AIRCRAFT SERIOUS INCIDENT FINAL REPORT

SI 01/23P

Air Accident Investigation Bureau (AAIB)

Ministry of Transport Malaysia

Piper Archer III PA28-181, Registration 9M-SKJ

at an Open Construction Area in Jasin, Malacca

on the 14 February 2023

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AIR ACCIDENT INVESTIGATION BUREAU (AAIB)
MALAYSIA

ACCIDENT REPORT NO.: SI 01/23

OPERATOR	**: MALAYSIAN FLYING ACADEMY SDN BHD**
AIRCRAFT TYPE	**: PIPER ARCHER III PA28-181**
NATIONALITY OF AIRCRAFT	**: MALAYSIA**
REGISTRATION	**: 9M-SKJ**
PLACE OF OCCURRENCE	**: OPEN CONSTRUCTION AREA IN JASIN, MALACCA**
DATE AND TIME	**: 14 FEBRUARY 2023 AT 1100 LT**

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.

The AAIB also conducts investigation into incidents when the occurrence shows evidence to have safety issues concerned.

The 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 16 February 2023 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 15 March 2023.

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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GLOSSARY OF ABBREVIATIONS

A

AAIB	Air Accident Investigation Bureau
ADAHRS	Air Data/Attitude and Heading Reference System
AMO	Approved Maintenance Organisation
ATC	Air Traffic Control
ATO	Approved Training Organisation
ATPL	Air Transport Pilot Licence

C

CAAM	Civil Aviation Authority Malaysia
CPL/IR	Commercial Pilot’s Licence/Instrument Rating
CVR	Cockpit Voice Recorder

E

EFATO	Engine Failure After Take-Off
EGT	Exhaust Gas Temperature
EIS	Engine Indicating System

F

FAA	Federal Aviation Administration
FDR	Flight Data Recorder
FI	Flight Instructor
FIS	Fuel Injection Servo
Ft	feet
FTO	Flight Training Organisation

G

GH	General Handling

H

Hrs	hours

I

ICAO	International Civil Aviation Organisation
i.e.	id est or ‘that is’
IIC	Investigator In-Charge
IR	Instrument Rating

K

KLIA	Kuala Lumpur International Airport
Kts	knots

L

Lbs	pounds
LT	Local Time

M

M	metres
MASB	Malaysia Airports Sdn Bhd
MFA	Malaysian Flying Academy
MFD	Multi-Function Display
MIA	Malacca International Airport
Mins	minutes
MOR	Mandatory Occurrence Report

O

OEM	Original Equipment Manufacturer

P

PFD	Primary Flight Display
PFL	Practice Force Landing
POH	Pilot’s Operating Handbook
Psi	pound per square inch

R

RPM	Revolution per Minute

S

SI	Serious Incident
SOP	Standard Operating Procedures
SP	Student Pilot
SPL	Student Pilot Licence

T

TPM	Training Procedure Manual

U

UTC	Coordinated Universal Time

SYNOPSIS

A Piper PA28-181 aircraft was on a planned training flight for a Student Pilot (SP) callsign ACADEMY 09. The aircraft departed Malacca International Airport (MIA) at 1000 hours for training area R239A2 as per flight brief.

On completion of all training area exercises, a rejoin for overhead Practice Force Landing (PFL) to MIA was requested. After passing the reporting point Chin Chin at 2,000 feet, the aircraft experienced engine vibration and the engine RPM was observed to have reduced from 2,300 RPM to 1,700 RPM. The engine did not response to the throttle advancement by the pilot and the RPM reduced further to below 1,000RPM when the pilot performed the engine roughness checklist.

The pilot decided to secure the engine and make a force landing when the aircraft descended below 1,000 feet with no power response after trouble shooting checks. The aircraft landed in an open construction area in Jasin with no reported damage on the aircraft and properties. Both the pilots safely evacuated from the aircraft with no injuries.

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 incident.

1.0 FACTUAL INFORMATION

1.1 History of the Flight

ACADEMY 09 was a day General Handling (GH) sortie to the training area for the Student Pilot (SP). It was the second sortie of the day for this particular aircraft (9M-SKJ) where a running change (without stopping the engine) was carried out after the first sortie. The pilots did all the necessary checks (ground/power check) in which there were no sign of abnormality during taxi and take-off to training area R239A2.

All plan GH exercises (stalling, steep turn, climbing turn stall, and PFL) were carried out without any sign of abnormalities. The final exercise carried out in the training area was a practiced force landing (PFL). In the PFL exercise, the throttle was reduced to idle and the alternate air was switched to open until the aircraft had reached a minimum altitude of 500 ft. Thereafter, the alternate air was switched to the close position and the throttle advanced to full power to commence a go around to climb to 2,000 ft.

On completion of the training area exercises, a rejoin via PFL overhead was requested and the ATC Controller cleared the aircraft to Chin Chin (reporting point). Approximately 1 minute after passing Chin Chin, the aircraft experienced engine vibrations and the engine RPM was observed to have reduced from 2,300 RPM (cruising power setting) to 1,700 RPM. The Flight Instructor (FI) took over controls of the aircraft and attempted to maintain the power setting by advancing the throttle while simultaneously attempting to maintain the altitude.

The FI asked the SP to carry out engine roughness checklist when the engine power was not responding despite advancing the throttle. The first action in the checklist was to switch the alternate air to the open position, however upon doing so, the engine RPM drastically reduced to 1,000 RPM and it progressively dropped further. Even after the drop-in engine RPM, both the pilots continued with the remaining parts of the checklist for engine roughness but there were still no changes to the engine performance. Subsequently, both the pilots carried out the troubleshoot checks in an attempted to regain power to the engine but there was no response.

The SP asked the FI if the engine should be secured (EFATO checks) as the aircraft was losing altitude and the engine was still not producing sufficient power. On passing below 1,000 ft, the SP secured the engine and the FI made a forced landing at an open construction site which was clear of obstacle. Once the aircraft had fully stopped, both the pilots evacuated the aircraft safely.

The aircraft was secured at site by the police. Air Accident Investigation Bureau (AAIB) Investigation Team arrived at the incident site the next morning (15 February 2023) to conduct site investigation and evidence gathering. The aircraft was cleared from the incident site at about 1600 LT the same day and placed in the aircraft operator's hangar. It was impounded for AAIB investigation. A police report was filed by the Aircraft Operator's Safety Manager at the Police Station in Jasin, Malacca on the same day.

1.2 Injuries to Persons

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

Figure 1: Injuries to Persons

1.3 Damage to Aircraft

Post-incident inspection revealed no damages to the aircraft. Both the aircraft wings were disassembled at the incident site and the aircraft was transported back by road to the aircraft operator's hangar at Batu Berendam, Malacca.

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

1.4 Other Damage

Nil.

1.5 Personnel Information

1.5.1 Pilot in Command – Flight Instructor (FI)

Nationality		Indonesian
Age		30
License Type		CPL
License Expiry		30 Nov 2023
Medical Expiry		30 Nov 2023
Aircraft Rating		Piper PA28
Instructor Rating		FI (2)
Flying Hours	**Total Hours**	3,206
	Total on Type	3,206

Figure 3: Personnel Information – Pilot in Command

1.5.2 Student Pilot (SP)

Nationality		Malaysian
Age		21
License Type		SPL for CPL
License Expiry		31/10/2023
Medical Expiry		31/10/2023
Aircraft Rating		Piper PA28
Instructor Rating		-
Flying Hours	**Total Hours**	150.35
	Total on Type	150.35

Figure 4: Personnel Information – Student Pilot

1.6 Aircraft Information

1.6.1 General

The Piper Archer III PA-28-181 is a single-engine aircraft designed and manufactured by Piper Aircraft, Inc. Florida, United States. The aircraft features a low-wing design, fixed landing gear, fixed-pitch propeller and is powered by a 180-horsepower Lycoming IO-360-B4A engine.

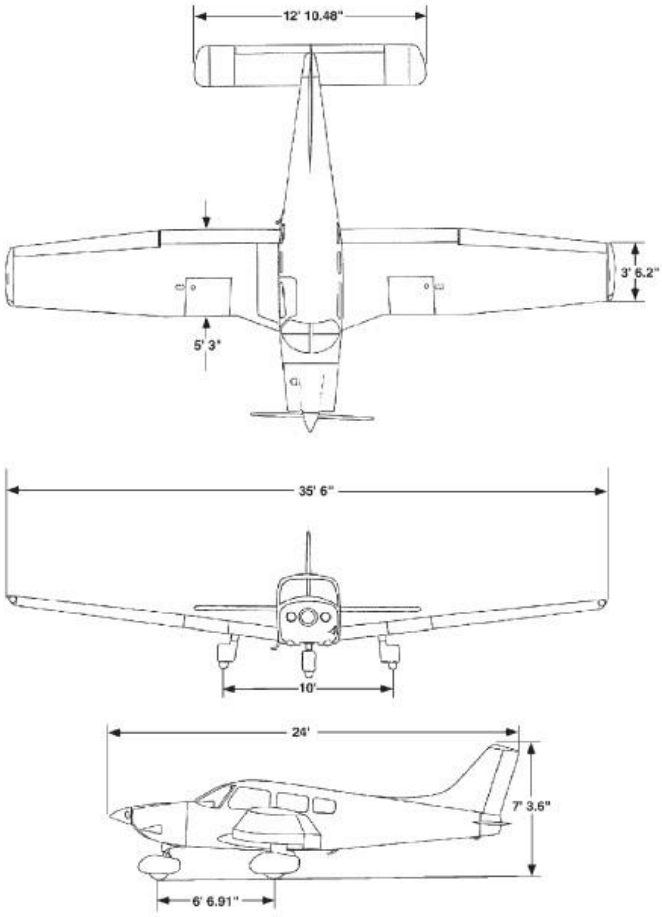


Figure 5: Three view of the aircraft

1.6.2 Aircraft Data

The latest Certificate of Registration was renewed on 18 December 2020 and is valid till 17 December 2023 while the Certificate of Airworthiness was renewed on 30 December 2022 and is valid till 27 January 2024.

Aircraft Type	Piper PA28-181
Manufacturer	Piper Aircraft Incorporation
Year of Manufacture	2019
Owner	Malaysian Flying Academy Sdn Bhd
Registration No.	9M-SKJ
Aircraft Serial No.	2881283
Certificate of Airworthiness Issue / Expiry date	30 Dec 2022 / 27 Jan 2024
Certificate of Registration Issue / Expiry date	18 Dec 2020 / 17 Dec 2023
Total Flight Hours	1,148.45

Figure 6: Aircraft Data

1.6.3 Preventive Maintenance

The last schedule maintenance i.e. 50 hours Inspection (1,113.40 hours) was carried out on 3 February 2023. The maintenance activities inspected for the period above found no defect related to fuel, engine or propeller systems. The aircraft had flown 35.05 hours after the schedule maintenance without reported defect. The next schedule maintenance is 100 hours Inspection due at 1,163.40 hours or 2 February 2024.

1.6.4 Corrective Maintenance

Inspection on the Aircraft Journey Log for a 6 months period from August 2022 to February 2023 revealed 2 defects only (Figure 7). All the defects were rectified with no reported recurrence again.

NO	DATE	DEFECT
1	27 Aug 2022	Left magneto drop.
2	03 Jan 2023	Fuel flow reading gauge show zero in flight.

Figure 7: Corrective maintenance for a 6 months period

1.6.5 Aircraft Airworthiness

The aircraft was in an airworthy condition. There was no reported abnormalities or malfunction by the pilot before and during the flight. The aircraft had flown a total of 463.75 hrs from August 2022 to February 2023 with only two reported defects. The breakdown monthly hours are as follows:

YEAR	MONTH	FLIGHT HOURS (HRS.MINS)
2022	August	54.50
	September	82.00
	October	70.30
	November	79.40
	December	85.20
2023	January	57.30
	February	35.05
	TOTAL	**463.75**

Figure 8: Aircraft flight hours from August 2022 to February 2023

1.7 Meteorological Information

The incident happened in day time. Actual weather was fine with few clouds at 2,000 feet. The visibility was reported as more than 10 kilometres and wind 080° at 04 knots.

1.8 Aids to Navigation

All navigation aids were operating normally.

1.9 Communications

All ATC communications frequencies were operating normally. The pilot (ACADEMY 09) informed Malacca ATC tower that the aircraft had mechanical problems and had to make a force landing but did not transmit any “MAYDAY”[1] or “PAN”[2] call.

A company aircraft (ACADEMY 16) had relayed message via ATC radio to Malacca ATC tower informing that the aircraft had made a forced landing safely at a factory area within training area R239A2.

1.10 Aerodrome Information

Airfield	Malacca International Airport
Runway	03/21
Length	2,135m
Width	45m
ICAO Designator	WMKM
IATA Designator	MKZ
Elevation	40ft

Figure 9: Malacca International Airport Aerodrome Information

[1] An international radio distress signal used by ships and aircraft.

[2] Pan, short for “possible assistance needed,” is used to communicate an urgent, but not emergency, situation over VHF radio, in the case of aviation, to air traffic control.

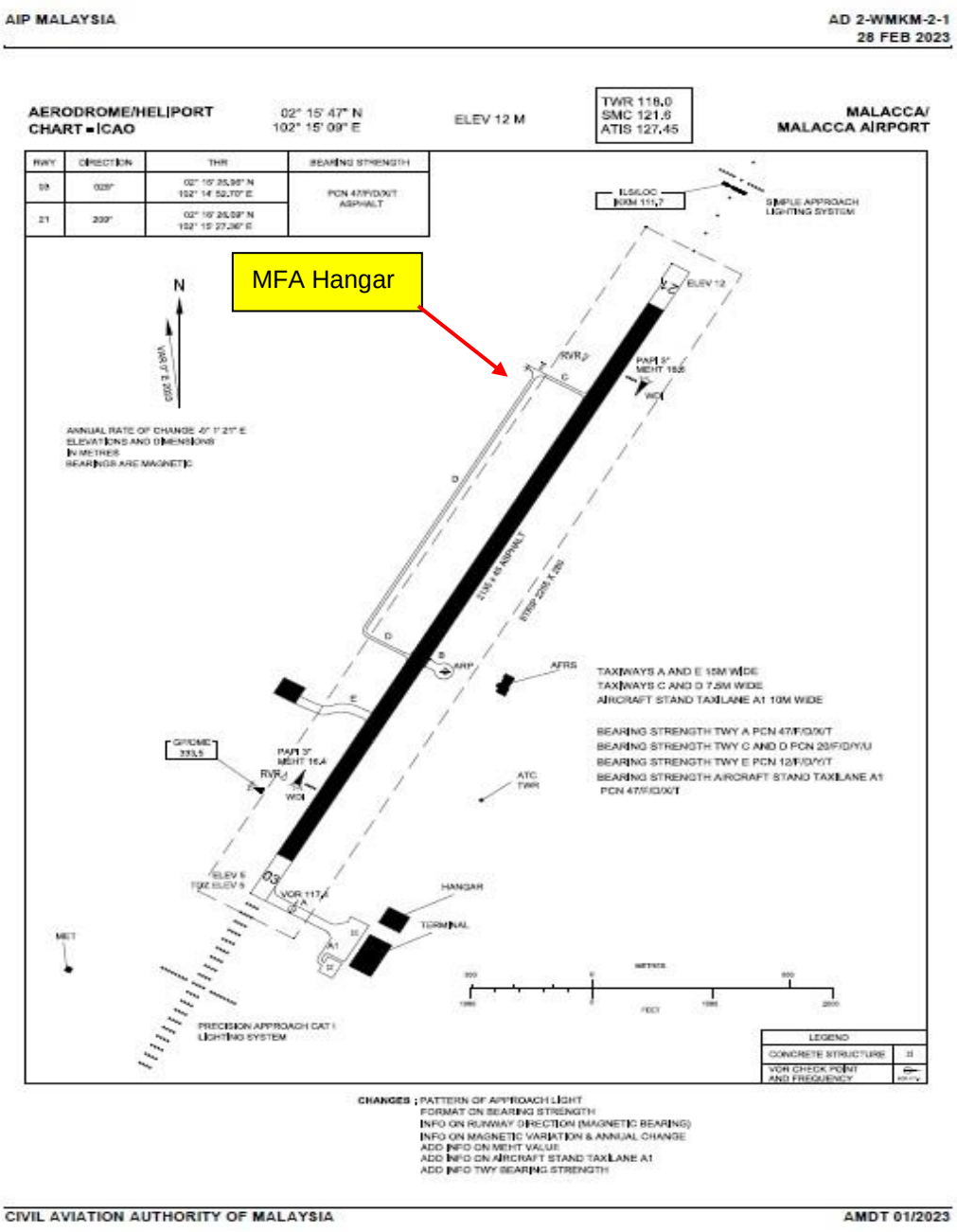


Figure 10: Malacca International Airport Aerodrome Layout

1.11 Flight Recorders

Aircraft is not equipped with Flight Data Recorder (FDR) and Cockpit Voice Recorder (CVR). It is equipped with a Garmin G1000 Integrated Avionics System as a flight display which records basic flight and engine information.

1.12 Wreckage and Impact Information

Figure 11: Flight path and final position of aircraft (Diagram not to scale)

Figure 12: Final position of aircraft at the open construction area in Jasin.

1.13 Medical and Pathological Information

The Flight Instructor and Student Pilot underwent blood and urine test and results were negative for substance abuse.

1.14 Fire

There was no pre or post impact fire.

1.15 Survival Aspects

Both the pilots safely evacuated from the aircraft with no injuries.

1.16 Tests and Research

1.16.1 Post-Incident Trouble Shooting Inspection

Post-incident Trouble Shooting Inspection[3] was completed on 04 March 2023 by the Aircraft Operator's Airworthiness Personnel. The Trouble Shooting Inspection on the following engine systems did not revealed any abnormalities:

a. Fuel system inspection including the fuel injector, fuel filter, fuel lines and fuel engine driven pump were normal.

b. Ignition system inspection including magneto and ignition harness were normal. One spark plugs at cylinder No. 2 had carbon deposit and was cleaned. The remainder spark plugs were in normal condition.

c. No sign of oil and fuel leak on the engine.

d. General condition of the engine externally was normal.

[3] Piper Archer III PA28-181 Maintenance Manual Chapter 71, Section 71-00-00, Page 13 Chart 2, Revision 3 August 2021.

e. Cold engine compression checks performed on all cylinders was satisfactory and within the limits. The results are as follows:

COLD ENGINE COMPRESSION CHECK	
CYLINDER	**RESULTS (psi)**
1	65/80
2	70/80
3	60/80
4	68/80

Figure 13: Cold Engine Compression Check Results

1.16.2 Recovery Plan Checklist

The engine was started up and engine run up checks were carried out in accordance with the Recovery Plan Checklist on the 8 March 2023 in the presence of AAIB Investigator In-Charge (IIC)**.** During the idle mixture check by leaning out the mixture lever, an increase of more than 10 RPM was observed. This indicates an excessive rich idle mixture. An adjustment of one notch to the lean direction was carried out and a recheck was carried out satisfactory. Other checks carried out in accordance to the Recovery Plan Checklist was satisfactory.

1.16.3 Trouble Shooting Inspection and Engine Run-Up

A Trouble Shooting Inspection[4] and subsequently two more engine run ups checks were performed in the presence of AAIB IIC on the 8 March 2023. The Trouble Shooting Inspection on all the engine systems and the two engine run-ups did not revealed any abnormalities.

[4] Piper Archer III PA28-181 Maintenance Manual Chapter 71, Section 71-00-00, Page 13 Chart 2, Revision 3 August 2021.

With reference to recommendation by the Engine OEM, Textron Lycoming, the loss of power, increasing oil consumption, hard starting or other evidence of unexplained abnormal operation is encountered, a compression check of the cylinders is recommended. Hot engine compression checks performed after the completion of engine run-up on all cylinders was satisfactory and within the limits[5]. The results are as follows:

HOT ENGINE COMPRESSION CHECK[6]	
CYLINDER	**RESULTS (psi)**
1	75/80 - satisfactory
2	78/80 - satisfactory
3	78/80 - satisfactory
4	78/80 - satisfactory

Figure 14: Hot Engine Compression Check Results

1.16.4 Fuel and Engine Oil Forensic Test

The aircraft fuel and engine oil were drain at incident site and sent to laboratory for forensic test. The test results revealed no abnormalities and complied to OEM specification.

1.16.5 Fuel Injection Servo (FIS) Inspection and Test by the Original Equipment Manufacturer (OEM)

On completion of the Engine Run-Up and Trouble Shooting Inspection by the aircraft operator's airworthiness personnel, the investigation team did not find any evidence

[5] Textron Lycoming Service Instruction No. 1191A – Cylinder Compression dated 28 September 1998.

[6] Pressure reading for all cylinders is equal and above 70 psi, the engine is satisfactory.
Less than 65 psi indicates wear has occurred and subsequent compression checks should be made at 100-hour intervals to determine rate and amount of wear.
Below 60 psi or if the wear rate increases rapidly, as indicated by appreciable decrease in cylinder pressure, removal and overhaul of the cylinders should be considered.

of engine or related components malfunction that could had possibly caused the incident.

The final engine component to be inspected and tested is the Fuel Injection Servo (FIS). The inspection and testing of this component were beyond the capability of the aircraft operator's airworthiness department. The FIS was sent to Original Equipment Manufacturer (OEM), AVStar Fuel System, United States for further inspection and test to verify its airworthiness condition.

The summary inspection report from Federal Aviation Administration (FAA) of United States and AVStar was received on 03 June 2023 from NTSB who assisted AAIB in its capacity as the Accredited Representative for this incident. The summary inspection report states that the idle leaning adjustment screw was beyond normal parameters and there was oil contamination in the centre seal area. The FIS had passed the rest of the acceptance test.

In response to the investigation team's query whether the factors found above would have adversely influenced the output of the FIS, the response from the Engineering Manager of AVStar Fuel System was that the contamination found within the servo venturi/regulator cannot conclusively be the cause of the incident. An overly rich condition would had probably caused the engine to lose RPM but without any data to substantiate the overly rich condition it cannot be concluded that the servo or the contamination found played a factor in this incident.

Reference to the Recovery Plan Checklist action (refer paragraph 1.16.2), an adjustment to the lean direction was made by the Aircraft Operator's Airworthiness Personnel on the FIS to rectify the excessive idle mixture condition. The adjustment was made before the removal of the FIS. It was later sent to the OEM, AVStar Fuel System for inspection and test.

1.17 Organisational and Management Information

The Aircraft Operator is an Approved Training Organisation (ATO) by Civil Aviation Authority of Malaysia (CAAM) for pilot training since 1983 and is situated at Malacca

International Airport, Malacca. It operates 2 types of aircraft i.e. 13 x single engine Piper PA28 and 4 x twin engine Piper PA44. 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 from the Aircraft Operator (MFA). It is a CAAM Approved Maintenance Organisation (approved number AMO/2017/25) and the approval is valid till 5 June 2024.

The Aerodrome Operator for Malacca Airport 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 was no reported defect on the fuel, engine or ignition systems after preventive maintenance during the latest 100 hours inspection completed on 12 January 2023 or during the latest 50 hours inspection completed on 03 February 2023. There was also no evidence of recurring defects after corrective maintenance were carried out on the reported defects in Figure 7.

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 FI holds a valid CPL rated on Piper PA28 issued by CAAM on 25 January 2023 and a FI (2) rating valid till 31 July 2025**.** The FI had accumulated a total of 3,206 hrs on the PA28 aircraft.

The SP holds a valid SPL issued by CAAM on 21 October 2022 and had accumulated a total of 150.35 hrs on the PA28 aircraft.

1.17.3 Flight Authorisation, Crew Duty and Rest Time

The flight was properly authorised in accordance with MFA Training and Procedure Manual (TPM)[7]. The FI flew the first sortie of the day with the first SP for a duration of 2 hours. The accident sortie was a running change sortie for the second SP. The duration of the sortie was approximately one hour before the accident happened.

The crew duty time, rest time and flight time limitation for both the pilots were in accordance with MFA TPM[8]. Both pilots had sufficient rest time. The FI last flown was on 13 February 2023 after a 2 days weekend rest period (11 & 12 February 2023). The SP last flown was on 10 February 2023 after 3 days off from flying duties. In accordance with the TPM, both pilots had more than 12 hrs rest time.

The total hours flown for the day by the FI including the accident sortie was about 3 hours while it was the first sortie of the day for the SP (about one-hour duration). In accordance to TPM[9], both pilots did not exceed the Flight Time Limitation of 4 hrs for General Flying and Monthly Limits of 80 hrs. The monthly and total hours for the 6 months period for the FI are as follows:

[7] MFA TPM paragraph 7.1, Approval / Authorisation of Flights at MFA.

[8] MFA TPM paragraph 7.4, Duty Periods, Rest Periods and Flight Time Limitation.

[9] MFA TPM paragraph 7.4.23 Flight Time Limitation for FI (2).

YEAR	MONTH	HOURS
2022	August	28:30
	September	62:00
	October	45:15
	November	44:30
	December	52:00
2023	January	62:00
	February	33:30

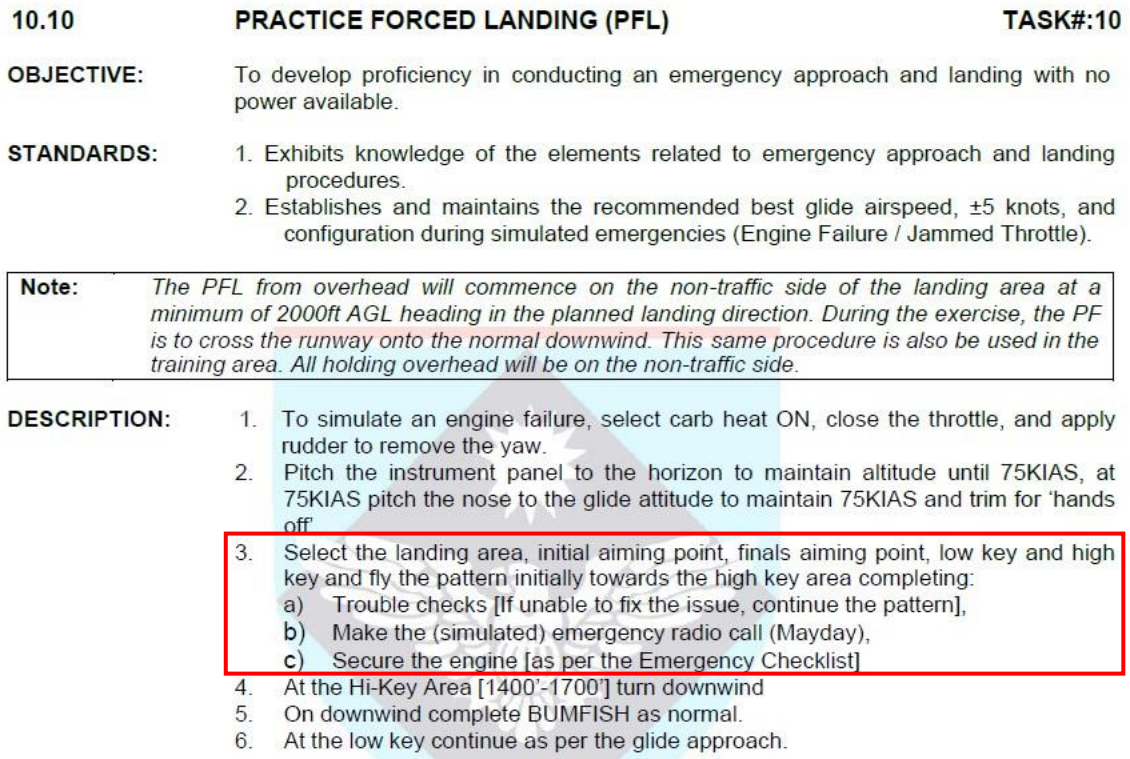
Figure 15: FI's Monthly and Total Hours for the 6 Months Period

1.17.4 Forced Landing Procedure

It was observed that the FI was concentrating on flying the aircraft while trying to complete two set of checks (Engine Roughness and Trouble Checks) albeit with the help from the SP. The heavy workload and low altitude of the aircraft (2,000 ft descending) had contributed to the FI forgetting to transmit the 'MAYDAY' call which would had alerted Malacca ATC on the nature of emergency and location of the forced landing area. Although the FI did inform the Malacca ATC tower that the aircraft had encountered a mechanical problem, it took another company aircraft to verify that the aircraft had safely forced landed. It took approximately 30 to 45 minutes after the aircraft forced landed for the police and other first responder to arrive at the incident site.

The FI had decided to secure the engine and make a forced landing at an open construction site when the aircraft had descended below 1,000 ft. In accordance to the MFA SOP - Practice Forced Landing Procedure (Figure 16), securing the engine to force land the aircraft should had been carried out just before High Key (1,400 ft to 1,700 ft). This will give a reasonable time for the pilot to fly and position the aircraft for a safe forced landing. Nevertheless, in this accident, due to heavy workload, the FI delayed the decision to secure the aircraft engine. Although the aircraft was low in altitude, the pilot was able to fly and make a successful forced landing.

It was observed that the pilots secured the aircraft's engine using the EFATO checks instead of the Power Off Landing checks. This contradicts with the correct usage of checklist procedures as EFATO checks are used when an engine fails after take-off while in this incident the aircraft was descending for a forced landing i.e. Power Off Landing checks should had been used.



10.10 **PRACTICE FORCED LANDING (PFL)** **TASK#:10**

OBJECTIVE: To develop proficiency in conducting an emergency approach and landing with no power available.

STANDARDS:
1. Exhibits knowledge of the elements related to emergency approach and landing procedures.
2. Establishes and maintains the recommended best glide airspeed, ±5 knots, and configuration during simulated emergencies (Engine Failure / Jammed Throttle).

Note: *The PFL from overhead will commence on the non-traffic side of the landing area at a minimum of 2000ft AGL heading in the planned landing direction. During the exercise, the PF is to cross the runway onto the normal downwind. This same procedure is also be used in the training area. All holding overhead will be on the non-traffic side.*

DESCRIPTION:
1. To simulate an engine failure, select carb heat ON, close the throttle, and apply rudder to remove the yaw.
2. Pitch the instrument panel to the horizon to maintain altitude until 75KIAS, at 75KIAS pitch the nose to the glide attitude to maintain 75KIAS and trim for 'hands off'.
3. Select the landing area, initial aiming point, finals aiming point, low key and high key and fly the pattern initially towards the high key area completing:
   a) Trouble checks [If unable to fix the issue, continue the pattern],
   b) Make the (simulated) emergency radio call (Mayday),
   c) Secure the engine [as per the Emergency Checklist]
4. At the Hi-Key Area [1400'-1700'] turn downwind
5. On downwind complete BUMFISH as normal.
6. At the low key continue as per the glide approach.

Figure 16: MFA SOP – Practice Forced Landing (PFL)

1.17.5 Pilot Operating Handbook versus Standard Operating Procedures

In accordance with the MFA SOP**,** Trouble Checks are to be carried out when the aircraft is above 1,000 ft AGL while EFATO Drill are to be made when the aircraft is below 1,000 ft AGL during an engine failure or power loss in flight. Both these checks are memory drills for the pilots. Although these checks are stated in the MFA SOP[10] (Figure 17 & 18), there is no mention of EFATO Drill and Trouble Checks in the Piper Archer III PA28-181 Pilot's Operating Handbook (POH) which is the Manufacturer's Authority Publication when operating the PA28 aircraft.

[10] Malaysian Flying Academy Standard Operating Procedures, Issue 3, Effective Date 03 January 2022.

It was also observed that the full Emergency Checklist was not incorporated in the MFA SOP[11]. It has only one page with many other Emergency Checks missing as compared with the full Emergency Checklist stated in the Piper Archer III PA28-181 POH.

15.2 ENGINE FAILURE AFTER TAKE-OFF (EFATO):

Immediate actions using the primary controls is to promptly pitch the nose to the glide attitude and choose a suitable landing area and plan the approach. Thereafter the pilot is to continue with emergency drills so as to minimize the risk of fire in the immediate aftermath of the landing.

Item 6: The main cabin door provides structural strength to the fuselage; however during a bad landing the fuselage could bend and pinch the door preventing the door from opening. So the side latch is disengaged.

Pilots are to remember that the EFATO drill and subsequent Trouble Checks are memory drills. Pilots are not to waste precious time consulting the checklist of what to do.

Note:	*When turning OFF the fuel pump at 1000ft, check the fuel pressure gauge for normal pressure. If fuel pressure is not stabilising (continues to decrease) this could indicate an engine fuel pump failure with imminent engine failure. The electric fuel pump is to be switched ON again and the pilot is to RTB to land.*

15.3 TROUBLE CHECKS:

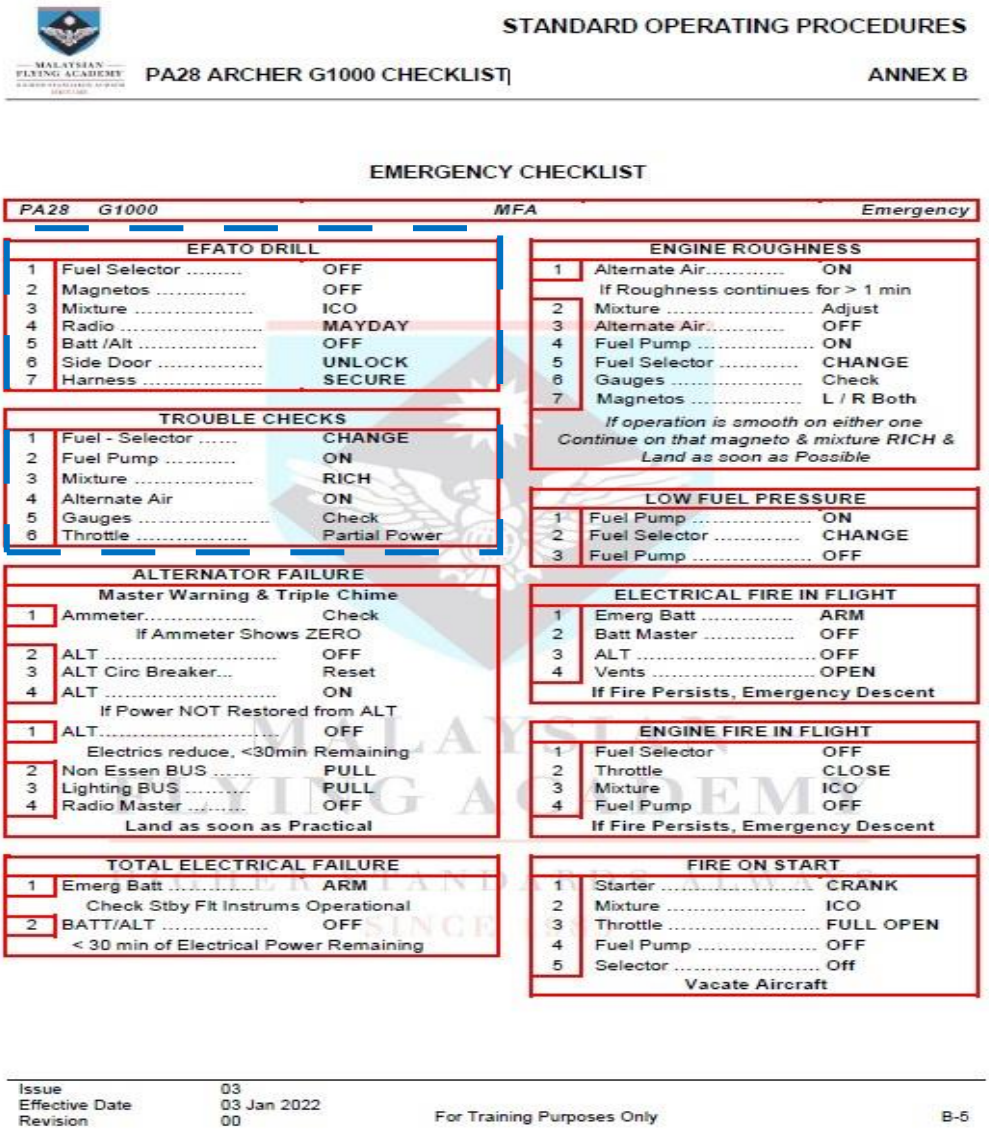
These checks are to find the source of why the engine failed. The most common reason is fuel starvation or sometimes an unlocked primer. Completing these checks will determine the cause as either the pilots fault or an engine fault. However, as the pilot is in training, these checks are mostly just touch checks.

Trouble checks are only to be made when the aircraft is more than 1000ft AGL. Aircraft below 1000 AGL are to continue with the EFATO drill.

Note:	*A sudden and total loss of power is very rare. An engine will give various signs of an impending failure. Monitoring the engine Ts & Ps will give an indication of an impending failure.*

Figure 17: MFA SOP - Expanded Emergency Procedures – PA28

[11] Malaysian Flying Academy Standard Operating Procedures, Annex B – Emergency Checklist.



STANDARD OPERATING PROCEDURES

PA28 ARCHER G1000 CHECKLIST ANNEX B

EMERGENCY CHECKLIST

PA28 G1000 MFA Emergency

EFATO DRILL

1	Fuel Selector	OFF
2	Magnetos	OFF
3	Mixture	ICO
4	Radio	MAYDAY
5	Batt /Alt	OFF
6	Side Door	UNLOCK
7	Harness	SECURE

TROUBLE CHECKS

1	Fuel - Selector	CHANGE
2	Fuel Pump	ON
3	Mixture	RICH
4	Alternate Air	ON
5	Gauges	Check
6	Throttle	Partial Power

ALTERNATOR FAILURE

Master Warning & Triple Chime

1	Ammeter.....	Check

If Ammeter Shows ZERO

2	ALT	OFF
3	ALT Circ Breaker...	Reset
4	ALT	ON

If Power NOT Restored from ALT

1	ALT.....	OFF

Electrics reduce, <30min Remaining

2	Non Essen BUS	PULL
3	Lighting BUS	PULL
4	Radio Master	OFF

Land as soon as Practical

TOTAL ELECTRICAL FAILURE

1	Emerg Batt	ARM

Check Stby Flt Instrums Operational

2	BATT/ALT	OFF

< 30 min of Electrical Power Remaining

ENGINE ROUGHNESS

1	Alternate Air.....	ON

If Roughness continues for > 1 min

2	Mixture	Adjust
3	Alternate Air.....	OFF
4	Fuel Pump	ON
5	Fuel Selector	CHANGE
6	Gauges	Check
7	Magnetos	L / R Both

If operation is smooth on either one Continue on that magneto & mixture RICH & Land as soon as Possible

LOW FUEL PRESSURE

1	Fuel Pump	ON
2	Fuel Selector	CHANGE
3	Fuel Pump	OFF

ELECTRICAL FIRE IN FLIGHT

1	Emerg Batt	ARM
2	Batt Master	OFF
3	ALT	OFF
4	Vents	OPEN

If Fire Persists, Emergency Descent

ENGINE FIRE IN FLIGHT

1	Fuel Selector	OFF
2	Throttle	CLOSE
3	Mixture	ICO
4	Fuel Pump	OFF

If Fire Persists, Emergency Descent

FIRE ON START

1	Starter	CRANK
2	Mixture	ICO
3	Throttle	FULL OPEN
4	Fuel Pump	OFF
5	Selector	Off

Vacate Aircraft

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For Training Purposes Only B-5

Figure 18: MFA SOP – Emergency Checklist

1.18 Additional Information

1.18.1 Garmin G1000 Integrated Avionics System (IAS)

The aircraft is equipped with a Garmin G1000 Integrated Avionics System. It consists of a Primary Flight Display (PFD), Multi-Function Display (MFD), Audio Panel, Air Data/Attitude and Heading Reference System (ADAHRS), and the sensors and computers to process flight and engine information for display to the pilot.

The Multi-Function Display (MFD) is located in the centre of the instrument panel. The primary functions of the MFD include the display of engine parameters and aircraft system parameters.

The MFD also incorporates a dedicated Engine Indicating System (EIS) page along the left side of the MFD window that displays engine parameters, electrical system parameters, and fuel quantity as shown in Figure 19.

Figure 19: Engine Indicating System Page on Multi-Function Display

1.18.2 Fuel System

The aircraft fuel system consists of 2 twenty-five-gallon (24 gallons usable) fuel tanks located at the leading edge of each wing. Each tank contains an indicator tab in the filler neck to determine fuel status. 17 gallons of usable fuel is measured at the bottom of each indicator tab.

The minimum fuel grade is AVGAS 100 or 100LL. There is one float type fuel sensor in each wing. The signal corresponding to the position of the floats is sent to the Garmin Engine Airframe (GEA) interface unit where it is converted into fuel quantity. The fuel quantity information is then sent to the MFD for display.

The fuel selector control contains three positions i.e. ‘OFF’, "L" (left tank), and "R" (right tank). To turn the fuel off, rotate selector handle counter clockwise to the ‘OFF’ position while depressing the button. Rotate the selector handle clockwise to either "L" or "R" positions to permit fuel flow. The button will release automatically preventing accidental selection of the fuel to the off position.

An auxiliary electric fuel pump is provided in case of failure of the engine driven pump. The electric pump should be on for all take-offs and landings, and when switching tanks. The fuel drain is provided at the lowest, inboard corner of each wing tank. An engine fuel strainer is accessible through the exterior, lower, left nose section. Each fuel drain and strainer should be opened and the fuel checked for contamination prior to the first flight of the day or after each refuelling.

1.18.3 Fuel Injector Servo (FIS)

The fuel injector servo incorporates an AVStar RSA-5AD1 type fuel injector. The injector is based on the principle of differential pressure, which balances air pressure against fuel pressure. The regulated fuel pressure established by the servo valve when applied across a fuel control (jetting system) makes the fuel flow proportional to airflow. Fuel pressure regulation by the servo valve causes a minimal drop in fuel pressure throughout the metering system. Metering pressure is maintained above most vapor forming conditions while fuel inlet pressure is low enough to allow use of a diaphragm pump. The servo system features also checks vapor lock and associated starting problems.

The servo regulation meters fuel flow proportionally with airflow and maintains the mixture as manually set for all engine speeds. The fuel flow divider receives metered fuel and distributes fuel to each cylinder fuel nozzle.

The induction airbox assembly contains a valve that can open and allow airflow into the engine in the event of blockage of the primary induction air source. The air provided through the alternate air source is heated, which will also provide induction system icing protection. As this alternate air source is not filtered, the primary air source should always be used for take-off. Control of the alternate air valve is through

a lever located to the right off the engine control lever quadrant. The Fuel System Schematic – Fuel Injection Engine is as shown in Figure 20.

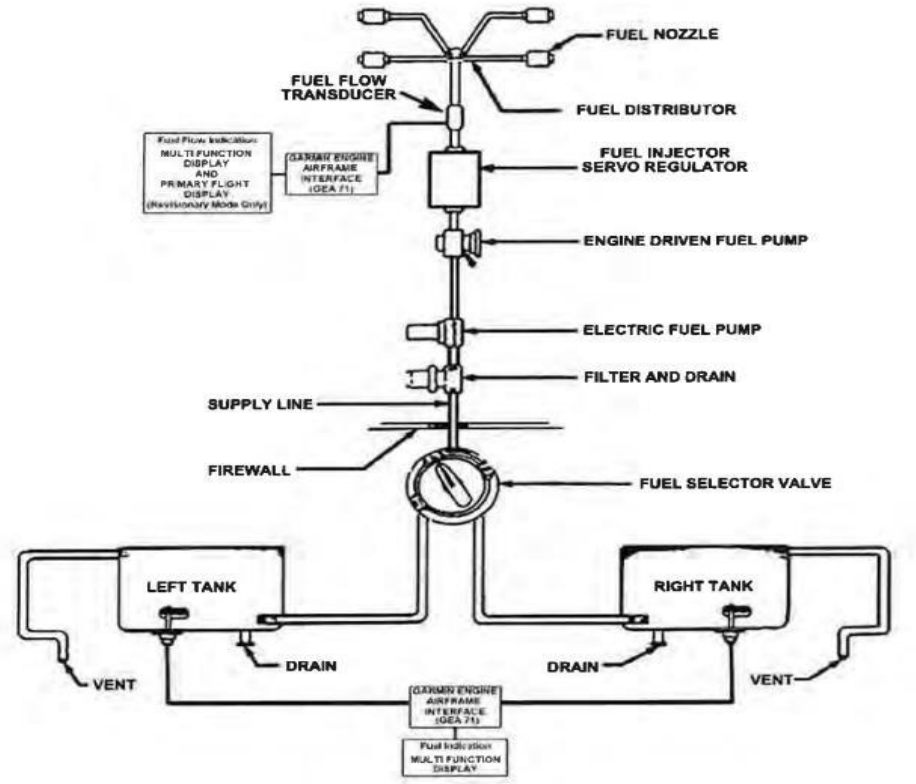

Figure 20: Fuel System Schematic – Fuel Injection Engine

1.18.4 Engine Indicating System (EIS) Data

The EIS data was downloaded to observe the engine performance during the incident flight. The summary data in Figure 21 was an extraction from the EIS data recording when the engine RPM started to show reduction in RPM till it was shut down by the pilot. All engine parameters data recording before the engine RPM started to show reduction was observed to be normal.

TIME (from engine start)	ENGINE RPM	FUEL FLOW (gallons/ Hour)	EGT 1 (°F)	EGT 2 (°F)	EGT 3 (°F)	EGT 4 (°F)	REMARKS
Recording shows all engine indications were normal before the events below.							
02:58:34	2275	10.92	1247	1228	1316	1215	Engine RPM starts to reduce
02:58:37	2117	11.51	1220	1222	921	1194	
02:59:23	2001	11.99	1181	1207	228	1170	
02:59:43	1849	11.98	1196	1210	207	1182	
02:59:49	1790	11.70	1204	1247	199	1217	
02:59:52	1949	11.76	1201	1252	195	1232	Engine RPM continuously reduce
03:00:01	1071	9.31	474	453	178	523	
03:00:10	1371	8.6	453	400	177	403	
03:00:18	990	8.84	511	404	164	393	
03:01:54	869	7.83	192	168	142	175	Recording stops (engine shutdown and power off)

Figure 21: Extraction from the EIS data recording

The following discrepancies were observed:

a. Engine RPM starts to reduce below 2300 RPM (cruise power setting) about 3 minutes before recording stops.

b. Engine RPM momentarily fluctuating between 2000 RPM and 1700 RPM and also between 1300 RPM and 1000 RPM.

c. No. 3 Exhaust Gas Temperature (EGT) reduces continuously when engine RPM starts to reduce below 2300 RPM while No. 1,2 and 4 EGT reading remains consistent throughout.

d. Fuel flow readings remains consistent throughout the various Engine RPM indications.

1.18.5 Visual Inspection on Cylinder No. 3

The FIS Inspection and Test carried out by the OEM did not reveal any abnormalities that would had caused the incident. To rule out a possible Cylinder No. 3 problem since the EGT shows a drastic reduction in flight, a trouble shooting inspection was carried out by the aircraft operator's airworthiness personnel by dismantling the Cylinder No. 3 to check for any abnormalities. All components of Cylinder No.3 were inspected and there were no abnormalities found.

1.18.6 Interview and Written Statements

The Investigation Team conducted separate interview sessions with the Pilots and Duty Air Traffic Controllers. 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.

1.19. Useful or Effective Investigation Techniques

The aircraft is not equipped with a Flight Recorder. Nevertheless, the availability of the engine data recording from the aircraft Garmin G1000 had provided the investigation team with crucial data on the engine performance during the incident.

This investigation will rely on witness statements and system investigation to analyse probable factors that had caused the reduction of engine RPM in flight. Human factors issue with regards to pilot actions, adherence to aircraft flying and maintenance procedures will also be looked into.

2.0 ANALYSIS

2.1 The Problem Statement

The aircraft experienced vibration with engine RPM reducing from about 2300 RPM to about 1,700 RPM despite the throttle being advance by the FI. It further reduced to about 1,000 RPM and when the alternate air was selected to open when performing the engine roughness checklist. Troubleshoot checks were subsequently carried out to regain engine power but the engine did not respond. The FI secure the engine and forced landed the aircraft in an empty construction site.

2.2 Engine System Investigation Analysis

2.2.1 Engine Indicting System Data (Refer Paragraph 1.18.4)

EIS Data shows that the engine was operating normally for about 2 hours and 59 minutes continuously from the start of the sortie. The data also shows that the fuel flow remained relatively consistent with the RPM and EGTs until time 02:59:23 when there was a 300 RPM decrease from about 2300 RPM to 2000 RPM accompanied by a drastic decrease in the EGT Cylinder No. 3 (EGT 3) from 1,316°F to 228°F.

The RPM continued to further reduced with the engine RPM momentarily fluctuating between 2000 RPM and 1700 RPM and also between 1300 RPM and 1000 RPM. The remaining cylinders' EGT remained consistent with no significant changes except for EGT 3 which continue to reduce progressively. This indicates there was an inefficient combustion in cylinder No.3 which led to an uneven output of power with other cylinders thus causing the engine to vibrate and the RPM to fluctuate momentarily. The subsequent reduction in power (engine RPM) is probably attributed to the drastic reduction in power output in cylinder No.3. The occurrence above is consistent with the witness statement given by both the pilots with regards to the history of flight.

To trouble shoot the Problem Statement, the Investigation Team together with the Aircraft Operator's Airworthiness Team performed all relevant inspection and checks

to identify the cause as per paragraph 1.16. The check results found that one spark plugs at cylinder No. 2 had carbon deposit which possibly indicate a rich mixture. Nevertheless, it did not affect the combustion in cylinder No.2 as the EGT 2 remain consistent throughout the engine operations.

The drastic reduction of EGT No.3 which indicate an inefficient combustion can be attributed to either a spark plug problem or an overly rich mixture. Engine Run-Up check did not reveal any abnormalities to all cylinders i.e. the spark plugs were all functioning normally. The idle mixture check carried out found an excessive rich idle mixture. An adjustment was made to the lean direction at the FIS and engine run-up found the idle mixture satisfactory.

2.2.2 Fuel Injection Servo (FIS) Inspection and Test (Refer Paragraph 1.16)

The FIS was sent to the OEM, AVStar Fuel System, United States for inspection and test. The inspection and test revealed that the idle leaning adjustment screw was beyond normal parameters and there was oil contamination in the centre seal area. The reason the idle leaning adjustment screw was beyond the normal parameters was due to the adjustment made to the lean direction during idle mixture adjustment carried by the aircraft operator's airworthiness personnel. The oil contamination found in the centre seal area was not a contributing factor to the engine power reduction.

Based on the Fuel System Schematic at Figure 20, the FIS regulates meter fuel flow proportionally with airflow and maintains the mixture for all engine speeds. The fuel flow divider receives metered fuel and distributes fuel to each cylinder fuel nozzle. Based on the EIS data recording (Figure 21), the fuel flow remains consistent with the power output.

There is a possibility that an excessive rich mixture condition could had contributed to the engine power reduction. If it was due to excessive rich mixture, all four cylinders will experience an inefficient cylinder combustion i.e. an EGT reduction as metered fuel are distributed equally to each cylinder via a flow divider. In this incident, only EGT Cylinder No.3 shows a reduction in EGT whereas the EGT for the remaining cylinders remained normal.

In summary, the evidence observed on the EIS data recording on fuel flow and EGT for all cylinders does not support an excessive rich mixture condition. The EIS data shows that the fuel flow and EGT for all cylinders were consistent with the engine RPM except for EGT Cylinder No. 3 only.

The leak check conducted by the OEM, AVStar Fuel System on FIS for Injection Servo, Air Bleed Nozzles and Flow Divider pressure test were normal. This indicates that the components were clear and non-obstructed. Therefore, the cause of the drastic reduction of Cylinder No. 3 EGT in flight cannot be conclusively determine.

In conclusion, there is no conclusive evidence to support the analysis that a malfunction of FIS had caused the engine power reduction in this incident.

2.2.3 Visual Inspection on Cylinder No. 3 (Refer paragraph 1.18.5)

To rule out a possible Cylinder No. 3 problem, a trouble shooting inspection by dismantling the Cylinder No. 3 was carried out by the aircraft operator's airworthiness personnel to check for any abnormalities. No abnormalities were found on the cylinder which would have caused an engine power reduction in this incident.

2.2.4 Fuel and Engine Oil Inspection and Forensic Test

The aircraft fuel and engine oil samples were also sent to the laboratory for forensic test. Test result did not reveal any abnormalities and complied to OEM specification.

There is no evidence to indicate fuel or engine oil contamination had cause the engine power reduction in this incident.

2.3 Adherence to Aircraft Maintenance Procedures

The investigation team scrutinised all preventive (50 and 100 hours inspection) and corrective maintenance for the year 2022 and 2023 especially for defects which are engine related. There is no evidence to show that there are related or recurring defects that would have probably caused this incident.

All maintenance inspections and rectifications were carried out according to schedule and in accordance to the Piper Airplane Maintenance Manual[12]. All maintenance records were managed and kept properly. It was easily accessible by the Investigation Team with the assistance from the aircraft operator's airworthiness department during the investigation process.

2.4 Adherence to Aircraft Flying Procedures

The FI carried out all the forced landing procedures as per MFA SOP and Emergency Checklist. By completing the relevant checklist, the FI had missed the 'MAYDAY' call. It had also contributed to the FI's late decision to secured the aircraft engine and make a force landing.

The Investigation Team observed that the practice of using EFATO checks by the FI to secure the engine is a non-standard practice as this check is meant for after take-off and not for landing. In accordance to the Piper Archer III PA28-181 POH, the Power Off Landing checks should had been used. This non-standard practiced had made the Power Off Landing checks redundant and will also lead to confusion as to which checks to be used when securing the aircraft engine in the event of an emergency in flight.

The missing of the 'MAYDAY' call and the non-standard practice of checks by the FI was not the cause or contributing factor of this incident. It was highlighted to ensure the adherence of proper flying and correct checklist procedures are taught and practiced by all pilots when operating the aircraft in accordance with the Piper Archer III PA28-181 POH.

With limited height, time and unable to determine the cause of the emergency despite completing the relevant checklist, based on the principle of Local Rationality[13], the

[12] Piper Archer III PA28-181 Airplane Maintenance Manual dated 30 July 2021.

[13] The decision to act in a certain way makes perfect sense to the individual in the local context given the information that he has in the moment. The local rationality principle says that people do what makes sense given the situation, operational pressures and organizational norms in which they find themselves.

Investigation Team would like to commend the FI for his excellent flying skill and captaincy, thus making a successful force landing with no injuries to the crew and no damage to the aircraft and surrounding properties.

2.5 Discrepancies between MFA SOP and Piper Archer III PA28-181 POH

There were two checks i.e. EFATO and Trouble Checks which are NOT stated in the Piper Archer III PA28-181 POH but was incorporated in the MFA SOP and used by all Piper Archer III PA28-181 pilots. The Piper Archer III PA28-181 POH is the authority publication issued by the aircraft manufacturer, Piper Aircraft Inc to all aircraft operators for the safe operations of the aircraft. Any amendment by the aircraft operator to any of the checks in the Piper Archer III PA28-181 POH must be approved by the aircraft manufacturer before it can be officially used to operate the aircraft. There is no evidence of any approval given by Piper Aircraft Inc. for these two checks i.e. EFATO and Trouble Checks to be used by the aircraft operator although it has been incorporated in the MFA SOP under Emergency Checklist and approved for used by CAAM[14].

After analysing the content of the Trouble Checks (SOP) versus Engine Power Loss in Flight Checks (POH) and EFATO (SOP) versus Power Off Landing (POH), it was observed that there is similarity in the content of the respective checks. The duplication of checks above causes redundancy and creates confusion to pilots as to which check to use during an emergency.

The aircraft operator is recommended to review the use of EFATO and Trouble Checks to ensure the checks comply with the Piper Archer III PA28-181 POH. Any new checks to be used should be approved by the aircraft manufacturer, Piper Aircraft Inc. before it is incorporated into the MFA SOP for the safe operations of the aircraft.

[14] Malaysian Flying Academy Standard Operating Procedures, Annex B – Emergency Checklist.

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, initial symptom of engine vibration and fluctuation of RPM is most probably caused by an inefficient combustion in Cylinder No.3 as the EIS data shows an initial reduction in EGT in this cylinder. Subsequently, as the RPM reduced further, the EGT started to reduce rapidly which most probably caused the engine to lose power.

Based on extraction from the EIS data recording, the fuel flow remains consistent with the power output. If there is an excessive rich mixture condition, all four cylinders will experience an inefficient cylinder combustion i.e. an EGT reduction as metered fuel are distributed equally to each cylinder via a flow divider. In this incident, only EGT Cylinder No.3 shows a reduction in EGT whereas the EGT for the remaining cylinders remained normal. The evidence shown on the EIS data recording on fuel flow and EGT also does not support an excessive rich mixture condition.

Leak check conducted by the OEM, AVStar Fuel System on FIS for Injection Servo, Air Bleed Nozzles and Flow Divider pressure test were normal. This indicates that the components were clear and non-obstructed. The test shows that the FIS is fully functional and did not cause the incident.

Visual inspection by dismantling the Cylinder No. 3 to trouble shoot the problem of drastic reduction in EGT also did not revealed any abnormalities. The inspection shows that the Cylinder No. 3 is fully functional and did not cause the incident.

In conclusion, the Investigation Team could not conclusively identify the cause to this unfortunate incident despite a comprehensive trouble shooting inspection and test.

The Investigation Team would like to record its appreciation to the Aircraft Operator’s Airworthiness Department personnel for the excellent cooperation given in the course of the investigation by carrying out all the relevant trouble shooting inspections, tests and engine run-up in an effort to find the cause to this incident.

The Investigation Team would also like to commend the FI's good flying skill and captaincy with the assistance from the SP in executing a prefect forced landing at an open construction site with no injuries to any person or damage to any properties.

3.1 Findings

3.1.1 Both Pilots were properly licensed to fly the training flight.

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

3.1.3 The incident happened in day time. Weather was fine.

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

3.1.5 Both Pilots were medically fit to fly and there was no evidence of substance abuse.

3.1.6 There were no reported abnormalities on the aircraft by the Pilots during the training flight.

3.1.7 The Pilots did not transmit any "MAYDAY" or "PAN" call but only reported to the ATC Tower that the aircraft had mechanical problems.

3.1.8 EFATO checks were used by the pilots instead of the approved Power Off Landing checks as stated in the Piper Archer III PA28-181 POH to secure the aircraft engine during the forced landing.

3.1.9 Two checks i.e. EFATO and Trouble Checks which are NOT stated in the Piper Archer III PA28-181 POH but was incorporated in the MFA SOP and used by all Piper Archer III PA28-181 pilots.

3.2 Causes/Contributing Factors

Based on Trouble Shooting Inspection, Cylinder Compression Check and Engine Run-Up carried out, the engine parameters did not show any abnormalities. There was no sign of engine vibration, power reduction or any EGT reduction similar to the symptoms observed in this incident during the Engine Run-Up checks. Visual Inspection on Cylinder No. 3 also did not reveal any abnormalities. The Investigation Team could not conclusively identify the cause to the power loss for this incident.

Human factors issues analysed was also not a contributing factor to this incident.

4.0 SAFETY RECOMMENDATIONS

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

4.1.1 To review the MFA Standard Operating Procedures as follows:

4.1.1.1 To review the use of EFATO and Trouble Checks which are closely similar with the Power Off Landing and Engine Power Loss in Flight Checks stated in the Piper Archer III PA28-181 Pilot's Operating Handbook to avoid confusion and non-standard practice by pilots.

4.1.1.2 To obtain approval from the aircraft manufacturer, Piper Aircraft Inc. United States the use of any new checklist before incorporating it in the MFA Standard Operating Procedures.

4.1.1.3 To amend MFA Standard Operating Procedures – Annex B – PA28 archer G1000 Checklist – Emergency Checklist to include the full list of Emergency Checklist as per the Piper Archer III PA28-181 Pilot's Operating Handbook.

4.1.1.4 To implement a suitable monitoring program (period or hours) to monitor the engine performance during flight for any similar recurrence of the problem as a safety defence.

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