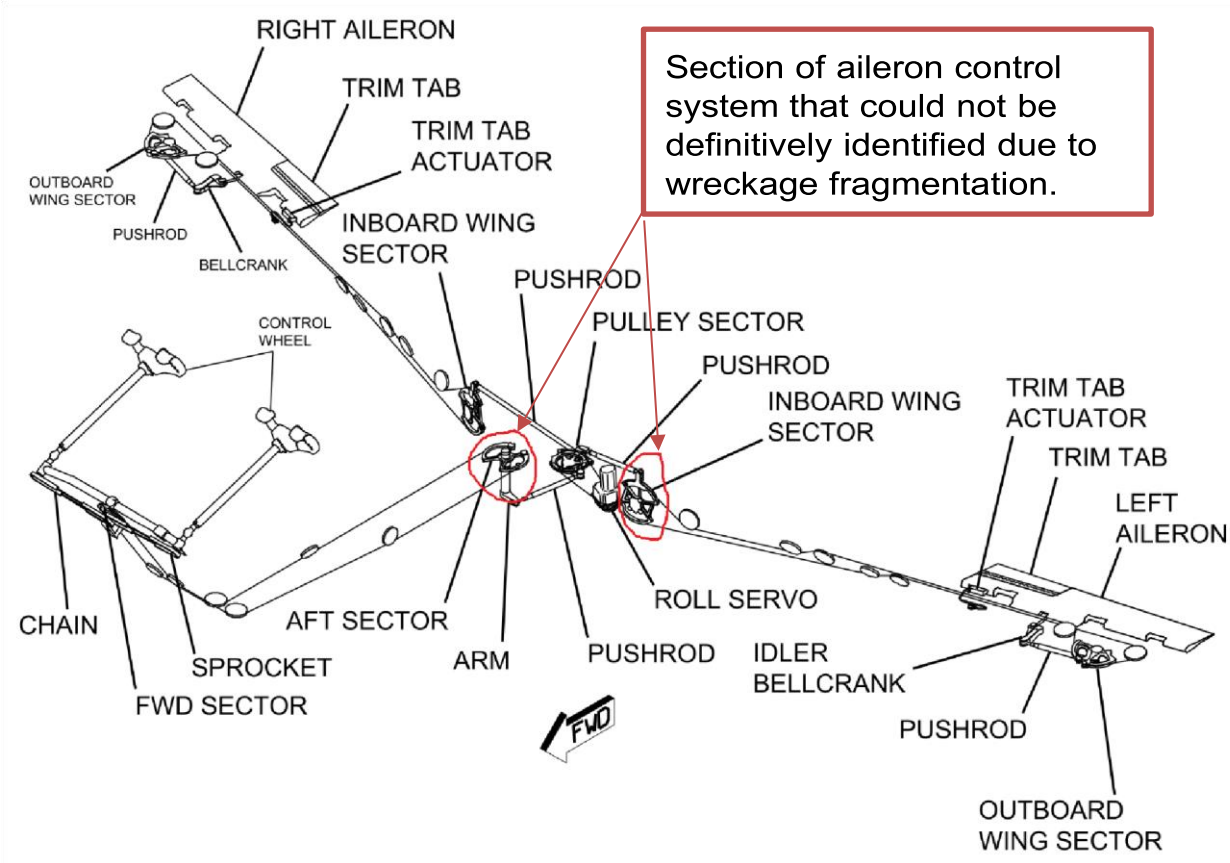

Figure 12. Aileron control system components examined during investigation.

The aileron trim actuators were examined. Both the left and right aileron trim actuators were extended approximately 1.9 inches. This corresponds to approximately 6 degrees aileron trim trailing edge tab up.

Aileron Trim Actuator	RAC Part Number	S/N	Extension Distance	Tab Position
Left Wing	390-381009-0009	080	~1.9 inches	6 deg trim tab up
Right Wing	390-381009-0008	67	~1.9 inches	6 deg trim tab up

1.5 Rudder System Examination

The rudder system was retrieved from the wreckage and examined. Portions of the rudder pedals and forward sector were found in the wreckage debris (Figure 13). The rudder cables from mid fuselage to the rudder were found and examined. Most breaks in the cable had ends that had a splayed, broom straw appearance consistent with tension overload. One break in a “right rudder” cable was retained for further examination. The rudder cables from mid fuselage to the rudder pedals could not be definitively identified due to wreckage fragmentation.

Flight control cables of various lengths were found that exhibited breaks consistent with tension overload but these cables could not be positively identified as rudder or elevator cables.

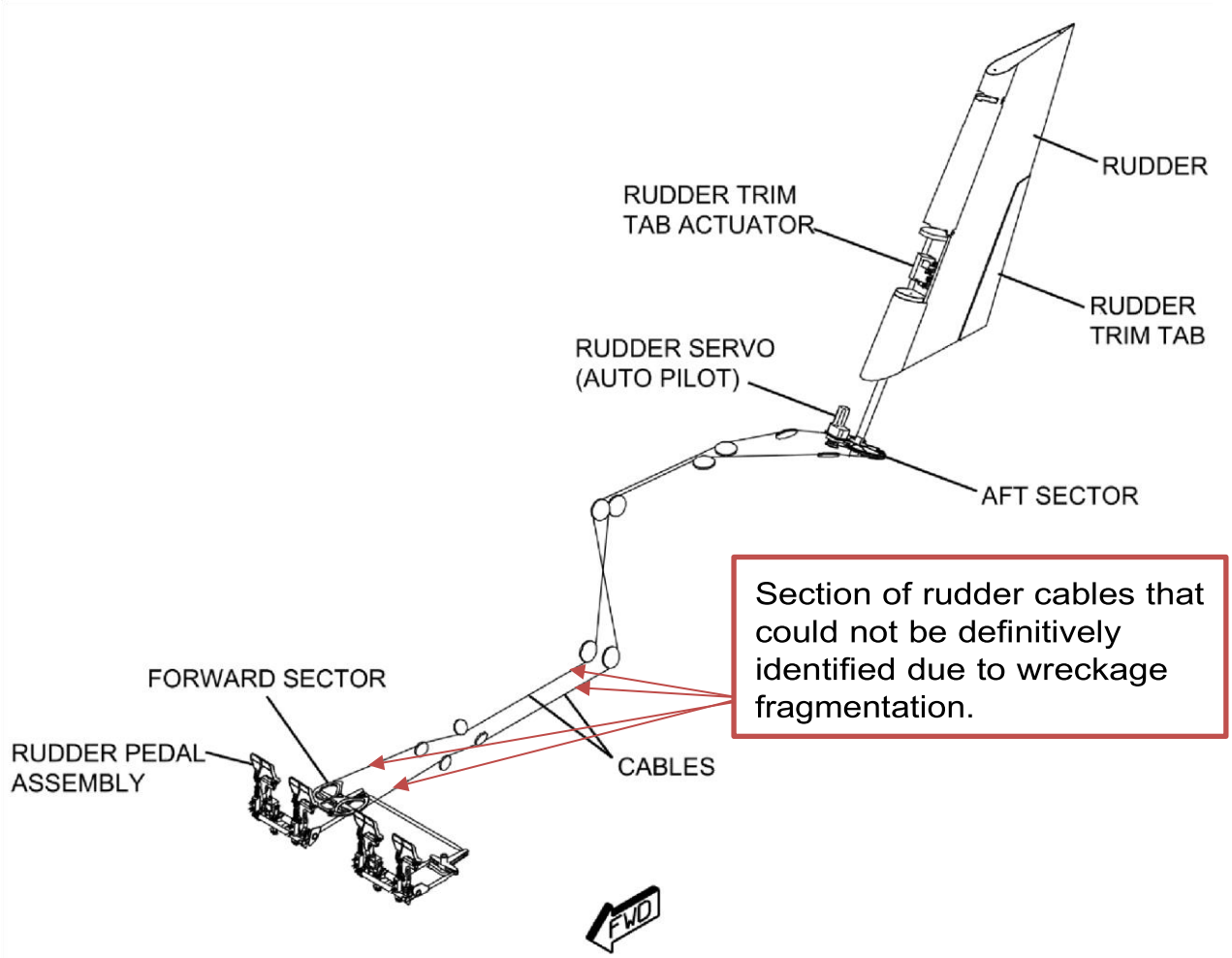

Figure 13. Rudder control system components examined during investigation.

The rudder trim actuator was examined. The trim actuator was close to the null position (0 degrees).

1.6 Elevator System Examination

The elevator system was retrieved from the wreckage and examined. Portions of the control columns and forward sector were found in the wreckage debris. The elevator cables from the cockpit to the elevator were found and examined. Most breaks in the cable had ends that had a splayed, broom straw appearance consistent with tension overload. One break in an elevator cable was retained for further examination.

1.7 Horizontal Stabiliser and Pitch Trim Examination

The pitch trim actuator was found broken with the severed links exhibiting indications of tensile overload. (Figure 14) The parts of the actuator were placed together and the extension distance was measured at approximately 16.5 inches. This corresponds to -3.6 degrees leading edge down. The take-off range is -3.2 degrees to -4.4 degrees. The pitch trim actuator range is -7.0 degrees to +1.4 degrees.

Figure 14. Pitch trim actuator.

1.8 Spoiler Examination

The right lift dump actuator was found in an extended position while the left lift dump actuator was found in the retracted position (Figure 15). The down-lock striker on the right lift dump panel was bent from impact (Figure 16). Both the left and right middle and outboard spoilers were in the stowed position.

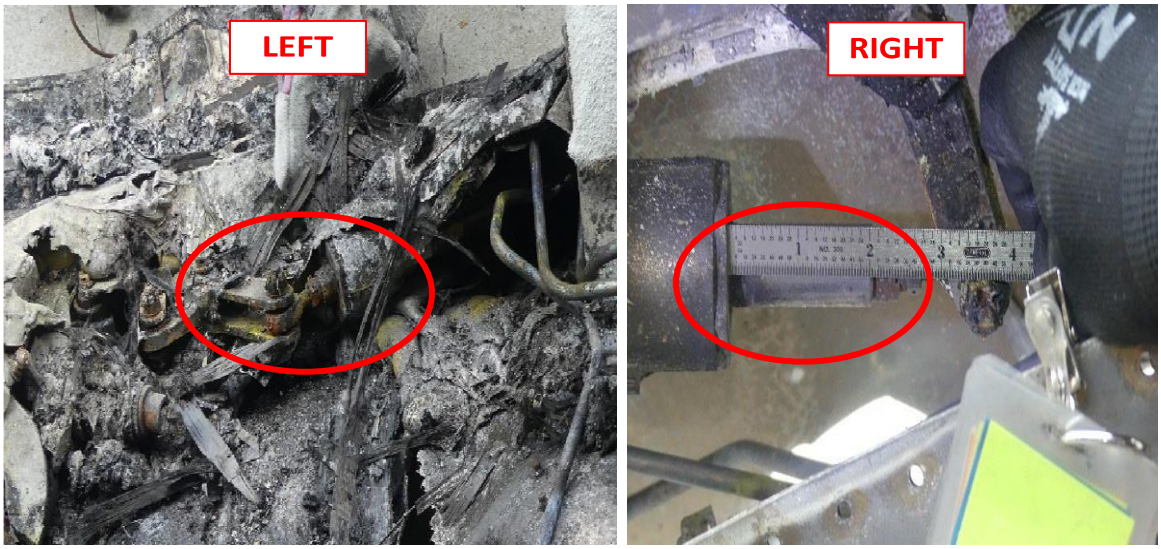

Figure 15. Left and Right Lift dump Actuators.

The Hydraulic Spoiler Control Module (HSCM) was impact and thermally damaged (Figure 17). It was retained for further examination. The Spoiler Control Unit (SCU) was thermally damaged (Figure 18).

The lift dump actuators, the roll control actuators and the pull (blow) down actuators were removed from the aircraft for further examination.

Figure 16. Right lift dump panel down-lock striker and locking actuator.

Figure 17. Hydraulic Spoiler Control Module (HSCM)

Figure 18. Spoiler Control Unit (SCU).

1.9 Flap System Examination

The eight (8) flap actuators were found at the wreckage site. Six (6) of the eight (8) actuators were easily measured. Two (2) actuators were separated from their control rods. By examining their control rods and the end of the ball screw, the position of the flaps was determined. The flap actuators were all in the “Down” position (fully extended). Where each actuator was installed on the aircraft could not be definitively identified due to the fragmentation of the wreckage.

Actuator	Description	RAC Part Number	S/N	Extension Distance	Flap Position
A	Long Actuator	390-381402-0018	00274	~8.125	DOWN
B	Short Actuator	390-381403-0011	unreadable	~4.75	DOWN
C	Short Actuator	390-381403-0011	HUxx	~4.5	DOWN
D	Long Actuator	390-381402-0019	G0165	~8.25	DOWN
E	Long Actuator	390-381402-0020	G0079	~8.00	DOWN
F	Long Actuator	390-381402-0017	G0305	~8.25	DOWN
G	Long Actuator	390-381402-00xx	unreadable	unmeasurable	DOWN based on visual inspection of ball screw and piston rod
H	Long Actuator	390-381402-00xx	unreadable	unmeasurable	DOWN based on visual inspection of ball screw and piston rod

1.10 Landing Gear System Examination

The left and right main landing gear assemblies remained intact, remained attached to their respective wing attachment and exhibited heat/thermal and impact damage. The left and right main landing gear actuators remained attached to their respective gear and wing, However, the right main landing gear actuator piston was impact separated. The left and right main landing gear actuators were found in the full extended/down position.

The nose gear was separated from its attachment point. The lower strut was separated from the upper trunnion. The nose gear assembly exhibited impact damage.

1.11 Components Retained for Further Examination

The following components were removed from the aircraft and will be sent to the NTSB for further examination.

Description	Part Number	Serial Number	Comment
Left Aileron Trim Actuator	390-381009-0009	080	
Right Aileron Trim Actuator	390-381009-0008	67	
Left Roll Control Actuator	390-381007-0003	0214R	
Right Roll Control Actuator	390-381007-0003	0252	
Left Pull Down Actuator	390-381010-0001	0202	
Right Pull Down Actuator	390-381010-0001	0197	
Left Lift Dump Actuator	390-381008-0001	0216	
Right Lift Dump Actuator	390-381008-0001	648	
Spoiler Hydraulic Control Module	N/A	N/A	The nameplate was not legible.

Elevator cable	N/A	N/A	
Rudder cable	N/A	N/A	
Annunciator panel	N/A	N/A	

- End -