AIRCRAFT ACCIDENT

FINAL REPORT

A 03/22

Air Accident Investigation Bureau (AAIB)

Ministry of Transport Malaysia

Accident Involving Fixed Wing Aircraft

Piper Warrior II PA28-161, Registration 9M-BAA

beside Sungai Pinji, near Medan Gopeng, Ipoh, Perak

on the 01 August 2022

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Issued on 16 January 2023
MOT.(S).600-5/4/86.

FINAL REPORT A 03/22

AIR ACCIDENT INVESTIGATION BUREAU (AAIB)
MALAYSIA

REPORT NO.: A 03/22

OPERATOR	**:**	**BATS AVIATION SDN BHD**
AIRCRAFT TYPE	**:**	**PIPER WARRIOR II PA28-161**
NATIONALITY	**:**	**MALAYSIA**
REGISTRATION	**:**	**9M-BAA**
PLACE OF OCCURRENCE	**:**	**BESIDE SUNGAI PINJI, NEAR MEDAN GOPENG, IPOH, PERAK**
DATE AND TIME	**:**	**01 AUGUST 2022 AT 2007LT**

The sole objective of the investigation is the prevention of accidents and incidents. In accordance with Annex 13 to the Convention on International Civil Aviation, it is not the purpose of this investigation to apportion blame or liability.

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 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 issues concerned.

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

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.

In accordance with ICAO Annex 13 paragraph 4.1, notification of the accident was sent on 05 August 2022 to National Transportation Safety Board (NTSB) of the United States as State of Manufacturer. A copy of the Preliminary Report was subsequently submitted to NTSB, Civil Aviation Authority of Malaysia (CAAM) and the Aircraft Operator on 13 August 2022.

In accordance with ICAO Annex 13 paragraph 6.3, a copy of the Draft Final Report was sent on 07 November 2022 to Civil Aviation Authority of Malaysia (CAAM) as State of Registry, National Transportation Safety Board (NTSB), United States as State of Manufacturer, Malaysia Airports Sdn Bhd (MASB) as Aerodrome Operator and Aircraft Operator inviting their significant and substantiated comments on the report.

Unless otherwise indicated, recommendations in this report are addressed to the investigating or regulatory authorities of the State having responsibility for the matters

with which the recommendations are concerned. It is for those authorities to decide what action is taken.

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APPENDICES

GLOSSARY OF ABBREVIATIONS

A	
A	Accident
AAIB	Air Accident Investigation Bureau
AFI	Assistant Flight Instructor
AFRS	Airport Fire and Rescue Services
AMO	Approved Maintenance Organisation
ATC	Air Traffic Control
ATO	Approved Training Organisation
ATPL	Air Transport Pilot Licence
AVGAS	Aviation Gasoline
AVSEC	Aviation Security
B	
BATS	BATS Aviation Sdn Bhd
BOMBA	Fire and Rescue Department of Malaysia
C	
CAAM	Civil Aviation Authority Malaysia
CAD	Civil Aviation Directive
CAMO	Continuing Airworthiness Management Organisation
CCTV	Closed-Circuit Television
CFI	Chief Flight Instructor
CG	Centre of Gravity
COVID-19	Coronavirus disease 2019
CP	Cadet Pilot
CPL	Commercial Pilot’s Licence
CVR	Cockpit Voice Recorder
D	
DFE	Designated Flight Examiner
E	
EFATO	Engine Failure After Take-Off
F	
FDR	Flight Data Recorder
FI	Flight Instructor
FOCC	Flight Operations Control Centre
ft	feet
FTO	Flight Training Organisation
G	
g	gravity

H

HFACS	Human Factors Analysis and Classification System
HOT	Head of Training
HP	Horsepower
hrs	hours

I

ICAO	International Civil Aviation Organisation
ie	id est or 'that is'
IR	Instrument Rating

K

Kts	knots

L

lbs	pounds
LHS	Left Hand Seat
LLFA	Layang-Layang Flying Academy
LT	Local Time

M

m	metres
MASB	Malaysia Airports Sdn Bhd
MAX	Maximum
MAYDAY	An international radio distress signal used by ships and aircraft
MOR	Mandatory Occurrence Report

N

NF	Night Flying
No.	Number
NTSB	National Transportation Safety Board of United States

O

OEM	Original Equipment Manufacturer

P

PF	Pilot Flying
PIC	Pilot In-Command
PM	Pilot Monitoring
POH	Pilot's Operating Handbook

R

RELA	Jabatan Sukarelawan Malaysia
RHS	Right Hand Seat
RPM	Revolution per Minute
RWY	Runway

S

SOP	Standard Operating Procedures

T

TPM	Training Procedure Manual

U

UK CAA	United Kingdom Civil Aviation Authority
UTC	Coordinated Universal Time

SYNOPSIS

A Piper Warrior II PA28-161 aircraft was on a planned night flying currency check flight for a Flight Instructor (FI) callsign BATS 03. The aircraft departed Sultan Azlan Shah Airport, Ipoh (IPH) at 2004 hrs for circuits and landing as per flight brief.

The take-off was reported to be normal. Three minutes after the aircraft took-off, two MAYDAY calls were transmitted by the pilot, one after another. No further transmission was heard despite repeated transmission enquiries by the Ipoh Air Traffic Control (ATC) Controller.

The aircraft crashed into a water diversion culvert beside Sungai Pinji, near Medan Gopeng, Ipoh, about 1.5 kilometres north-east direction from the airport. The aircraft suffered major damage on impact and there was no fire. The Right-Hand Seat (RHS) Pilot suffered fatal injuries while the Left-Hand Seat (LHS) Pilot was unconscious with serious injuries. Both pilots were extricated from the aircraft cockpit by the Fire and Rescue Department (BOMBA) personnel and were immediately sent to Raja Permaisuri Bainun Hospital, Ipoh for post-accident medical treatment and actions.

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

1.0 FACTUAL INFORMATION

1.1 History of the Flight

BATS 03 was a night circuits currency check flight for a FI (BATS 02) at Ipoh Aerodrome on 01 August 2022. The night currency check flight was only planned on the day itself replacing a planned Night Flying (NF) training flight for a Cadet Pilot (CP). This night currency check flight was the fourth flight of the day for the Check FI (BATS 03) after completing two-day training flights and one-night training flight (solo night check) with three CPs.

Pre-flight briefing for the NF training was carried out at about 1800 hrs which was attended by both the FIs (BATS 02 & BATS 03) and a CP (BATS 103). The FI's night currency check flight was planned for 2000 hrs while the CP's NF training was for 1900 hrs. The FI (BATS 02) carried out a walkaround check on the aircraft registered 9M-BAA and started the aircraft alone at about 1950 hrs while waiting for the Check FI (BATS 03) to completed his NF training flight with the CP (BATS 103) on aircraft registered 9M-BAE.

On completion of the NF training flight (solo night check) with the CP at about 1955 hrs, the Check FI (BATS 03) exited the aircraft 9M-BAE without shutting down the aircraft engine and did a running change boarding aircraft 9M-BAA which had its engine started and readied by the other FI (BATS 02).

The CP (BATS 103) subsequently taxied the aircraft (9M-BAE) out for his solo night flight followed by BATS 03's aircraft (9M-BAA). BATS 103 took-off at 2001 hrs and was followed by BATS 03 at 2004 hrs. Both aircraft did an intersection take-off (Taxiway D) for Runway 04 left hand circuits.

There were no reported abnormalities by both the FI during aircraft start up, taxi or take-off. About 3 minutes after take-off, two MAYDAY calls, one after another, were made by the BATS 03 at 2007 hrs to Ipoh Tower. No further transmission was heard despite repeated transmission enquiries by the Ipoh ATC Controller.

Ipoh Tower received information from the public that the aircraft had crashed into the side of a water diversion culvert beside Sungai Pinji near Medan Gopeng. The ATC Controller on duty activated the necessary emergency services and instructed the CP (BATS 103) to make a full stop landing.

The aircraft's right wing hit a lamp post situated on a road bridge and the wing broke into two. It then veered right and rotated 180° slamming into the side of the water diversion culvert, aircraft belly first before coming to a rest with the aircraft nose facing vertically down. The aircraft suffered major damage to the right side, undercarriage, engine nacelle lower section and rear T-tail plane.

Both the pilots were found unconscious and remained stuck in their individual pilot seat. Both the pilots were extricated from the cockpit by the Fire and Rescue Department (BOMBA) personnel. The Right-Hand Seat (RHS) FI (Pilot 1) suffered fatal injuries while the Left-Hand Seat (LHS) FI (Pilot 2) was unconscious with serious injuries. Both pilots were immediately sent to Raja Permaisuri Bainun Hospital, Ipoh for post-accident medical treatment and actions.

The aircraft wreckage was secured at site by the police. Air Accident Investigation Bureau (AAIB) Investigation Team arrived at the accident site the next morning (02 August 2022) to conduct site investigation and evidence gathering. The aircraft wreckage was cleared from the accident site at about 1515 hrs the same day and placed in BATS Aviation hangar. It was impounded for AAIB investigation. A police report was filed by the Aircraft Operator's Quality and Safety Manager at Kg. Rapat, Ipoh Police Station on the next day.

1.2 Injuries to Persons

Injuries	Crew	Passengers	Others	Total
Fatal	1	Nil	Nil	1
Serious	1	Nil	Nil	1
Minor/None	Nil	Nil	Nil	Nil

Figure 1: Injuries to persons

1.3 Damage to Aircraft

Post-accident inspection revealed the following damages to the aircraft:

a. Engine – No extensive damage on the cylinder, oil sump and crankcase.

b. Magnetos - No extensive damage on both magnetos.

c. Carburettor - No extensive damage on the carburettor and only carburettor induction box crushed.

d. Engine Accessory – Most of the engine accessory are badly damaged beyond repair.

e. Propeller – Damaged beyond repair.

f. Fuselage – Cockpit area is badly damaged. All the avionics equipment is beyond repair. Aircraft main frame badly distorted and beyond repair.

g. Wings - Starboard wing broken into two. Both wing main spar distorted beyond repair.

h. Empennage – Tail section of the aircraft is badly damaged and beyond repair.

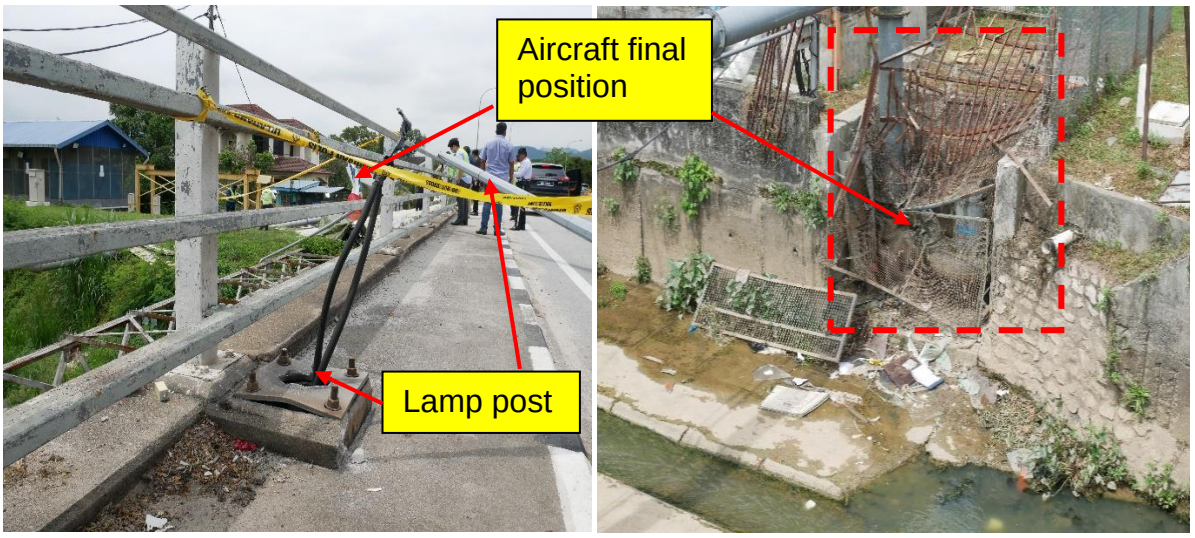
i. Landing Gear – Nose landing gear bent. Both main landing gear still attached to the wing.

Detail Aircraft Damage Assessment report is as per **Appendix A**.

Figure 2: Aircraft condition at the hanger after salvage activities from the crash site

1.4 Other Damage

One lamp post on the main road bridge over Sungai Pinji broken off at the base and collapsed due to the impact from the aircraft propeller blade and right wing. The impact also caused some damages to the protective metal rail that surrounds the water pump house main pipe located at the water diversion culvert. No other damages were observed.



Left - collapsed lamp post at the road bridge over Sungai Pinji.	**Right** - damaged to the protective metal rail at the water diversion culvert.

Figure 3: Other damages due to aircraft impact

1.5 Personnel Information

1.5.1 Pilot in Command / Pilot 1 (RHS)

Nationality		Malaysian
Age		52
Gender		Male
License Type		CPL
License Expiry		31 August 2022
Medical Expiry		31 August 2022
Aircraft Rating		PA-28
Instructor Rating		31 October 2024
Flying Hours	Total Hours	3646.35
	Total on Type PA-28	371.40

Figure 4 Personnel Information – Pilot in Command

1.5.2 Pilot 2 (LHS)

Nationality		Malaysian
Age		62
Gender		Male
License Type		ATPL
License Expiry		31 October 2022
Medical Expiry		31 October 2022
Aircraft Rating		PA-28/PA-34
Instructor Rating		31 December 2024
Flying Hours	Total Hours	18657.25
	Total on Type PA-28	116.25

Figure 5 Personnel Information – Pilot 2

1.6 Aircraft Information

1.6.1 General

The Piper Warrior II PA-28-161 is a four-seater, piston-engine aircraft equipped with a fixed tricycle landing gear, 160hp four-cylinder engine and fixed-pitch propeller. It has a single door on the right side, which is entered by stepping on the wing. The aircraft is manufactured by Piper Aircraft, Inc. Florida, United States.

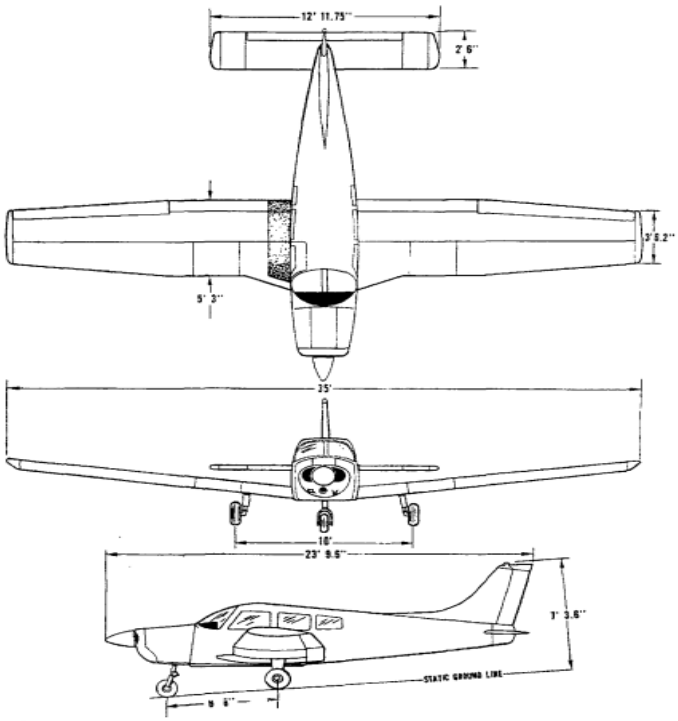


Figure 6: Three view of the aircraft

1.6.2 Aircraft Data

The latest Certificate of Aircraft Registration was renewed on 19 February 2020 and is valid till 18 February 2023 while the Certificate of Airworthiness was renewed on 19 August 2021 and is valid till 18 August 2022. The aircraft had a valid insurance coverage for a period from 20 March 2022 till 19 March 2023.

Aircraft Type	Piper Warrior II PA28-161
Manufacturer	Piper Aircraft Inc. Florida, United States
Year of Manufacture	1984
Owner	BATS Aviation Sdn Bhd
Registration No.	9M-BAA
Aircraft Serial No.	28-8416032
Certificate of Airworthiness Issue / Expiry date	19 August 2021 / 18 August 2022
Certificate of Registration Issue / Expiry date	19 February 2020 / 18 February 2023
Total Flight Hours	22,199.49

Figure 7: Aircraft Data

1.6.3 Engine Data

Engine	4 Cylinders, Direct Drive, Horizontally Opposed, Air Cooled
Manufacturer	Lycoming Engines, Pennsylvania, United States
Overhauled by	Western Skyways Inc.
Date overhaul authorised release certificate	03 January 2012
Model	O-320-D3G
Serial	RL 10035-39E
TTSN	2,298.53 hours
TTSO	1,698.31 hours

Figure 8: Engine Data

1.6.4 Propeller Data

Propeller	2 Blade Propellers Fixed Pitch
Manufacturer	Sensenich Propeller
Repaired by	C & A Aviation Sdn Bhd, Johor, Malaysia
Date repair authorised release certificate	21 March 2013
Model	74DM6-0-60
Serial	A61915
TTSN	2,966.33 hours
TTSO	967.47 hours

Figure 9: Propeller Data

1.6.5 Aircraft Performance Specifications

WEIGHT (lbs)			
Maximum Take-off and Landing Weight		2,440	
Maximum Ramp Weight		2,447	
SPEED			
		IAS (knots)	
Take-off (0° flaps)		40 -52	
Landing Final Approach (Flaps 40°)		63	
Never Exceed (VNE)		160	
Power Off Glide		73	
Maximum Cruise (VNO)		126	
Maximum Flap Extension (VFE)		103	
Manoeuvring (2440lbs) (VA)		111	
Maximum Crosswind		17	
Stall 40° Flaps		44	
Stall 0° flaps		50	
OTHERS			
Load Factors		**Positive** 3.8g	**Negative** No inverted manoeuvres
Maximum Horsepower		160HP	
Maximum RPM		2,700RPM	
Fuel Grade		AVGAS 100LL	
Fuel Capacity (U.S GAL)		**Left Tank**	**Right Tank**
	Full	**50**	
	Usable	24	24
	Unusable	1	1
	Total	**25**	**25**

Figure 10: Aircraft performance specifications

1.6.6 Preventive Maintenance

The latest 100 hours / annual inspection (airframe 22149:19 hours) was completed and the aircraft was certified airworthy on 27 June 2022 in accordance with CAAM approved maintenance program reference EJA/AMP/PA28-161/1/20 Appendix 4. The maintenance activities inspected for the period above found no defect related to fuel, engine or flight control systems. The aircraft had flown a total of 58:10 hrs with only one reported defect dated 04 July 2022 (Figure 11) after the schedule maintenance. It was rectified satisfactory and there was no reported recurrence of the defect.

The next schedule maintenance ie 50 hours / 4 months inspection (airframe 22,198.49 hours) was completed and the aircraft was certified airworthy on 27 July 2022 in accordance CAAM approved maintenance program reference EJA/AMP/PA28-161/1/20 Appendix 3. The maintenance activities inspected for the period above found no defect related to fuel, engine or flight control systems.

The aircraft had flown for 1.0 hour only on 28 July 2022 after the schedule maintenance. There were no reported abnormalities to the aircraft after that flight. The next flight for the aircraft was the flight on the accident day.

1.6.7 Corrective Maintenance

Inspection on the Aircraft Journey Log for a 6 months period from February 2022 to July 2022 revealed 2 defects only (Figure 11). All the defects were rectified with no reported recurrence again.

NO	DATE	DEFECT
1	11 May 2022	Both radios failed in flight
2	04 July 2022	Artificial Indicator not erected and wobbling all the way from take-off to landing

Figure 11: Corrective maintenance for a 6 months period

1.6.8 Aircraft Airworthiness

The aircraft was in an airworthy condition. There was no reported abnormalities or malfunction by the pilot before and during the night flight. The Aircraft Journey Log shows the aircraft had flown one flight on 28 July 2022 after schedule maintenance for a total of 1.0 hour prior to the accident. The aircraft did not fly for the next 3 days and the accident happened on the first flight of the day for the aircraft.

The aircraft weight and CG are within operating limits during the accident although there was no weight and CG calculations made. This is in accordance to the Training and Procedures Manual (TPM), Chapter 2 paragraph 2.3 - Instructions for Aircraft Loading and Securing of Load where calculations of weight and CG are to be made only for flights where more than 2 persons or baggage are carried.

The aircraft had flown a total of 190:55 hrs from January 2022 to July 2022. The breakdown by months are as follows:

YEAR	MONTH	FLIGHT HOURS (HRS : MINS)
2022	JANUARY	28:10
	FEBRUARY	08:45
	MARCH	09:05
	APRIL	28:30
	MAY	39:05
	JUNE	33:55
	JULY	43:25
	TOTAL	**190:55**

Figure 12: Aircraft flight hours from January to July 2022

1.7 Meteorological Information

The accident happened at night. Actual weather was hazy with scattered clouds at 2,500 feet. The visibility was reported as 8 kilometres and wind 350° at 04 knots. The weather was suitable for NF training on the night of the accident.

1.8 Aids to Navigation

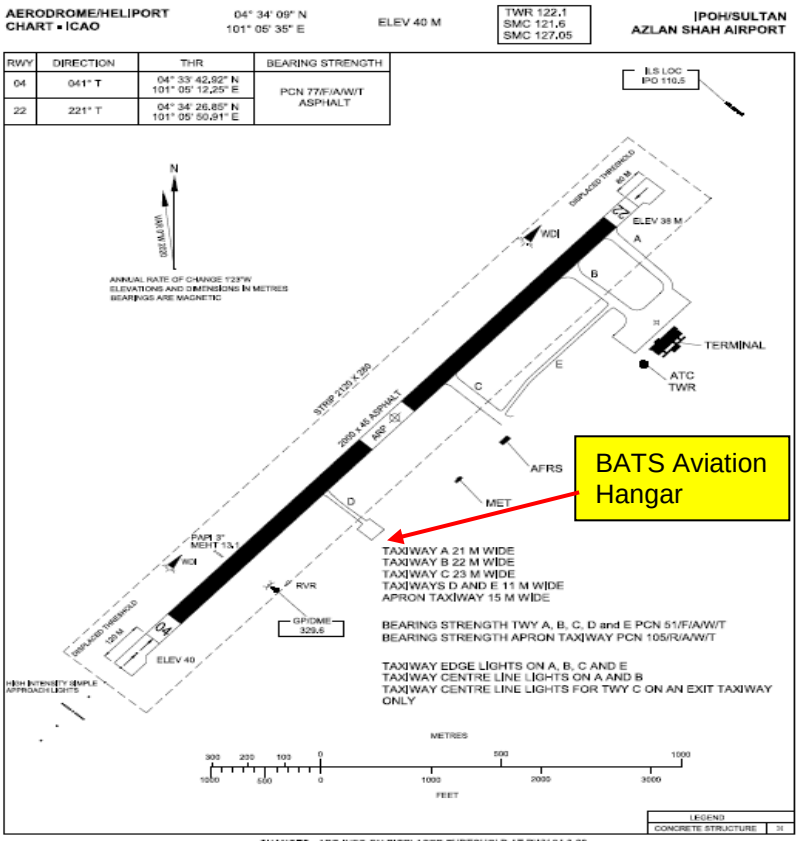
All navigation aids were operating normally.

1.9 Communications

All ATC communications frequencies were operating normally. Crash alarm was not activated by the ATC Controller on duty. All crash information was transmitted by ATC Tower to AFRS Watch Room via direct line.

The ATC Controller informed the Investigation Team that the crash alarm was not activated because the aircraft crashed outside of the aerodrome vicinity despite receiving a MAYDAY call from the pilot.

1.10 Aerodrome Information



Airfield	Sultan Azlan Shah Airport, Ipoh (IPH)
Runway	04/22
Length	2000m
Width	45m
ICAO Designator	WMKI
IATA Designator	IPH
Elevation	131ft
Operations Hours	0800 - 1700

Figure 13: Sultan Azlan Shah Airport Aerodrome Information

The Aeronautical Information Publication (AIP) Malaysia provides the following information to local flying restrictions at Ipoh Aerodrome[1] (Figure 14). It has an uni-directional runway due to hilly terrain and geology vibration control due to densely populated area surrounding the aerodrome as seen in google satellite photo in Figure 15.

WMKI AD 2.20 LOCAL TRAFFIC REGULATIONS

2.20.1 Local Flying Restrictions

2.20.1.1 Uni-directional runway in used due to hilly terrain

- Landing Runway 04
- Take-off Runway 22

2.20.1.2 Local circuit procedure (pattern)

- Left-hand Runway 04 1500 FT QNH or 1000 FT for light aircraft
- Right-hand Runway 04 1000 FT QNH for helicopter only

2.20.1.3 Restriction on runway usage to aircraft MLW/MTOW 100,000 kg and below due geology vibration control.

Figure 14: AIP Malaysia – WMKI AD 2.20

[1] AIP Malaysia 10 Sep 2021 – page AD 2-WMKI-1-8

Figure 15: Google satellite photo showing densely populated area surrounding Ipoh Aerodrome

1.11 Flight Recorders

Aircraft was not equipped with Flight Data Recorder (FDR) and Cockpit Voice Recorder (CVR).

1.12 Wreckage and Impact Information

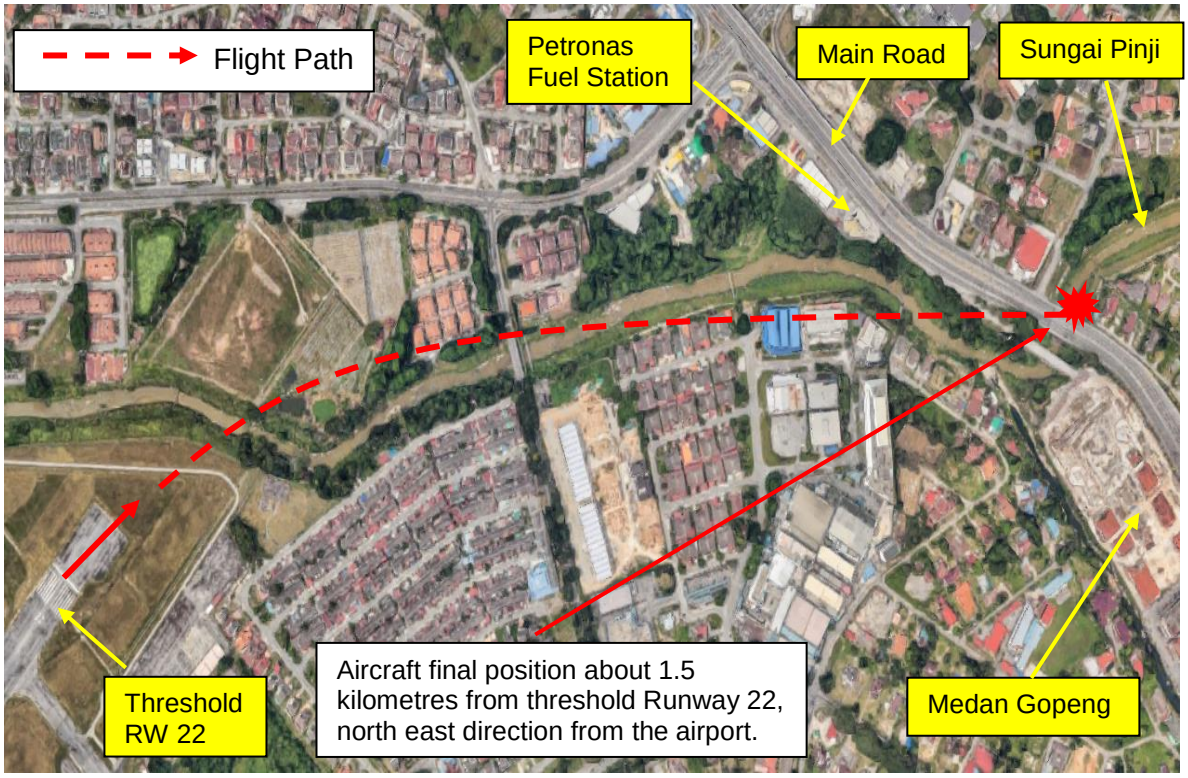


Figure 16: Flight path and final position of aircraft
(Diagram not to scale)

Figure 17: Final position of aircraft at the water diversion culvert beside Sungai Pinji.

Evidence at the aircraft wreckage shows that the Magneto Switch was at 'L' (Left) position and the Carburettor Heat Lever at 'ON' position. The Fuel Selector was selected to Left Tank. The Throttle Lever was at 'CLOSED' and Mixture Lever was at 'IDLE CUT-OFF' position. One propeller had bend inwards after impacting the lamp post while the other blade was in normal condition with some scratch marks. Flaps were observed to be at UP position (Figure 18 to 23).

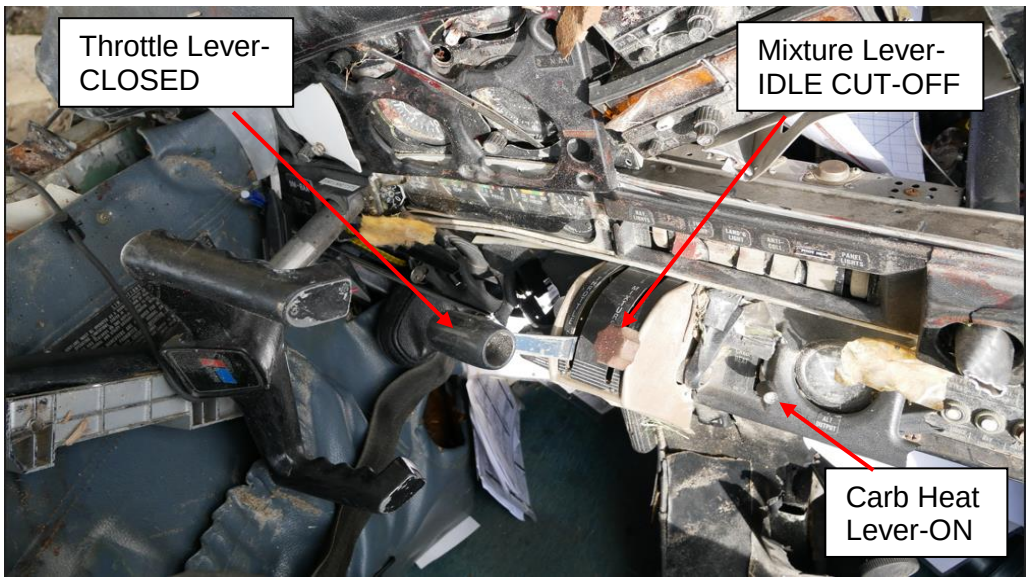


Figure 18: Throttle, Mixture and Carburettor Heat Position on the Aircraft Wreckage

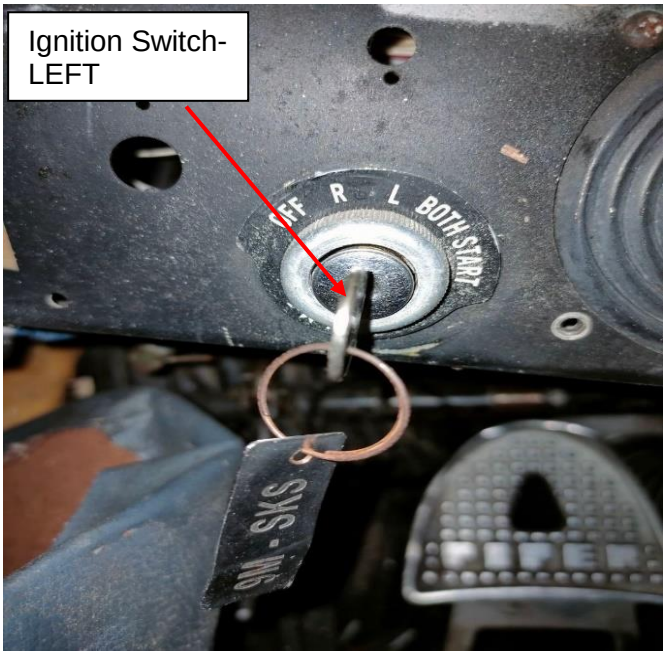


Figure 19: Ignition Switch Position on the Aircraft Wreckage

Figure 20: One propeller blade bend inwards and the other blade was in normal condition with some scratch marks

Figure 21: Flaps at UP position

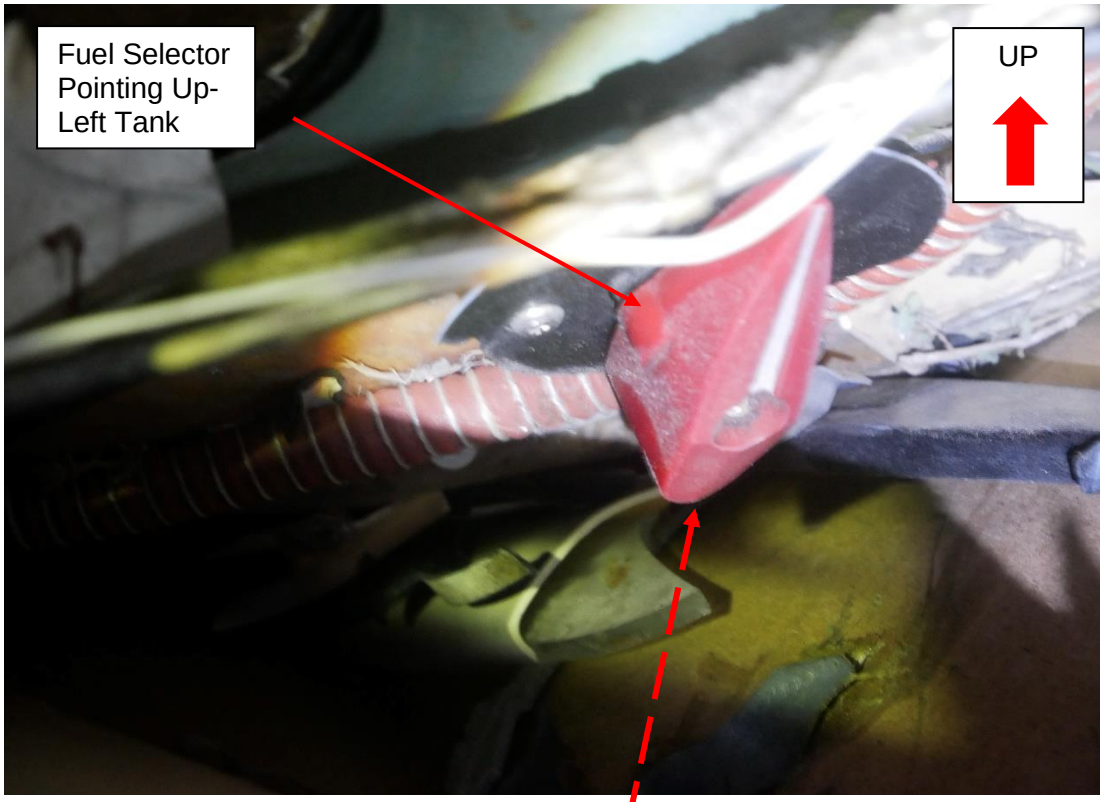


Figure 22: Fuel Selector Position on the Aircraft Wreckage

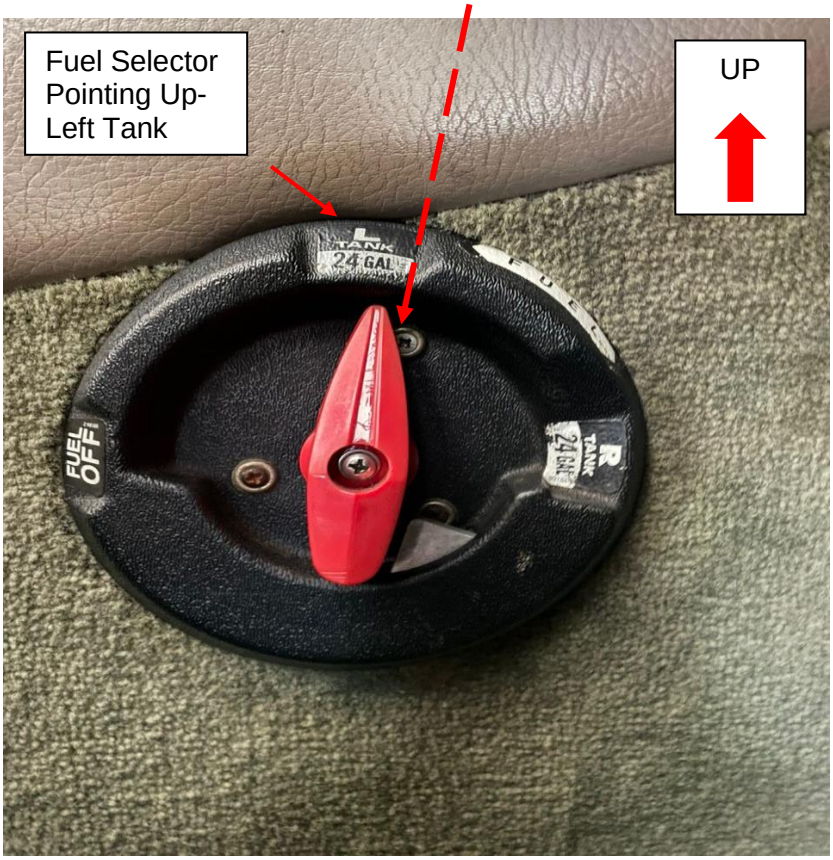


Figure 23: Fuel Selector Position on a Normal Aircraft

1.13 Medical and Pathological Information

Post mortem on Pilot 1 was carried out by the Forensic Department, Raja Permaisuri Bainun Hospital, Ipoh on 02 August 2022. Pilot 2 injuries were assessed and initial medical treatment was rendered at the same hospital. Pilot 2 condition was stable and remained in the hospital for medical treatment. Pilot 2 was later transferred to a Private Hospital in Kuala Lumpur to continue follow-up medical treatment.

A Post Air Accident Medical Report by CAAM Chief Medical Assessor was submitted to AAIB after receiving the Post Mortem Report from the Forensic Department, Raja Permaisuri Bainun Hospital, Ipoh. Fatal injuries on Pilot 1 were consistent with the nature of impact during the crash. There was no evidence found suggesting of inflight cockpit incapacitation by Pilot 1.

Pilot 2 was reported to have passed out before the impact. Interview by the CAAM Chief Medical Assessor found Pilot 2 had experienced dissociative amnesia with startle effect that disrupted Pilot 2 skilled motor task momentarily. It resulted in Pilot 2 not being able to recall what had happened moments prior to the aircraft crash till waking up in an ambulance after being rescued from the aircraft wreckage.

Pilot 2 has been temporarily declared medically unfit to exercise his Air Transport Pilot Licence (ATPL) privileges by CAAM. Pilot 2 will be assessed by CAAM Chief Medical Assessor upon full recovery and an aeromedical review will be conducted before reinstating Pilot 2 to full fitness to fly. There was no evidence found suggesting of inflight cockpit incapacitation by Pilot 2.

1.14 Fire

There was no pre or post impact fire.

1.15 Survival Aspects

Both the pilots were extricated from the aircraft cockpit by BOMBA personnel via the damaged port side pilot window and front windscreen of the cockpit.

1.16 Tests and Research

1.16.1 Post Accident Inspection and Test at the FTO Hangar

Post-accident inspection and test carried out by the Investigation Team at the Flight Training Organisation's (FTO) Hangar on the various engine and fuel system components did not revealed any abnormalities. The detail report on the post-accident inspection and test is as per **Appendix B**. The summary result of the post-accident inspection and test are as follows:

a. **Fuel system**

i. **Carburettor** – Sustained impact damage on the induction box. No damage found on the carburettor body. There was fuel contained in the carburettor. Fuel sprayed from the injector nozzle when the throttle arm was operated. This indicates that fuel was supplied to the engine and not starved. The carburettor filter screen was also inspected and found no evidence of blockage. Overall condition of the carburettor found no abnormalities.

ii. **Fuel Engine Driven Pump** - Sustained impact damage on the bottom of the pump (punctured by the broken linkage). Unable to verify the functionality of the pump due to the damage. Overall condition of the pump found no abnormalities.

iii. **Electrical Fuel Pump** - Overall condition of electrical fuel pump found no abnormalities. The filter was inspected and found no evidence of blockage.

Observation in the cockpit after the accident found the fuel pump switch was at ON position, indicating the pump was switched ON during take-off.

iv. **Gascolator Fuel Drain Valve** - The gascolator fuel drain valve fitted to the aircraft is of the non-lockable type part number 492-312[2] as per Piper Aircraft PA28-151/161 Warrior Airplane Parts Catalogue (Figure 24). The gascolator sustained impact damage and its functionality cannot be verified. The cup holding the filter had broken off missing together with the fuel drain valve.

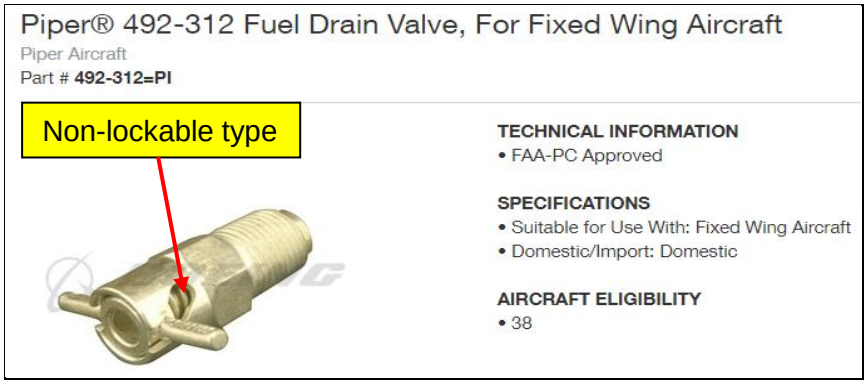


Figure 24: Gascolator Fuel Drain Valve fitted on the aircraft

b. **Ignition system**

i. **Magneto** - Both magnetos showed no impact damage. All ignition harness coupling intact and in good condition. All contact breaker points for both magnetos were also in good condition. With impulse coupling, firing test was performed in situ on both magneto and found to be working satisfactory. Overall condition of both the magnetos found no abnormalities.

Observation in the cockpit after the accident found the ignition switch was in 'L' (Left) position. The ignition switch must be in 'BOTH' position for all phases of normal flight.

ii. **Ignition Harness and Spark Plug** – One of the spark plugs at No 1 cylinder found broken due to impact. All other spark plugs and ignition harnesses were in normal condition.

[2] Reference - https://shop.boeing.com/aviation-supply/p/492-312=PI

c. No observed sign of oil and fuel leak from the engine.

d. General condition of the engine externally was normal.

1.16.2 Fuel and Engine Oil Sample Test

The aircraft fuel and engine oil were drained at accident site and samples were sent to the laboratory for forensic test. Test result did not reveal any abnormalities to both fuel and oil samples except there were slight dirt in the fuel samples **(Appendix C)**. This is most probably due to the need to collect the fuel samples by drilling a hole near the leading edge of the right wing and left wing of the aircraft at the crash site as the right wing had detached off while the left wing was suspended with the aircraft in a nose down position beside the water diversion culvert. There is also the requirement to drain all the fuel from both the fuel tanks before the wreckage salvage operation begins for safety reasons.

Nevertheless, inspection on the carburettor filter screen found no dirt or any evidence of blockage.

1.16.3 Inspection and Test at Lycoming Approved Service Centre

The engine was sent to Lycoming Approved Service Centre and Distributor, C & A Aviation Sdn Bhd, Senai, Johor, Malaysia for further inspection and bench test to verify its airworthiness condition as follows:

a. Disassemble the engine to inspect any abnormal damage not related to the impact.

b. Inspection on the condition of the cylinders, piston, rod and other related components that may lead and cause a possible engine failure.

c. Bench test the functionality of the magnetos, ignition harness and spark plugs.

d. Bench test the functionality of the Carburettor.

The inspection and test found no abnormalities on the engine, magnetos, ignition harness, spark plugs and carburettor. There was no evidence to indicate a fuel starvation or an engine malfunction had caused the engine to lose power in this accident.

In conclusion, the engine and its associated components were in an airworthy condition prior to the accident. The detail inspection and test report from Lycoming Approved Service Centre and Distributor, Johor, Malaysia is as per **Appendix D**.

1.16.4 Simulated Check Inadvertent Take-Off with One Magneto Selected

To simulate as close as possible to an inadvertent take-off with the ignition switch selected to one magneto, the Investigation Team together with a FI from the Aircraft Operator and a CAAM Flight Operations Inspector carried out a static engine ground check at the dispersal before performing 3 high speed take-offs runs on the Ipoh Airport runway with a similar aircraft type registration 9M-BAE. The throttle was set to MAX position and the aircraft roll till 50kts before aborting take-off. The ignition switch and carburettor heat selection were set to the last position as observed in the aircraft wreckage. Data obtained from the simulated check are as in Figure 25.

POWER (RPM)	IGNITION SWITCH SELECTED	CARB HEAT SELECTED	RESULTS
GROUND CHECK			
2,000	Left	Off	Drop about 100 RPM
2,000	Right	Off	Drop about 75 RPM
TAKE-OFF RUN TILL 50 KTS			
2,350	Both	Off	Normal Power.
2,200	**Left**	**On**	1. Engine runs smoothly when power increases from 1000RPM to full power before take-off roll. 2. No engine vibration, surge or misfiring throughout the high-speed take-off run. 3. Slightly slower acceleration due less power which is not really noticeable compared to normal power take-off run.
2,275	Right	On	

Figure 25: Data Simulated Check on Inadvertent Take-Off with One Magneto Selected

In conclusion, the simulated check shows that it is possible for the pilots to inadvertently take-off the aircraft with the ignition switch selected to one magneto without noticing the error. Although the aircraft accelerate slightly slower than normal due to less power, it will be hardly noticeable by the pilots for a night take-off as the visual cues are limited due to darkness. The simulated check also shows that the take-off roll was normal with no engine rough running or back firing sound heard, and no engine vibration or surging felt. All engine instrument indications were normal throughout the simulated check.

1.17 Organizational and Management Information

The Aircraft Operator is a Civil Aviation Authority of Malaysia (CAAM) Approved Training Organisation (ATO) – Flight Training Organisation (FTO) for pilot training established since September 2020 and is situated at Sultan Azlan Shah Airport, Ipoh, Perak. It operates 2 types of aircraft ie 3 x single engine Piper PA28 and 1 x twin engine Piper PA34. The main flying course conducted by the Aircraft Operator is the Commercial Pilot Licence (CPL) (A)/IR with Frozen Air Transport Pilot Licence (ATPL).

The Maintenance Organisation which performed all aircraft maintenance activities is Executive Jet Aviation Sdn Bhd. It is a CAAM Approved Maintenance Organisation (AMO) under approval No. AMO/2016/21 and is valid till 21 January 2023. The continuing airworthiness of the aircraft is also managed by Executive Jet Aviation Sdn Bhd under Continuing Airworthiness Management Organisation (CAMO) approval No. CAMO/2017/34 and is valid till 27 November 2022.

The Aerodrome Operator for Sultan Azlan Shah Airport (IPH), Ipoh is Malaysia Airports Sdn Bhd (MASB). MASB is licenced by the Ministry of Transport Malaysia to operate, manage, and maintain all airports in Malaysia except Kuala Lumpur International Airport (KLIA) and Senai International Airport.

1.17.1 Aircraft Maintenance

There is not reported defect on the fuel, engine or flight control systems after preventive maintenance during the last 100 hours / annual inspection completed on 27 June 2022 or during the last 50 hours / 4-month inspection completed on 27 July 2022. There was also no evidence of recurring defects after corrective maintenance were carried out to rectified the reported defects in Figure 11.

Evidence from the aircraft maintenance record history and documents inspected did not reveal any abnormalities on maintenance performed on the aircraft. Examination of the aircraft documentations and records shows that the

operations of the aircraft comply with the current CAAM airworthiness requirements.

1.17.2 Pilot Experience

The Pilot 1 holds a valid CPL/IR rated on Piper PA28 issued by CAAM on 04 March 2022 and a FI rating valid till 31 October 2024**.** Pilot 1 has accumulated a total of 3,646 hrs on all types and a total of 1,917 hrs as FI on all types. Pilot 1 has accumulated a total of 371 hrs on the PA28 aircraft.

The Pilot 2 holds a valid ATPL rated on Piper PA28 and Piper PA34 issued by CAAM on 04 April 2022 and a FI rating valid till 31 December 2024**.** Pilot 2 is also appointed as a Designated Flight Examiner (DFE) by CAAM and the appointment is valid till 30 November 2024. Pilot 2 has accumulated a total of 18,767 hrs on all types and a total of 5,740 hrs as FI on all types. Pilot 2 has accumulated a total of 180 hrs on the PA28 aircraft.

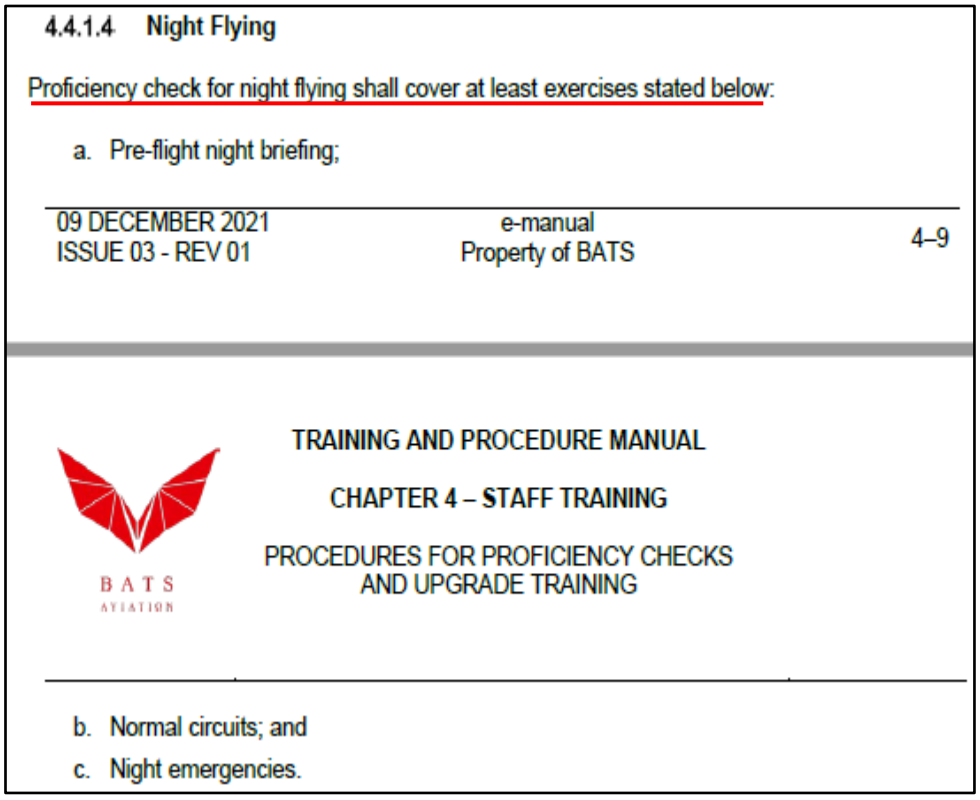
1.17.3 Night Flying Currency

Pilot 1 and Pilot 2 NF currency had lapsed due to no NF flight flown for the past 6 months[3]. Pilot 1 completed his currency check flight with a FI from another FTO, Layang-Layang Flying Academy (LLFA) on 26 July 2022. The currency check flight was approved by CAAM. The last NF flight for Pilot 1 prior to the currency check flight was on 10 February 2021. There was no assessment form submitted to show the performance of Pilot 1 and the flight exercises carried out during the currency check flight. This is due to the non-availability of a Night Flying Currency Check from the Aircraft Operator concerned.

[3] CAAM Civil Aviation Directive – 1, Personnel Licensing, Chapter 2 - Licenses and Rating for Pilots paragraph 2.3.2.2.

The flight on the accident day was supposed to be Pilot 2 NF currency check flight by Pilot 1. The last NF flight for Pilot 2 prior to the currency check flight was on 9 February 2021 which is about 18 months ago. CAAM Civil Aviation Directive (CAD) 1 – Personnel Licensing, Chapter 2 Paragraph 2.3.2.2 states licence holder shall have received dual instruction in aircraft within the appropriate category of aircraft in night flying, including take-off, landing and navigation. The night rating shall only be valid when the pilot in the last 6 months carry out 5 take-offs and landings at night.

The Training and Procedure Manual (TPM) states that night flying currency check shall cover at least the exercises stated in Figure 26[4]. A more specific directive is needed to include ground operations which covers start-up, engine ground check, taxi and shutdown since night flying training is flying syllabus dependent and not regularly carried out at the FTOs.



4.4.1.4 Night Flying

Proficiency check for night flying shall cover at least exercises stated below:

a. Pre-flight night briefing;

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BATS
AVIATION

TRAINING AND PROCEDURE MANUAL

CHAPTER 4 – STAFF TRAINING

PROCEDURES FOR PROFICIENCY CHECKS
AND UPGRADE TRAINING

b. Normal circuits; and

c. Night emergencies.

Figure 26: BATS Training and Procedure Manual – Night Flying

[4] TPM Chapter 4 Paragraph 4.4.1.4 – Night Flying.

1.17.4 Daily Flying Programme

A total of 6 flights were planned on 01 August 2022 as shown on the Daily Flying Programme. The Daily Flying Programme was approved by the Head of Training (HOT) as Pilot 2 who is the Chief Flying Instructor (CFI) responsible to prepare and approved the Daily Flying Programme was on annual leave from 27 July 2022 till 01 August 2022. The Daily Flying Programme shows that Pilot 1 was planned to fly 4 flights with 4 different CP on that day whereas Pilot 2 was not programme to fly on the said day.

Pilot 1 was the only FI current on NF after his currency check on 26 July 2022. Pilot 2 decided to cancel his leave for 01 August 2022 to report back for duty to carry out his NF currency check with Pilot 1 and subsequently to assist Pilot 1 with the NF training for the CPs on the next day, 02 August 2022 due to the reduced night flying day approved by the Aerodrome Operator.

The cancellation of the leave was done via telephone message to the Administrative Executive and Flight Operations Supervisor (FOS) on the same day ie 01 August 2022 at about 1345 hrs without informing the HOT. The plan for Pilot 2 NF currency check was to replace a CP's flying slot from 2000 to 2100 hrs. The changes made to the Daily Flying Programme was done through the Flight Logger and neither the HOT or Ipoh ATC Tower was officially informed of the changes.

1.17.5 Night Flying Training Approval and Aerodrome Operating Hours

The FTO was allocated 4 nights for NF training ie from 01 August till 04 August 2022 with a duration of 2 hrs per night from 1900 hrs to 2100 hrs. Another FTO, LLFA also applied for night flying training for the same date. A verbal compromised was reached with both FTOs by the Aerodrome Operator where one FTO will fly on 01 and 02 August 2022 while the other FTO, LLFA will fly on the 2 remaining nights. Although both FTOs applied for a 3 hours duration for night flying training, it was not approved by the Aerodrome

Operator. The limited duration imposed by the Aerodrome Operator is mainly due to the shortage of manpower ie Operations and AVSEC personnel.

The limited slot time (1900 hrs – 2100 hrs) imposed by the Aerodrome Operator for NF is critically insufficient as only 2 flights per night per aircraft can be carried out. On top to the above restriction, CAAM Ipoh also imposed flying restrictions whereby only 2 aircraft of the same category are allowed in circuits at the same time[5]. These restrictions resulted in delay to complete the NF syllabus considering the number of students and each student to complete 5 hrs NF training. There are 3 FTO in Ipoh and only 1 FTO is allowed to operate on one particular night for NF training. It was observed that the pilots were rushing to complete the NF training due to the limited slot time imposed by the Aerodrome Operator.

Other limitations imposed by the Aerodrome Operator on all FTOs are the requirement to pay charges for any flights operating outside Ipoh Aerodrome normal operating hours. These charges were implemented effective November 2021.

1.17.6 Flight Duty and Rest Hours Limitation

Both the pilots flight duty and rest hours limitation complied with the TPM. It was the first sortie for Pilot 2 and the fourth sortie for Pilot 1 who has accumulated a total of 3 hrs on that particular day. In accordance to the TPM, the flight time daily limit for FI/AFI is 4.0 hrs daily for general flying[6].

Both pilots had sufficient rest time. Pilot 1 last flown was on 28 August 2022 while Pilot 2 had just returned from 5 days leave. Pilot 1 reported for duty at about 1400 hrs while Pilot 2 reported for duty at about 1730 hrs. In accordance with the TPM, both pilots had more than 12 hrs rest time[7].

[5] Manual of Air Traffic Services Volume 2 (Peninsular Malaysia), Part 20-Ipoh Airport, Section 9 – Other Procedures, paragraph 9.1.2 - Local Circuit Procedure for night flying.
[6] TPM Chapter 1 Paragraph 1.9.11.3 b - Limitations for AFI/FI.
[7] TPM Chapter 1 Paragraph 1.9.12 - Rest Periods for Flying Staff and Students.

1.17.7 Flight Operation Control Centre and Aircraft Dispatching Management

There were no personnel manning the FTO's Flight Operation Control Centre (FOCC) on the day of the accident. The FOS was on sick leave that day while the Flight Operations Assistance (FOA) was on COVID-19 quarantine at home. Ipoh ATC Controller was unable to relay emergency message (MAYDAY call) to FOCC via the land line and had to inform the solo CP flying in circuits to inform FOCC to return Ipoh ATC Controller's call on landing. The emergency message was later transmitted to the FTO Maintenance Manager via handphone.

It was observed that the Maintenance Manager was the only person on duty on the accident night. CCTV recording shows that the Maintenance Manager was alone marshalling two aircrafts taxying out for take-off, one after another. Prior to taxiing out for take-off, the aircraft 9M-BAA was started by Pilot 2 while waiting for Pilot 1 to land on completion of a CP solo check flight with aircraft 9M-BAE. A running change was carried out with the CP who flew solo on aircraft 9M-BAE after Pilot 1 had exited the aircraft. After exiting the aircraft, Pilot 1 boarded the other aircraft 9M-BAA immediately for the currency check flight on Pilot 2.

The original daily flying programme requires only one marshaller as it was not programmed for a running change flight for Pilot 2. There were no documented evidence relating to running change procedures and the minimum required number of marshaller on duty when two or more aircrafts are starting and taxying out at the more or less the same time[8].

With reference to the TPM[9], the CFI (Pilot 2) responsibilities includes monitoring of the overall flying training activities, preparing flying training programme; responsible for elaborating, planning, and publishing the flight

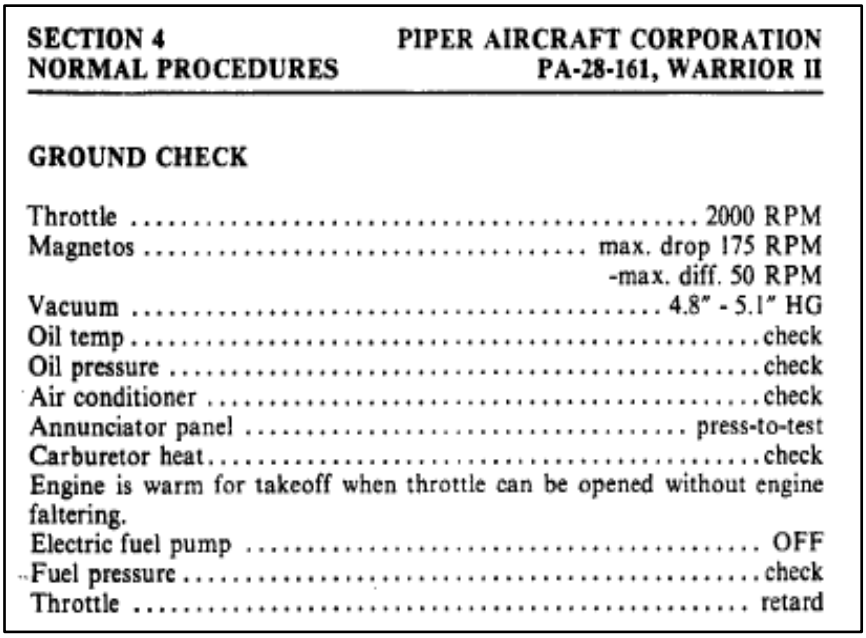
[8] Aircraft Ground Handling and Refuelling Procedure, Chapter 2 – Aircraft Ground Handling, paragraph 2.2.
[9] TPM, Chapter 1 – General, paragraph 1.8.3.2.

schedule; coordinate aircraft requirement with the Maintenance Manager and suspending flight operation for safety reason amongst others.

With reference to Pilot 2 interview statement, it was acknowledged that the above practices are non-standard. In view of the non-standard practices, appropriate corrective actions should have been taken by Pilot 2 who is also the CFI to ensure safe flight operation on the night of the accident. The absence of various operations personnel is also contrarily to the TPM, Chapter 1 General, paragraph 1.8 - Responsibilities and Succession of Command of Management and Key Operational Personnel.

1.17.8 Aircraft Engine Ground Check

Pilot 2 started and completed the engine ground check prior to Pilot 1 boarding the aircraft to save time. There were no reported abnormalities after the engine ground check which was carried out as per Piper Warrior II PA28-161 Pilot's Operating Handbook (POH) – Engine Ground Checklist in Figure 27.



SECTION 4 **PIPER AIRCRAFT CORPORATION**
NORMAL PROCEDURES **PA-28-161, WARRIOR II**

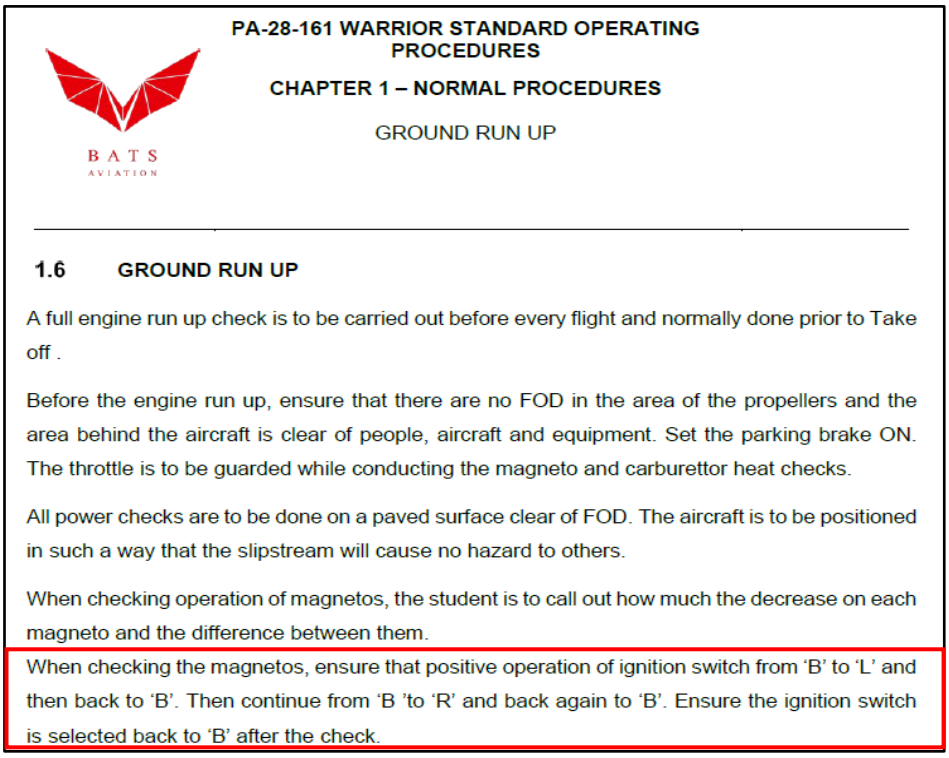
GROUND CHECK

Throttle ..... 2000 RPM
Magnetos ..... max. drop 175 RPM
-max. diff. 50 RPM
Vacuum ..... 4.8" - 5.1" HG
Oil temp ..... check
Oil pressure ..... check
Air conditioner ..... check
Annunciator panel ..... press-to-test
Carburetor heat ..... check
Engine is warm for takeoff when throttle can be opened without engine faltering.
Electric fuel pump ..... OFF
Fuel pressure ..... check
Throttle ..... retard

Figure 27: Pilot's Operating Handbook - Engine Ground Checklist

The PA28-161 Warrior Standard Operating Procedures (SOP) also provides clear guidelines on the correct procedure to carry out an engine

ground check especially with regards to performing magneto operations check (Figure 28).



PA-28-161 WARRIOR STANDARD OPERATING PROCEDURES

CHAPTER 1 – NORMAL PROCEDURES

GROUND RUN UP

BATS AVIATION

1.6 GROUND RUN UP

A full engine run up check is to be carried out before every flight and normally done prior to Take off .

Before the engine run up, ensure that there are no FOD in the area of the propellers and the area behind the aircraft is clear of people, aircraft and equipment. Set the parking brake ON. The throttle is to be guarded while conducting the magneto and carburettor heat checks.

All power checks are to be done on a paved surface clear of FOD. The aircraft is to be positioned in such a way that the slipstream will cause no hazard to others.

When checking operation of magnetos, the student is to call out how much the decrease on each magneto and the difference between them.

When checking the magnetos, ensure that positive operation of ignition switch from 'B' to 'L' and then back to 'B'. Then continue from 'B 'to 'R' and back again to 'B'. Ensure the ignition switch is selected back to 'B' after the check.

Figure 28: Standard Operating Procedures – Ground Run Up

Pilot 2 started and performed the engine ground check alone despite not current on NF. Pilot 2 interview statement states that the engine ground check was monitored by Pilot 1 after Pilot 1 boarded the aircraft. Nevertheless, CCTV recording shows that Pilot 2 actually performed the engine ground check before Pilot 1 boarded the aircraft. The marshaller can be clearly seen giving the engine ground check hand signal to the Pilot 2 after the aircraft engine was started. The engine ground check was carried out before Pilot 1 aircraft had landed. Interview statement from the Maintenance Manager who was also the marshaller on duty that night confirms the above actions.

CCTV recording also shows that after Pilot 1 had boarded Pilot 2 aircraft (9M-BAA), the marshaller who was facing the solo CP's aircraft (9M-BAE) which was parked diagonally across in the dispersal area gave the hand signal for the solo CP's aircraft to taxi out followed by Pilot 2 aircraft. Based on CCTV evidence, it would had been a hazardous situation had Pilot 2 performed an

engine ground check without the marshaller knowledge as the marshaller was facing the solo CP's aircraft and standing in the centre between both the aircraft.

1.17.9 Intersection versus Full Runway Length Take-off for Night Flying

All take-off for day and night training flights on the accident day was an intersection take-off (taxiway Delta). The Ipoh ATC/MASB/ATO/FTO Local Procedures states that in the absence of a request for back track, ATC shall assume that the aircraft will be departing from the intersection[10]. Therefore, it is the pilot's responsibility to decide whether to use the full runway length or to carry out an intersection take-off after exercising his captaincy and airmanship to mitigate the potential risk during take-off.

Based on calculation and plotting on the runway grid map[11], the total distance covered from take-off position on RWY 04 till engine loss power at the height of 200 feet is about 3,489 feet. The aircraft position is about abeam Taxiway 'A' when taking-off from intersection 'D'. If the take-off was carried out using full runway length, the aircraft will be just about abeam Taxiway 'C' **(refer calculation and plotting at Appendix E)**.

Based on the above data, if the take-off had utilised the full runway length, there is a good probability that the pilot would be able to make a force landing within the aerodrome area which would have increase the chances of a safe forced landing.

[10] Ipoh ATC/MASB/ATO/FTO Local Procedures Issue 3, 30 September 2022, Chapter 3 – Start Up and Take-Off Procedures, paragraph 3.5 – Line-Up.
[11] Take-Off Weight=2,240lbs; OAT=30°C; Wind=Nil; Climb Speed=70kts; ROC=600ft/min.

1.17.10 Forced Landing Area during Engine Fail After Take-Off

The standard circuits pattern for circuits training at Ipoh Runway is Left Hand RWY 04 for light aircraft and Right Hand RWY 04 for helicopter[12]. The runway is geographically surrounded by hilly terrain and densely populated area which limits the force landing area available in an event of an engine failure especially an Engine Failure after Take-Off (EFATO). Due to the geographical location, it provides the FTOs with safety challenges when conducting flights especially circuits training within the vicinity of Ipoh aerodrome. The FTOs should identify and pre-nominated suitable EFATO areas within the circuit. This will enable all pilots to be familiar and thoroughly brief on the suitable area to be selected based on the aircraft height in the event of an EFATO. Amendment have been made to Ipoh ATC/MASB/ATO/FTO Local Procedures Issue 2 dated 28 February 2022 to include pre-nominated suitable EFATO areas within the circuits. The detail EFATO areas for RWY 04 are stated in latest Ipoh ATC/MASB/ATO/FTO Local Procedures Issue 3 dated 30 September 2022[13].

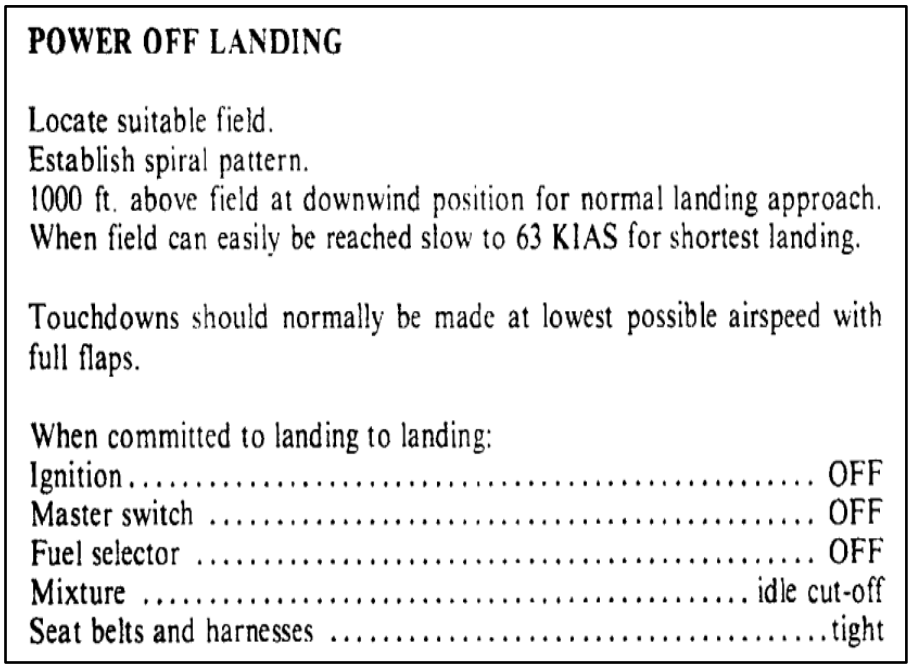
1.17.11 Engine Power Loss in Flight Procedures

With reference the Piper Warrior II POH[14], a complete engine power loss is usually caused by fuel flow interruption, and power will be restored shortly after fuel flow is restored. If power loss occurs at a low altitude, the first step is to prepare for an emergency landing.

The Piper Warrior II POH[15] also states that when committed to a landing, lower the flaps as desired, close the throttle, move the mixture to idle cut-off, and shut OFF the magnetos. Turn the battery master and alternator switches

[12] Ipoh ATC/MASB/ATO/FTO Local Procedures Issue 3, 30 September 2022, Chapter 4 – Circuit Training, paragraph 4.2.1 – Standard Circuit Pattern.
[13] Refer Ipoh ATC/MASB/ATO/FTO Local Procedures Issue 3, 30 September 2022, Chapter 7 – Simulated EFATO and PFL, paragraph 7.5 – EFATO Areas for Runway 04.
[14] Piper Warrior II PA28-161 POH, Section 3 – Emergency Procedures, paragraph 3.11 – Engine Power Loss in Flight.
[15] Piper Warrior II PA28-161 POH, Section 3 – Emergency Procedures, paragraph 3.13 – Power Off Landing.

OFF. Move the fuel selector valve to OFF. The seat belts and shoulder harness should be tightened (Figure 29).



POWER OFF LANDING

Locate suitable field.
Establish spiral pattern.
1000 ft. above field at downwind position for normal landing approach.
When field can easily be reached slow to 63 KIAS for shortest landing.

Touchdowns should normally be made at lowest possible airspeed with full flaps.

When committed to landing to landing:

Ignition	OFF
Master switch	OFF
Fuel selector	OFF
Mixture	idle cut-off
Seat belts and harnesses	tight

Figure 29: Piper Warrior II PA28-161 POH, Section 3 – Power Off Landing

From Pilot 2 interview statement, the aircraft engine loss power at a height of approximately 200 feet just after take-off. Therefore, time and altitude are limited and crucial in decision making. Pilot 2 stated that he performed the immediate action drills by ensuring the fuel selector was not at OFF position while he was unsure whether he had glanced to verify the ignition switch was at BOTH position and the fuel pump was ON due to darkness. Pilot 2 stated that he was not sure of the mixture position as he had passed out. Pilot 2 also could not recall if Pilot 1 had shut down the aircraft engine subsequently.

Evidence observed at the aircraft wreckage found the throttle at CLOSE, mixture at IDLE CUT-OFF, ignition switch at ‘L’ position, Carb Heat at ‘ON’, fuel selector was at LEFT tank and flaps were at UP position. This shows that Pilot 1 most probably took over controls and did the ‘Power Off Landing’ checks before the aircraft crash landed after Pilot 2 had passed out.

1.17.12 Night Flying Brief

The NF brief was conducted by Pilot 1 and attended by Pilot 2 and CP 1. The NF brief covers all items as stated in the Warrior SOP[16] as in Figure 30.

6.1.2 Night Flying Briefing Format

The following format is to be followed as guide for the briefing:

a. roll call;
b. flying program;
c. duty Flight Instructor;
d. duty engineering personnel;
e. aircraft allocation;
f. weather brief and sunset/last landing time;
g. crew change;
h. refueling;
i. airfield lighting layout including obstruction lights;
j. light signals to Ground Crew;
k. emergency procedures; and
l. miscellaneous.

Figure 30: PA28-161 Warrior SOP - Night Flying Briefing Format

All emergencies procedures in the air and on the ground ie total electrical failure, radio failure and loss of lights were briefed accordingly. No evidence to indicate that EFATO procedures were covered during the NF brief. There is no EFATO brief stated in the Warrior SOP Chapter 6 – Night Flying Procedures. A review is recommended to the Warrior SOP to include an EFATO brief in the Night Flying Briefing Format. The EFATO brief must also include specific details like the pre-identified location of force landing areas available which are very critical when operating in Ipoh Aerodrome (refer ATC/MASB/ATO/FTO Local Procedures Issue 3, 30 September 2022 Chapter 7 – Simulated EFATO and PFL).

[16] Piper Warrior PA28-161 SOP, Chapter 6, paragraph 6.1.2 – Night Flying Briefing Format.

1.17.13 Take-Off Safety Briefing

In accordance to the Warrior SOP[17], the take-off safety briefing is to be completed prior to line up and will inform the actions to be followed in the event of an emergency (Figure 31). The take-off safety briefing did not clearly state if the PIC should take over controls in the event of an emergency. In this accident, there was also no positive identification and confirmation from either pilot of the nature of emergency. Pilot 2 was the Pilot Flying and did the EFATO Immediate Action Drill without confirming it to be an engine failure while Pilot 1 who was the PIC and Pilot Monitoring did the MAYDAY call only without assisting Pilot 2 to identify and confirmed the emergency. Pilot 1 subsequently took over controls and force landed the aircraft as Pilot 2 claimed to have passed out and could not remember further events during the emergency.

To avoid ambiguity of who is in control of the aircraft when an emergency happens during a dual flight either flying with another FI or a CP, the take-off safety brief should state that the PIC must be in control of the aircraft in the event of an emergency.

1.7 TAKE OFF PROCEDURES

1.7.1 Take off Safety Briefing

Take off safety briefing will inform the actions to be followed in the event of an emergency. It is to be completed prior to line up. The format is to be concise and to cover the following:

a. type of Take off ;
b. decision speeds;
c. action in an emergency;
d. intended direction after takeoff.

An example of a Take off safety brief to the local training area is as follows: -

"This will be a _____ (type of Take off).

V_R is ____kt.

I will climb out at _____kt and at 300ft agl carry out after takeoff checks, thereafter _____kt.

Any malfunction during takeoff roll whoever notice will call abort 3 times; I will abort the takeoff.

If the engine fails after takeoff, I will select the attitude for 75kt and carry out the EFATO drill.

Any questions?"

Figure 31: PA28-161 Warrior SOP - Take-Off Safety Briefing

[17] Piper Warrior PA28-161 SOP, Chapter 1 – Normal Procedures, paragraph 1.17.1 -Take-Off Safety Brief.

1.17.14 Aircraft Instrument Lighting Aircraft 9M-BAA

Pilot 2 and Pilot 5 interview statement revealed that the aircraft (9M-BAA – Warrior II) instrument lights were dimmer than normal as compared to another similar aircraft. There was no evidence on any defect raised on the instrument's lights by any pilots. The Warrior II aircraft does not have a variable instrument lighting intensity control switch like in the Warrior III aircraft which allows the pilot to control the brightness for instrument reading clarity. The light switch in the Warrior II aircraft is a roll ON and roll OFF type switch as in Figure 32.

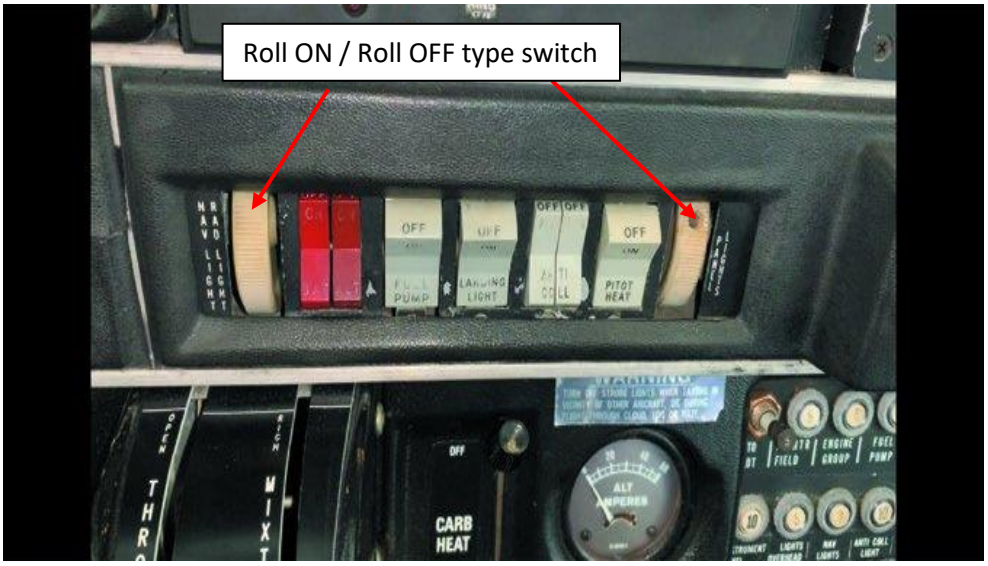


Figure 32: Instrument Light Switch

1.17.15 CCTV Camera at Dispersal Area

There is a CCTV camera located at the left side of the FTO Hangar view towards the direction of the dispersal area and runway (Figure 33). Observation revealed that this camera is 'motion activated' type and focus mainly on the right side of the dispersal area (Figure 34). It is also observed that the recording time is not synchronised to the actual real time as it indicates about 15 minutes ahead compared to actual real time.

The location of the CCTV camera resulted in no recording of activities on the left side of the dispersal. The aircraft 9M-BAA which was park on the left side of the dispersal was not seen in the CCTV recording. There was no continuous recording which would have provided critical information on events taking place on the runway, taxiway and dispersal area. The inaccurate time of recording also does not give real time information when an event which is time critical happens.

The Aircraft Operator should consider to place at a suitable location a 180° or 360° view CCTV camera with continuous recording for safety and security reasons. There is also a need to ensure the CCTV system is operating normally. It will assist in any incident or accident investigation and provide evidence if there is a breached of safety or security.

Figure 33: CCTV Camera location

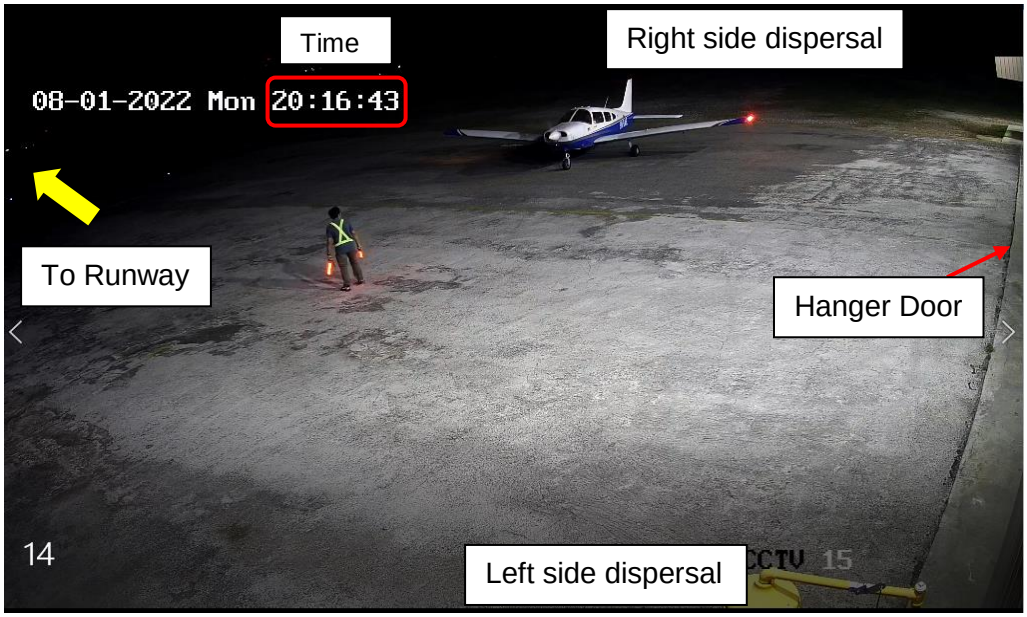


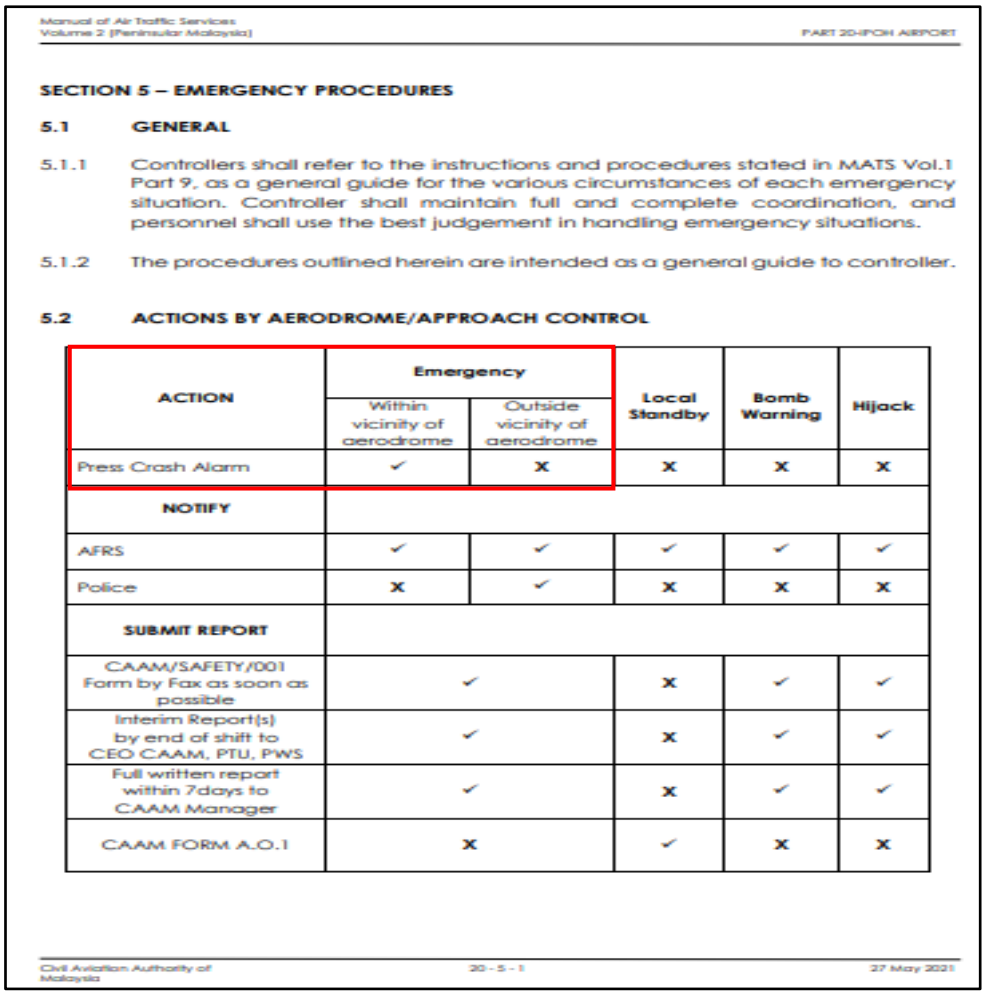
Figure 34: CCTV Camera limited view and inaccurate time of recording

1.17.16 Crash Alarm Not Activated

The pilot transmitted a MAYDAY call which was received by the ATC Controller on duty. Although the aircraft position was just after take-off and just outside of the aerodrome vicinity, the ATC Controller on duty did not activate the crash alarm. This is due to the requirement as stated in the Manual of Air Traffic Services Volume 2 (Peninsular Malaysia), Part 20-Ipoh Airport[18] which requires the crash alarm to be activated only when the emergency happened within the vicinity of the aerodrome (Figure 35).

This requirement needs urgent review as the action by ATC Controller to press the crash alarm should be determined by the nature of emergency declared by the pilot and not by the aircraft location when an emergency is declared ie within aerodrome or outside aerodrome vicinity.

[18] Manual of Air Traffic Services Volume 2 (Peninsular Malaysia), Part 20-Ipoh Airport, Section 5 – Emergency Procedures, paragraph 5.2 - Actions by Aerodrome/Approach Control.



Manual of Air Traffic Services
Volume 2 (Peninsular Malaysia) PART 20-IPOH AIRPORT

SECTION 5 – EMERGENCY PROCEDURES

5.1 GENERAL

5.1.1 Controllers shall refer to the instructions and procedures stated in MATS Vol.1 Part 9, as a general guide for the various circumstances of each emergency situation. Controller shall maintain full and complete coordination, and personnel shall use the best judgement in handling emergency situations.

5.1.2 The procedures outlined herein are intended as a general guide to controller.

5.2 ACTIONS BY AERODROME/APPROACH CONTROL

ACTION	Emergency		Local Standby	Bomb Warning	Hijack
	Within vicinity of aerodrome	Outside vicinity of aerodrome			
Press Crash Alarm	✓	X	X	X	X
NOTIFY					
AFRS	✓	✓	✓	✓	✓
Police	X	✓	X	X	X
SUBMIT REPORT					
CAAM/SAFETY/001 Form by Fax as soon as possible	✓		X	✓	✓
Interim Report(s) by end of shift to CEO CAAM, PTU, PWS	✓		X	✓	✓
Full written report within 7days to CAAM Manager	✓		X	✓	✓
CAAM FORM A.O.1	X		✓	X	X

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Figure 35: Manual of Air Traffic Services Volume 2 (Peninsular Malaysia), Part 20-Ipoh Airport

1.17.17 Safety Issues Meeting at Ipoh Aerodrome

Evidence revealed that the Ipoh ATC/MASB/ATO/FTO Local Procedures Issue 2 dated 28 February 2022 was not up to date and does not have Appendices which are specific to certain FTO operations despite it had been signed and published.

In view of the above, a Safety Issue Meeting pertaining to the safety of flight operations at Ipoh Aerodrome was coordinated by AAIB to discussed and mitigate safety issues observed in the course of the accident investigation. The meeting was held on 6 September 2022 at Ipoh Airport. It was chaired by the Aerodrome Operator Manager.

The safety issues discussed and mitigating action taken are as follows:

NO	ISSUES	MITIGATING ACTIONS
1	Limited NF training duration leading to 'act of rushing' by the pilots.	a. The Aerodrome Operator extended NF duration from 2 hrs (1900 to 2100 hrs) to 3 hrs (1930 to 2230 hrs). – **Inserted in new Ipoh ATC/MASB/ATO/FTO Local Procedures Issue 3, 30 September 2022**. b. The Aerodrome Operator requested additional manpower for operations and security (AVSEC) staff.
2	The use of intersection take-off.	a. No intersection take-off for NF. - **Inserted in new Ipoh ATC/MASB/ATO/FTO Local Procedures Issue 3, 30 September 2022**. b. Safety Recommendation by AAIB – **Aircraft Operator to review the Warrior SOP**.
3	The number of aircraft permitted in circuits.	Only two (2) aircraft allowed at one time during NF with NO MIXED TYPE of aircraft operation. - **Inserted in new Ipoh ATC/MASB/ATO/FTO Local Procedures Issue 3, 30 September 2022**.
4	The activation of Crash Alarm during a MAYDAY call.	Safety Recommendation by AAIB – **CAAM to review Manual of Air Traffic Services Volume 2 (Peninsular Malaysia), Part**

		20-Ipoh Airport, Section 5 – Emergency Procedures, paragraph 5.2 - Actions by Aerodrome/Approach Control (see Figure 35).
5	Aircraft Operator's Operation Room manning and communication with ATC Tower.	Safety Recommendation by AAIB – **Aircraft Operator to review the Training and Procedure Manual**.
6	Engine Failure after Take-Off (EFATO) – Pre-identified suitable forced landing areas within Ipoh Aerodrome vicinity.	**Inserted in new Ipoh ATC/MASB/ATO/FTO Local Procedures Issue 3, 30 September 2022.**

Figure 36: Safety issues discussed and mitigating actions taken

The respective safety issues above had been reviewed and amendments were made to Ipoh ATC/MASB/ATO/FTO Local Procedures Issue 2 dated 28 February 2022 by CAAM Ipoh. A newly issued Ipoh ATC/MASB/ATO/FTO Local Procedures Issue 3 dated 30 September 2022 had been formalised and published as reference for all FTOs operating at Ipoh Aerodrome.

1.18 Additional Information

1.18.1 Interview and Written Statements

The Investigation Team conducted separate interview sessions with the Pilots, Duty Air Traffic Controllers, Airport Fire and Rescue Services and Public Eye Witnesses. The interview sessions were all recorded under the express knowledge of all the parties. All of the above personnel had also submitted a written statement.

1.18.2 Contrary Interview Statement by Pilot 2

In the course of the accident investigation, Pilot 2 was interviewed twice ie 5 August 2022 at a private hospital and a follow up on 23 August 2022 at Pilot 2 residence. The following statements were found contrary to evidence as follows:

a. Pilot 2 stated that the engine ground check was carried together with Pilot 1. Evidence from Maintenance Manager interview statement and CCTV recording disputed Pilot 2 statement. Evidence clearly shows that Pilot 2 started and did the engine ground check before Pilot 1 boarded the aircraft.

1.18.3 AAIB Bulletin 5/2021 Accident Piper Warrior PA28-161 Registration G-BZDA at White Waltham Airfield, United Kingdom[19]

A recent accident in September 2020 which involved a similar aircraft type was reported to have loss power after take-off at a height about 100 feet. The loss of power resulted from the gascolator drain being inadvertently locked open leading to partial fuel starvation. Following this accident, the United Kingdom Civil Aviation Authority (UK CAA) released a Safety Notice reminding owners and operators of this potential hazard for aircraft fitted with lockable gascolator and recommending replacement with 'suitable, non-locking alternatives'.[20]

Refer to paragraph 1.16.1. a. iv, the gascolator fuel drain valve fitted to the aircraft (9M-BAA) is of the non-lockable type part number 492-312 as per Piper Aircraft PA28-151/161 Warrior Airplane Parts Catalogue (Figure 24) and was in compliance to the UK CAA Safety Notice.

[19] https://assets.publishing.service.gov.uk/media/6076fa3dd3bf7f400f5b3c44/Piper_PA-28-161_G-BZDA_05-21.pdf

[20] CAA Safety Notice SN-2021/005: Lockable Gascolator Drain Valves on General Aviation Aircraft, issued 4 February 2021. Available at https://publicapps.caa.co.uk/modalapplication.aspx?catid=1&pagetype=65&appid=11&mode=detail&id=10140.

Although the gascolator sustained impact damage with the cup holding the filter broken off missing together with the fuel drain valve, there were no evidence of blockage at the carburettor filter screen. There was fuel contained in the carburettor indicating the engine did not malfunction due to fuel starvation.

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1.19. Useful or Effective Investigation Techniques

This investigation will rely on witness statements and system investigation to analyse probable factors that had caused the engine to lose power in flight. Pilot actions will also be looked into as possible caused to the engine loss of power.

1.19.1 Engine System Investigation and Pilot Actions

The following are probable causes or contributing factors that caused the aircraft's engine to lose power after take-off:

a. Ignition system malfunction.
b. Fuel system problem.
c. Engine malfunction.
d. Incorrect ignition switch position during take-off.

1.19.2 On-Site Investigation

The aircraft was not installed with FDR or a CVR. On-site investigation was carried out to look for evidence which will assist in reconstructing the probable chain of events leading to this accident. Witness statements were also being used to assist in the reconstruction of events.

1.19.3 Human Factors Issues

The Reason's "Swiss Cheese" Model will be used to analysed probable human factor issues. The Model (Figure 37) will be used to describe the layers

of defences at which active failures/conditions and latent failures/conditions may occur in this accident.

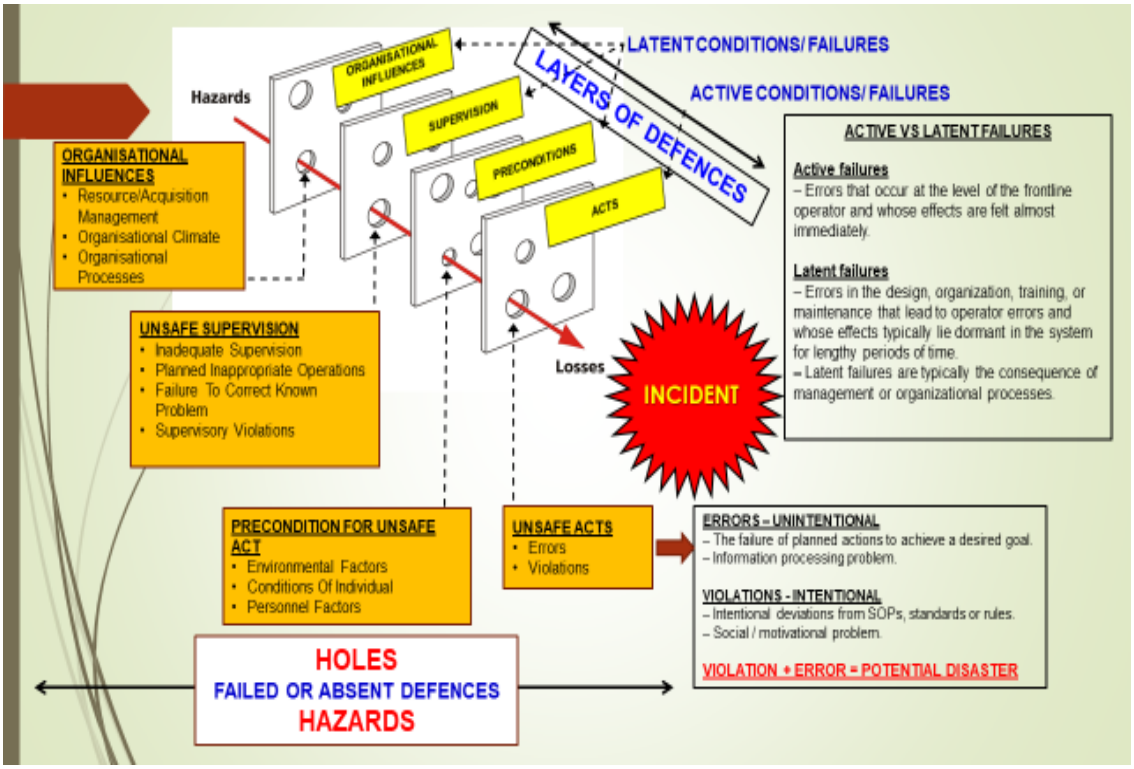

Figure 37: Reason's 'Swiss Cheese' Model

From the described layers of defences in the "Swiss Cheese" model at which active failures/conditions and latent failures/conditions may had occur in this accident, Human Factors Analysis and Classification System (HFACS) will be used to evaluate and rule in or eliminate the various preconditions that resulted in the unsafe act. It will then evaluate the supervisory and subsequent organisational issues that had contributed to the precondition. Finally, this will provide a detailed human factors picture of all the event that led up to the accident as in Figure 38.

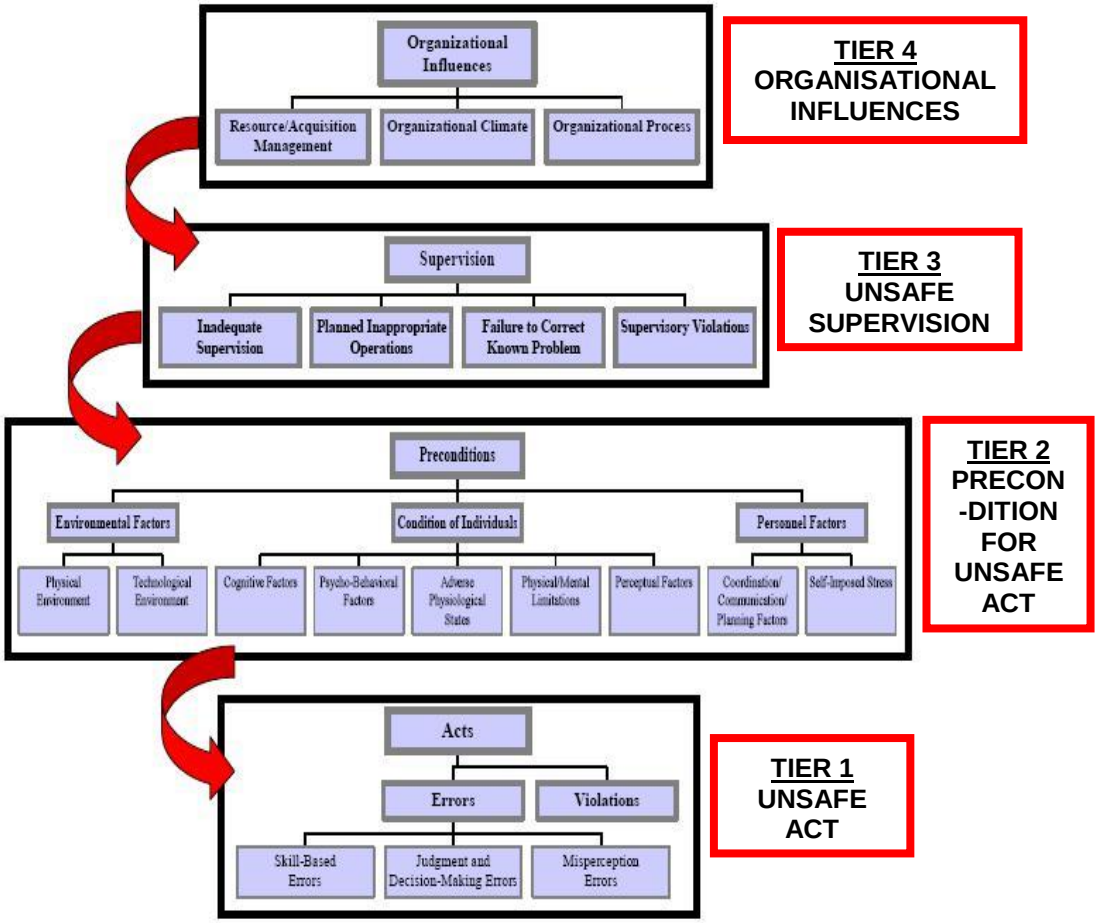

Figure 38: Human Factors Analysis and Classification System (HFACS)

2.0 Analysis

2.1 The Problem Statement

Pilot 2 stated that the aircraft took-off normally. On passing a height of about 200 feet, the engine noise was heard winding down and the engine RPM was observed to have reduced. There was no engine vibration, surge or misfiring when the engine RPM reduces. Pilot 2 immediately carried out actions drill to restore the engine power and there was a momentary positive engine response, but the engine quit again. Pilot 2 could not recall anything about the accident thereafter until the rescuers rescued him from the aircraft wreckage.

2.2 Engine System Investigation Analysis

Post-accident inspection and test carried out by the Investigation Team at the FTO Hangar on the various engine and fuel system components did not revealed any abnormalities. To further verify the post-accident inspection and test, the engine was sent to Lycoming Approved Service Centre and Distributor, C & A Aviation Sdn Bhd, Senai, Johor, Malaysia for detailed inspection and bench test to verify its airworthiness condition. The inspection and test found no abnormalities on the engine, magnetos, ignition harness, spark plugs and carburettor.

The aircraft fuel and engine oil samples were also sent to the laboratory for forensic test. Test result did not reveal any abnormalities to both fuel and engine oil samples except there were slight dirt in the fuel samples.

There was no evidence to indicate fuel contamination, fuel starvation, engine or associated components had malfunctioned and subsequently caused the engine to lose power in this accident.

In conclusion, the engine and its associated components were in an airworthy condition prior to the accident. The detail test and research findings are as per paragraph 1.16.

2.3 Pilot's Action - Incorrect Ignition Switch Position During Take-Off Analysis

On-site investigation found that the ignition switch was at 'L' position. Other crucial evidence observed were the throttle at CLOSE position, mixture at IDLE CUT-OFF, Carb Heat at 'ON' and fuel selector was at LEFT tank.

Pilot 2 states that a power check at 2,000RPM was performed at the dispersal area after start-up while the power check on line up was to check all engine parameters were normal before take-off. Circumstantial evidence shows that Pilot 2 most probably did not return the ignition switch to 'BOTH' position on completion of the right magneto

check during the engine ground check at the dispersal area. The error was not noticed by Pilot 1 as the magneto check was completed before Pilot 1 boarded the aircraft.

During the engine parameters check on line up, Pilot 2 who was seated on the LHS most probably did not notice the roughly 100RPM less on the RPM gauge when selecting to maximum power as it would have been difficult to accurately read the engine instrument if it is done in a quick manner and with dim instrument lights. Pilot 1 who was seated on the right-hand seat will probably have more difficulty reading the engine instrument accurately due parallax error coupled with dim instrument lights as the RPM gauge is located at the left side in front of Pilot 2. The error was most probably aided by the unsafe act of ‘rush action’ and the pre-condition for unsafe act of night condition and dim instrument lights of the aircraft.

With reference to simulated check outcome in paragraph 1.16.4, the simulated check shows that it is possible for the pilots to inadvertently take-off the aircraft with the ignition switch selected to one magneto without noticing the error. Although the aircraft accelerates slightly slower than normal due to less power, it will be hardly noticeable by the pilots for a night take-off as the visual cues are limited due to darkness. The simulated check take-off roll was also normal with no engine rough running or back firing sound heard, and no engine vibration or surging felt. All engine instruments indication was normal throughout the simulated check. In summary, there were no visual or audio cues to warn the pilots of their error before the aircraft lift-off from the runway.

The Piper Warrior II PA28-161 runs on a 4-cylinder, direct drive, horizontally opposed, air cooled engine. Each cylinder has 2 spark plugs, one on the top side of the cylinder head, and one on the bottom side. The spark plug ignites the fuel/air mixture that has been sucked into the engine and causes a controlled burn to push the piston down the cylinder and turn the crankshaft in turn turning the propeller as it is connected to the end of the crankshaft.

Each cylinder has two spark plugs, one connected to the "left" magneto, and another connected to the "right" magneto. If one magneto is turned "off" or grounded (selecting ignition switch to either ‘L’ or ‘R’ position), only one spark plug in each

cylinder will "fire" to ignite the fuel/air mixture. This causes the mixture to have a delayed and less effective burn, meaning that the piston does not get to pushed down the cylinder as effectively, meaning the crankshaft will not rotate as fast, and hence, leads to a drop in the propeller RPM. This explains the drop-in engine RPM when performing magneto check during engine ground check and the less power available during the simulated take-off check with one magneto selected only.

The Piper Warrior II PA28-161 has a fixed pitch propeller. The angle of attack of a fixed pitch propeller is set at installation and cannot be changed during aircraft operation. The propeller is mechanically linked to the engine which produces thrust and the propeller rotational speed (propeller RPM) is directly related to the engine speed (engine RPM).

Based on direct and circumstantial evidence, it is analysed the aircraft most probably taxied, line up and took-off with the magneto inadvertently selected to ‘L’ position. During take-off, as the throttle is increased to maximum, the engine produces less power than normal with the propeller RPM also lower than normal. Although the engine is producing less power to generate thrust (lower propeller RPM), the less power available is sufficient to propel the aircraft forward during the take-off roll as demonstrated in the simulated check for inadvertent take-off with the ignition switch selected to one magneto.

When the pilot rotates the aircraft at 60kts, the aircraft climbs and accelerates to the climb speed of about 80kts initially. With a fixed pitch propeller, the drag force that a propeller generates while under power is expressed as a torque applied to the engine's crankshaft (engine RPM) and arises because of skin friction drag on the propeller blade surfaces. As the engine is not running at actual full power as explained above, theoretically, the engine speed (engine RPM) will reduce as drag on the propeller increases to opposed the propeller rotation as the aircraft climbs ie propeller rotational speed (propeller RPM) is directly related to the engine speed (engine RPM). This theoretically explains Pilot 2 observation of a reduction in engine RPM indication and the engine noise winding down with speed reducing to below 60kts during the climb.

Analogy to the above explanation is similar to a car going uphill. The car engine (aircraft engine) transmits its power directly to the wheel (propeller) which overcomes the friction between the wheel and the road surface (drag on the propeller) for the car to continue its motion. As the car continues to go uphill with constant power, the car's engine power will not be sufficient to drive the wheel to overcome the friction between the wheel and the road surface. Subsequently, at one stage, the engine RPM will start to wind down and the car will slow down due to insufficient power to overcome the drag on the wheels similar to the situation encountered by the aircraft operating with less power on a climb.

Pilot 2 states that after the immediate action drill was carried out which Pilot 2 did not fully complete as he had passed out, there was a momentarily positive engine response but the engine quit again. Pilot 2 also states that the propeller did not stop when the engine quit again. The momentarily positive engine response can be attributed to probably the pilot lowering down the aircraft nose attitude to maintain glide speed. This action will reduce the drag on the propeller and cause the engine to respond. Subsequently the engine quit again as stated by Pilot 2 can be attributed to probably the pilot's action to either raise the aircraft nose attitude again or to fully closed the throttle. The propeller did not stop, indicating that the engine did not fail but had insufficient power to climb the aircraft.

Evidence shows that Pilot 1 would had most probably taken over control of the aircraft and carried out the engine shut down drill after Pilot 2 had passed out. With the engine losing power at about a height of 200 feet and at night, both pilots had no time and any options other than to make a controlled crash landing.

Evidence at aircraft wreckage shows the throttle was at 'CLOSED', mixture at 'IDLE CUT-OFF', carburettor heat at 'ON' and ignition switch at 'L' position. Evidence at site shows that only one of the two propeller blades had bent inwards indicating it had hit something hard like a lamp post while the other propeller blade was normal with scratch marks only. This indicates that the engine and propeller had stopped prior to the crash landing. Pilot 1 who was seated on the RHS most probably would not have time and also be able to reach the ignition switch situated on the left side of the

cockpit panel while piloting the aircraft at night and at low speed in search of a force landing area.

2.4 On-Site Investigation

On-site investigation was carried out at the crash site to look for impact marks, debris and wreckage location which will provide crucial evidence and information in determining the final flight path of the aircraft. Sequence of events of the accident can be traced and reconstructed as in Figure 39.

Photo 1 – Aircraft heading towards Sg Pinji river for a forced landing. Approaching the river, the right wing impacted a lamp post situated on the road bridge which span over Sg Pinji river.

Photo 2 – Impact marks on the lamp post shows that one of the propeller blades struck the upper section of the lamp post followed by the right wing which resulted in a U-bend at the middle section of the lamp post. The force of the impact sheared the lamp post from its base.

Photo 3 & 4 – The impact on the lamp post caused the right wing to break into two and shear off from the main fuselage. The shape of the damage to the leading edge of the inner wing matches to the evidence of impacting a lamp post. Inner wing was found located just beside the river on top of some pipes spanning across Sg Pinji river.

Photo 5 - The outer wing was located further away from the river not too far from the inner wing's location.

Photo 6 & 7 – The aircraft's right wing impacted the lamp post and rotated clockwise 180° nose down pivoting on the lamp post and swung across the water diversion culvert, belly first. When the aircraft swung across the culvert, it missed hitting an electrical pole as the right wing had sheared off from the aircraft main fuselage.

Photo 8 – The wreckage stuck and was hanging at the side of the water diversion culvert in a nose down position.

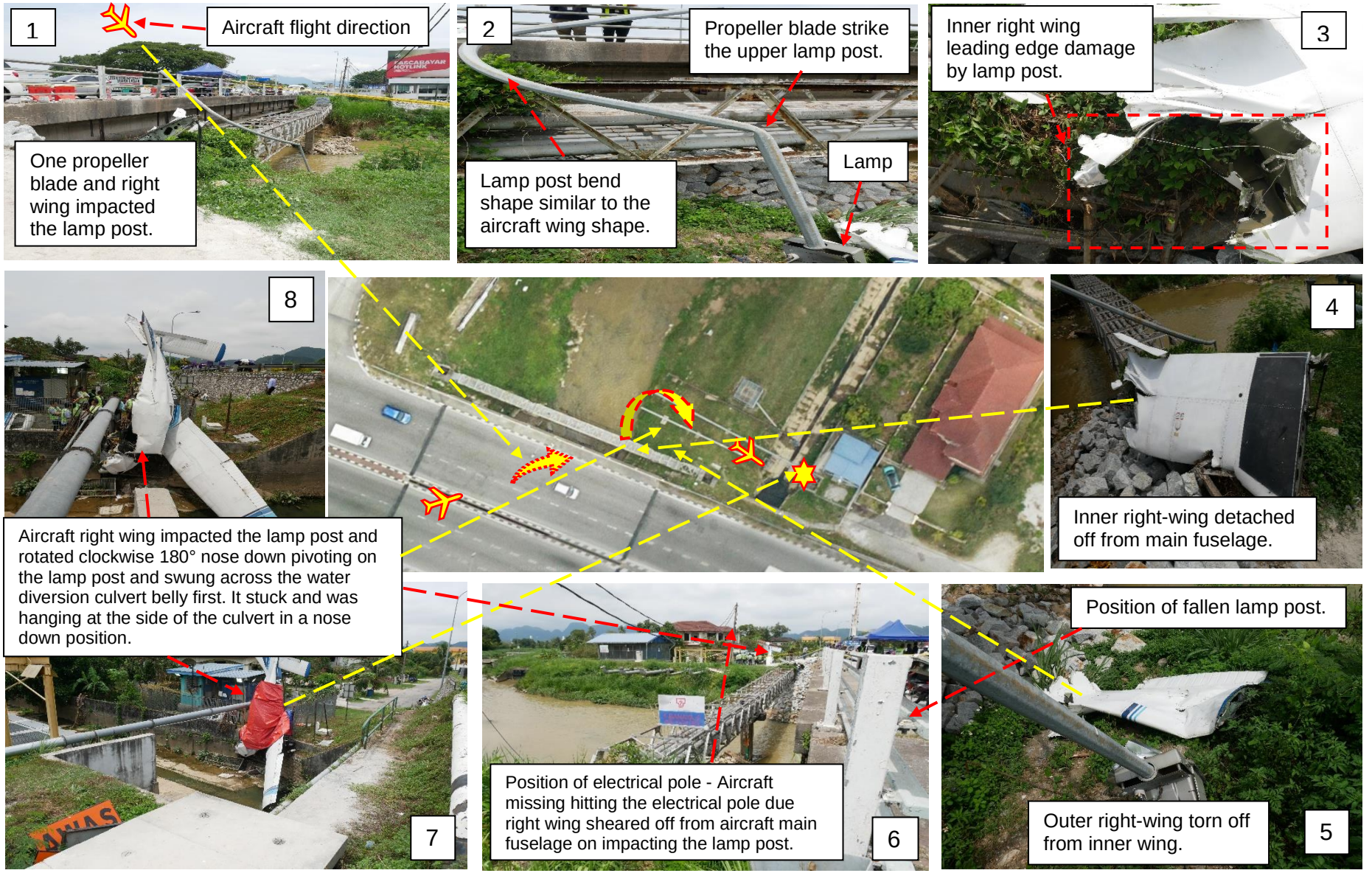

Figure 39: On-site investigation sequence of event

2.5 On-Site Investigation Analysis

With reference to Pilot 2's statement, the immediate action drill was not completed fully as Pilot 2 had passed out and could not remember subsequent events till the BOMBA personnel rescued him from the wreckage. Circumstantial evidence shows that Pilot 1 most probably took over control of the aircraft immediately, shut down the engine and steered the aircraft towards Sg Pinji river which was the only possible forced landing area on the right side of Runway 04 flight path. Evidence also clearly shows that the engine had been shut down prior to the aircraft impacting the lamp post as only one propeller blade had bent inwards indicating forward motion while the other blade condition was in normal condition with some scratch marks only.

Approaching Sg Pinji river passing the road bridge, the aircraft propeller impacted the lamp post followed by the right wing with force as the aircraft would have most probably been gliding at between 50kts to 60kts just above the stall speed. The impact yawed and rotated the aircraft to the right in a nose down position. The impacting force sheared off the right wing from the main fuselage and also tore the right wing into two parts. With the aircraft's rotating momentum pivoting on the lamp post initially, the aircraft continued to rotate clockwise about 180° before the right wing sheared off from the main fuselage. When the right wing sheared off from the main fuselage, the rotating momentum created a catapult effect and swung the aircraft belly first, across the water diversion culvert. Evidence shows that the aircraft had missed impacting an electrical pole when it was swung across the water diversion culvert. This is only possible if the aircraft had rotated about 180° and the right wing had torn off. The aircraft wreckage slammed into the side of the water diversion culvert and stuck hanging in a nose down position. The RELA Personnel who witnessed the sequence of events from the aircraft impacting the lamp post to its final position confirms the above on-site analysis in his interview statement.

The Investigation Team would like to commend Pilot 1 for his excellent flying skill and captaincy in controlling and flying the aircraft towards Sg. Pinji river thus averting a catastrophic accident. Despite being at low altitude, low speed, night condition and limited forced landing area, Pilot 1 quick thinking and actions had prevented the further loss of lives and damage to properties.

2.6 Human Factors Analysis

Human factor issues related to this accident were examined using the Reason's "Swiss Cheese" model and HFACS worksheet as per **Appendix F**. From the HFACS worksheet, evidence statements will be provided for rating of 2,3, and 4 as shown in paragraph 2.6.1 to 2.6.4. Subsequently an Investigation Analysis Summary is tabulated in paragraph 2.7.

2.6.1 Tier 1 - Unsafe Acts

AE	ERRORS	EVIDENCE
AE 1	**Skill-Based Errors**	
AE 1.1	**Inadvertent Operation.** Inadvertent Operation is a factor when individual's movements inadvertently activate or deactivate equipment, controls or switches when there is no intent to operate the control or device. This action may be noticed or unnoticed by the individual.	Inadvertently selected ignition switch to 'L' position instead of 'BOTH' on completion of right magneto check.
AE 2	**Judgement and Decision-Making Errors**	
AE 2.3	**Necessary Action (Rushed).** Necessary Action – Rushed is a factor when the individual takes the necessary action as dictated by the situation but performs these actions too quickly and the rush in taking-action leads to an unsafe situation.	1. Pilot 2 cancelled leave at the last minute and self-programmed to fly to meet the shortened NF duration from 4 days to 2 days as approved by the Aerodrome Operator. 2. Pilot 2 started the aircraft and carried out engine ground check while waiting for Pilot 1 to do running change to meet the limited approved NF slot time. 3. Pilot 2 immediately taxy out aircraft behind solo CP after Pilot 1 boarded the aircraft without performing engine ground check. 4. Aircraft line up and did an intersection take-off instead of using full runway length.
AE 2.6	**Decision-Making During Operation.** Decision-Making During Operation is a factor when the individual through faulty logic selects the wrong course of action in a time-constrained environment.	No positive identification and confirmation on the nature of emergency when engine loss power after take-off by both pilot.

Analysis Tier 1 - Unsafe Acts

A chain of latent failures as analysed in paragraph 2.6.1 to 2.6.4 had led to the unsafe acts as described in paragraph 2.3 and 2.5 which had caused the aircraft to lose power after take-off and crash landed at the side of a water diversion culvert beside Sg Pinji river.

The chain of unsafe act started with the application to conduct night flying training by another FTO on the same date as approved to the Aircraft Operator ie from 01 to 04 August 2022. The approval from the Aerodrome Operator to the Aircraft Operator for 4 days duration was received on 29 July 2022, 2 days before the actual night flying date. The Aircraft Operator accepted a last minute compromised to carry out NF training on 01 and 02 August 2022 while the other FTO will fly on the remaining 2 nights. The shorten duration for the NF training triggered a 'rushing effect' to get Pilot 2 current on night flying on 01 August 2022 and subsequently assist Pilot 1 to conduct night flying training with the CPs on 02 August 2022.

The last NF flight for Pilot 2 was on 9 February 2021 which is about 18 months ago. Pilot 2 who is supposed to be on leave on from 27 July to 01 August 2022 decides to cancel one day leave (01 August 2022) on the plan flying day itself. Pilot 2 rushed to plan his night flying currency check flight with Pilot 1 to meet the shorten day duration as approved by the Aerodrome Operator. The last-minute night flying currency check flight was not programme in the daily flying programme for that day but was planned as a replacement to a CP's NF training flight.

The approval for the night flying training slot time was for only 2 hours (1900 to 2100 hrs). The 2 hours duration is very limited for 2 flights per night per aircraft for a one-hour duration flight. To save time, during the pre-flight brief, it was decided that Pilot 2 will start-up the aircraft while waiting for Pilot 1 to land and carry out a running change.

Pilot 2 through self-initiative performed the engine ground check alone while waiting for Pilot 1 to land. While performing the engine ground run check alone, circumstantial evidence shows that Pilot 2 most probably selected the ignition switch to 'L' instead of to 'BOTH' position on completion of the right magneto check. The long duration in which Pilot 2 had not been current in night flying would had probably affected Pilot 2 competency in performing an engine ground check at night despite being current on day flying.

Evidence from CCTV shows that the running change was also done in a rush manner. The speed when the aircraft is ready to taxi out after Pilot 1 had boarded the aircraft and the decision to do an intersection take-off indicates that the pilots were rushing to meet the night flying training limited slot time as approved by the Aerodrome Operator.

Evidence from Pilot 2 interview statement shows that there was no positive identification and confirmation on the nature of emergency by both the pilots when the engine loses power after take-off. It led to the pilots mistakenly identifying that the engine had malfunction whereas the engine had actually insufficient power during the climb as it was running on one magneto only. The lack of height after take-off at night, the limited force landing area couple with the aircraft's dim instrument lighting had probably contributed to the confused state experienced by both the pilots when the emergency happened.

In conclusion, skill-based error caused the pilot to inadvertently select the ignition switch to the wrong position during the engine ground check. This resulted in the engine running on less power. Decision making error subsequently caused the pilots to inaccurately identifying the nature of emergency during take-off. Self-initiative to performed engine ground run check and the rush to carry out night flying currency check in a shorter duration and limited time slot are 'rush actions' that had contributed to the unsafe act.

2.6.2 Tier 2 - Preconditions for Unsafe Acts

PE	**ENVIRONMENTAL FACTORS**	
PE 2	**Technology Environment**	
PE 2.4	**Controls and Switches**. Controls and Switches is a factor when the location, shape, size, design, reliability, lighting or other aspect of a control or switch is inadequate and this leads to an unsafe situation.	No brightness control for instrument light which caused all instrument lights to be dimmer than normal as compared to a similar aircraft.
PC	**CONDITIONS OF INDIVIDUAL**	
PC 2	**Psycho-Behavioural Factors**	
PC 2.8	**Complacency.** Complacency is a factor when the individual's state of reduced conscious attention due to an attitude of overconfidence, under-motivation or the sense that others "have the situation under control" leads to an unsafe situation.	1. Pilot 1 fourth flight of the day which probably caused Pilot 1 to have reduced awareness. 2. Pilot 1 performing currency check on Pilot 2 who is a very experienced pilot and FI. It probably leads to having a sense that Pilot 2 will "have the situation under control".
PP	**PERSONNEL FACTORS**	
PP 1	**Coordination/Communication/Planning Factors**	
PP 1.2	**Cross-Monitoring Performance.** Cross-monitoring performance is a factor when crew or team members failed to monitor, assist or back-up each other's actions and decisions.	1. EFATO procedures were not covered during the NF brief. 2. Pilot 1 did not adequately monitor Pilot 2 when performing engine ground check during the NF currency check flight.

Analysis Tier 2 - Preconditions for Unsafe Acts

The breach in the precondition for unsafe acts defence layer is a combination of environment, individual and personnel factors which had contributed to the unsafe act analysed in paragraph 2.6.1. Evidence shows that Pilot 1 had report for flying duties at 1400 hrs and had flown two-day flights with 2 CPs albeit with a short rest before flying a night solo check flight with another CP. The night flying currency check with Pilot 2 will be Pilot 1 fourth flight for the day. The effort to complete all the flights with the CPs and the rush to ensure the night flying training completes on time according to the duration approved probably leads to Pilot 1 reduced in awareness when flying with Pilot 2.

The reduce in awareness is further exacerbated by the knowledge that Pilot 1 will be flying with a very experience pilot and FI for the currency check flight after flying 3 training flights with CPs. This probably leads to complacency where both pilots have a sense that “the situation is under control” with their combine experience as FI.

The reduced in awareness and complacency resulted in Pilot 1 lack of monitoring on Pilot 2 when performing the duties as a check pilot on Pilot 2 who has lapse in night flying currency. Evidence shows that Pilot 1 did not monitor Pilot 2 when carrying out engine ground check as Pilot 2 had completed the engine ground run prior to Pilot 1 coming aboard the aircraft. Pilot 1 also did not insist upon Pilot 2 to perform a complete engine ground check on line-up but instead did an engine instrument check only. The failure to monitor Pilot 2 resulted in the ignition switch selected to ‘L’ instead of ‘BOTH’ position during take-off which eventually caused the engine to experience a loss of power during climb.

During the pre-flight night flying brief, all emergencies procedures in the air and on the ground ie total electrical failure, radio failure and loss of lights were briefed accordingly. No evidence to indicate that EFATO procedures were covered during the NF brief. It resulted in both the pilots not fully prepared to handle the emergency especially with limited height, time and in darkness.

In conclusion, complacency by both pilots due to a sense of the other pilot “have the situation under control” and the lack of cross monitoring on the part of both pilots had resulted in both pilots not fully prepared to handle the emergency. This breached of the precondition defence layer ultimately contributed to the unsafe act.

2.6.3 Tier 3 - Unsafe Supervision

SI	**INADEQUATE SUPERVISION**	
SI 1	**Leadership/Supervision/Oversight Inadequate.** Leadership/ Supervision/Oversight Inadequate is a factor when the availability, competency, quality or timeliness of leadership, supervision or oversight does not meet task demands and creates an unsafe situation. Inappropriate supervisory pressures are also captured under this code.	Lack of supervision by HOT and CFI to oversee the whole night flying training operations and manpower requirement.
SP	**PLANNED INAPPROPRIATE OPERATIONS**	
SP 6	**Risk Assessment –** Formal. Risk Assessment – Formal is a factor when supervision does not adequately evaluate the risks associated with a mission or when pre-mission risk assessment tools or risk assessment programs are inadequate.	1. Inadequate safety risk assessment by the pilots a. To ensure a safe take-off in the event of an EFATO when performing intersection take-off at night. b. To pre-identified forced landing areas for EFATO to cater for the challenging geographical nature of the aerodrome location.
SF	**FAILURE CORRECT KNOWN PROBLEM**	
SF 2	**Operations Management.** Operations management is a factor when a supervisor fails to correct known hazardous practices, conditions or guidance that allows for hazardous practices within the scope of his/her command.	Failure to correct the following known problem: a. Unavailability of personnel to manned the FOCC without HOT knowledge. CFI acknowledges it is non-standard practice. b. Insufficient aircraft marshaller to marshal 2 aircraft at the same time without HOT knowledge. CFI acknowledges it is non-standard practice. c. Only one person was on duty for the whole night flying training operations.

Analysis Tier 3 – Unsafe Supervision

The whole night flying training operations on the accident night was akin to an aircraft flying on autopilot mode. For the autopilot system to function properly and safely, it needs human management and supervision to oversee its safe operations. Similarly, in this accident, proper management and supervision is needed to ensure the night flying training operations is carried out safely. The HOT who is responsible for the night flying operations (CFI was

supposed to be still on leave) was not informed that the CFI (Pilot 2) had cancel leave and was schedule to fly that night. This new flying requirement was also not informed to the ATC Tower.

The manpower issue on that night was also not known to the HOT. The FOCC was not manned at all and there was only one marshaller on duty (Maintenance Manager) to marshal 2 aircrafts at the same time. There was a lack of communication between the HOT and CFI to supervise the night flying training and to take corrective actions on the known problems above. There was also communication problem between the Aircraft Operator and the ATC Tower when the pilot declared an emergency after take-off. It resulted in the ATC Tower not being able to communicate with FOCC and the slow response to activate the Aircraft Operator's Emergency Response Plan when the aircraft had crashed landed.

In summary, there was a lack of supervision and communication in the whole night flying training operations which resulted in only one person on duty to manage the flying operations and the emergency situation when the aircraft declared emergency and crash landed. The unsafe supervision is further exacerbated by the failure to correct the known problem above. The CFI should have taken corrective actions to mitigate and manage the manpower problem since he was present and was on flying duty that night.

The Ipoh ATO/FTO ATC Local Procedure states that all take-off and landing during night flying training will be mainly confined to RWY 04 Left Hand Circuit. It was observed that the majority of take-off carried out by the Aircraft Operator's pilots were from intersection 'D'. There was inadequate safety risk assessment by the pilots to ensure a safe take-off in the event of an EFATO especially at night when performing an intersection take-off.

Based on estimated ground calculation, when the aircraft took-off from runway 04 intersection 'D' and had an engine power loss at a height of 200 feet, the position of the aircraft is about abeam of taxiway 'A' just before threshold runway 22 (confirmed by interview statement ATC Controller 1). Meanwhile, if

the aircraft uses the full runway length ie take-off from threshold runway 04, the aircraft position will be about abeam taxiway 'C' (**refer Appendix E**). The available runway length from intersection taxiway 'C' to threshold 22 is about 2,310 feet. With this available length, it is analysed that if the pilot uses the full runway length for take-off that night, there is a good probability that the pilot would be able to make a force landing within the aerodrome area which would have increased the chances of a safe force landing.

Based on the above calculated runway length data for take-off, it is of paramount importance that all take-off especially night flying training must utilise the full runway length to allow for contingencies when an EFATO happens. This is due to the nature of Ipoh Aerodrome which is surrounded by hilly terrain and highly populated areas. To mitigate the risk, it is recommended to pre-identify the limited available force landing area within the vicinity of the aerodrome and to ensure all pilots are familiar with their location in the event of an engine failure.

In conclusion, inadequate safety risk assessment by the pilots to ensure a safe take-off in the event of an EFATO when performing an intersection take-off at night, inadequate supervision and failure to correct known problem when faced with management and operational issue had resulted in the breached of supervision defence layers which ultimately contributed this very unfortunate accident.

2.6.4 Tier 4 – Organisation Influence

OR	**RESOURCE/ACQUISITION MANAGEMENT**	
OR 7	**Personnel Resources**. Personnel Resources is a factor when the process through which manning, staffing or personnel placement or manning resource allocations are inadequate for mission demands and the inadequacy causes an unsafe situation.	Manpower shortage faced by Aerodrome Operator caused the reduction in number of days and shorter slot time for NF training for all FTO at Ipoh Aerodrome.
OC	**ORGANISATIONAL CLIMATE**	
OC 5	**Organisational Structure.** Organisational Structure is a factor when the chain of command of an individual or structure of an	1. Uncertain in chain of command between HOT and CFI when CFI cancelled leave

	organisation is confusing, non-standard or inadequate and this creates an unsafe situation.	and programmed to fly without HOT knowledge. 2. Lack of control on the NF training operations and during aircraft emergency situations contrarily to the TPM, Chapter 1 General, paragraph 1.8 - Responsibilities and Succession of Command of Management and Key Operational Personnel.
OP	**ORGANISATIONAL PROCESSES**	
OP 3	**Procedural Guidance/Publications.** Procedural Guidance/ Publications is a factor when written direction, checklists, graphic depictions, tables, charts or other published guidance is inadequate, misleading or inappropriate and this creates an unsafe situation.	1. No documented EFATO procedure briefing for night flying in the Warrior SOP. 2. No documented Running Change procedure in the Warrior SOP. 3. No documented directive to utilize the full runway length during NF take-off especially at night in the Warrior SOP. 4. No directive to man FOCC when flying activities are active in the TPM. 5. No Currency Assessment Form available in the TPM. 6. No documented procedures on minimum numbers of marshaller on duty when 2 or more aircrafts are starting and taxying out at the more or less the same time in the Aircraft Ground Handling and Refuelling Procedures.

Analysis Tier 4 - Organisation Influence

The decision by the Aerodrome Operator to limit the number of days and the night flying hours due to shortage of personnel was supposed to be a short-term mitigating action. The long-term solution to this issue is for the Aerodrome Operator to request for additional manpower to meet the FTOs night flying training requirement ie a minimum of 3 hours per night. The Aerodrome Operator officially requested for additional manpower only after it was highlighted by the Investigation Team in the Safety Issue Meeting held on 6 September 2022.

The limited slot time (1900 hrs – 2100 hrs) imposed by the Aerodrome Operator for NF is critically insufficient as only 2 flights per night per aircraft can be carried out for a one-hour duration flight. This further aggravated by the decision to reduce the night flying training days from 4 days to 2 days. CAAM Ipoh also imposed flying restrictions whereby only 2 aircraft of the same category are allowed in circuits at the same time[21]. These restrictions in day, time and number of aircraft resulted in the "act of rushing" to get Pilot 2 to be current and to assist to complete the NF syllabus considering the number of students and each student to complete 5 hrs NF training. There are 3 FTO in Ipoh and only 1 FTO is allowed to operate at one particular night for NF training. The above events were one of the main contributing factors to the unsafe act under organisational influence factors.

As for the Aircraft Operator, there was inadequate control and management of the whole night flying training operations when the CFI cancel its leave at the last minute and self-programme to fly on the same day without informing the HOT. This simple act changes the dynamics of chain of command for the night flying operations that night. Officially, the HOT is responsible for the whole night flying training operations as the Daily Flying Programme was approved by him since the CFI is on leave. When CFI reports for flying duties on the accident night, it was assumed that he would carry out his duties as a CFI, ie ensuring the FOCC and the aircraft dispatching are properly managed and ready to support the night flying training operations. Evidence from Pilot 2 (CFI) interview statement shows that the shortcomings were known and acknowledged as non-standard but was not corrected immediately whereas the HOT was not informed of the problems faced by FOCC and aircraft dispatching. This contrarily to the TPM, Chapter 1 General - Responsibilities and Succession of Command of Management and Key Operational Personnel.

The above shortcomings had the potential to put the entire NF training operations in great safety risk. If the aircraft had crash on the runway, it put the

[21] Manual of Air Traffic Services Volume 2 (Peninsular Malaysia), Part 20-Ipoh Airport, Section 9 – Other Procedures, paragraph 9.1.2 - Local Circuit Procedure for night flying.

single solo CP flying in circuits at risk to carry out a diversion to another aerodrome at night. One personnel performing aircraft marshalling for 2 aircrafts at once is a safety risk especially at night. Any fire emergency that involved an aircraft at dispersal area will also have disastrous consequences with only one personnel on duty.

Proper safety defences need to be put in place as seen by the various safety breached in this accident. There is a need to establish proper procedures in the various publications to provide proper operating guidance to all personnel. A review of the Warrior SOP is to be carried out to include EFATO procedures briefing at night, running change procedures and the use of full runway at night. There is also a need to review the Aircraft Ground Handling and Refuelling Procedures to include the minimum manpower requirement when 2 or more aircrafts are starting at more or less the same time.

A proper Night Currency Check Form should be made available and the requirement to man the FOCC when there are active flying activities needs to be included in the TPM. CAAM Ipoh had review and updated the Ipoh Local Procedures after the Safety Issue meeting held on 6 September 2022 after the accident. A newly issued Ipoh ATC/MASB/ATO/FTO Local Procedures Issue 3 dated 30 September 2022 had been formalised and published as reference for all FTOs operating at Ipoh Aerodrome.

2.7 INVESTIGATION ANALYSIS SUMMARY

FALLIBLE DECISIONS	HUMAN FACTORS HFACS	TIER 4 ORGANISATIONAL INFLUENCE	TIER 3 SUPERVISION FAILURES	TIER 2 PRECONDITIONS UNSAFE ACT	TIER 1 UNSAFE ACT	BREACHED BARRIERS	INCIDENT
- Inadvertent take-off with ignition switch selected to one magneto only. - No positive identification and confirmation on nature of emergency when engine loss power after take-off.	**Tier 1** - Skill-Based Errors. - Judgement and Decision-Making Errors. **Tier 2** - Psycho-Behavioural Factors - Coordination /Communication/ Planning Factors. **Tier 3** - Inadequate Supervision. - Planned Inappropriate Operations. - Failure Correct Known Problem **Tier 4** - Resource/ Acquisition Management. - Organisational Climate - Organisational Processes.	1. Manpower shortage faced by Aerodrome Operator caused the reduce in number of days and shorten duration for NF training for all ATO at Ipoh Aerodrome resulting in 'rushing effect". 2. Lack of control on the NF training operations and during aircraft emergency situation. 3. No documented EFATO procedure briefing for night flying in the FTO Warrior SOP.	1. Lack of supervision to oversee the whole night flying training operations and manpower requirement. 2. Inadequate safety risk assessment by the pilots a. to ensure a safe take-off in the event of an EFATO when performing intersection take-off at night. b. to pre-identified forced landing area for EFATO to cater for the challenging geographical nature of the aerodrome location. 3. Failure to correct the following known management and operations problem during NF training operations.	1. Currency check on a very experienced pilot and FI which probably leads to having a sense that the experience pilot will "have the situation under control". 2. EFATO procedures were not covered during the NF brief. 3. Inadequate monitoring during the NF currency check flight.	1. Inadvertent selection of the ignition switch to 'L' position instead of 'BOTH' position on completion of right magneto check. 2. No positive identification and confirmation on nature of emergency when engine loss power after take-off.	1. Non-compliance to PA28-161 Warrior SOP on a. Ground Run-Up procedures. b. Take-Off Safety Brief where no positive identification and confirmation from either pilot of the nature of emergency. c. No EFATO procedures were covered during the NF brief. 2. Non-compliance to TPM on Responsibilities and Succession of Command of Management and Key Operational Personnel.	Aircraft loss power after take-off and crash landed into a water diversion culvert.

3.0 Conclusions

From the problem statement in paragraph 2.1, the Investigation Team carried out a detailed test and research on the engine systems as per paragraph 1.16. From the engine system investigation analysis in paragraph 2.2, there was no evidence to indicate fuel contamination, fuel starvation, engine or associated components had malfunctioned and subsequently caused the engine to fail in this accident. Test results on both fuel and engine oil samples also did not reveal any abnormalities. It is concluded that the engine and its associated components were in an airworthy condition prior to the accident.

Human factors issues had caused this very unfortunate accident. Active and latent condition failures had breached the various defence layers which had been systematically put in place to ensure the Aircraft Operator operates in a safe flight training environment. The various defence layers are put in place to ensure flight safety risks are mitigated and reduced to the minimum when carrying out any flight training.

The main unsafe act for this accident is the inadvertent selection of the ignition switch to the wrong position after engine ground check. Skill-based error caused the pilot who had lost currency in night flying to inadvertently select the ignition switch to ‘L’ instead of ‘BOTH’ position on completion of the right magneto check. This resulted in the engine running on less power. Decision making error subsequently caused the pilots to inaccurately identifying the nature of emergency during take-off. Self-initiative to performed engine ground run check and the rush to carry out night flying currency check in a shorter night flying training duration are ‘rush actions’ that had contributed to the unsafe act.

The main pre-condition for unsafe act is the lack of cross monitoring when performing duties as a check pilot on another pilot who had lost currency in night flying. The failure to monitor the engine ground run check resulted in the ignition switch selected to the wrong position for take-off which eventually caused the engine to experience a loss of power during climb.

Complacency on the part of both pilots probably leads to the check pilot having a sense that the other pilot who is a very experience FI will “have the situation under control” when performing the currency check flight. The lack of cross monitoring and complacency on the part of both pilots had resulted in the breached of precondition defence layer which ultimately contributed to the unsafe act.

The main unsafe supervision was the inadequate safety risk assessment by the pilots to ensure a safe take-off in the event of an EFATO especially at night when performing an intersection take-off. It resulted in insufficient runway length to carry out a forced landing either on the runway or within the aerodrome area. Due to the limited available forced landing areas within the vicinity of Ipoh Aerodrome, safety assessment should had been carried out to pre-identified the possible forced landing areas and ensure all pilots are familiar with their locations.

The lack of supervision and communication which resulted in only one person on duty to manage the entire flying operations and the emergency situation when the aircraft crash landed had also contributed to the unsafe supervision factor. The unsafe supervision is further exacerbated by the failure to correct the known problem during the night flying operations.

Inadequate safety risk assessment to ensure safe take-off in the event of an EFATO couple with inadequate supervision and failure to correct known problem when face with management and operational issues had resulted in the breached of supervision defence layer which ultimately contributed to this very unfortunate accident.

The organisation influences that contributed to this accident was the decision by the Aerodrome Operator to reduce the number of days and slot time for night flying operations to mitigate its manpower shortage issue. The various breached of safety defences above would had been better mitigated and managed had the Aircraft Operator managed and taken corrective actions on the shortcomings faced that night before proceeding with the night flying training operations. These include a last-minute change in flying programme, the need to rush to complete the night flying training, proper manning for FOCC and aircraft dispatching.

Proper safety defences need to be put in place as seen by the various safety breached in this accident. There is a need to establish proper procedures in the various publications ie the Warrior SOP, TPM and Manual of Air Traffic Services Volume 2 (Peninsular Malaysia), Part 20-Ipoh Airport to provide proper operating guidance to the Aircraft Operator and all the FTO operating in Ipoh Aerodrome.

3.1 Findings

3.1.1 Both the Pilots were properly licensed to fly the night currency check flight.

3.1.2 The aircraft was properly maintained and airworthy for the flight.

3.1.3 Aircraft weight and balance is within the operating limit.

3.1.4 The accident happened at night. Weather was fine.

3.1.5 Both the Pilots crew duty and rest time were in accordance with the Training Procedure Manual.

3.1.6 Both pilots were medically fit to fly and there was no evidence of incapacitation in flight.

3.1.7 There were no reported abnormalities on the aircraft by the pilots during the night training flight.

3.1.8 Inspection and bench test found the engine and its associated components were in an airworthy condition prior to the accident.

3.1.9 The aircraft engine did not fail on take-off but was operating on reduced power.

3.1.10 The Pilot completed the engine ground check while waiting for the Check Pilot to land and board the aircraft.

3.1.11 The Pilot did an intersection take-off (Taxiway D) from Runway 04 instead of using the full runway length.

3.1.12 The Pilot made two MAYDAY calls about 3 minutes after take-off.

3.1.13 The aircraft crashed on the first circuits for the night training.

3.1.14 Crash alarm was not activated by the ATC Controller on duty. Crash information was transmitted by ATC Tower to AFRS Watch Room via direct line.

3.1.15 The Aerodrome Operator only approved 2 days as compared to 4 days originally with a limited time slot of 2 hours per day for the Aircraft Operator to carry out its night flying training.

3.1.16 The Pilot cancelled one day leave and planned a last-minute currency check flight which was not originally planned in the daily flying programme.

3.1.17 There were no personnel manning the Aircraft Operator's Flight Operations Control Centre during the night flying training operations.

3.1.18 There was only one personnel on duty to marshall two aircraft taking-off about the same time.

3.1.19 The ATC Tower was unable to contact any personnel on duty at the Aircraft Operator's Flight Operations Control Centre when the emergency happened except to relay message to the solo Cadet Pilot who was flying in circuits to land and inform the personnel on duty to return the ATC Tower's call.

3.1.20 CCTV camera located in front of the hanger had limited view and is motion activated. The recording time was inaccurate and was not synchronised with the actual time.

3.2 Causes/Contributing Factors

3.2.1 From the human factor analysis as shown in the summary of the HFACS worksheet in Figure 40 below (see **Appendix F** for details), it has been determined that the above accident **primary causes** were attributed to:

a. **2 Unsafe Acts (Tier 1)** as follows:
   i. 1 Skilled-Based Errors.
   ii. 1 Judgement and Decision-Making Errors.

3.2.2 The **secondary causes** were attributed to:

a. **1 Unsafe Act (Tier 1)** as follows:
   i. 1 Judgement and Decision-Making Error.

b. **2 Preconditions of Unsafe Acts (Tier 2)** as follows:
   i. 1 Psycho-Behavioural Factors.
   ii. 1 Coordination/Communication/Planning Factors.

c. **3 Unsafe Supervision (Tier 3)** as follows:
   i. 1 Inadequate Supervision.
   ii. 1 Planned Inappropriate Operations.
   iii. 1 Failure Correct Known Problem.

d. **3 Organisational Influences (Tier 4)** as follows:
   i. 1 Resource/Acquisition Management
   ` ii. 1 Organisational Climate.
   i. 1 Organisational Processes.

UNSAFE ACTS - ERRORS		4	3	2	1
AE 1	Skill-Based Errors	1			5
AE 2	Judgement and Decision-Making Errors	1	1		4
AE 3	Misperception Error				1
UNSAFE ACTS – VIOLATIONS					
AV 1	Violations - Based on Risk Assessment				1
AV 2	Violations - Routine / Widespread				1
AV 3	Violations – Lack of Discipline				1
UNSAFE ACTS SUB TOTAL		**2**	**1**	**0**	**13**
PRECONDITIONS FOR UNSAFE ACTS - ENVIRONMENTAL FACTORS					
PE 1	Physical Environment				11
PE 2	Technology Environment			1	7
PRECONDITIONS FOR UNSAFE ACTS - CONDITIONS OF INDIVIDUAL					
PC 1	Cognitive Factors				8
PC 2	Psycho-Behavioural Factors		1		14
PC 3	Adverse Physiological State				16
PC 4	Physical / Mental Limitation				5
PC 5	Perceptual Factors				11
PRECONDITIONS FOR UNSAFE ACTS - PERSONNEL FACTORS					
PP 1	Coordination/Communication/Planning Factors		1		11
PP 2	Self-Imposed Stress				6
PRECONDITIONS FOR UNSAFE ACTS SUB TOTAL		**0**	**2**	**1**	**89**
UNSAFE SUPERVISION					
SI	Inadequate Supervision		1		5
SP	Planned Inappropriate Operations		1		6
SF	Failure Correct Known Problem		1		1
SV	Supervisory Violations				4
UNSAFE SUPERVISION SUB TOTAL		**0**	**3**	**0**	**16**
ORGANIZATIONAL INFLUENCES					
OR	Resource/Acquisition Management		1		8
OC	Organisational Climate		1		4
OP	Organisational Processes		1		5
ORGANIZATIONAL INFLUENCES SUB TOTAL		**0**	**3**	**0**	**17**
TOTAL UNSAFE ACTS		**2**	**9**	**1**	**135**

Figure 40: Summary of HFACS Worksheet

3.2.3 The first primary cause was attributed to a probable skill-based error where the pilot inadvertent selected the ignition key to ‘L’ position on completion of the right magneto check during the engine ground check at the dispersal while waiting for the Check Pilot to completed the Cadet Pilot training flight before boarding the aircraft. The error was not notice by both pilot which resulted in the aircraft taking-off with less engine power and subsequently cause a power loss during the climbing phase. Contributing factors to this skill-based error was the inadequate monitoring and complacency of flying with a very experienced pilot and flight instructor which probably leads to having a sense that the experience pilot will “have the situation under control” during the night flying currency check flight.

3.2.4 The second primary cause was attributed to a judgement and decision-making error where the pilots inaccurately identifying the nature of emergency as an engine failure after take-off. The engine which is operating with less power on full throttle had actually loss power during the climb due to the engine operating on one magneto only instead of two magnetos. Contributing factors to this judgement and decision-making error was EFATO procedures were not adequately covered during the night flying brief which resulted in both pilots not ready to handle the emergency when it happened at low altitude, at night and the knowledge that there are limited safe landing areas within the aerodrome vicinity. The decision to carry out an intersection take-off instead of using the full runway length further complicated the judgement and decision-making error.

4.0 Safety Recommendations

4.1 The Aircraft Operator is to carry out the following safety recommendations:

4.1.1 To review the PA28-161 Warrior Standard Operating Procedures as follows:

4.1.1.1 To formulate a crew Running Change Procedure for all flights.

4.1.1.2 To include the requirement to use the full runway length for all night flying take-off on Ipoh runway (refer new Ipoh ATC / MASB / ATO / FTO Local Procedures Issue 3, 30 September 2022, Chapter 10 – Night Flying Procedures).

4.1.1.3 To include in the Take-Off Safety Briefing the requirement for the PIC to be in control of the aircraft in the event of an emergency when flying a dual flight.

4.1.1.4 To include in the Night Flying Briefing Format an EFATO brief. The EFATO brief must include specific details on the pre-identified location of suitable force landing areas available within the vicinity of Ipoh Aerodrome (refer new Ipoh ATC / MASB / ATO / FTO Local Procedures Issue 3, 30 September 2022, Chapter 7 – Simulated EFATO and PFL).

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4.1.2 To review the Training and Procedure Manual as follows:

4.1.2.1 To include the requirement of compulsory manning of the Flight Operations Control Centre when aircrafts are active flying.

4.1.2.2 To formulate a process whereby all personnel who are officially absent are required to inform and perform proper handing / taking over of duties.

4.1.2.3 To include the ground operations exercises ie start up, engine ground check, taxi, and shutdown to the exercises stated in Chapter 4 – Staff Training paragraph 4.4.1.4 - Night Flying, in the Night Flying Proficiency Check assessment.

4.1.2.4 To formulate an assessment form for Night Flying Proficiency Check to include all exercises to be carried out as stated in paragraph 4.1.2.3 above.

4.1.3 To review the Aircraft Ground Handling and Refuelling Procedure as follows:

4.1.3.1 To include the minimum number of marshaller on duty when there are 2 or more aircraft flying especially for night flying.

4.1.4 To consider relocating the CCTV camera position or change the CCTV camera to a 180° or 360° view type with continuous recording for better dispersal area view for safety and security purposes.

4.2 CAAM is to carry out the following safety recommendations:

4.2.1 To review and standardise the Manual of Air Traffic Services Volume 2 (Peninsular Malaysia) dated 27 May 2021, Part 20 - Ipoh Airport, Section 5 – Emergency Procedures, paragraph 5.2 - Actions by Aerodrome / Approach Control, the requirement for Air Traffic Control Controllers to press the crash alarm should be based on the nature of emergency and not the location of the aircraft ie within vicinity or outside the vicinity of the aerodrome for all aerodromes in Malaysia when an emergency is declared by the pilot.

4.3 MASB is to carry out the following safety recommendations:

4.3.1 To fulfil the manpower requirement requested by MASB Ipoh to meet the night flying training requirement of the FTO operating in Ipoh Aerodrome (refer MASB-IPH-ADMIN / 2022 / 04 dated 8 September 2022).

4.3.2 To consider extending the Ipoh aerodrome operations hours till 2300 hours or later to cater to the night flying training requirement from the FTO once the manpower requirement had been fulfilled.

5.0 COMMENTS TO DRAFT FINAL REPORT AS REQUIRED BY ICAO ANNEX 13 PARAGRAPH 6.3

In accordance with ICAO Annex 13, paragraph 6.3, the Draft Final Report was sent to State of Registry (CAAM), State of Manufacturer (National Transportation Safety Board of United States), Aerodrome Operator (MASB) and the Aircraft Operator (BATS Aviation) inviting their significant and substantiated comments on the report. The following are the status of the comments received: -

Organisations	Status of Significant and Substantiated Comments
National Transportation Safety Board of United States (NTSB)	Report accepted and no comments.
Civil Aviation Authority of Malaysia (CAAM)	Paragraph 1.16.3 - Comments accepted and amended accordingly.
Malaysia Airports Sdn Bhd (MASB)	Report accepted and no comments.
BATS Aviation Sdn Bhd	Paragraph 1.17.2 - Comments accepted and amended accordingly.

Figure 41: Status of significant and substantiated comments

INVESTIGATOR IN-CHARGE
Air Accident Investigation Bureau
Ministry of Transport
Malaysia

APPENDICES

APPENDIX A

AIRCRAFT PHYSICAL DAMAGE ASSESSMENT REPORT

Aircraft 9M-BAA Physical Damage Report

Accident of Piper-28-161 Warrior II 9M-BAA
at Ipoh on 1st August 2022

1

Table of Contents

1 Narrative of the Events

Around 1945 hrs pilot Captain Muhammad Din Fikri Zainal Abidin carried out a walkaround check of aircraft 9M-BAA. At 1950 hrs, the pilot started the aircraft and performed a power check, magneto test, and other checks on the aircraft. Captain Fajim Juffa Mustaffa Kamal who was previously on training flight duty with aircraft 9M-BAE had a running change and enter 9M-BAA around 1955 hrs. No reports of any system malfunction by the pilot before the aircraft taxi for take-off routine. The aircraft 9M-BAA taxing, line-up on runway 04 (just after DELTA) and took off from the airport around 2004 hrs with Captain Din Fikri and Captain Fajim on board.

Around 2006 hrs soon after take-off, an emergency call was made by the pilot (MAYDAY) and can be heard over the radio before the aircraft crashed at Sungai Rokam bridge. The distress signal was later confirmed with Ipoh Tower.

First impact point, the aircraft hit a lamp post and later hit the public water supply pipe in reverse before it came to rest.

2 Aircraft Information

Manufacturer:	Piper Aircraft, Inc.
Type:	PA-28-161 (Warrior II)
Manufacturer serial number:	28-8416032
Year of manufacture:	1984
Type of flight:	Training (Night flying currency)
Total airframe hours:	22199:39
Aircraft type certificate data sheet:	2A13
Engine manufacturer:	Textron Lycoming, Inc.
Engine serial number:	RL 10035-39E
Propeller manufacturer:	Sensenich Propeller Manufacturing Co, Inc
Propeller serial number:	A60915
Certificate of Registration:	YES, 18th February 2023
Certificate of Airworthiness:	YES, 22nd August 2022
Last maintenance check:	50 HRS/4 Monthly

2.2 Damage to Aircraft

2.2.1 Propeller blade bent inward, another blade scratches

2.2.2 Nose spinner damaged

2.2.3 The upper engine cowl detached

2.2.4 The lower engine cowl damaged (crushed) but still attached

2.2.5 Nose landing gear damaged

2.2.6 Starboard wing detached, broken into two

2.2.7 Starboard fuselage cockpit area damage

2.2.8 Baggage door detached, fuselage hogging

2.2.9 Horizontal stabilizer damaged

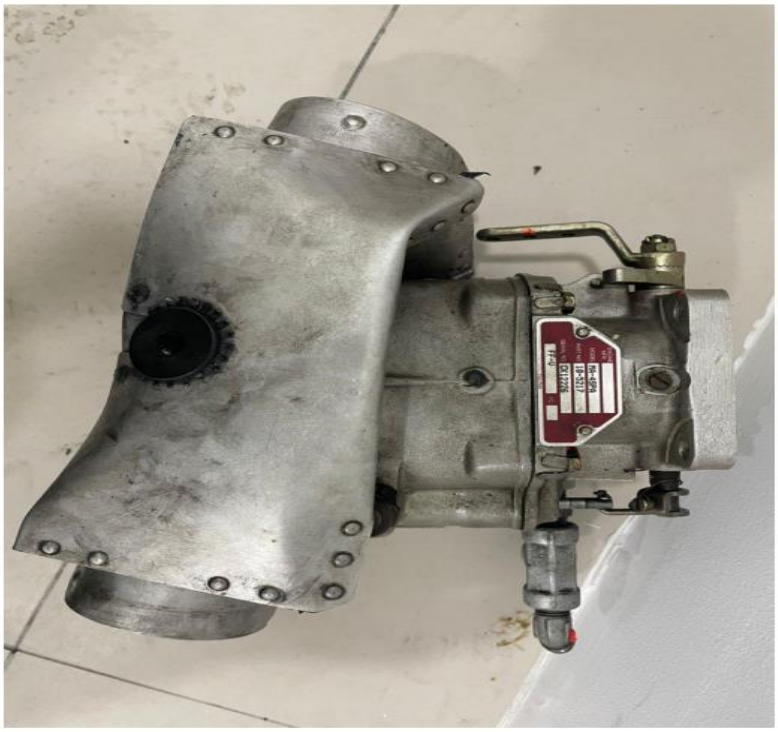
2.2.10 Port wing leading edge dented

2.2.11 Induction air box damaged

2.2.12 All aircraft instrumentation in the cockpit damaged due to impact

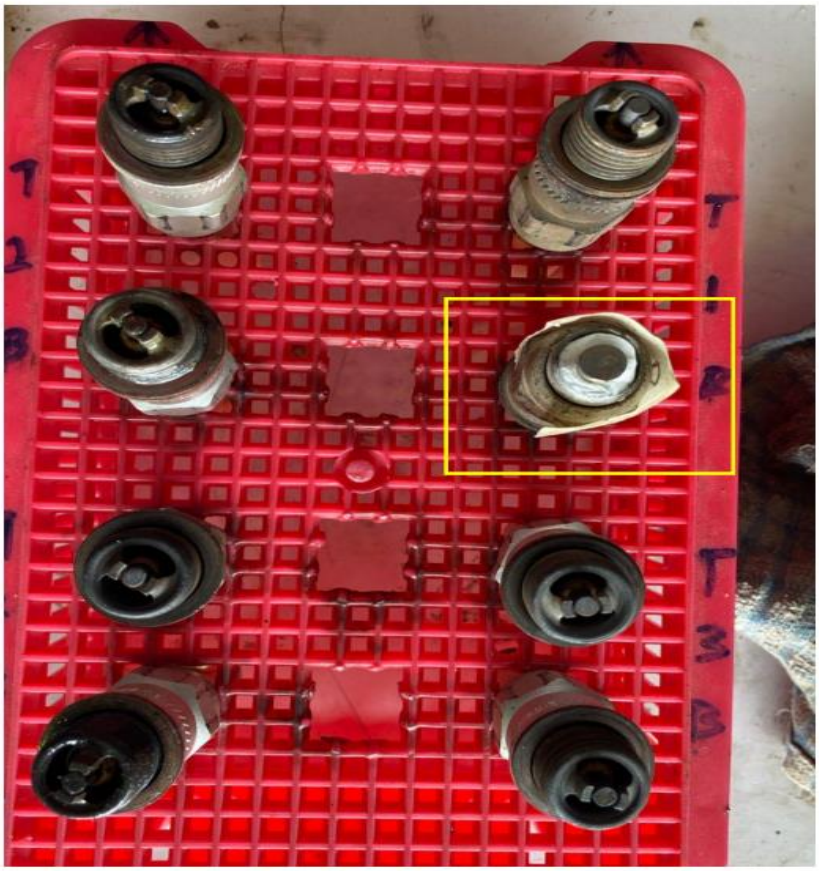
2.3 Damage to engine

2.3.1 Carburetor induction box crushed; carburetor body not affected



2.3.2 Engine driven fuel pump punctured by broken engine mount

2.3.3 One spark plug broken



2.3.4 Alternator broken

2.3.5 Starter broken

2.3.6 Oil filter punctured by broken engine mount

2.3.7 Engine mount broken few places

2.3.8 Battery box crushed

3. Damage Summary

I. ENGINE – No extensive damage on the cylinder, oil sump and crankcase. Engine will be sent to C&A Aviation for further inspection.
II. MAGNETOS - No extensive damage on both magnetos. Magnetos will be sent to C&A Aviation for further inspection.
III. CARBURETTOR - No extensive damage on the carburetor and only carburetor induction box crushed. Carburetor will be sent to C&A Aviation for further inspection.
IV. ENGINE ACCESSORY – Most of the engine accessory are badly damaged. Beyond repair.
V. PROPELLER – Damage is beyond repair.
VI. FUSELAGE – Cockpit area is badly damaged. All the avionics equipment are beyond repair. Aircraft main frame badly distorted. Beyond repair.
VII. WINGS – Starboard wing broken into two. Both wing main spar distorted. Beyond repair.
VIII. EMPENANGE – Tail section of the aircraft is badly damaged. Beyond repair.
IX. LANDING GEAR – Nose landing gear bent. Both main landing gear still attached to the wing.

Note: The damage assessment is according to physical assessment. Further damage will be assess later.

APPENDIX B

POST ACCIDENT INSPECTION AND TEST REPORT – CAAM AIRWORTHINESS INVESTIGATION REPORT

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CAAM Airworthiness Investigation Report

Report on the accident to Piper-28-161 Warrior II 9M-BAA at Ipoh on 1st August 2022

Report No. CAAM/AW/AAI/9M-BAA
Issue 1 Revision 0 dated 4 September 2022

Objective

This investigation report is to assist AAIB team on the technical investigation perfomed on the 9M-BAA accident on 1st August 2022. According to Annex 13 of the Convention on the International Civil Aviation, which established the International Civil Aviation Organization (ICAO), and Malaysia Civil Aviation Regulations (MCAR), the sole objective of this investigations and the final report from AAIB is to prevent future accidents and incidents.

In accordance with the principles of ICAO Annex 13 it is not the purpose of investigations to assign any blame or liability. The sole purpose of this investigation is the enhancement of flight safety. As an output of the investigation process, safety recommendations are issued by AAIB if they were necessary, addressed to CAAM or affected organisation in accordance with the primary objective of preventing accidents and incidents. Thus, this report principally to provide the input to AAIB on investigation done regarding the airworthiness/technical issue only.

Basically the objective of this report are:

i) to provide the information of the aircraft
ii) to provie the information from the inspection/observation done in respect of the airframe and engine.
iii) to provide the maintenance status of the aircraft.
iv) to issue any recommendation action if necessary

This report doesn't constitute the final outcome from the investigation. It is only the partial part of the investigation. Therefore, the report herein is only for internal use only and wil not be published anywhere. The final investigation report of this accident will be published by the AAIB on their website.

RESTRICTED

Table of Contents

1 Narrative of the Events

A Piper PA28-161 aircraft was on a plan night flying recency check flight for a Flight Instructor (FI) callsign BATS 03. The aircraft departed Sultan Azlan Shah Airport, Ipoh (IPH) at 2004 hours for circuits and landing as per flight brief.

The take-off was observed to be normal. Two MAYDAY calls were transmitted by the pilot, one after another, 3 minutes after the aircraft took-off. No further transmission was heard despite repeated transmission enquiries by the Ipoh Tower Controller.

The aircraft crash into a water diversion culvert beside Sungai Pinji, near Medan Gopeng, Ipoh, about 1.5 kilometres north-east direction from the airport. The aircraft suffered major damage on impact and there was no fire. The Right-Hand Seat (RHS) Pilot suffered fatal injuries while the Left-Hand Seat (LHS) Pilot was unconscious with serious injuries. Both pilots were extricated from the aircraft cockpit by the Civil Fire Rescue Services (BOMBA) personnel and was immediately sent to Raja Permaisuri Bainun Hospital, Ipoh for post-accident medical treatment and actions.

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

The CAAM Airworthiness was not at the scene during the accident happened and only arrived on the 3rd of August 2022. The wreckage has been removed and quarantined at BATS Aviation Hangar, Ipoh.

2 Team members

The investigation team from CAAM Airworthiness consist of:

Name of Inspector	Position	Credentials
Mazlan bin Mat Jan	Senior Assistant Director	Attended the Air Accident Investigation @ Cranfield, UK
Dzul Haqimie bin Mohd	Assistant Director	Attended the Air Accident Investigation with AAIB, Malaysia

3 Summary of Daily Actions

3.1 Summary on 3rd August 2022

The airworthiness team performing aircraft physical inspection of the wreckage at BATS Aviation hangar mainly on the aircraft engine with the assistance of Executive Jet Aviation (EJA) Approve Maintenance Organisation (AMO) maintenance personnel. In addition, the team also took picture of the physical, documentary & data evidence and carry-out informal interview with the maintenance personnel.

3.2 Summary on 4th August 2022

The airworthiness team performing 9M-BAA aircraft document inspection at EJA Continuining Airworthiness Maintenance Organisation (CAMO) office located at Kelana Business Centre, Petaling Jaya. The documents inspected were airframe log book, engine log book, aircraft technical log, aircraft maintenance work pack, and aircraft maintenance data such as POH, AD & SB.

3.3 Summary on 15th August 2022

The airworthiness team with AAIB Investigator In-Charge (IIC), BATS Aviation representative, EJA represenatative went to C&A Aviation Sdn. Bhd. to witness the engine test inspection. The engine test consist of ignition system test, carburation system test and engine components physical inspection.

3.4 Summary on 16th August 2022

The second day witnessing the engine test inspection.

4 Airworthiness Division Observation

4.1 Aircraft Information

4.1.1 General

Manufacturer:	Piper Aircraft, Inc.
Type:	PA-28-161 (Warrior II)
Manufacturer serial number:	28-8416032
Year of manufacture:	1984
Type of flight:	Training
Total airframe hours:	22199:39
Aircraft type certificate data sheet:	2A13
Engine manufacturer:	Textron Lycoming, Inc.
Engine serial number:	RL-10035-39E
Propeller manufacturer:	Sensenich Propeller
Propeller serial number:	A61915
Certificate of Registration:	Due 18/2/2023
Certificate of Airworthiness:	Due 22/8/2022
Last maintenance check:	50hrs / 4months

4.1.2 Standard Configuration

Standard aircraft empty weight:	1546.50 lbs	
Maximum permitted all-up weight:	2325.00 lbs	
Length overall:	23ft 9.6inch	
Height overall:	7ft 3.6inch	
Wingspan:	35ft	
Fuel Type:	AVGAS 100LL	
Fuel capacity:	Maximum Capacity	Usable
LH tip tank:	25 US Gal	24
RH tip tank:	25 US Gal	24
Maximum speed:	160 KIAS	

4.1.3 Aircraft History

Year	Remarks
26 August 1995	The aircraft was first registered in the US as N43263
20 November 2011	The aircraft had been registered in Malaysia with registration of 9M-SKS.
30 August 2016	The aircraft was re-registered as 9M-REN
19 February 2020	The aircraft was re-registered as 9M-BAA with BATS Aviation Sdn Bhd as the registered owner.

4.1.4 Weight and Centre of Gravity

The weight and centre of gravity schedule and weighing report was prepared on the 15 August 2020 by Executive Jet Aviation and found satisfactory. In addition, based on BATS Aviation Maintenance Manager, there was no weight schedule calculation perfomed during the day of accident.

4.1.5 Organisational Information

The Aircraft Operator is an Approved Training Organisation (ATO) by Civil Aviation Authority of Malaysia (CAAM) for pilot training since September 2020 and is situated at Sultan Azlan Shah Airport, Ipoh, Perak. It operates 2 types of aircraft ie 3 x single engine Piper PA28 and 1 x twin engine Piper PA34. The main flying course conducted by the Aircraft Operator is the Commercial Pilot Licence (CPL) (A)/IR with Frozen Air Transport Pilot Licence (ATPL).

4.1.6 Maintenance history

The aircraft was maintained by Executive Jet Aviation AMO under approval No. AMO/2016/21. The last 50 hr / 4-month inspection was completed on 27 July 2022 with last airframe hours of 22198:49 and engine hours at 1698.31. In addition, and the last annual inspection was completed on 17 January 2022 at 22050:01 hours in accordance with CAAM approved maintenance program reference EJA/AMP/PA28-161/1/20. The maintenance activities inspected for the period above found no defect related to fuel system, engine, or flight control malfunction. The aircraft was released to service in satisfactory condition.

The continuing airworthiness of the aircraft was being managed by Executive Jet Aviation Sdn Bhd under CAMO approval No. CAMO/2017/34. The last Airworthiness Review Report was issued on 29 July 2022.

The aircraft maintenance manuals that were furnished to the investigation team by the EJA CAMO were to the correct revision status.

Airframe:	Piper Warrior Service Manual 761-539 PR190711 11 JULY 2019
Engine:	Operator's Manual Lycoming Engine 0-320 60297-30 OCT 2006
Propeller:	Sensenich Service Bulletin up to R-17 16th March 1999

From the maintenance record history and documented inspection performed at EJA CAMO facilities, there were no evidence that the aircraft has any abnormalities regarding the maintenance performed. Examination of the aircraft documentation records that the aircraft was compliant with current CAAM airworthiness requirements.

4.2 Damage to Aircraft

Based on the observation during the aircraft physical inspection at BATS Aviation hangar, the Airworhiness team found that:

i) LH Propeller blade bent inward and RH blade scratches
ii) Nose spinner damaged
iii) The upper engine cowl damaged but still attached
iv) Lower engine cowl damaged(crushed) but still attached
v) Nose Landing Gear damaged broken
vi) Starboard LH wing detached
vii) Starboard fuselage cockpit area damage

Meanwhile, all Instruments still intact onto the panel but connectors at the back has been damaged such as:

i) Airspeed
ii) Turn & bank
iii) Artificial Horizon
iv) Directional Gyro
v) Altimeter

vi) Vertical Speed Indicator

vii) Instrument Landing Systems

In addition, all radio still intact on the panel but crushed due to the impact:

i) Audio Panel (KMA 24)

ii) Comm 1/Nav 1 (KX155 TSO)

iii) Comm 2Nav 2 (KX155 TSO)

iv) Auto Directional Finder (ADF)

v) Distant Measuring Equipment (DME)

vi) Transponder

4.3 Damage to Engine

Moreover, based on our observation, all engine monitoring gauges still intact but front panel already damaged such as:

i) Oil Temperatures

ii) Fuel Pressure

iii) Fuel Capacity LH & RH

iv) Oil Pressure

v) Vacuum Pressure

Furthermore, from the engine examination:

i) Linkages was broken.

ii) Carburetor induction box crushed, carburetor body not affected

iii) Engine-driven pump punctured by broken linkage

iv) Gascolator drain broken, filter not found

v) 1x spark plug damaged (The rest not affected)

vi) Alternator & starter crushed

4.3.1 Engine examination

4.3.1.1 Magneto

Both magnetos showed no impact damage, the last maintenance was performed in 2018 for 500 hrs inspection. Both magnetos were installed new in 2013.

i) RH Magneto (Slick Magneto)

Model no. 4370 s/no. 12011131- ignition harness coupling intact and in good condition, contact breaker point in good condition. Overall condition of the magneto found no abnormalities

ii) LH magneto (Slick Magneto) with impulse coupling

Model no. 4371 s/no. 12041651- ignition harness coupling intact and in good condition, contact breaker point in good condition. With impulse coupling, the firing test can be performed in situ for the functional test, found to be working properly. Overall condition of the magneto found no abnormalities.

Observation in the cockpit found the magneto switch in 'L' position, for take-off supposed to be in 'BOTH' position or in 'OFF' position during the emergency.

4.3.1.2 Carburettor (Part no. :10-5217 s/no.: CK12226)

Sustained impact damage on the induction box, no damage on the carburetor body.Evidence of fuel contained in the carburetor. Fuel is sprayed whenever the throttle arm operates which indicates the fuel was supplied and not starved. The carburetor filter screen was also inspected and found no debris or any evidence of blockage. Overall condition of the carburetor found no abnormalities.

4.3.1.3 Engine Driven Pump

Sustain impact damage on the bottom of the pump (punctured by the broken linkage). Unable to verify the functionality of the pump due to the damage. Overall condition of the pump found no abnormalities.

4.3.1.4 Electrical Fuel Pump

The filter was inspected and found no evidence of blockage. Overall condition of electrical fuel pump found no abnormalities.

The switch in the cockpit indicates that the pump was in operative mode. The selector was switched ON.

4.3.1.5 Gascolator Fuel Drain

Sustained impact damage, filter not found. Unable to be verified due to the damage. The cup holding the filter was broken and detached.

With the engine inspected, the fuel system and ignition system found no abnormalities which could lead to engine failure. However, the engine is sent to C & A Aviation Sdn. Bhd. for further inspection and testing for verification.

4.4 Fuel system inspection

The fuel and oil samples recovered from the wreckage on the first day of the investigation were sent for lab testing to check if there any possibility of fuel contamination.

4.5 Propeller inspection

Both the propeller was still attached to the hub with one blade bent inward and the other sustained multiple scratches. The coning spinner sustained impact crushed but still attached to the hub.

4.6 Stall warning

During the inspection, the stall warning CB was found to be in "pop-out" condition.

4.7 Engine Test Analysis

The engine test was performed at C&A Aviation on 15 & 16 August 2022. From the analysis report, it was found that the engine was in a good confition and no abnormalities was found on the ignition system, carburation system and the engine modelue itselt.

5 Recommended Action

Based on the inspection and engine analysis done, airworthiness team found that the aircraft was in a good condition before the accident happened. The maintenance of the aircraft was propery maintained accordingly to the approved maintenance program. Therefore, Airworthiness team not able to recommend any recommendation at this point of time.

6 Remarks/Conclusion

From our investigation, the aircraft was crash due to loss of power couldn't be verified. There was no evidence of engine fuel starvation and no fuel leakage appeared during the investigation. Furthermore, the maintenance history of the aircraft was perfectly maintained.

APPENDIX C

LABORATORY TEST RESULTS FOR FUEL AND ENGINE OIL SAMPLE

INSTITUT PENYELIDIKAN SAINS DAN TEKNOLOGI PERTAHANAN
SCIENCE AND TECHNOLOGY RESEARCH INSTITUTE FOR DEFENCE
KEMENTERIAN PERTAHANAN MALAYSIA
KOMPLEKS INDUK STRIDE
TAMAN BUKIT MEWAH FASA 9
43000 KAJANG
SELANGOR

STRIDE

Tel. : 03-87324400
www.stride.gov.my

Ruj Kami : KP/STRIDE/BTJA/CTB/ 600-10/3/2 Jld 6 (26)
Tarikh : 15 Sept. 2022

Ketua Setiausaha
Kementerian Pengangkutan Malaysia
No. 26, Jalan Tun Hussein 2, Oresint 4,
Pusat Pentadbiran Kerajaan Persekutuan,
62100 PUTRAJAYA
(u.p: **Brigedier Jeneral Izani bin Ismail, TUDM**)

Tuan,

KEPUTUSAN UJIAN CONTOH BAHANAPI PESAWAT PIPER WARRIOR II YANG TERHEMPAS DI SUNGAI PINJI, IPOH, PERAK PADA 1 OGOS 2022

Dengan segala hormatnya saya merujuk kepada surat tuan MOT (S).600-5/4/86(1) bertarikh 08 Ogos 2022 mengenai perkara di atas.

2. Bersama ini disertakan laporan makmal (TB/P2292/078 (B)) yang telah selesai dilaksanakan.

Sekian, terima kasih.

"WAWASAN KEMAKMURAN BERSAMA 2030"
"BERKHIDMAT UNTUK NEGARA"
"PERTAHANAN NEGARA, TANGGUNGJAWAB BERSAMA"

Saya yang menjalankan amanah,

(HARYATTI MOHD ARIF)
b.p: Ketua Pengarah STRIDE

INSTITUT PENYELIDIKAN SAINS DAN TEKNOLOGI PERTAHANAN (STRIDE)
Kompleks Induk
Taman Bukit Mewah Fasa 9
43000 Kajang Selangor
TEL: 03-87324400 FAX: 03-87336219

STRIDE

REPORT

Report No: TB/P2292/078(B)

Date of Issue: 15 September 2022

Customer's Reference:
MOT(S).600-5/4/86(1) dated 8 Ogos 2022

Customer's Name and Address:
Ketua Setiausaha
Kementerian Pengangkutan Malaysia
No. 26, Jalan Tun Hussein2, Presint 4
Pusat Pentadbiran Kerajaan Persekutuan
62100 PUTRAJAYA
(Attn: Brigedier Jeneral Izani bin Ismail TUDM)

STRIDE's Reference:
KP/STRIDE/BTJA/CTB/600-10/3/2 Jld 6 (26)

Sample Description:

Type:	AVGAS, Lubricant
Quantity:	3
Identification:	**RH Wing Tank, LH Wing Tank (AVGAS 100LL)**
	Engine Oil [Aeroshell W100]
Date Received:	08 August 2022
Location of Testing:	Laboratory Technology Material

Approved for issue:

Ir. Zainol Abidin bin Awang Sa
Director
Mechanical & Aerospace
Technology Division

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Background

Two (2) AVGAS 100LL samples labelling as RH Wing Tank and LH Wing Tank and one (1) Aeroshell W100 sample labelling as engine oil were sent to Materials Technology Laboratory for laboratory testing.

Methodology

1. Testing methods for AVGAS samples

   a. ASTM D86 Standard Test Method for Distillation of Petroleum Products and Liquid Fuels at Atmospheric Pressure

   b. ASTM D4052 Standard Test Method for Density, Relative Density, and API Gravity of Liquids by Digital Density Meter

   c. ASTM D2624 Standard Test Methods for Electrical Conductivity of Aviation and Distillate Fuels

   d. ASTM D5006 Standard Test Method for Measurement of Fuel System Icing Inhibitors (Ether Type) in Aviation

2. Testing methods for Engine Oil sample

   a. ASTM D7042 Standard Test Method for Dynamic Viscosity and Density of Liquids by Stabinger Viscometer (and the Calculation of Kinematic Viscosity)

   b. ASTM D92 Standard Test Method for Flash and Fire Points by Cleveland Open Cup Tester

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Report No : TB/P2292/078(B)
Date of Issue : 15 September 2022

STRIDE

Test Results

	Property	Units	Test Method	Test Limits		Sample RH Wing Tank (AVGAS 100LL)	Sample LH Wing Tank (AVGAS 100LL)
				DEF STAN 91-90 Issue 5	MSDS Petronas (Avgas 100LL Version 1.0 dated 11.04.2016)		
1	*Appearance	-	Visual	Clear, bright and visually free from solid matter and undissolved water at ambient temperature.	Light blue. Clear and bright liquid.	Blue. Bright and clear, visually free from undissolved water at ambient temperature, contains some dirt.	Blue. Bright and clear, visually free from undissolved water at ambient temperature, contains some dirt.
2	Distillation						
2.1	Initial Boiling Point,	°C		Report	25 - 170	56.5	44.2
2.2	10%	°C	ASTM	Max 75		92.1	77.4
	Evaporated	°C	D86	Min 75		103.9	101.2
2.3	40%	°C		Max 105		105.5	104.2
	Evaporated	°C		Max 135		112.8	112.5
2.4	50%	°C		Max 170		148.7	165.2
	Evaporated						
2.5	90%	°C		Min 135			
	Evaporated						
2.6	Final Boiling					197.6	181.6
	Point	%v/v		Max 1.5			
2.7	Sum of	%v/v		Max 1.5			
	10%+50%					0.9	0.9
	Evaporated					2.9	4.5
2.8	Residue						
2.9	Loss						
3	Density at 15°C	g/cm³	ASTM D4052	Report	0.700 -0.760	733.4	727.1

* **Not SAMM** Accreditated.

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Report No : TB/P2292/078(B)
Date of Issue : 15 September 2022

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	Property	Unit	Test Method	Test Limits **MIL-L-22851D**	Sample **Engine Oil**
1	*Appearance	-	Visual	-	Black and opaque
2	*Kinematic Viscosity at 40°C, min	mm^2/s	ASTM D445	Report	246.0 (ASTM D7042)
3	*Kinematic Viscosity at 100°C, min	mm^2/s	ASTM D445	16.3 – 21.9	20.36 (ASTM D7042)
4	*Flash Point, COC (min)	°C	ASTM D92	243	248

Note: The Kinematic Viscosity Test was performed by third party laboratory which not under SAMM accredited. The test required for the sample is using ASTM D445 Test Method, Standard Test Method for Kinematic Viscosity of Transparent and Opaque Liquids (and Calculation of Dynamic Viscosity). The laboratory, however, is using ASTM D7042, Standard Test Method for Dynamic Viscosity and Density of Liquids by Stabinger Viscometer (and the Calculation of Kinematic Viscosity). The result stated in the report is obtained using ASTM D7042, while the limits are in accordance with ASTM D445 Test Method.

*** Not SAMM Accreditated**

Findings

1. Both samples **RH Wing Tank** and **LH Wing Tank** were found contain some dirt.
2. The sample **Engine Oil [Aeroshell W100]** was found complying with the requirement of specification **MIL-L-22851D** on properties tested.

Conclusions

AVGAS 100LL sample test limits are refer to requirements in DEF STAN 91-90 Issue 5 and MSDS Petronas (Avgas 100LL Version 1.0 dated 11.04.2016) while engine oil (aeroshell W100) is based on specification MIL-L-22851D.

Verified by:

Haryatti binti Mohd Arif
Head of Branch
Materials Technology Branch

Prepared by:

ChM. TAN LAY HONG
Research Officer
Materials Technology Branch

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APPENDIX D

**AIRCRAFT 9M-BAA ENGINE INSPECTION REPORT –
C & A AVIATION SDN. BHD.**

C & A AVIATION SDN.BHD.(782482-X)
Location: Lot AP 5, Senai Aerospace Park 1, Senai International Airport
81250 Johor Bahru, Johor, Malaysia
Postal address: Letter Box No. 2, Senai Cargo Centre, Senai International Airport
81250 Johor Bahru, Johor, Malaysia

AIRCRAFT 9M-BAA ENGINE INSPECTION REPORT

1

C & A AVIATION SDN.BHD.(782482-X)
Location: Lot AP 5, Senai Aerospace Park 1, Senai International Airport
81250 Johor Bahru, Johor, Malaysia
Postal address: Letter Box No. 2, Senai Cargo Centre, Senai International Airport
81250 Johor Bahru, Johor, Malaysia

TABLE OF CONTENTS

C & A AVIATION SDN.BHD. (782482-X)
Location: Lot AP 5, Senai Aerospace Park 1, Senai International Airport
81250 Johor Bahru, Johor, Malaysia
Postal address: Letter Box No. 2, Senai Cargo Centre, Senai International Airport
81250 Johor Bahru, Johor, Malaysia

INTRODUCTION

On 8th August 2022, under instruction AAIB, aircraft 9M-BAA engine has been sent to C&A Aviation Sdn. Bhd. (LYCOMING Engine Approved Service Centre) for the further inspection. The inspection was done from 8th to 9th August 2022.

The inspection was joined by:

AAIB:

1. Datuk Yee Yit Hong

CAAM (Airworthiness):

1. Mazlan b. Mat Jan

BATS Aviation:

1. Hazlee Jehan b. Hashim
2. Muhammad Yasser b. Kamarudin
3. Muhammad Aufa Azim. Osman

Executive Jet Aviation:

1. Tharuma Dorai A/L Ratnasingam

C & A AVIATION SDN.BHD.(782482-X)
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It was agreed for the inspection to be divided into three major sections:

1. Ignition system test
2. Carburation system test
3. Engine physical inspection

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1. IGNITION SYSTEM TEST

To inspect the magnetos, ignition harness and spark plugs for functionality and endurance check.

1.1 RIGHTHAND MAGNETO:

a. Basic details:

i. Type: SLICK MAGNETO

ii. Model No.: 4370

iii. S/N: 12011131

b. Work carried out:

i. Removing the gearing for preparation of the bench test. The MAGNETO is placed on the special stand.

ii. MAGNETO timing check – Found SATISFACTORY.

iii. Internal gearing of the MAGNETO inspected and found that the internal gearing is still good.

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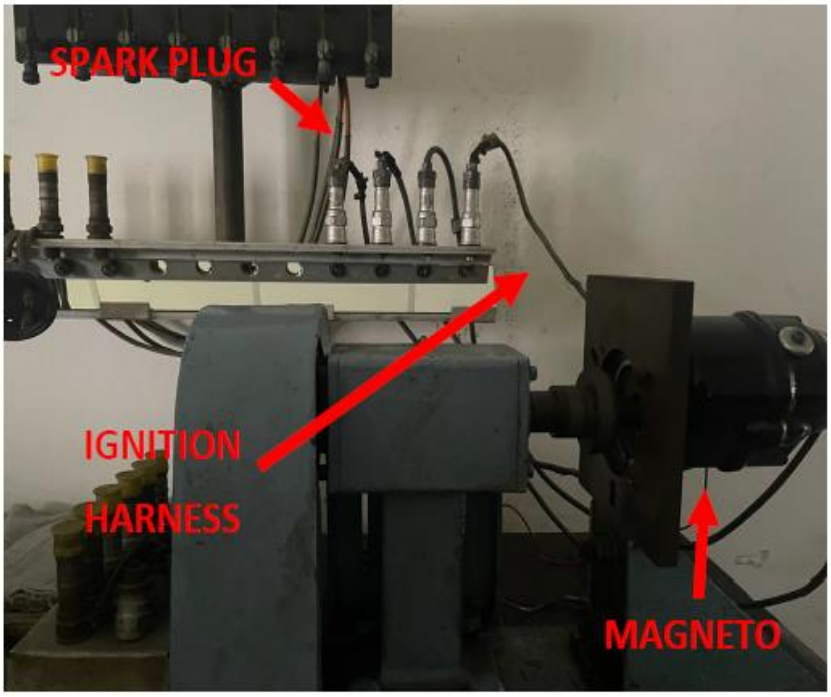
81250 Johor Bahru, Johor, Malaysia

iv. Then after, the MAGNETO is placed onto the magneto bench test machine for further inspection, the ignition harness and the spark plus used is the bench's:



*MAGNETO, Ignition harness and spark plug on the bench test.

v. Initial test at low RPM (700 RPM) found the MAGNETO is performing good. The quality of the spark produced is good and the MAGNETO test (earthing) found satisfactory.

6

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vi. Further are result of the test carried out on the MAGNETO:

No.	Speed	Temperature (Degree Fahrenheit)	MAGNETO Switch (earthing)	Spark
1.	1800 RPM	96.4	GOOD	GOOD
2.	2000 RPM	101.5	GOOD	GOOD
3.	2400 RPM	107.5	GOOD	GOOD
4.	2700 RPM	116.8	GOOD	GOOD

Note : Each reading is taken after 5 minutes interval

Note : Increment of the temperature is gradual, means the internal bearing of the MAGNETOS is good.

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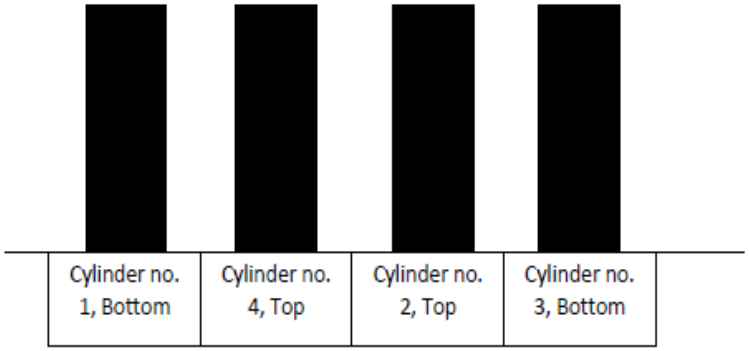
vii. The original ignition harness from the aircraft then installed to the MAGNETO and the spark plus used is the bench's:

Location of the ignition harness to the engine cylinder



viii. Further are result of the test carried out on the ignition harness:

No.	Location	Speed 2000 RPM	Speed 2400 RPM	Speed 2700 RPM
1.	Cylinder no. 1, Bottom	GOOD	GOOD	GOOD
2.	Cylinder no. 4, Top	GOOD	GOOD	GOOD
3.	Cylinder no. 2, Top	GOOD	GOOD	GOOD
4.	Cylinder no. 3, Bottom	GOOD	GOOD	GOOD

Note : All ignition harness earthing test (MAGNETO switch) found satisfactory.

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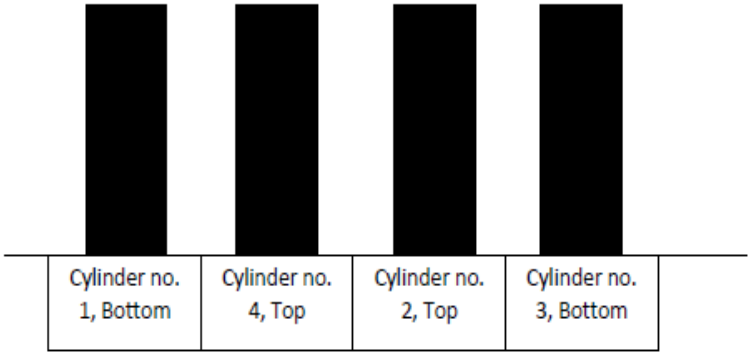
81250 Johor Bahru, Johor, Malaysia

ix. The original spark plugs from the aircraft then installed to the ignition harness and the MAGNETO:

Location of the spark plugs to the engine cylinder



x. Further are result of the test carried out on the spark plugs:

No.	Location	Speed 2000 RPM	Speed 2400 RPM	Speed 2700 RPM
1.	Cylinder no. 1, Bottom	**The test is not done due to impact damaged to the spark plug during the incident.**		
2.	Cylinder no. 4, Top	GOOD	GOOD	GOOD
3.	Cylinder no. 2, Top	GOOD	GOOD	GOOD
4.	Cylinder no. 3, Bottom	GOOD	GOOD	GOOD

Note : All spark plugs earthing test (MAGNETO switch) found satisfactory.

C & A AVIATION SDN.BHD.(782482-X)
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81250 Johor Bahru, Johor, Malaysia

1.2 LEFTHAND MAGNETO:

a. Basic details:

i. Type: SLICK MAGNETO

ii. Model No.: 4371

iii. S/N: 12041651

b. Work carried out:

i. Removing the gearing for preparation of the bench test. The MAGNETO is placed on the special stand.

ii. MAGNETO timing check – Found SATISFACTORY.

iii. Internal gearing of the MAGNETO inspected and found that the internal gearing is still good.

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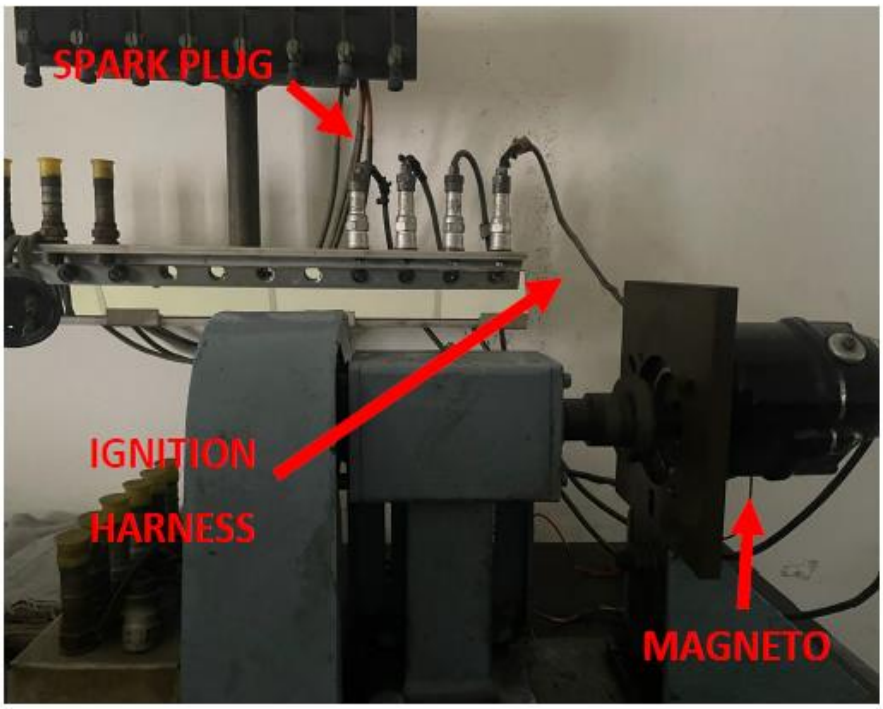
iv. Then after, the MAGNETO is placed onto the magneto bench test machine for further inspection, the ignition harness and the spark plus used is the bench's:



*MAGNETO, Ignition harness and spark plug on the bench test.

v. Initial test at low RPM (300 RPM where the impulse coupling starting to disengage) found the MAGNETO is performing good. The quality

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of the spark produced is good and the MAGNETO test (earthing) found satisfactory.

vi. Further are result of the test carried out on the MAGNETO:

No.	Speed	Temperature (Degree Fahrenheit)	MAGNETO Switch (earthing)	Spark
1.	1800 RPM	91.0	GOOD	GOOD
2.	2000 RPM	94.9	GOOD	GOOD
3.	2400 RPM	99.0	GOOD	GOOD
4.	2700 RPM	103.0	GOOD	GOOD

Note : Each reading is taken after 5 minutes interval

Note : Increment of the temperature is gradual, means the internal bearing of the MAGNETOS is good.

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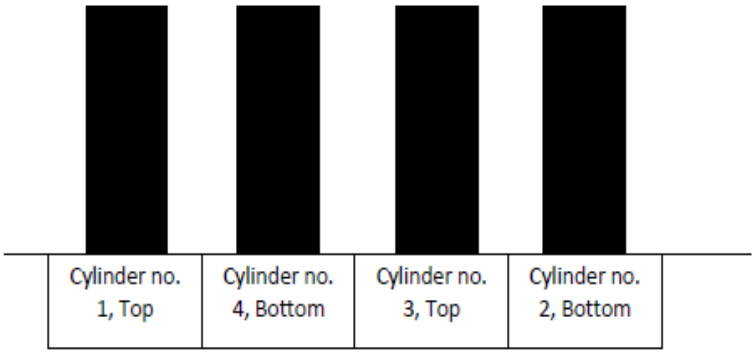
vii. The original ignition harness from the aircraft then installed to the MAGNETO and the spark plus used is the bench's:

Location of the ignition harness to the engine cylinder



viii. Further are result of the test carried out on the ignition harness:

No.	Location	Speed 2000 RPM	Speed 2400 RPM	Speed 2700 RPM
1.	Cylinder no. 1, Top	GOOD	GOOD	GOOD
2.	Cylinder no. 4, Bottom	GOOD	GOOD	GOOD
3.	Cylinder no. 3, Top	GOOD	GOOD	GOOD
4.	Cylinder no. 2, Bottom	GOOD	GOOD	GOOD

Note : All ignition harness earthing test (MAGNETO switch) found satisfactory.

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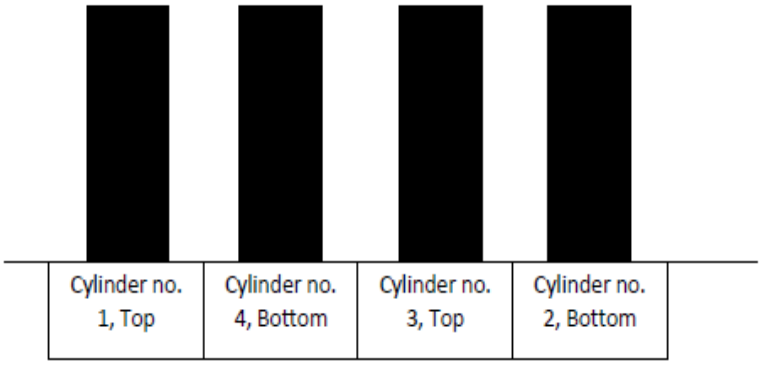
ix. The original spark plugs from the aircraft then installed to the ignition harness and the MAGNETO:

Location of the spark plugs to the engine cylinder



x. Further are result of the test carried out on the spark plugs:

No.	Location	Speed 2000 RPM	Speed 2400 RPM	Speed 2700 RPM
1.	Cylinder no. 1, Top	GOOD	GOOD	GOOD
2.	Cylinder no. 4, Bottom	GOOD	GOOD	GOOD
3.	Cylinder no. 3, Top	GOOD	GOOD	GOOD
4.	Cylinder no. 2, Bottom	GOOD	GOOD	GOOD

Note : All spark plugs earthing test (MAGNETO switch) found satisfactory.

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Summary of the Ignition system test:

No faulty is found on the ignition system (Magnetos, Ignition harnesses and spark plugs). Ignition system test found satisfactory.

ENGINE / MAGNETO PERFORMANCE

a. **On LYCOMING O-320-D3G both LH & RH magnetos are timed at 20 deg. BTDC on compression stroke.**

b. **When both magnetos fire, correct fuel/air mixture burns and maximum pressure exert on piston at the beginning of power stroke.**

c. **If only one magneto fires fuel/air mixture will take longer time to burn and pressure on piston will be somewhat delay. Engine power output, accordingly will be affected.**

d. **It is imperative to ensure both magnetos are serviceable, correctly timed to engine.**

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2. CARBURETION SYSTEM TEST

To inspect the carburettor and the system for any physical damage, functionality and the endurance.

2.1 BASIC DETAILS

i. Type: Marvel-Schebler Aircraft Carburettors (MA-4SPA)

ii. Model No.: 10-5217

iii. S/N: CK12226

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2.2 WORK CARRIED OUT

i. Removing damaged air box from the carburettor.

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ii. Physical inspection of the carburettor condition.

No physical damage found; carburettor looks good.

Note: Air box damaged due to impact during the accident.

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2.3 TEST 1:

With the fuel added to the carburettor fuel inlet, then the throttle arm lever is moved. Fuel seen to be ejected via injector nozzle.

Inspection of the injector nozzle found fuel is ejected. No blockage by the butterfly valve. **Found satisfactory**.

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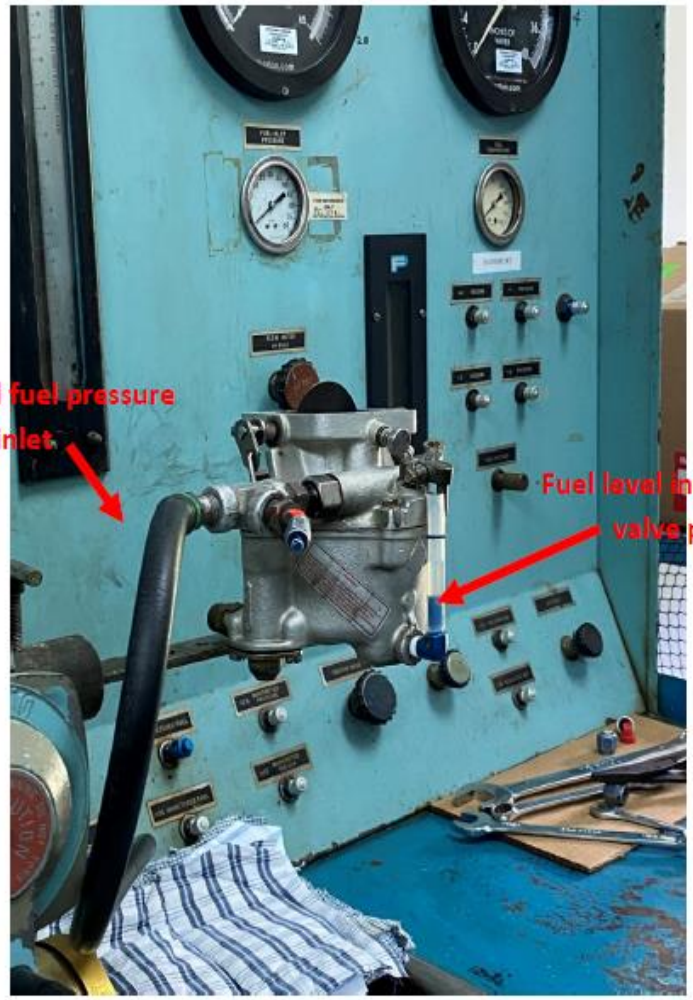
2.4 Test 2:

The carburettor is the placed on the test bench. Carburettor fuel inlet then is connected to calibrated fuel pressure inlet of the test bench. This is to test the ability of the float valve in holding the fuel and test the leaking.



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The results are as followed:

No.	Input fuel pressure	Observation
1.	3 psi	Float valve is able to maintain the fuel. No leaks observed.
2.	4 psi	Float valve is able to maintain the fuel. No leaks observed.
3.	5 psi	Float valve is able to maintain the fuel. No leaks observed.
4.	6 psi	Float valve is able to maintain the fuel. No leaks observed.

Note: Light knocking onto carburettor body to simulate turbulence condition. Float valve is still able to maintain the fuel. No leaks observed.

Note: Normal engine fuel operation pressure is 5 psi.

Summary of the Carburation system test:

No faulty is found on the carburettor system (carburettor).

Carburation system test found satisfactory.

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3. ENGINE PHYSICAL INSPECTION

To inspect the engine condition, for any damage that may lead to the possible engine failure.

3.1 BASIC DETAILS

i. Type: TEXTRON LYCOMING Aircraft Engine

ii. Model No.: O-320-D3G

iii. S/N: RL 10035-39E

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3.2 WORK CARRIED OUT

i. Engine is placed on the stand.

ii. Engine baffle removed.

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iii. Accessories case removed and checked for condition.

FOUND SATISFACTORY

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iv. Oil sump removed and checked for condition. FOUND SATISFACTORY.

v. Both magneto driven gears removed and checked for condition. FOUND SATISFACTORY.

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vi. Removing crankshaft-accessories driven gear and checked for condition. FOUND SATISFACTORY.

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vii. Inspecting the crankshaft-accessories driven gear's bolt. FOUND SATISFACTORY.

Note: Bolt's locking tab still intact.

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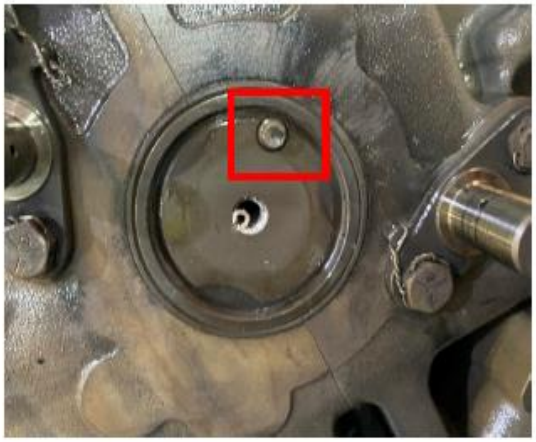
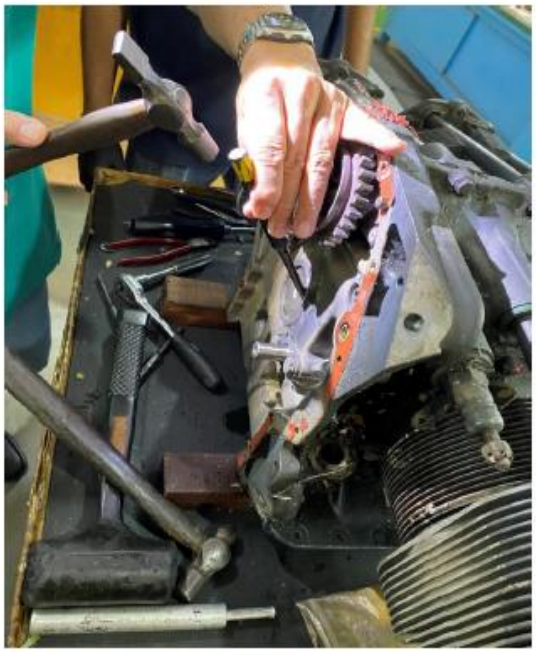
viii. Inspecting the dowel pin the condition especially for looseness and crack. Knocking the dowel pin with punch to hear the sound. Sound of the dowel pin is solid. FOUND SATISFACTORY.





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ix. All cylinder's rocker box, rocker arms, and push-rod. Condition inspected. FOUND SATISFACTORY.

Note: Rocker box removed.

Note: Rocker arm removed.

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Note: Push-rod removed.

x. Removing cylinder barrel and inspected for condition. No damaged found except for cylinder No. 1 cooling fin (damage due to impact). FOUND SATISFACTORY.

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Note: Barrel removed off the engine.

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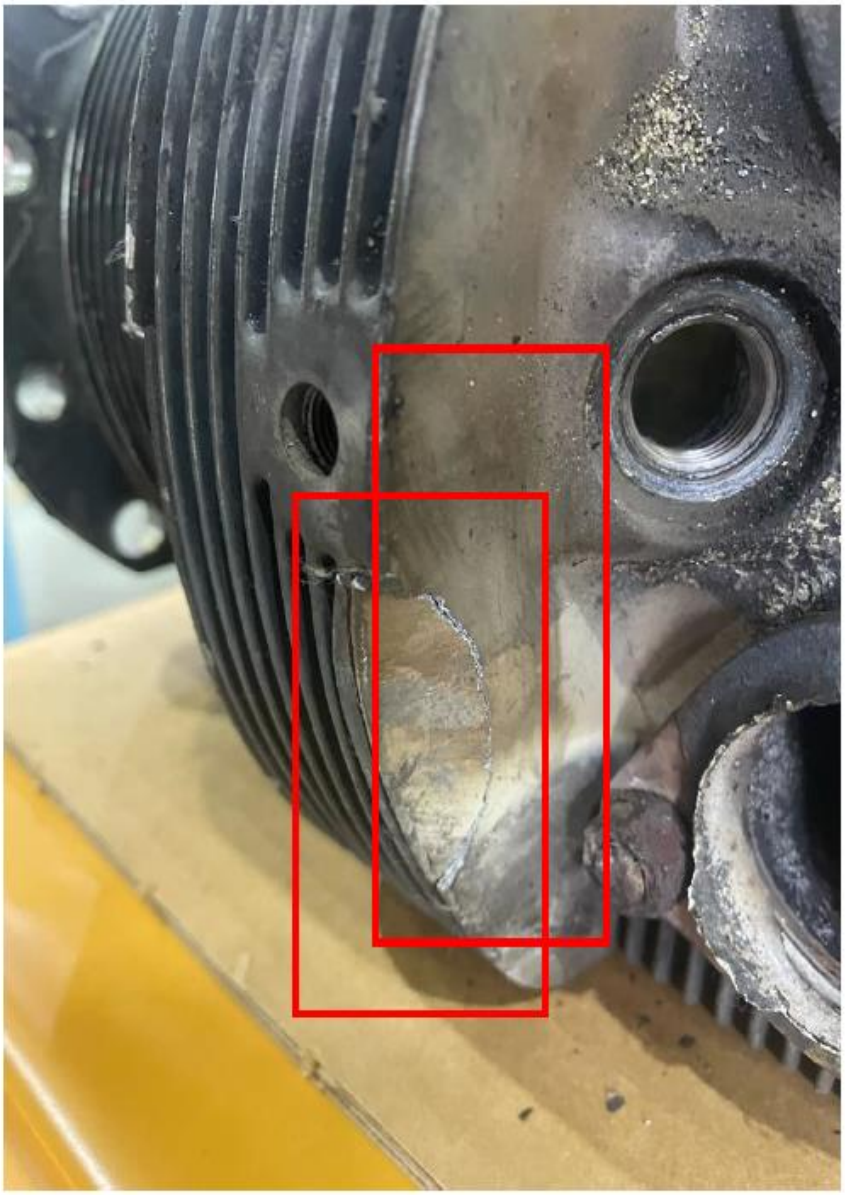

Note: Cylinder No. 1 cooling fin damage due to impact.

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xi. Piston removed from the piston rod. Piston, piston ring and piston rod checked for condition. FOUND SATISFACTORY.

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Note: Piston rod checked for gap. Found satisfactory.

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xii. Carried out DTI (Dial test indicator) for crankshaft run out. Tolerance is within limit. FOUND SATISFACTORY.

Summary of the Engine physical inspection test:

No faulty is found on the engine physical. Physical inspection carried out found satisfactory.

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4. SUMMARY OF THE INSPECTION

Inspection of the ignition system, carburation system and engine physical found no faulty.

INSPECTION CARRIED FOUND SATISFACTORY.

Report prepared by,

K. H. Chui, M.S.

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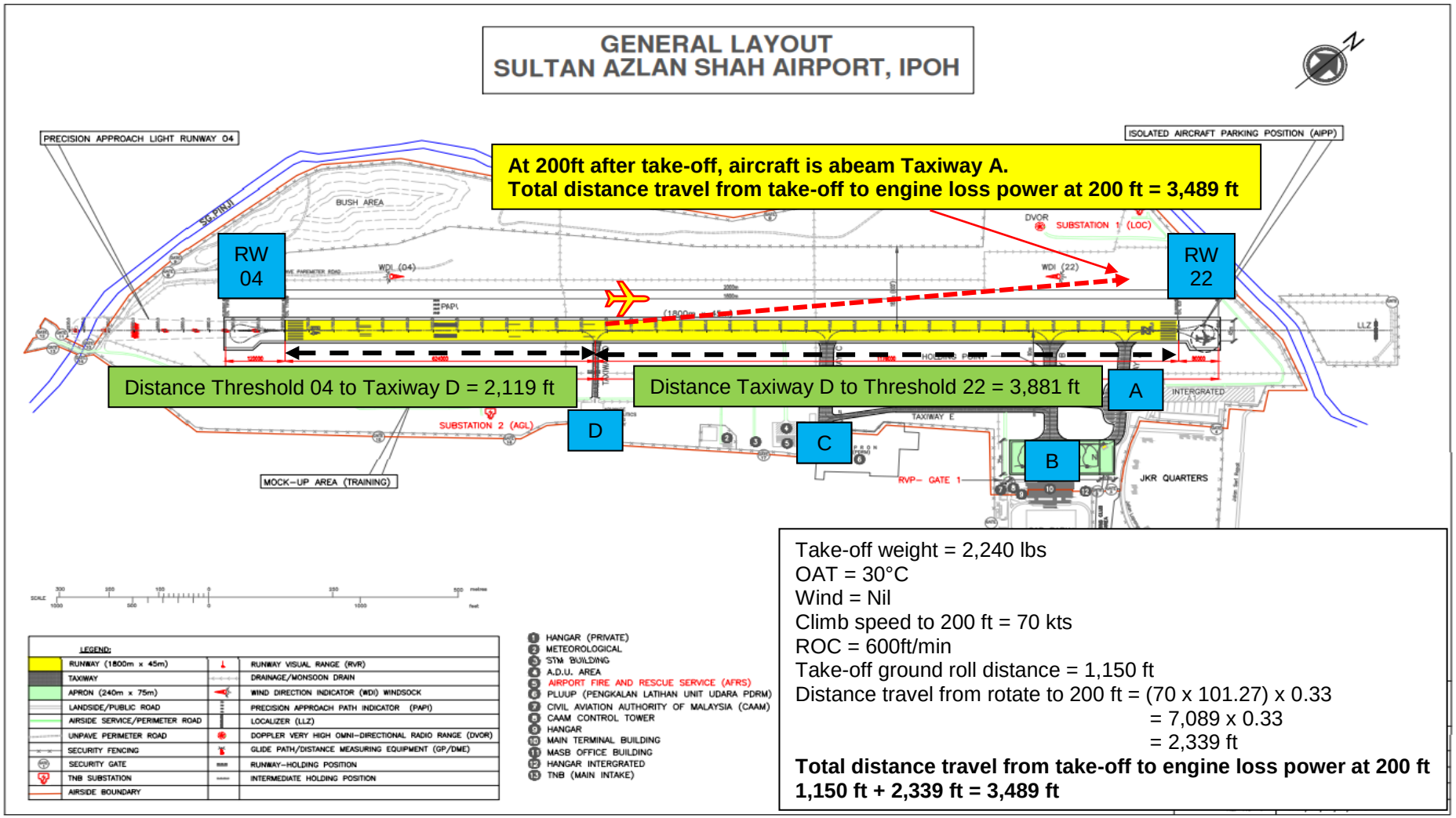
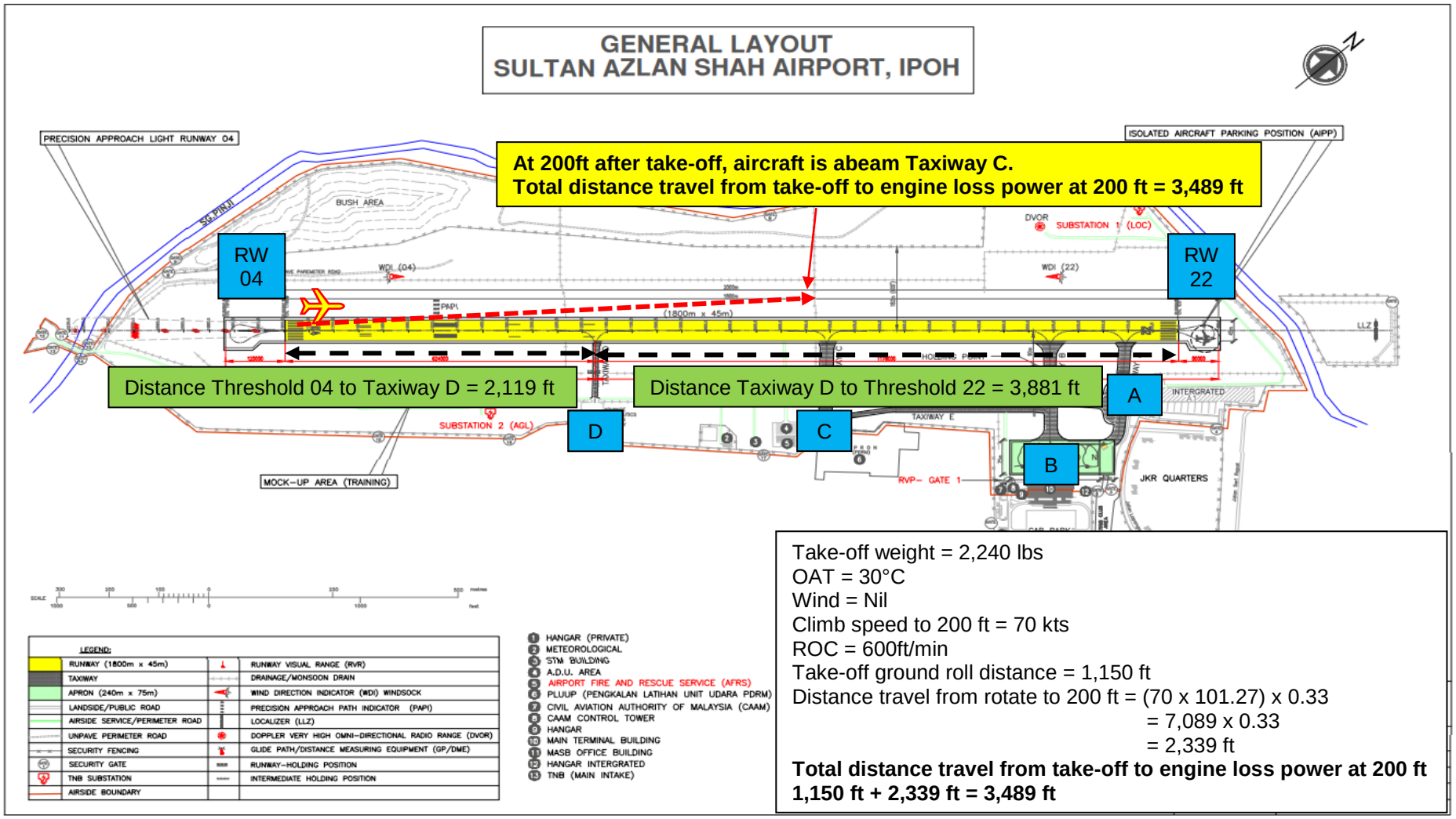
APPENDIX E

AIRCRAFT GROUND POSITION WHEN TAKE-OFF FROM INTERSECTION 'D'



AIRCRAFT GROUND POSITION WHEN TAKE-OFF FROM THRESHOLD RUNWAY 04



APPENDIX F

HUMAN FACTORS ANALYSIS AND CLASSIFICATION SYSTEM (HFACS) WORKSHEET A 03/22 PIPER WARRIOR II PA28-161 9M-BAA

1. This worksheet is on HFACS. It is divided into four (4) sections having question pertaining to that area. There are total 147 statements and each statement is to be rated on a 4-point scale, where:

a. **4 - Primary cause**. Main factors that directly contributed to / responsible for accident/incident.
b. **3 - Secondary cause**. Factor was present but not the most important / critical factor responsible for accident / incident and contributed indirectly.
c. **2 -** Factor was present but didn't affect the outcome at all, was not contributory.
d. **1 -** Factor was not present.

2. It is mandatory to rate each statement. Wherever the rating is 2, 3 or 4 the explanation has to be provided for the reasons responsible in a narrative form at the end of the rating sheet.

TIER 1 - UNSAFE ACTS

AE - Errors

		4	3	2	1
AE 1	**Skill-Based Errors**				
AE 1.1	Inadvertent Operation	√			
AE 1.2	Checklist Error				√
AE 1.3	Procedural Error				√
AE 1.4	Over-control / Under-control				√
AE 1.5	Breakdown in Visual Scan				√
AE 1.6	Inadequate Anti - 'G' Straining Manoeuvre				√

		4	3	2	1
AE 2	**Judgement and Decision-Making Errors**				
AE 2.1	Risk Assessment – During Operation				√
AE 2.2	Task Misprioritization				√
AE 2.3	Necessary Action – Rushed		√		
AE 2.4	Necessary Action – Delayed				√
AE 2.5	Caution / Warning – Ignored				√
AE 2.6	Decision-making During Operation	√			
		4	3	2	1
AE 3	**Misperception Error**				
AE 3.1	Errors due to Misperception				√

AV – Violations

		4	3	2	1
AV 1	Violations - Based on Risk Assessment				√

AV 2	Violations - Routine / Widespread				√
AV 3	Violations – Lack of Discipline				√

TIER 2 - PRECONDITIONS FOR UNSAFE ACTS

PE - Environmental Factors

		4	3	2	1
PE 1	**Physical Environment**				
PE 1.1	Vision Restricted by Icing/Windows Fogging/etc.				√
PE 1.2	Vision Restricted by Meteorology Conditions				√
PE 1.3	Vibration				√
PE 1.4	Vision Restricted in Workspace by Dust/Smoke/etc.				√
PE 1.5	Windblast				√
PE 1.6	Thermal Stress-Cold				√
PE 1.7	Thermal Stress-Heat				√
PE 1.8	Manoeuvring Forces-In-Flight				√
PE 1.9	Lighting of another Aircraft / Vehicle				√
PE1.10	Noise Interference				√
PE 1.11	Brownout / Whiteout				√

		4	3	2	1
PE 2	**Technology Environment**				
PE 2.1	Seating and Restraints				√
PE 2.2	Instrumentation and Sensory Feedback Systems				√
PE 2.3	Visibility Restriction				√
PE 2.4	Controls and Switches			√	
PE 2.5	Automation				√
PE 2.6	Workspace Incompatible with Human				√
PE 2.7	Personal Equipment Interference				√
PE 2.8	Communications - Equipment				√

PC - Conditions of Individual

		4	3	2	1
PC 1	**Cognitive Factors**				
PC 1.1	Inattention				√
PC 1.2	Channelized attention				√
PC 1.3	Cognitive Task Oversaturation				√
PC 1.4	Confusion				√
PC 1.5	Negative Transfer				√
PC 1.6	Distraction				√
PC 1.7	Geographic Misorientation (Lost)				√
PC 1.8	Checklist Interference				√

		4	3	2	1
PC 2	**Psycho-Behavioural Factors**				
PC 2.1	Pre-Existing Personality Disorder				√

PC 2.2	Pre-Existing Psychological Disorder				√
PC 2.3	Pre-Existing Psychosocial Disorder				√
PC 2.4	Emotional State				√
PC 2.5	Personality Style				√
PC 2.6	Overconfidence				√
PC 2.7	Pressing Beyond Limits				√
PC 2.8	Complacency		√		
PC 2.9	Inadequate Motivation				√
PC 2.10	Misplaced Motivation				√
PC 2.11	Overaggressive				√
PC 2.12	Excessive Motivation to Succeed				√
PC 2.13	Get-Home-It is / Get-There-Itis				√
PC 2.14	Response Set				√
PC 2.15	Motivational Exhaustion (Burn out)				√

		4	3	2	1
PC 3	**Adverse Physiological State**				
PC 3.1	Effects of G-Forces (G-LOC, etc,)				√
PC 3.2	Prescribed Drugs				√
PC 3.3	Operational Injury/Illness				√
PC 3.4	Sudden Incapacitation / Unconsciousness				√
PC 3.5	Pre-Existing Physical Illness/Deficit				√
PC 3.6	Physical Fatigue (Overexertion)				√
PC 3.7	Fatigue – Physiological / Mental				√
PC 3.8	Circadian Rhythm Desynchrony				√
PC 3.9	Motion Sickness				√
PC 3.10	Trapped Gas Disorders				√
PC 3.11	Evolved Gas Disorders				√
PC 3.12	Hypoxia				√
PC 3.13	Hyperventilation				√
PC 3.14	Visual Adaption				√
PC 3.15	Dehydration				√
PC 3.16	Physical Task Oversaturation				√

		4	3	2	1
PC 4	**Physical / Mental Limitation**				
PC 4.1	Learning Ability / Rate				√
PC 4.2	Memory Ability / Lapses				√
PC 4.3	Anthropometric / Biomechanical Limitations				√
PC 4.4	Motor skill / Coordination or Timing deficiency				√
PC 4.5	Technical / Procedural Knowledge				√

		4	3	2	1
PC 5	**Perceptual Factors**				
PC 5.1	Illusion – Kinesthetics				√
PC 5.2	Illusion – Vestibular				√
PC 5.3	Illusion – Visual				√

PC 5.4	Misperception of Operational Conditions				√
PC 5.5	Misinterpreted / Misread Instrument				√
PC 5.6	Expectancy				√
PC 5.7	Auditory Cues				√
PC 5.8	Spatial Disorientation (Type 1) Unrecognized				√
PC 5.9	Spatial Disorientation (Type 2) Recognized				√
PC 5.10	Spatial Disorientation (Type 3) Incapacitating				√
PC 5.11	Temporal Distortion				√

PP - Personnel Factors

		4	3	2	1
PP 1	**Coordination/Communication/Planning Factors**				
PP 1.1	Crew/Team Leadership				√
PP 1.2	Cross-Monitoring Performance		√		
PP 1.3	Task Delegation				√
PP 1.4	Rank / Position Authority Gradient				√
PP 1.5	Assertiveness				√
PP 1.6	Communicating Critical Information				√
PP 1.7	Standard / Proper Terminology				√
PP 1.8	Challenge and Reply				√
PP 1.9	Mission Planning				√
PP 1.10	Mission Briefing				√
PP 1.11	Task/Mission-In-Progress Re-Planning				√
PP 1.12	Miscommunication				√

		4	3	2	1
PP 2	**Self-Imposed Stress**				
PP 2.1	Physical Fitness				√
PP 2.2	Alcohol				√
PP 2.3	Drugs/Supplements/Self-Medication				√
PP 2.4	Nutrition				√
PP 2.5	Inadequate Rest				√
PP 2.6	Unreported Disqualifying Medical Condition				√

TIER 3 – UNSAFE SUPERVISION

SI - Inadequate Supervision

		4	3	2	1
SI 1	Leadership / Supervision / Oversight Inadequate		√		
SI 2	Supervision-Modelling				√
SI 3	Local Training Issues / Programs				√
SI 4	Supervision – Policy				√
SI 5	Supervision – Personality Conflict				√
SI 6	Supervision-Lack of Feedback				√

SP – Planned Inappropriate Operations

		4	3	2	1
SP 1	Ordered / Led on Mission Beyond Capability				√
SP 2	Crew / Team / Flight Makeup / Composition				√
SP 3	Limited Recent Experience				√
SP 4	Limited Total Experience				√
SP 5	Proficiency				√
SP 6	Risk Assessment – Formal		√		
SP 7	Authorized Unnecessary Hazard				√

SF - Failure Correct Known Problem

		4	3	2	1
SF 1	Personnel Management				√
SF 2	Operations Management		√		

SV - Supervisory Violations

		4	3	2	1
SV 1	Supervision – Discipline Enforcement (Supervision act of Omission)				√
SV 2	Supervision – Defacto Policy				√
SV 3	Directed Violation				√
SV 4	Currency				√

TIER 4 - ORGANIZATIONAL INFLUENCES

OR - Resource/Acquisition Management

		4	3	2	1
OR 1	Air Traffic Control Resources				√
OR 2	Air Field Resources				√
OR 3	Operator Support				√
OR 4	Acquisition Policies / Design Processes				√
OR 5	Attrition Policies				√
OR 6	Accession/Selection Policies				√
OR 7	Personnel Resources		√		
OR 8	Informational Resources / Support				√
OR 9	Financial Resources / Support				√

OC - Organisational Climate

		4	3	2	1
OC 1	Unit / Organisational Values / Culture				√
OC 2	Evaluation / Promotion / Upgrade				√
OC 3	Perceptions of Equipment				√
OC 4	Unit Mission / Aircraft / Vehicle / Equipment Change or Unit Deactivation				√
OC 5	Organisational Structure		√		

OP - Organisational Processes

		4	3	2	1
OP 1	Ops Tempo / Workload				√
OP 2	Program and Policy Risk Assessment				√
OP 3	Procedural Guidance / Publications		√		
OP 4	Organisational Training Issues / Programs				√
OP 5	Doctrine				√
OP 6	Program Oversight / Program Management				√