AIRCRAFT SERIOUS INCIDENT

FINAL REPORT

SI 08/20

Air Accident Investigation Bureau (AAIB)

Ministry of Transport Malaysia

Serious Incident Involving Fixed Wing Aircraft

Beechcraft Bonanza F35 Registration N5045B

at km 47.8 Southbound, North South Expressway (PLUS)

Near Sedenak, Kulai, Johor.

on the 22 November 2020

Air Accident Investigation Bureau
Ministry of Transport
No.26, Jalan Tun Hussein, Precinct 4
Federal Government Administrative Centre
62100 PUTRAJAYA
Malaysia
Phone: +603-8892 1072
Fax: +6038888 0163
E-mail: aaib@mot.gov.my
Website: http://www.mot.gov.my/en

Issued on 1 July 2021
MOT.(S).600-5/4/76

AIR ACCIDENT INVESTIGATION BUREAU (AAIB)
MALAYSIA

REPORT NO. : SI 08/20

OPERATOR	**:**	**PRIVATE**
AIRCRAFT TYPE	**:**	**BEECHCRAFT BONANZA F35**
NATIONALITY	**:**	**UNITED STATES**
REGISTRATION	**:**	**N5045B**
PLACE OF OCCURRENCE	**:**	**KM 47.8 SOUTHBOUND NORTH SOUTH EXPRESSWAY (PLUS) NEAR SEDENAK, KULAI, JOHOR**
DATE AND TIME	**:**	**22 NOVEMBER 2020 AT 1105LT**

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 accident and serious incident investigation authority in Malaysia and is responsible to the Minister of Transport. Its mission is to promote aviation safety through the conduct of independent and objective investigations into air accidents and serious incidents.

The AAIB conducts the 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 serious incident was sent on 25 November 2020 to Transport Safety Investigation Bureau (TSIB) of Singapore as State of Operator and National Transportation Safety Board (NTSB) of United States as State of Manufacturer/Registry. A copy of the Preliminary Report was subsequently submitted to the above organization on 18 December 2020.

In accordance with ICAO Annex 13 paragraph 6.3, a copy of the Draft Final Report was sent on 21 April 2021 to Civil Aviation Authority of Malaysia (CAAM) as State of Occurrence, Transport Safety Investigation Bureau (TSIB) of Singapore as State of Operator, National Transportation Safety Board (NTSB) of United States as State of Manufacturer/Registry and the 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.

TABLE OF CONTENTS

GLOSSARY OF ABBREVIATIONS

A	
AAIB	Air Accident Investigation Bureau
AMP	Authorized Maintenance Personnel
A & P	Airframe and Powerplant
ATC	Air Traffic Control
ATPL	Airline Transport Pilot Licence
C	
CAAM	Civil Aviation Authority of Malaysia
CAAS	Civil Aviation Authority of Singapore
C of A	Certificate of Airworthiness
C of R	Certificate of Registration
COVID-19	Coronavirus Disease 2019
F	
FAA	Federal Aviation Administration United States
G	
g	A unit of acceleration equal to the acceleration caused by gravity at the earth's surface, about 9.8 meters (32 feet) per second
GA	General Aviation
I	
ICAO	International Civil Aviation Organisation
ie	id est or 'that is'
K	
km	kilometres
kts	knots

L

lbs	pounds
LT	Local Time

M

m	metres
MAYDAY	an international radio distress signal used by ships and aircraft
METAR	Meteorological Terminal Air Report
MHz	MegaHertz
MOR	Mandatory Occurrence Report
mph	miles per hour

N

NTSB	National Transportation Safety Board United States

P

PAN	an international standard urgency signal used by ship and aircraft
PLUS	Projek Lebuhraya Utara Selatan (North-South Expressway Malaysia)
PPL	Private Pilot Licence

R

RPM	Revolutions per minute

S

SI	Serious Incident

T

TMA	Terminal Manoeuvring Area
TSIB	Transport Safety Investigation Bureau of Singapore

U

UTC	Coordinated Universal Time

SYNOPSIS

On 22 November 2020 at approximately 0825 hours, a light aircraft Beechcraft Bonanza F35 bearing registration N5045B took-off from Seletar Airport (WSSL) for a leisure multi sector flight to Malacca (WMKM) - Senai (WMKJ) - Malacca (WMKM) and back to Seletar (WSSL) later in the day. The first two sector Seletar – Malacca – Senai was carried out as planned without any incident.

On arrival into Senai for the second sector, a visual approach and a touch and go was carried out without problems. The aircraft climbed normally out of Senai and levelled off at 5000 feet for the third sector to Malacca. About 5 minutes at cruising level, a pop sound was heard and a shudder was felt by the pilot. The aircraft experienced a sudden loss in fuel pressure and the engine started losing power.

Initially the electrical fuel pump and later the manual Wobble pump was operated to boost the fuel pressure but the engine did not respond.

The pilot glided the aircraft for an emergency landing on the North-South (PLUS) Highway and landed safely without causing damage to the aircraft and any of the surrounding public properties. The aircraft was taxied to a stop at the left side of the highway to avoid obstructing the traffic behind. The pilot and passenger exited the aircraft and directed the traffic to the outer lane to prevent any possible accidents.

The police and the PLUS Highway personnel arrived later to render assistance and directed traffic on the highway.

A Mandatory Occurrence Report (MOR) was submitted by the Pilot to Civil Aviation Authority of Malaysia (CAAM) and a copy to Air Accident Investigation Bureau, Malaysia (AAIB) on 27 November 2020.

1.0 FACTUAL INFORMATION

1.1 History of flight

On 22 November 2020 at approximately 0825 hours, a light aircraft Beechcraft Bonanza F35 bearing registration N5045B took-off from Seletar Airport (WSSL) for a leisure multi sector flight to Malacca (WMKM) - Senai (WMKJ) - Malacca (WMKM) and back to Seletar (WSSL) later in the day. The first two sector Seletar – Malacca – Senai was carried out as planned without any incident. On the third sector from Senai to Malacca, the aircraft experienced a loss of power and subsequently made an emergency landing on North-South Highway near Sedenak, Kulai, Johor.

The aircraft was loaded with full fuel in 6 tanks with a combined of 87 gallons of usable fuel. The 6 tanks on this aircraft from port to starboard are, LEFT TIP, LEFT AUX, LEFT MAIN, RIGHT MAIN, RIGHT AUX and RIGHT TIP. The pilot physically checked the fuel quantity during the pre-flight by opening the fuel caps as well as correlating with the fuel gauge. The fuel gauge is a 6 tank gauge, showing individual indicator for each tank. It shows the bar as well as an indicator of the actual volume of fuel remaining for each tank when selected.

With reference to the Pilot's Operating Handbook and the recommended fuel management procedure for this aircraft, the pilot departed on the LEFT MAIN tank and flew on the LEFT MAIN tank for about 25 to 30 minutes. The procedure recommends using about 10 gallons from the LEFT MAIN and then switch over to the other tanks. The pilot switched over to the AUX tanks (fuel is consumed from both LEFT AUX and RIGHT AUX tanks simultaneously, no individual selection to LEFT AUX or RIGHT AUX tank) and noted on the indicators that the AUX tanks fuel level drop gradually and the fuel consumption is in accordance to the cruise requirement which is about 10 to 11 gallons per hour. There was also an increase of LEFT MAIN tank level due to the fuel return at 3 gallons per hour as excess fuel from the carburettor. All the fuel indication was observed to be operating normally.

Shortly after using the AUX tanks, about 10 to 15 minutes into the flight from Seletar to Malacca, the fuel selector was switched to the RIGHT TIP tank where most

of the fuel on the RIGHT TIP tank were used. Subsequently the pilot switched tank to the LEFT TIP tank and consumed some of the fuel there. There were no problems with the engine power which indicates the fuel line is working well. During all these times, the pilot recorded the fuel quantity on the fuel log and note that tanks were not empty.

On arrival at Malacca and as part of pre-landing procedure, the fuel selector was switched to the RIGHT MAIN tank and a touch and go was carried out without problems. Once levelled off at 5000 feet, the pilot then flew to Senai on the second sector on the combination of AUX and TIP tanks. The pilot specifically reduced the use of RIGHT MAIN tank for most part of the flights as the plan was to reserve it for take-off and landing or when not flying straight and level, and for the final return flight from Malacca to Seletar. During this time, the fuel gauge was constantly monitored with the LEFT MAIN tank level increasing gradually whenever the AUX and TIP tanks were used.

On approach into Senai during the second sector, the RIGHT MAIN tank was selected as part of the pre-landing check list. A visual approach and a touch and go was carried out without problems. The aircraft climbed out of Senai normally at about 500 to 800 feet per minute and levelled off at 5000 feet for the third sector back to Malacca.

On cruising at 5,000 feet, the fuel selector was switched back to AUX tank again. The pilot observed that the fuel indicator was showing green for all the tanks except for TIP tanks. About 5 minutes after switching, a pop sound was heard by the pilot accompanied with a shudder. The pilot noticed a sudden loss in fuel pressure and the engine started losing power.

As per Pilot Operating Handbook emergency procedure, the fuel selector was switched to LEFT MAIN tank, RIGHT MAIN tank and TIP tanks in various combinations but the engine performance did not improve. The pilot also turned on the electrical fuel pump which improved the engine power for a minute or two. During this time, the toggle switch of the electrical fuel pump broke accidentally. The pilot also tried to manually pump the fuel pressure up with the manual wobble pump as described in the

emergency procedure. However, the engine did not come back to live for sustained period of time.

The pilot decided to carry out an emergency landing and saw that the aircraft can safely glide to land on the biggest road which was the North-South (PLUS) Highway. The traffic was light and the area was clear of power lines. The aircraft landed in the direction of the traffic, lowered down the landing gear and landed without damage to aircraft and any of the surrounding structures. The aircraft was taxied to a stop, by keeping to the left side of the road as much as possible to avoid obstructing the traffic behind. The pilot and passenger exited the aircraft and directed the traffic to the outer lane to prevent any possible accidents.

The police and the PLUS Highway personnel arrived later to render assistance and directed traffic on the highway. A police report was filed by the pilot at Kulai Police Station on the same day.

AAIB Investigation Team visited the incident site the next day to conduct on-site investigation. The aircraft was transported back to Senai Airport later by road after receiving approval from AAIB to remove the aircraft from the incident site.

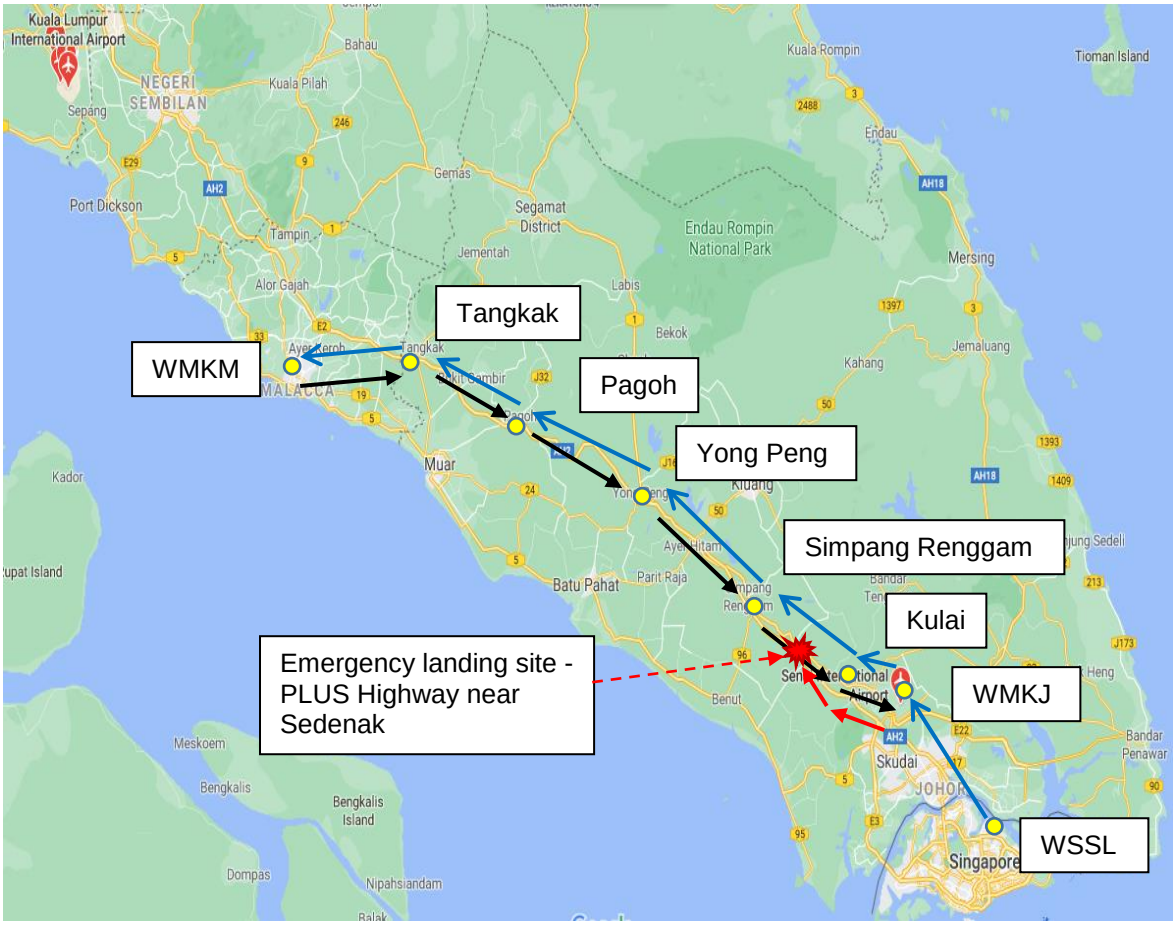


Figure 1: Flight Route Seletar (WSSL) – Malacca (WMKM) – Senai (WMKJ)

First Sector WSSL to WMKM.

Second Sector WMKM to WMKJ.

Third Sector WMKJ to WMKM (Aircraft emergency landed on PLUS Highway near Sedenak.

1.2 Injuries to persons

Injuries	Pilot	Passenger
Fatal	Nil	Nil
Serious	Nil	Nil
Minor	Nil	Nil
None	1	1

Figure 2: Injuries to persons

1.3 Damage to aircraft

No damage reported on the aircraft.

1.4 Other damage

No damage reported to public and private properties.

1.5 Personnel Information

1.5.1 Pilot in Command (PIC)

Nationality		Singaporean
Age		52
Gender		Male
License Type		Private
License Validity		PPL issued on 18 November 2019 with no expiry
Medical Examination		Class III. Examination on 03 June 2019 valid till 03 June 2021.
Aircraft Rating		Single engine land, Complex, High performance
Instructor Rating		NIL
Flying Hours	Total Hours	480
	Total on Type	125 (Complex & high performance)

Figure 3: Personal Information – Pilot in Command

1.5.2 Passenger

Nationality		Singaporean
Age		41
Gender		Male
License Type		ATPL
License Validity		No expiry
Medical Examination		Class II
Aircraft Rating		A320, GA
Instructor Rating		Yes
Flying Hours	**Total Hours**	3720
	Total on Type	1800 (Complex & high performance)

Figure 4: Personal Information – Passenger

1.6 Aircraft Information

1.6.1 General

The Beechcraft Bonanza F35 is a low-wing, single engine monoplane equipped with a fully retractable tricycle landing gear and a V-tail control surfaces which are arranged to act as both elevator and rudder (combination elevator-rudders called "ruddervators"). The Beechcraft Bonanza F35 aircraft is manufactured by Hawker Beechcraft Corporation of Wichita, Kansas, United States.

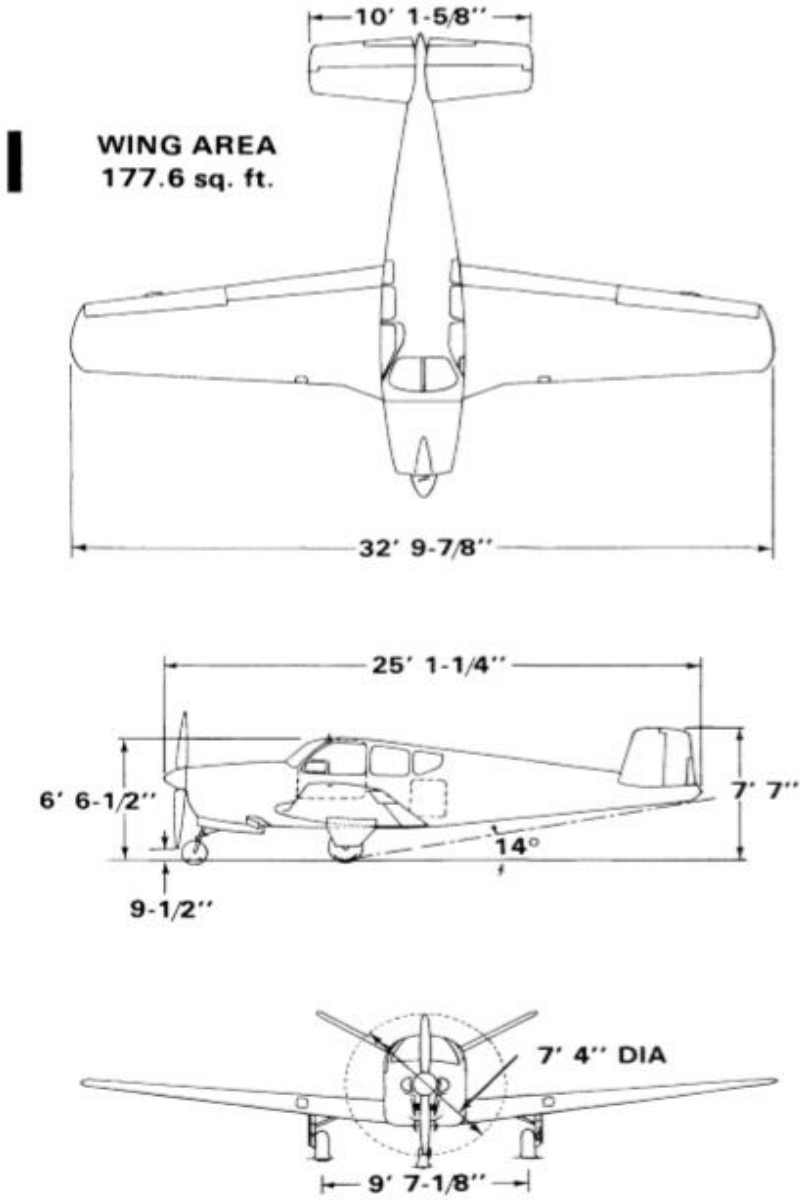


Figure 5: Three view of the aircraft

1.6.2 Aircraft Ownership

The owner of the aircraft is the pilot himself. The aircraft is registered with Federal Aviation Administration (FAA), United States under the name of a citizen residing in United States. The latest Certificate of Aircraft Registration was renewed on 30 April 2020 and is valid till 30 April 2023. The aircraft had a valid insurance coverage for a period from 03 March 2020 till 02 March 2021.

The pilot bought the aircraft from a private owner in United States in 2016 and the aircraft arrived in Senai Johor, Malaysia in 2017. The aircraft engine was overhauled by Airmark Overhaul Inc., Florida, United States in August 2016. The aircraft was made operational in March 2020 after engine fitment and an annual inspection. The aircraft did not fly till October 2020 due to flying and travel restrictions imposed by the Government of Malaysia and Singapore as a result of the COVID-19 pandemic.

1.6.3 Aircraft Data

Aircraft	Beechcraft Bonanza F35
Manufacturer	Beech Aircraft Corporation, United States
Owner	Private
Registration	N5045B
Serial No.	D-4323
C of A No.	NA
C of A Expiry	Date of issue 16 Sep 1955 (no expiry)
C of R No.	Date of issue 30 Apr 2020 (latest renewal)
C of R Expiry	30 Apr 2023 (latest renewal)
Year of Manufacture	1955

Figure 6: Aircraft Data

1.6.4 Engine Data

Engine	Continental six cylinder horizontally opposed engine
Manufacturer	Continental Motors Inc.
Overhauled by	Airmark Overhaul Inc., Florida, United States
Date overhaul authorised release certificate	26 August 2016
Model	E225-8
Serial	36254-D-8-8-R
Total accumulated time before overhaul	525.0 hours
Time since overhaul	17.3 hours

Figure 7: Engine Data

1.6.5 Propeller Data

Propeller	2 blade propellers with Beech electrical variable pitch control
Manufacturer	Beech
Repaired by	Stockton Propeller Inc., California, United States
Date repair authorised release certificate	28 June 2019
Model	Beech 215-107/215-213-84
Serial	4-1803
Time since repair	17.3 hours

Figure 8: Propeller Data

1.6.6 Aircraft Performance Specifications

WEIGHT		
Maximum Take-off and Landing Weight	2,750lbs	
Zero Fuel Weight	No structural limitation	
Maximum Ramp Weight	2,760lbs	
SPEED		
	IAS	
	knots	**mph**
Take-off	62	71
Landing Approach	63	73
Never Exceed	173	199
Normal Operating Range	57 – 150	66 – 173

Maximum Cruise		150	173
Maximum Landing Gear Operating		108	124
Maximum Flap Extension		90	104
Manoeuvring		112	129
Maximum Crosswind		17	20
Stalling Speed Full Flaps		48	55
OTHERS			
Load Factors		4.4g (flaps Up)	2.0g (flaps down)
Maximum Take-off (1 minutes)		225HP at 2,650RPM	
Maximum Continuous Operation		185 HP at 2,300RPM	
Fuel Grade		MOGAS RON 95	
Fuel Capacity	**Tanks (Left & Right)**	**Max Capacity (gallons)**	**Usable (gallons)**
	Main	40	34
	Aux (No individual selection)	20	19
	Tip	40	34
	Total	**100**	**87**

Figure 9: Aircraft performance specifications

1.6.7 Fuel System

Fuel supply is carried in two bladder type cells with a total capacity of 20 gallons each (usable 17 gallons), located in the wings just outboard of the fuselage. Both the main tanks can be selected individually via the fuel selector valve when the selector valve is set to either LEFT or RIGHT MAIN. Fuel is fed from the cells to a selector valve just forward of the front seat, on the left side, then through a strainer to the fuel pump and the engine as shown in the aircraft fuel system schematic in Figure 10.

There are two auxiliary 10 gallons (usable 9.5 gallons) fuel cells installed in the wings, outboard of the wheel wells. Both auxiliary cells are connected to a common port in the fuel selector valve so that both feeds simultaneously when the selector valve is set to AUX.

Additionally, two tip fuel cells 20 gallons each (usable 17 gallons) are located at each of the wing tip. Both the tip tanks can be selected individually

via the fuel selector valve when the selector valve is set to either LEFT or RIGHT TIP.

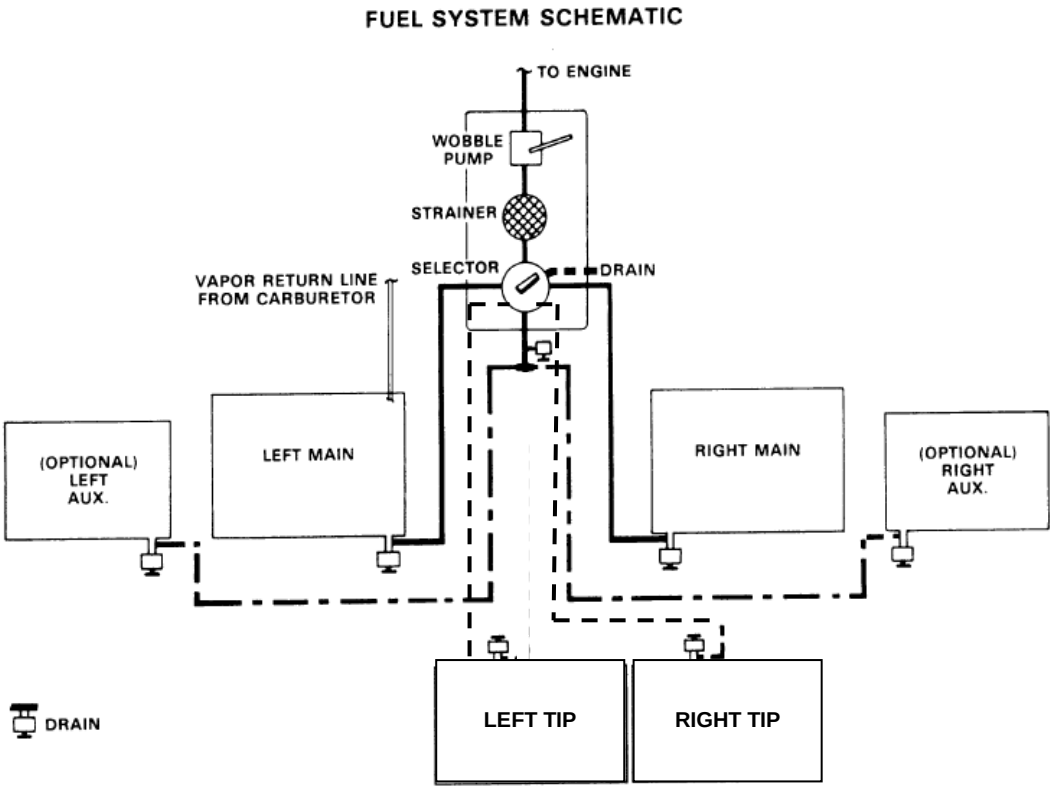


Figure 10: Fuel System Schematic

Fuel quantity is measured by float operated sensors located in each fuel cells. These sensors transmit electrical signals to the indicator through the selector switch located on the fuel gauge to indicate fuel remaining in the tank selected (Figure 11).

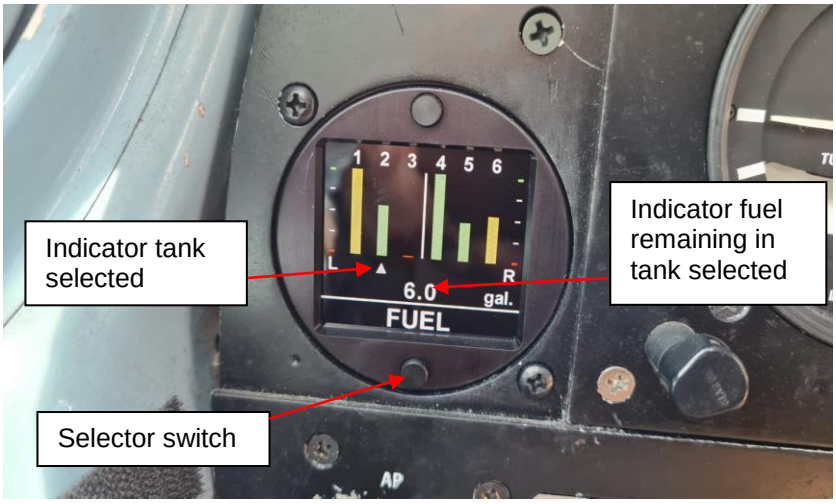


Figure 11: Fuel Gauge

A manually operated auxiliary (wobble) fuel pump incorporated with the fuel selector valve provides pressure for starting and emergency operation if the engine driven pump should fail. The manual pump is operated by working the handle up and down. An electrical fuel boost pump is also installed to boost fuel pressure during starting and for emergency operation (Figure 12).

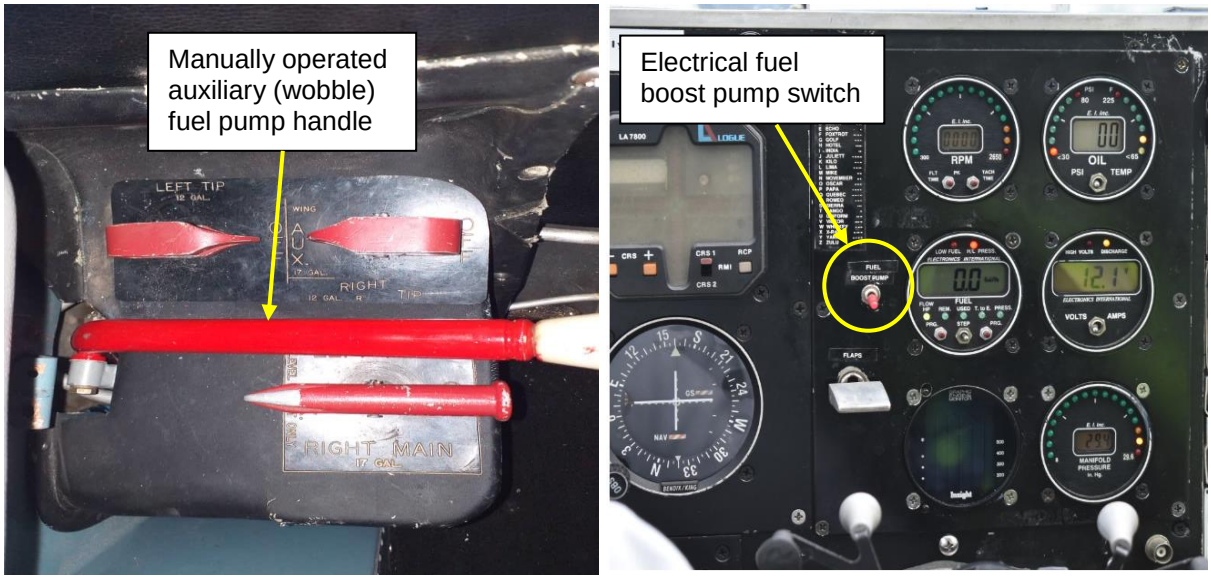


Figure 12: Manually operated Auxiliary (Wobble) Fuel Pump Handle at fuel selector panel and Electrical Fuel Boost Pump Switch at cockpit engine instrument panel

Take-offs should be made using the left main tank and landings should be made using the main tank that is more or nearly full. Take-off should not be

made if the fuel indicators show less than 10 gallons of fuel in each main tank. The pressure type carburettor returns about 3 gallons per hour of excess fuel to the left main tank, regardless which tank is selected. To provide capacity for the returned fuel, the left main tank should be consumed to approximately half full before switching tank. The cruise fuel consumption is about 11 gallons per hour.

1.6.8 Preventive Maintenance

Annual inspection was carried out on the aircraft airframe, engine and propeller in accordance to the Beechcraft Annual Inspection Check by the AMP and was certified airworthy on 20 March 2020.

1.6.9 Corrective Maintenance

Inspection on the aircraft, engine and propeller logbook reveal no reported unserviceability since the aircraft was airworthy to fly in March 2020 till the day of incident.

1.6.10 Flight Operations

The aircraft total flight hours since certified airworthy in March 2020 till the day of incident are as follows:

YEAR	MONTH	FLIGHT HOURS
2020	OCTOBER	5.4
	NOVEMBER	8.7
	TOTAL	**14.1**

Figure 13: Aircraft flight hours

The aircraft flight routes in the month of November 2020 are as follows:

DATE	ROUTE	FLIGHT HOURS
06 November 2020	Senai (WMKJ) – Seletar (WSSL)	0.8
14 November 2020	WSSL – Gunung Pulai – WMKJ	2.0
19 November 2020	WMKJ - WSSL	0.9

21 November 2020	WSSL – Malacca (WMKM) – WSSL	2.3
22 November 2020	WSSL – WMKM – WMKJ - (Incident)	2.7
	TOTAL	**8.7**

Figure 14: Flight routes in the month of November 2020

1.7 Meteorological Information

Weather at the time of the emergency landing was reported by the pilot to be fine and sunny with very good visibility. METAR for Senai Airport indicate fine weather with visibility more than 10km.

1.8 Aids to navigation

The flight was conducted under visual flight rule as indicated in the flight plan submitted by the pilot.

1.9 Communications

Pilot informed Johor ATC on the nature of emergency and requested to return to Senai Airport but did not declare “MAYDAY or PAN”. There was no communication between the pilot and Johor ATC after that until Johor ATC later received a telephone call from the pilot that he had safely landed the aircraft on the North-South Highway.

1.10 Aerodrome information

The aircraft was in Johor TMA airspace and under Johor Approach control when the incident occurred. Nearest airport to the incident site is Senai Airport.

Airport	Senai Airport
Runway	16/34
Length	3,800m
Width	45m
ICAO Designator	WMKJ
IATA Designator	JHB
Elevation	127ft

Navaids	VOR VJR, ILS IJB
Radio	JOHOR GROUND: 121.8MHz JOHOR TOWER 118.15MHz JOHOR APPROACH: 124.7MHz JOHOR INFO (ATIS): 123.05MHz

Figure 15: Senai airport information

1.11 Flight Recorders

There are no flight recorders installed in the aircraft.

1.12 Wreckage and impact information

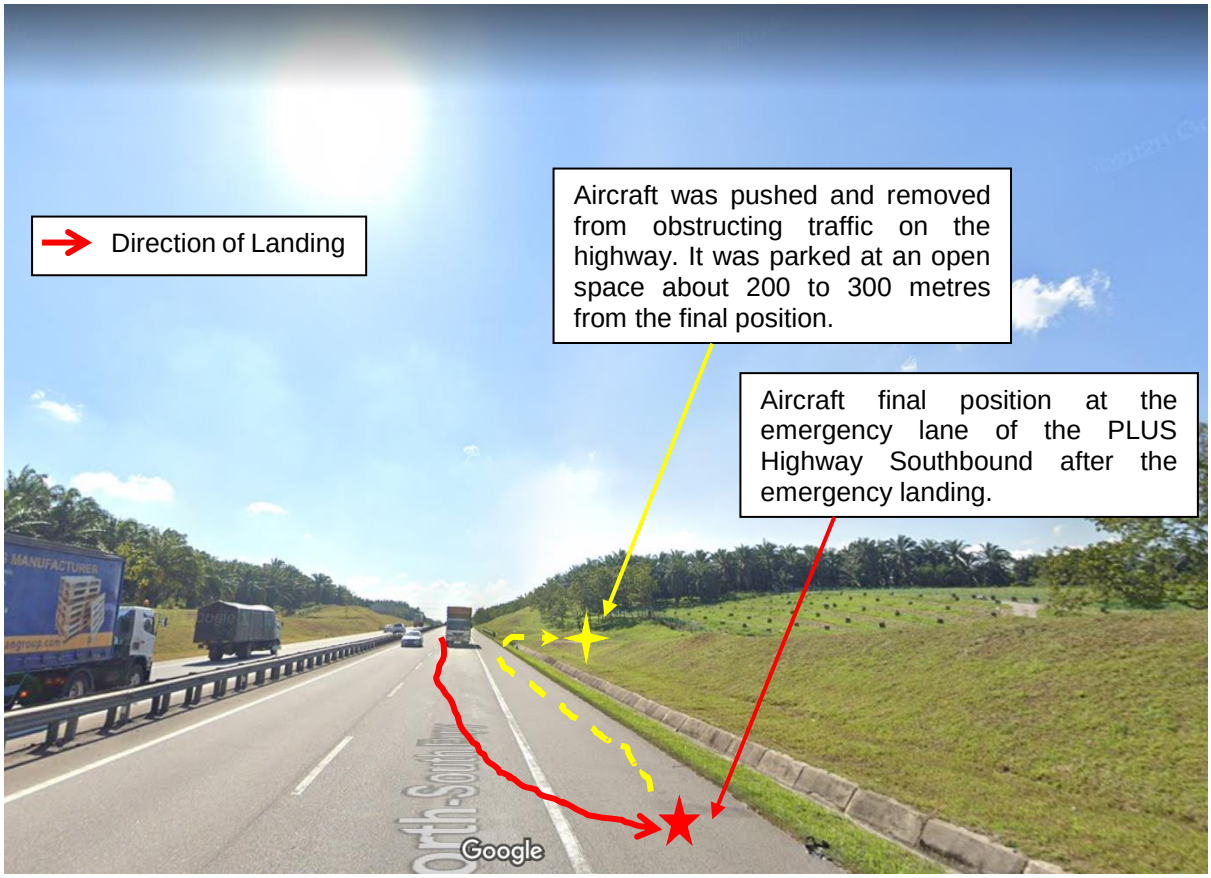


Figure 16: Emergency landing path and final position of aircraft

1.13 Medical and pathological information

The pilot had a valid Medical Certificate Third Class issued by FAA. The medical examination was conducted on 03 June 2019 and is valid till 03 June 2021. The pilot

did an Analytical Toxicology Blood Test within 24 hours of the incident. Test results shows no evidence of any relevant medical or toxicological factors that could affect the performance of the pilot.

1.14 Fire

No fire to the aircraft was reported before, during and after the incident.

1.15 Survival aspects

Both the pilot and passenger exited the aircraft via the aircraft cabin door safely.

1.16 Tests and research

1.16.1 Fuel, Engine Oil and Brake Fluid Sample Test

The aircraft fuel, engine oil and brake fluid were drained at incident site and samples were sent to the laboratory for forensic test. Test result did not reveal any abnormalities to all samples.

1.16.2 Fuel Sender Unit Inspection and Overhaul

The 6 fuel sender unit located in each of the 6 fuel tanks which give fuel quantity indication on the fuel gauge were sent for inspection and overhaul to identify its functionality. An inspection carried out by the FAA Approved Repair Station found that all 6 floats were in bad and dirty condition. All the floats were replaced and all 6 fuel sender units were overhauled and calibrated by the FAA Approved Repair Station. The fuel sender units were refitted back to the aircraft after overhaul and calibration. Current inspection schedule for the fuel sender units are ‘on condition’ item as stated in the Bonanza 35 Series Shop Manual.[1]

[1] Bonanza 35 Series Shop Manual Section 8 – Accessory and Component Replacement Schedule, Fuel System Page 4.

1.16.3 Fuel Selector Valve Inspection and Overhaul

The fuel selector valve which direct fuel from various fuel tanks to the engine was also sent for inspection to identify its functionality. Inspection for damage, corrosion and excessive wear was carried out by the aircraft AMP. No significant defects were found during the inspection. The fuel selector valve was cleaned, 'O' ring replaced and a functional test was carried out in accordance with Bonanza 35 Series Shop Manual. It was certified satisfactory and serviceable after the functional test by the aircraft AMP.

1.16.4 Fuel Gauge Calibration and Physical Fuel Quantity Check

The aircraft was fitted with a new FL206 fuel gauge (serial number ASL011126) from Aerospace Logic Inc (Canada). The new gauge was purchased and installed on the aircraft on October 2020. To verify the accuracy of the fuel gauge, a manual calibration was conducted after the overhauled fuel sender unit was installed by manually filling each fuel tanks with the correct amount of fuel and verifying it on the fuel gauge display. The functional test did not reveal any abnormalities on the fuel gauge.

1.16.5 Engine Ground Run Functional Checks

Two engine ground run functional checks were carried out at Senai Airport in the presence of the AAIB Investigation Team on 10 December 2020 and 23 February 2021 found no abnormalities to the engine. The first functional check on 10 December 2020 was carried out by the pilot himself and witnessed by the AMP after the wing reassemble process following the transporting of the aircraft from the incident site to General Aviation (GA) Hangar, Senai Airport. The functional check confirmed all engine parameters were normal with no abnormalities observed on the engine.

A second functional check was carried out on 23 February 2021 by the aircraft AMP after the fitment of the overhauled fuel sender units, fuel selector valve and the calibrated fuel gauge. Functional checks on all these

components on the aircraft post overhaul and calibration revealed no abnormalities and all engine parameters were observed to be within operating limits.

1.17 Organisational and management information

1.17.1 Pilot Experience

The pilot regularly flies the aircraft for leisure purposes around Peninsula Malaysia and is considered to be a fairly experienced pilot for a PPL holder.

The pilot holds a valid PPL with instrument rating issued by the FAA on 18 November 2019. The flight practical and instrument rating test for the PPL was carried out on 17 and 18 November 2019 in United States and endorsed in his Flying Log Book. The pilot has accumulated a total of 125 hours on type (complex & high performance) and 480 hours on all types. Aircraft types flown by the pilot are as follows:

NO	AIRCRAFT	STATUS
1	Beechcraft Bonanza F35	Owner and current flying
2	Beechcraft Debonair 35-C33	Owner and current flying
3	Cessna 172	Not current flying
4	Piper PA – 28 Cherokee	Not current flying
5	Cirrus SR20	Not current flying
6	Aero AT4	Not current flying
7	Robinson R22 Helicopter	Owner and not current flying

Figure 17: Aircraft types flown by the pilot

1.17.2 Aircraft Maintenance

The aircraft is maintained by a Malaysian Authorized Maintenance Personnel (AMP) with a FAA Airframe and Powerplant (A & P) Licence. All maintenance activities are carried out at GA Hangar Senai Airport, Johor. The aircraft is parked either at Senai or Seletar Airport subject to the owner's flying activities.

The AMP had carried out an annual inspection on the aircraft airframe, engine and propeller on 20 March 2020 before being issued with a Certificate of Aircraft Registration on 30 April 2020.

1.17.3 Fuel Quantity Monitoring and Fuel Log Entry

It is the pilot's responsibility to ascertain the fuel quantity gauge is functioning and maintaining at a reasonable degree of accuracy and be certain of ample fuel for flight.[2]

With reference to the pilot's witness statement, it was highlighted that the pilot had continuously monitored the fuel indicators on the fuel gauge and fuel consumption of the engine. Pilot's statement also expressed that the fuel indicators and fuel consumption did not show any sign of abnormalities, in consistent with the fuel gauge and fuel log of the aircraft (Figure 18). The last entry on the fuel log shows 13 gallons of fuel in the left main tank at time 1049 hours, about 15 minutes before the engine experience a loss of power in flight.

[2] Beechcraft Bonanza F35 Pilot's Operating Handbook, Section VII, System Description, Page 7-23.

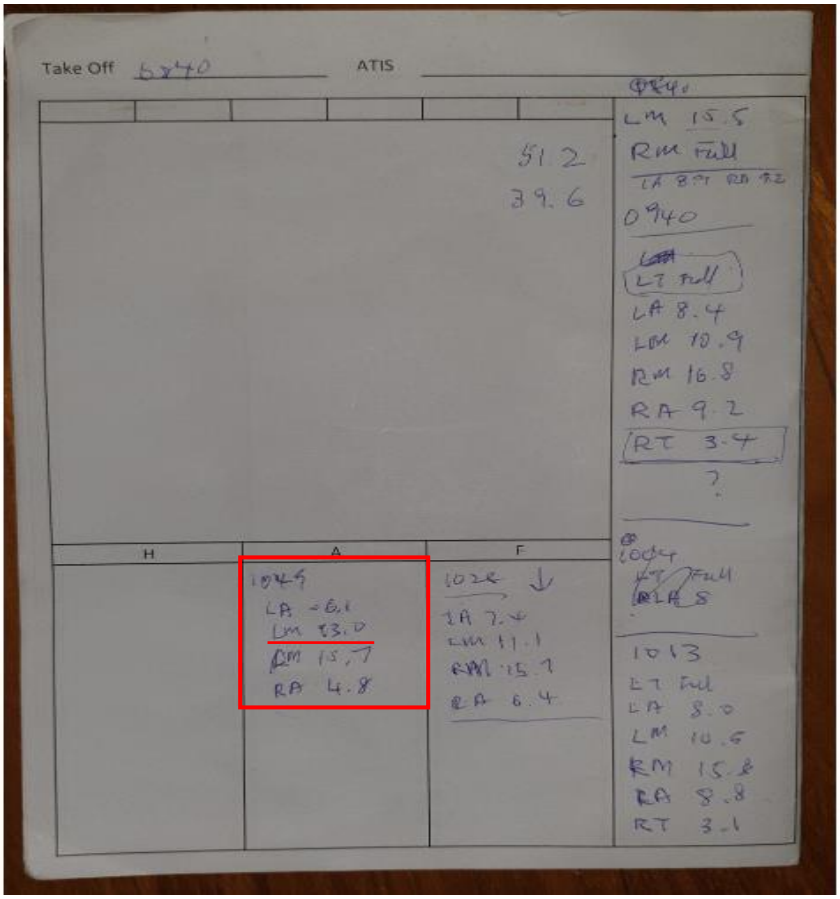


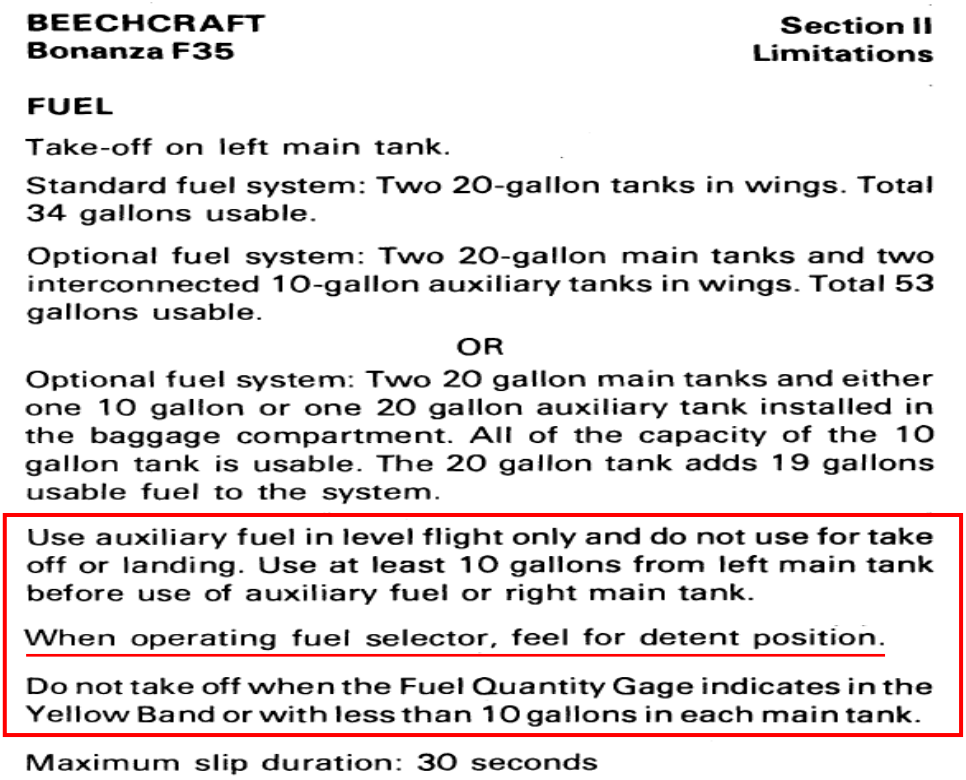
Figure 18: Aircraft Fuel Log

Nevertheless, on-site physical fuel quantity check after the emergency landing revealed that the fuel quantity on the left main tank was physically empty and the left main tank fuel indicator on the fuel gauge was indicating zero fuel quantity. The right main tank and both auxiliary tanks were observed to have reasonable amount of fuel in the tanks (see paragraph 1.18.3) while both the tip tanks were close to empty.

1.17.4 Fuel System Operating Limitations

The pilot stated that the fuel tank was switched from RIGHT MAIN tank to AUX tank on levelling at 5,000 feet after the touch and go at Senai Airport. With reference to the Beechcraft Bonanza F35 Pilot's Operating Handbook, Section II – Limitations (Figure 19), it is important for the pilot to feel for the selection detent when operating the fuel selector valve. Improper selection of

the fuel selector valve not in detent position will result in fuel flow restriction causing fuel starvation and eventually leading to a loss of engine power.



BEECHCRAFT
Bonanza F35

Section II
Limitations

FUEL

Take-off on left main tank.

Standard fuel system: Two 20-gallon tanks in wings. Total 34 gallons usable.

Optional fuel system: Two 20-gallon main tanks and two interconnected 10-gallon auxiliary tanks in wings. Total 53 gallons usable.

OR

Optional fuel system: Two 20 gallon main tanks and either one 10 gallon or one 20 gallon auxiliary tank installed in the baggage compartment. All of the capacity of the 10 gallon tank is usable. The 20 gallon tank adds 19 gallons usable fuel to the system.

Use auxiliary fuel in level flight only and do not use for take off or landing. Use at least 10 gallons from left main tank before use of auxiliary fuel or right main tank.

When operating fuel selector, feel for detent position.

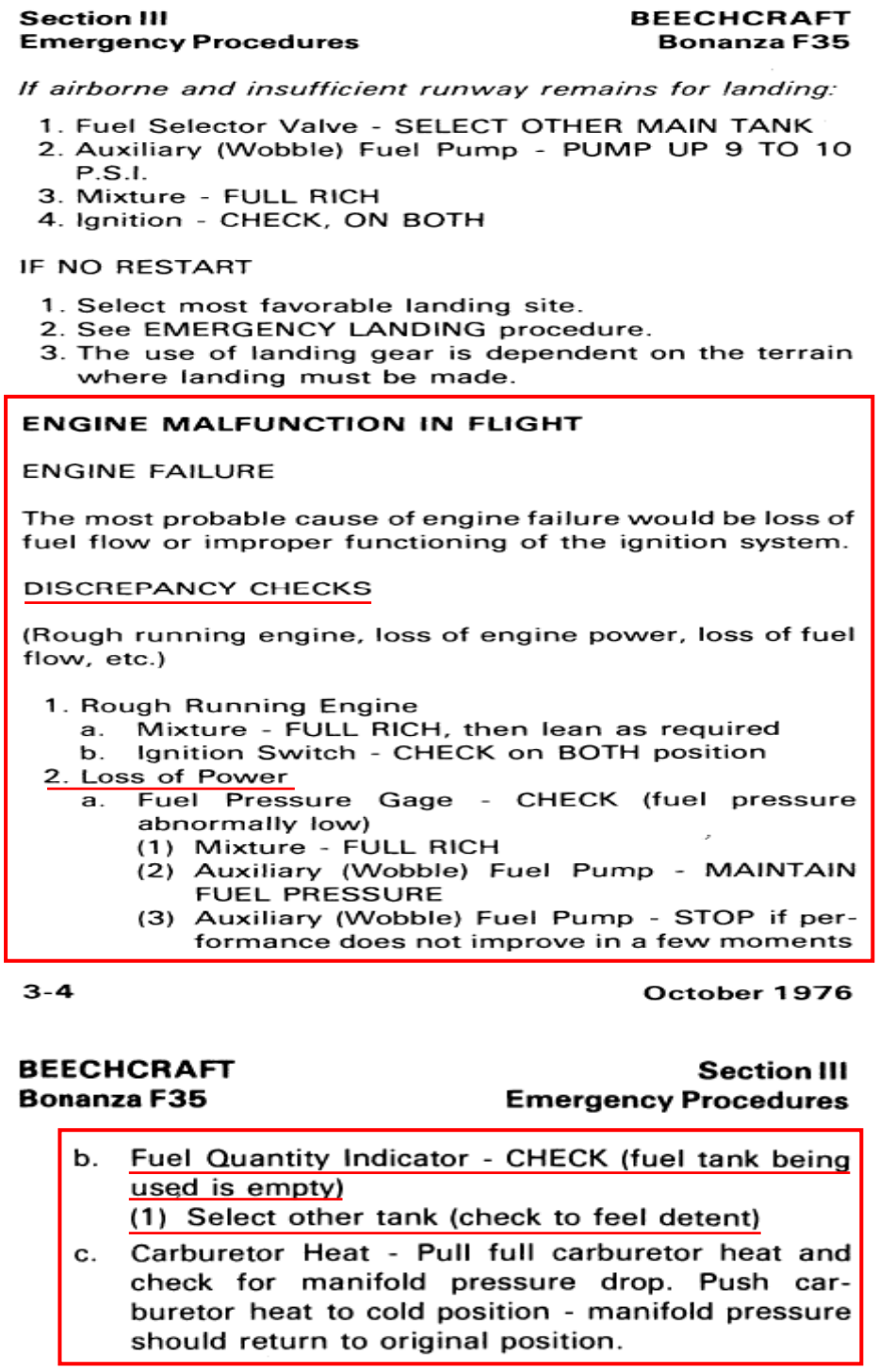
Do not take off when the Fuel Quantity Gage indicates in the Yellow Band or with less than 10 gallons in each main tank.

Maximum slip duration: 30 seconds

Figure 19: Fuel System Operating Limitations

1.17.5 Discrepancy Checks for Engine Power Loss in Flight

With reference to the Beechcraft Bonanza F35 Pilot's Operating Handbook, Section III – Emergency Procedures, the most probable cause of engine malfunction in flight would be the loss of fuel flow or improper functioning of the ignition system. The pilot stated that the engine suffered a loss of power about 5 minutes after switching from RIGHT MAIN tank to AUX tank during level cruise. A loss of power requires the pilot to carry out the Discrepancy Checks as in Figure 20.



Section III
Emergency Procedures

BEECHCRAFT
Bonanza F35

If airborne and insufficient runway remains for landing:

1. Fuel Selector Valve - SELECT OTHER MAIN TANK
2. Auxiliary (Wobble) Fuel Pump - PUMP UP 9 TO 10 P.S.I.
3. Mixture - FULL RICH
4. Ignition - CHECK, ON BOTH

IF NO RESTART

1. Select most favorable landing site.
2. See EMERGENCY LANDING procedure.
3. The use of landing gear is dependent on the terrain where landing must be made.

ENGINE MALFUNCTION IN FLIGHT

ENGINE FAILURE

The most probable cause of engine failure would be loss of fuel flow or improper functioning of the ignition system.

DISCREPANCY CHECKS

(Rough running engine, loss of engine power, loss of fuel flow, etc.)

1. Rough Running Engine
   a. Mixture - FULL RICH, then lean as required
   b. Ignition Switch - CHECK on BOTH position
2. Loss of Power
   a. Fuel Pressure Gage - CHECK (fuel pressure abnormally low)
      (1) Mixture - FULL RICH
      (2) Auxiliary (Wobble) Fuel Pump - MAINTAIN FUEL PRESSURE
      (3) Auxiliary (Wobble) Fuel Pump - STOP if performance does not improve in a few moments

3-4

October 1976

BEECHCRAFT
Bonanza F35

Section III
Emergency Procedures

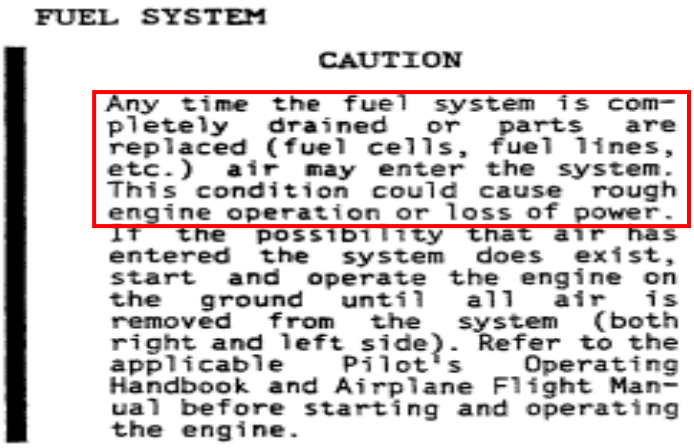
b. Fuel Quantity Indicator - CHECK (fuel tank being used is empty)
   (1) Select other tank (check to feel detent)
c. Carburetor Heat - Pull full carburetor heat and check for manifold pressure drop. Push carburetor heat to cold position - manifold pressure should return to original position.

Figure 20: Engine Malfunction in Flight Emergency Procedures

In accordance with the Discrepancy Checks, the pilot had activated the electrical and later the auxiliary (wobble) fuel pump to try and restore fuel pressure but the engine performance did not improve. The pilot also noted that the fuel quantity indicators were indicating green for all tanks except for the tip

tanks. Carburettor heat was not utilised in this flight as the aircraft was not operating in cold weather or environment.

Another possible cause of engine power loss as stated in the Bonanza 35 Series Shop Manual is when the fuel system is completely drain of fuel (Figure 21). This scenario is only possible if the pilot inadvertently run the selected fuel tank dry in flight. When the tank is dry, there is a possibility that air has entered the fuel system causing the engine to lose power.



FUEL SYSTEM

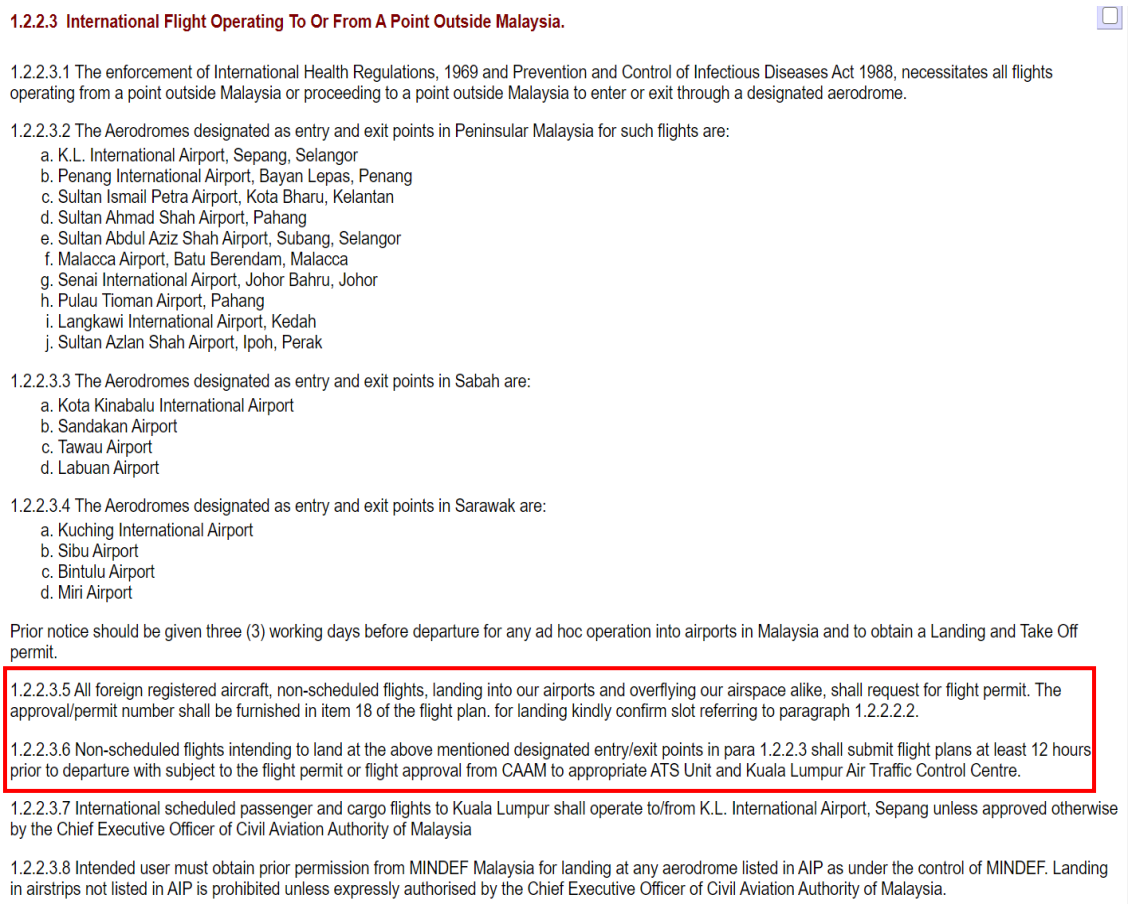
CAUTION

Any time the fuel system is completely drained or parts are replaced (fuel cells, fuel lines, etc.) air may enter the system. This condition could cause rough engine operation or loss of power. If the possibility that air has entered the system does exist, start and operate the engine on the ground until all air is removed from the system (both right and left side). Refer to the applicable Pilot's Operating Handbook and Airplane Flight Manual before starting and operating the engine.

Figure 21: Bonanza 35 Series Shop Manual, Section 3 System Description and Maintenance – Fuel System Page 3-14

1.17.6 Regulatory Regulations and Requirements for Foreign Registered Aircraft Entering Malaysia

With reference to national regulations and requirements as stated in AIP Malaysia in Figure 22, all foreign registered aircraft intending to land or overfly Malaysia airspace shall obtained an approved flight permit from CAAM 72 hours in advance before departure date and to submit a flight plan at least 12 hours prior to departure.



1.2.2.3 International Flight Operating To Or From A Point Outside Malaysia.

1.2.2.3.1 The enforcement of International Health Regulations, 1969 and Prevention and Control of Infectious Diseases Act 1988, necessitates all flights operating from a point outside Malaysia or proceeding to a point outside Malaysia to enter or exit through a designated aerodrome.

1.2.2.3.2 The Aerodromes designated as entry and exit points in Peninsular Malaysia for such flights are:

a. K.L. International Airport, Sepang, Selangor
b. Penang International Airport, Bayan Lepas, Penang
c. Sultan Ismail Petra Airport, Kota Bharu, Kelantan
d. Sultan Ahmad Shah Airport, Pahang
e. Sultan Abdul Aziz Shah Airport, Subang, Selangor
f. Malacca Airport, Batu Berendam, Malacca
g. Senai International Airport, Johor Bahru, Johor
h. Pulau Tioman Airport, Pahang
i. Langkawi International Airport, Kedah
j. Sultan Azlan Shah Airport, Ipoh, Perak

1.2.2.3.3 The Aerodromes designated as entry and exit points in Sabah are:

a. Kota Kinabalu International Airport
b. Sandakan Airport
c. Tawau Airport
d. Labuan Airport

1.2.2.3.4 The Aerodromes designated as entry and exit points in Sarawak are:

a. Kuching International Airport
b. Sibu Airport
c. Bintulu Airport
d. Miri Airport

Prior notice should be given three (3) working days before departure for any ad hoc operation into airports in Malaysia and to obtain a Landing and Take Off permit.

1.2.2.3.5 All foreign registered aircraft, non-scheduled flights, landing into our airports and overflying our airspace alike, shall request for flight permit. The approval/permit number shall be furnished in item 18 of the flight plan. for landing kindly confirm slot referring to paragraph 1.2.2.2.2.

1.2.2.3.6 Non-scheduled flights intending to land at the above mentioned designated entry/exit points in para 1.2.2.3 shall submit flight plans at least 12 hours prior to departure with subject to the flight permit or flight approval from CAAM to appropriate ATS Unit and Kuala Lumpur Air Traffic Control Centre.

1.2.2.3.7 International scheduled passenger and cargo flights to Kuala Lumpur shall operate to/from K.L. International Airport, Sepang unless approved otherwise by the Chief Executive Officer of Civil Aviation Authority of Malaysia

1.2.2.3.8 Intended user must obtain prior permission from MINDEF Malaysia for landing at any aerodrome listed in AIP as under the control of MINDEF. Landing in airstrips not listed in AIP is prohibited unless expressly authorised by the Chief Executive Officer of Civil Aviation Authority of Malaysia.

Figure 22: AIP Malaysia Part 1 General 1.2 – Entry, Transit and Departure of Aircraft

The pilot had submitted a request for flight permit on 12 November 2020 and obtained an approval from CAAM on 18 November 2020 for the flight from Seletar - Malacca - Seletar for 22 November 2020. Flight plans were subsequently submitted for the planned flight routes Seletar – Malacca – Senai – Malacca – Senai - Seletar.

The Permit for Foreign Registered Aircraft / General Aviation Operations in Malaysia Form clearly requires the pilot to specify details of route, point of departure, landing in Malaysia and the final destination. It was observed that there is discrepancy between the approved flight permit routes and the flight plan routes. There was neither a request from the pilot nor an approval from CAAM to fly into Senai Airport as the request and approval were only for Malacca Airport for the flight on 22 November 2020.

It was also observed that the permit number furnished in the flight plan by the pilot as CAAM/ATM/0241/11/20 was incorrect with reference to the flight permit number approved from CAAM (CAAM/ATM/0245/11/20) for the flight on 22 November 2020.

1.17.7 Observation during Investigation

1.17.7.1 Incorrect Certificate in Engine Logbook

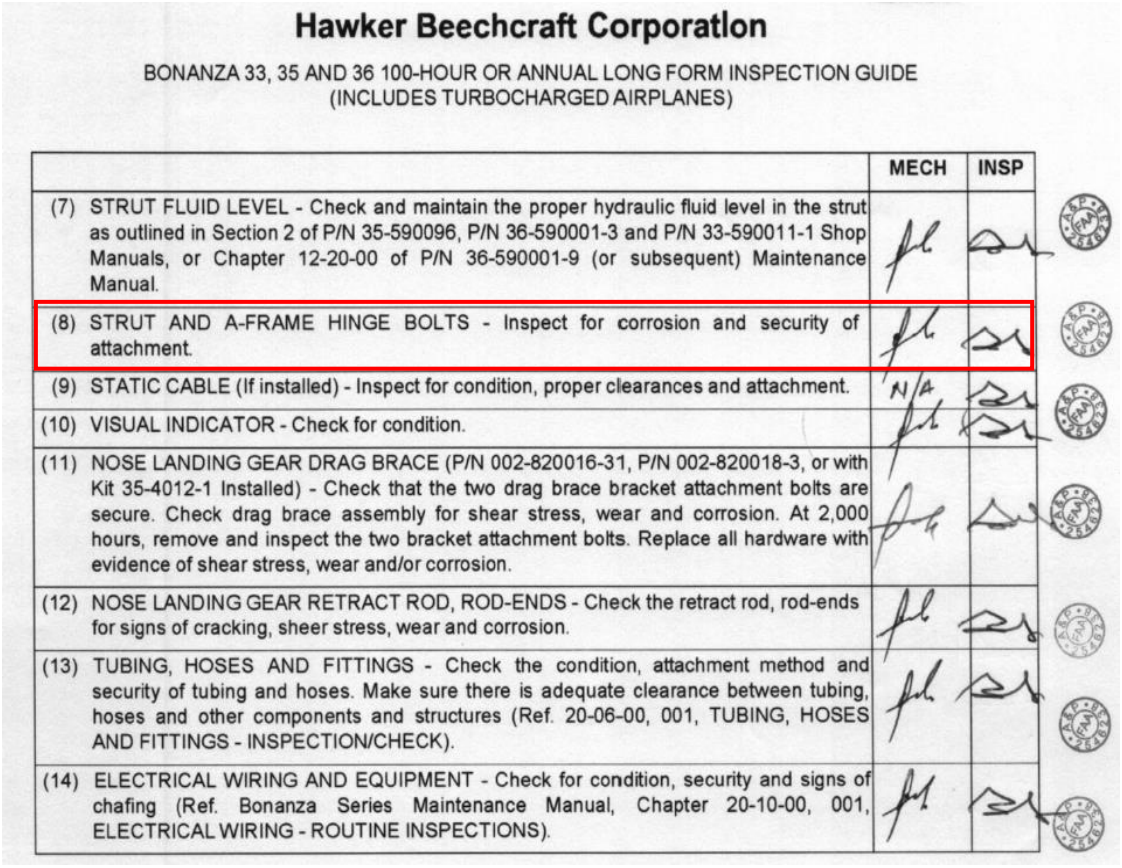
The aircraft Technical Log Sheet, Airframe and Propeller Logbook were all well maintained. However, inspection carried out on the Engine Logbook shows that the Annual Inspection Certificate is of a different engine model, Continental R-IO470K3B but with the same engine serial number 1007883. The correct engine model type should be Continental E225-8.

1.17.7.2 Corrosion at Nose Gear Shock Strut

The annual inspection check calls for the inspection of the nose gear shock strut for corrosion as in Figure 23. It was observed that the aircraft nose gear shock strut shows sign of severe corrosion at various places despite undergoing annual inspection in March 2020 as in Figure 24.

The annual inspection check log shows all the inspections were carried out satisfactory. The only repair task carried out by the AMP during the annual inspection was the replacement of the nose gear rod end HM-5S as recorded in the detail task of the airframe logbook (Figure 25).

Corrosion treatment was carried out on the nose gear shock strut after the observation by the investigation team. Comparison of the nose gear shock strut before and after treatment are as shown in Figure 24.



Hawker Beechcraft Corporation

BONANZA 33, 35 AND 36 100-HOUR OR ANNUAL LONG FORM INSPECTION GUIDE
(INCLUDES TURBOCHARGED AIRPLANES)

	MECH	INSP
(7) STRUT FLUID LEVEL - Check and maintain the proper hydraulic fluid level in the strut as outlined in Section 2 of P/N 35-590096, P/N 36-590001-3 and P/N 33-590011-1 Shop Manuals, or Chapter 12-20-00 of P/N 36-590001-9 (or subsequent) Maintenance Manual.		
(8) STRUT AND A-FRAME HINGE BOLTS - Inspect for corrosion and security of attachment.		
(9) STATIC CABLE (If installed) - Inspect for condition, proper clearances and attachment.	N/A	
(10) VISUAL INDICATOR - Check for condition.		
(11) NOSE LANDING GEAR DRAG BRACE (P/N 002-820016-31, P/N 002-820018-3, or with Kit 35-4012-1 Installed) - Check that the two drag brace bracket attachment bolts are secure. Check drag brace assembly for shear stress, wear and corrosion. At 2,000 hours, remove and inspect the two bracket attachment bolts. Replace all hardware with evidence of shear stress, wear and/or corrosion.		
(12) NOSE LANDING GEAR RETRACT ROD, ROD-ENDS - Check the retract rod, rod-ends for signs of cracking, sheer stress, wear and corrosion.		
(13) TUBING, HOSES AND FITTINGS - Check the condition, attachment method and security of tubing and hoses. Make sure there is adequate clearance between tubing, hoses and other components and structures (Ref. 20-06-00, 001, TUBING, HOSES AND FITTINGS - INSPECTION/CHECK).		
(14) ELECTRICAL WIRING AND EQUIPMENT - Check for condition, security and signs of chafing (Ref. Bonanza Series Maintenance Manual, Chapter 20-10-00, 001, ELECTRICAL WIRING - ROUTINE INSPECTIONS).		

Figure 23: Annual inspection form – Nose Gear Shock Strut Inspection

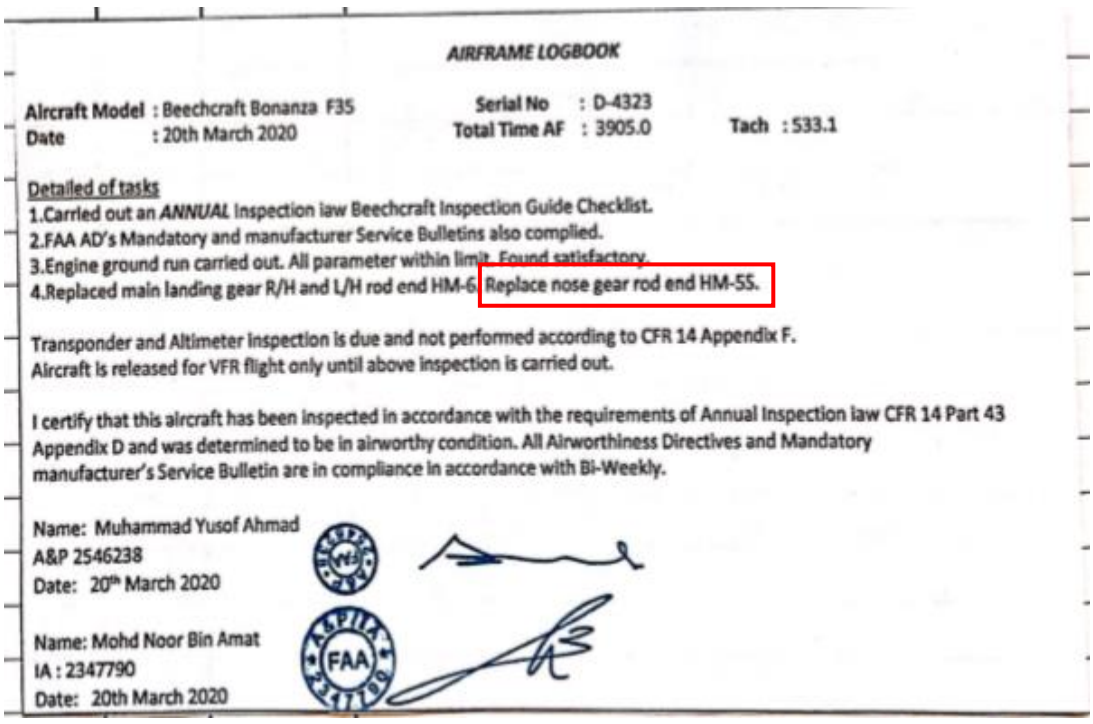
Before corrosion treatment

After corrosion treatment

Before corrosion treatment

After corrosion treatment

Figure 24: Corrosion at nose gear shock strut before and after corrosion treatment



AIRFRAME LOGBOOK

Aircraft Model : Beechcraft Bonanza F35 Serial No : D-4323
Date : 20th March 2020 Total Time AF : 3905.0 Tach : 533.1

Detailed of tasks
1.Carried out an *ANNUAL* Inspection law Beechcraft Inspection Guide Checklist.
2.FAA AD's Mandatory and manufacturer Service Bulletins also complied.
3.Engine ground run carried out. All parameter within limit. Found satisfactory.
4.Replaced main landing gear R/H and L/H rod end HM-6 Replace nose gear rod end HM-5S.

Transponder and Altimeter Inspection is due and not performed according to CFR 14 Appendix F.
Aircraft is released for VFR flight only until above inspection is carried out.

I certify that this aircraft has been inspected in accordance with the requirements of Annual Inspection law CFR 14 Part 43 Appendix D and was determined to be in airworthy condition. All Airworthiness Directives and Mandatory manufacturer's Service Bulletin are in compliance in accordance with Bi-Weekly.

Name: Muhammad Yusof Ahmad
A&P 2546238
Date: 20th March 2020

Name: Mohd Noor Bin Amat
IA : 2347790
Date: 20th March 2020

Figure 25: Annual Inspection Certificate – Replacement of gear rod end HM-5S

1.18 Additional information

1.18.1 Interview and Written Statements

The AAIB investigation team conducted separate interview sessions with the Pilot, Passenger, Duty Air Traffic Controllers, and Authorized Maintenance Personnel. 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 The Fuel Selector Valve Panel

The aircraft has 6 fuel tanks located at both its wings, consisting two main tanks, two auxiliary tanks and two tip tanks. Fuel flow to the engine are controlled by 3 selector valves, all located on the fuel selector valve panel mounted on the cabin floor, slightly forward on the left side of the pilot seat. Individual selection of tanks is only available for both the main (LEFT & RIGHT)

and tip (LEFT & RIGHT) tanks, while both the auxiliary tank is connected to a common port in the fuel selector valve so that both feeds simultaneously when the selector valve is set to AUX.

The location of the fuel selector valve panel is not in line of sight of the pilot when the pilot is in seated flying position (Figure 26). Any switch of tanks in flight requires the pilot to physically lean forward and glance at the fuel selector valve panel to ensure the correct selector valve is selected corresponding to the tank desired. It also requires the pilot to feel for the detent when turning the selector to ensure the selector valve is set to the correct position.

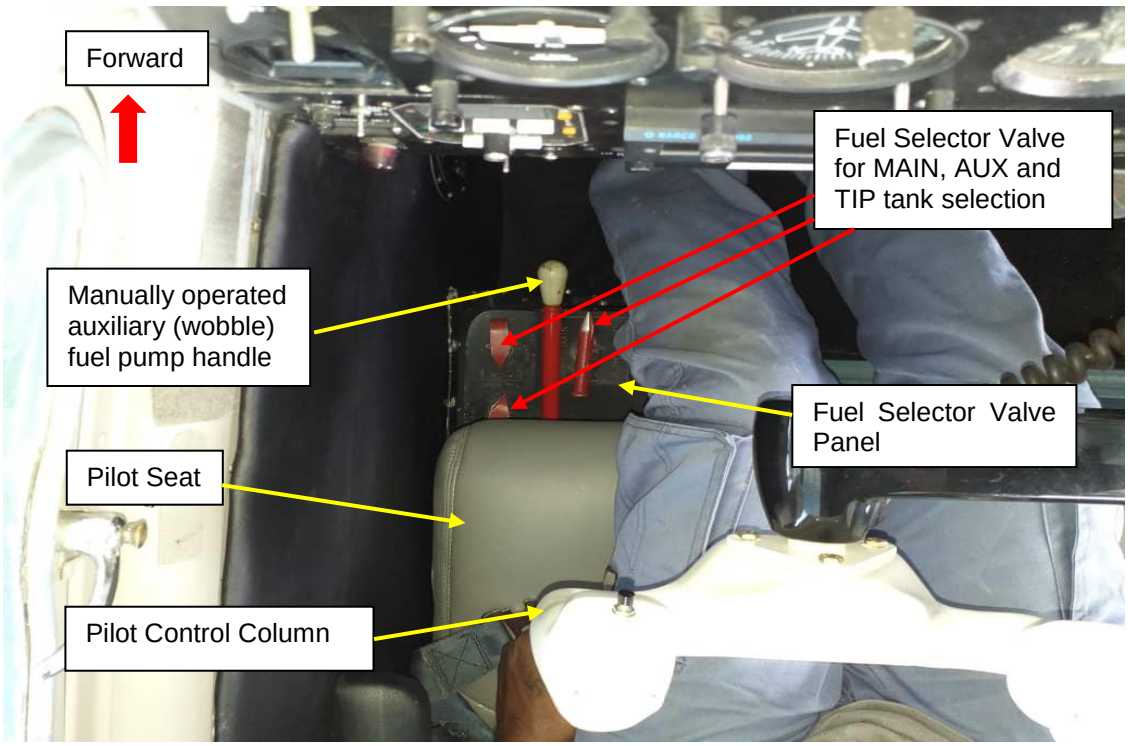


Figure 26: Top view location of the fuel selector valve panel in the cockpit

The position of the fuel selector valve corresponding to its selected fuel tanks are shown in Figure 27 to Figure 33. The design of the 3 selector valves requires the pilot to select the correct combination when using the different tanks in flight. As shown in Figure 27, 28 and 29, the selection of OFF, LEFT and RIGHT main tanks are straightforward.

Figure 27: All tanks OFF

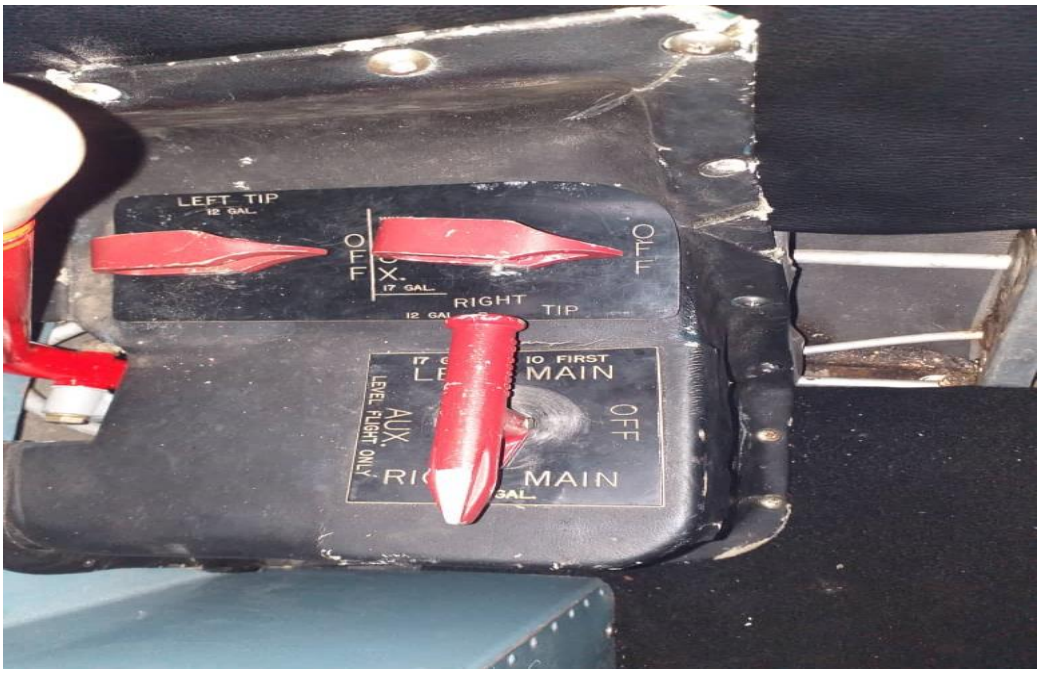


Figure 28: RIGHT MAIN tank in use

Figure 29: LEFT MAIN tank in use

To use fuel from the auxiliary tanks, two selectors must be pointed to AUX as both the auxiliary tanks are connected to a common port in the fuel selector valve as shown in Figure 30. This is to allow both tanks to feed simultaneously when the selector valve is set to AUX.

Figure 30: Both AUX tank in use.
There is no individual tank selection for auxiliary tank

To use fuel from the tip tanks, the main selector must first be pointed to AUX. Subsequently, the tip tank selector valve can be set individually to either LEFT or RIGHT, as desired (Figure 31 and 32).

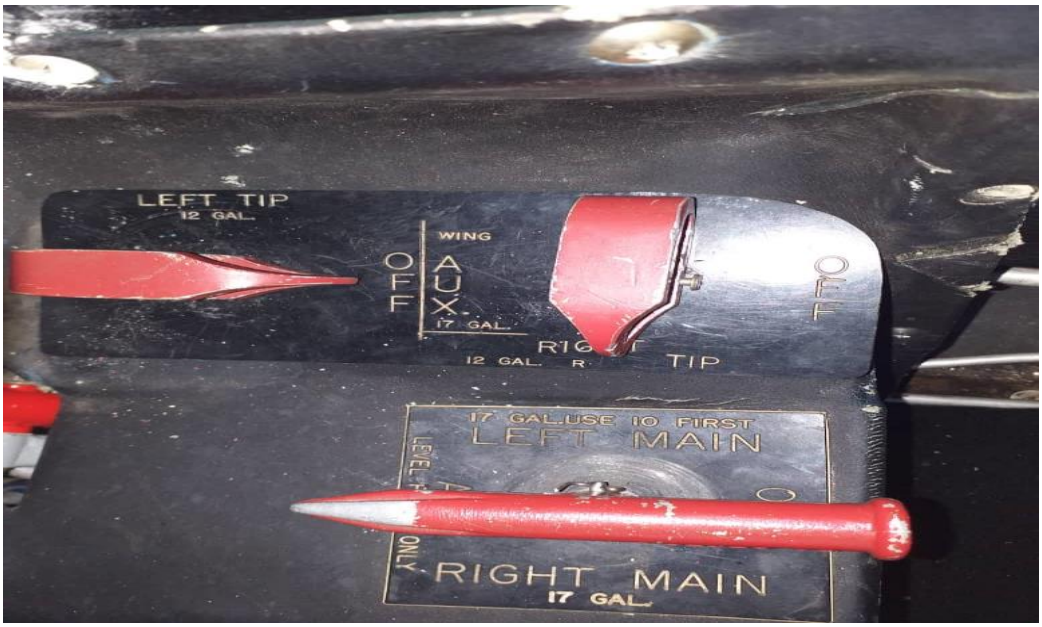


Figure 31: RIGHT TIP tank in use

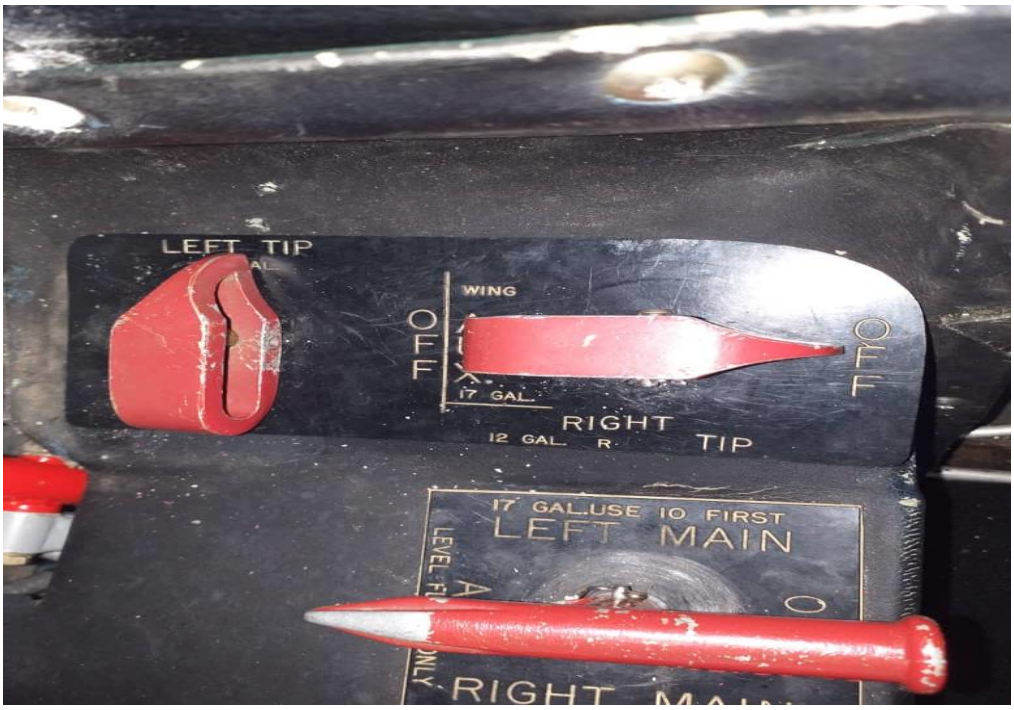


Figure 32: LEFT TIP tank in use

1.18.3 Physical Fuel Remaining versus Indication on Fuel Gauge

The fuel gauge indication after the emergency landing on the day of the incident is shown in Figure 33. The indication shows both tip tanks close to empty (yellow bar indication), left and right auxiliary tank about half full, right main tank full while the left main tank indicate zero fuel (red bar indication).

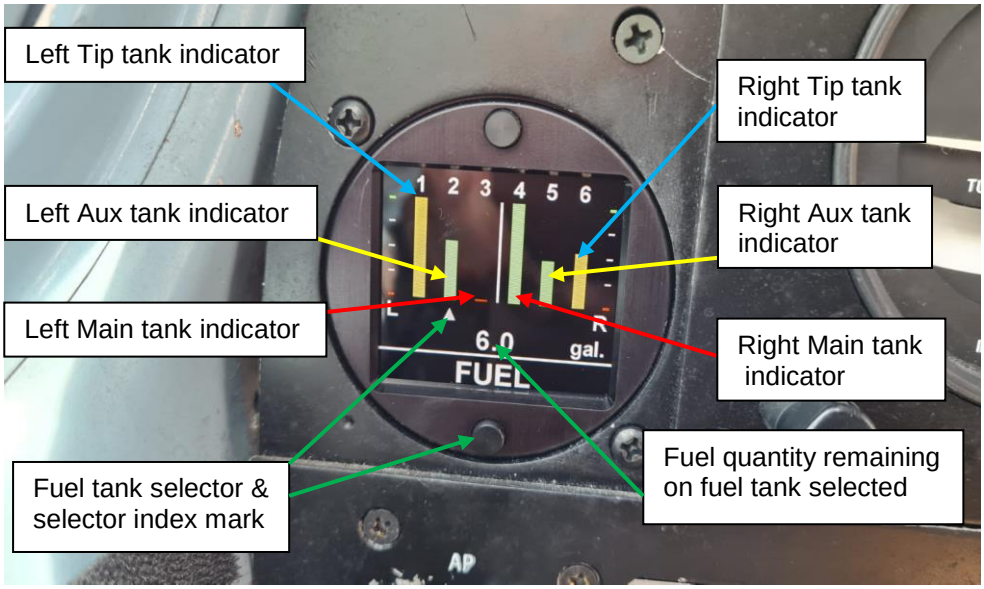
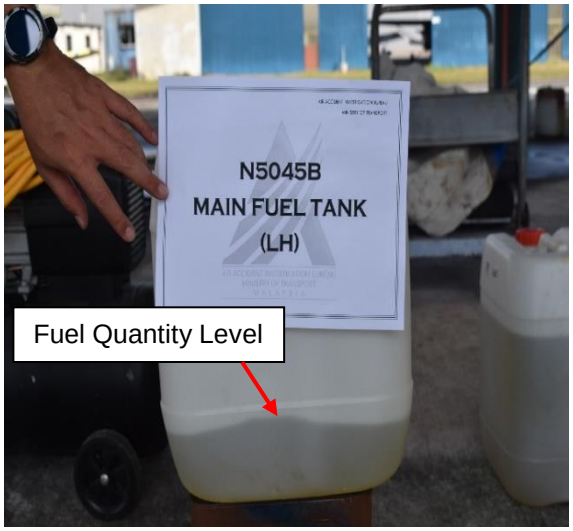
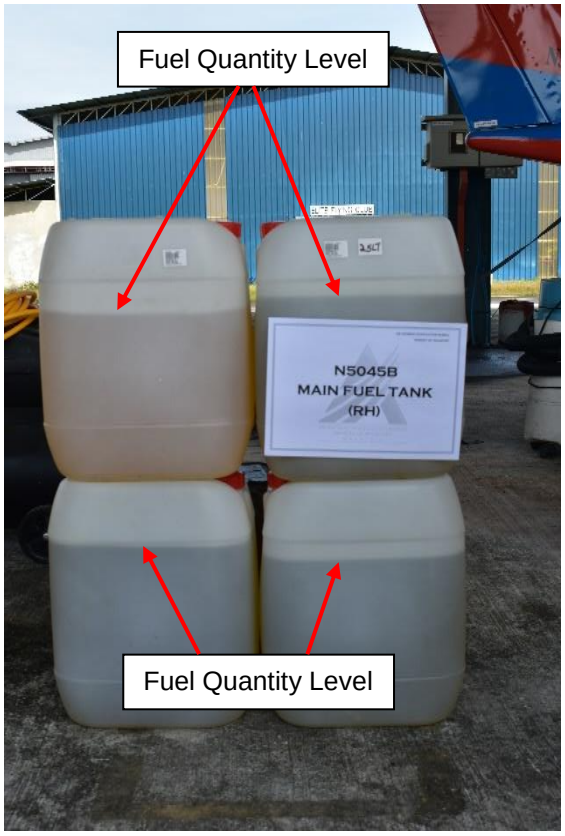


Figure 33: Fuel Gauge indication after emergency landing

The remaining fuel in all tanks were drained after the emergency landing. Jerry cans with a maximum capacity of 5 gallons each were used to measure the actual remaining fuel quantity, as shown in Figure 34 and 35. Although not to accurate measurement, this serve as a guide to visually estimate the actual quantity of remaining fuel after the incident. After comparing between the two, it is found that the readings shown on the fuel gauge indicator is reasonably accurate, in relative to the quantity obtained from the jerry cans. The fuel quantity remaining at both tip tanks were very minimum and not significant to be measured.

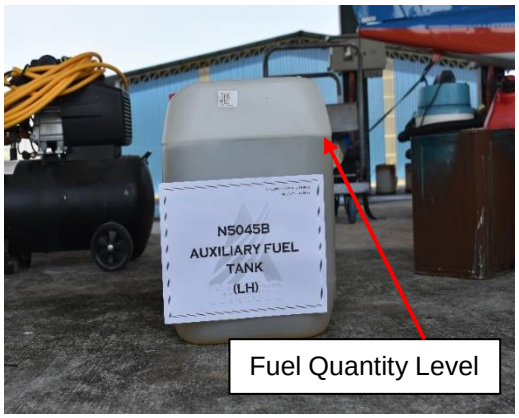


LEFT MAIN Tank – quantity about **1 gallon**



RIGHT MAIN Tank – quantity about **17 gallons**

Figure 34: Actual fuel quantity remaining after emergency landing for Left and Right Main Tank



LEFT AUX TANK – quantity about **4 gallons**

RIGHT AUX TANK – quantity about **3 gallons**

Figure 35: Actual fuel quantity remaining after emergency landing for Left and Right Auxiliary Tank

1.19 Useful or effective investigation techniques

This investigation will rely on witness statement and system investigation to analyse probable factors that had caused the engine to lose power in flight. Pilot actions and decision making will also be looked into for probable human factor issues.

1.19.1 Possible Causes or Contributing Factors

The following are probable causes or contributing factors that resulted in the aircraft's engine power loss in flight:

a. Engine and ignition system malfunction.

b. Fuel system problem.

c. Human factor.

1.19.2 Non-Contributing Factors Issues

The investigation team also looked into the issues below, which were not contributing factors to this incident.

a. Aircraft maintenance.

b. Regulatory requirements for foreign registered aircraft entering Malaysia.

2.0 ANALYSIS

2.1 The Problem

The pilot stated that the aircraft climbed out of Senai normally and levelled off at 5000 feet for the third sector flight back to Malacca. On cruising at 5,000 feet, the fuel selector was switched from RIGHT MAIN tank to AUX tank. The pilot observed that the fuel indicator was normal and showing green for all the tanks except for TIP tanks. About 5 minutes after switching tank, a pop sound was heard by the pilot accompanied with a shudder. The pilot noticed a sudden loss in fuel pressure and the engine started losing power. Emergency procedures were carried out but the engine did not come back to live for a sustained period of time. An emergency landing was carried out and the aircraft landed safely on the PLUS Highway.

2.2 Engine and Ignition System Malfunction

Two engine ground functional checks were carried out, one each by the pilot and the AMP as discussed in paragraph 1.16.5 found no abnormalities on the engine and ignition system. All engine parameters were normal throughout both the functional check.

In conclusion, engine and ignition system malfunction was not a cause or a contributing factor to this incident.

2.3 Fuel System Problem

2.3.1 Fuel Contamination

Fuel was drained from the main and auxiliary tanks and sent to laboratory for forensic test. Test result did not reveal any abnormalities to the fuel samples as stated in paragraph 1.16.1.

In conclusion, fuel contamination was not a cause or a contributing factor to this incident.

2.3.2 Fuel Quantity Indication Discrepancy

The pilot reported the fuel quantity indications for both the main and auxiliary tanks on the fuel gauge were indicating normally with sufficient fuel while in flight. Only both the tip tanks were indicating close to empty. The aircraft fuel log entry taken 15 minutes before the engine suffered a power loss showed reasonable amount of fuel in both the main and auxiliary tanks. Nevertheless, the investigation team found that the fuel quantity on the left main tank was physically empty and the left main tank fuel indicator showed zero fuel after the emergency landing on ground.

Comparison between the reading of the main and auxiliary fuel indicators on the fuel gauge and the physical check on the actual fuel quantity remaining in both the main and auxiliary fuel tanks revealed that the fuel indications on the fuel gauge at the incident site on ground was reasonably accurate as discussed in paragraph 1.18.3

The above discrepancy between the fuel quantity remaining reading in flight and actual fuel quantity remaining in the fuel tanks on ground was a result of a faulty sending unit (sensor) which caused an overreading to the left main tank indication on the fuel gauge in the cockpit. The overreading was found to be caused by the bad and dirty float in the sending unit.

The malfunction in the fuel sending unit gave an over reading on the left main fuel indicator in flight. It provided inaccurate fuel quantity remaining information to the pilot which led the pilot to believe that the left main tank is having about half tank of fuel but in actual fact much less.

Current preventive maintenance practice for the sending unit is an ‘on condition’ inspection item. A review to the inspection hours for the fuel sender unit is recommended by the AMP from ‘on condition’ to every 50 hours interval.

To verify the accuracy of the fuel gauge which was newly installed on the aircraft in October 2020, manual fuel quantity calibration was carried out however did not revealed any abnormalities in the fuel indicator reading.

In conclusion, a faulty fuel sender unit in the left main tank had resulted in an inaccurate fuel quantity reading on the fuel gauge. The inaccurate fuel reading had affected the pilot's fuel management decision in flight which is a contributing factor to this incident. The new fuel gauge was reasonably accurate and was not a cause or a contributing factor to this incident.

2.3.3 Fuel Selector Valve Malfunction

The fuel selector valve was sent for inspection and overhaul to identify its functionality. Inspection for damage, corrosion and excessive wear was carried out by the aircraft AMP. No significant defects were found during the inspection which might had caused or contributed to the engine power loss in flight. It was certified satisfactory and serviceable after the functional test by the aircraft AMP as discussed in paragraph 1.16.3.

In conclusion, the fuel selector valve was in airworthy condition and was not a cause or a contributing factor to this incident.

2.4 Human Factor

2.4.1 Possible Fuel Selector Valve Not in Detent Position

The design of the fuel selector valve is a bit complicated for any general aviation pilot who is new or do not have many flying hours experience on the aircraft type. The pilot must have a good understanding on the operations of the selector valve and must also be very conversant with how to select the various selection combination to use the fuel in the desired tank. It is also very important to ensure to feel for the detent when selecting the selector valve to any required tank (refer paragraph 1.17.4). This is to ensure the selector valve is correctly set at its required position to prevent fuel flow restriction.

The pilot had switched fuel tank from RIGHT MAIN to AUX tank when the aircraft was at cruise level. There is a possibility that the pilot did not set the selector valve correctly to the detent position as required by the Beechcraft Bonanza F35 Pilot's Operating Handbook when making the selection to AUX tank. It is proven during engine ground run functional check, when the selector is set not in the detent position, the engine will run for a very short duration (about 10 to 15 seconds) before it starts to lose power due to restricted fuel flow.

Nevertheless, this possibility is not supported by the pilot's interview statement which states that the aircraft loss power after 5 minutes when the tank was switched during cruise flight. The investigation team do not have supporting evidence to verify the accuracy of the 5 minutes duration as stated by the pilot.

In conclusion, there is a possibility that the fuel selector valve was not in the detent position leading to the engine losing power. However, this possibility is not supported by the pilot's interview statement as the aircraft flew for about 5 minutes before experiencing power loss while power loss will occur within 10 to 15 seconds if the selector valve was not in the detent position. Therefore, the possibility of the fuel selector valve not in the detent position is rule out.

2.4.2 Probable Selector Selection to Incorrect Tank

The location of the fuel selector panel is not ergonomically situated as discussed in paragraph 1.18.2. The Beechcraft Bonanza F35 is a single pilot operated aircraft. The aircraft is equipped with an autopilot but was not operative during the flight, therefore to physically fly, navigate and operate the system of the aircraft requires reasonably heavy workload from the pilot. With the fuel selector panel situated on the cockpit floor and in a very cramp cockpit environment, the pilot needs to lean forward and momentarily glance down to reach and select the correct selector valve when switching tanks in flight. The 3 selector valve design also further complicates the tank switching action in flight.

It was observed that the view of the selector valve panel from the pilot's seated flying position is limited. There is a possibility for the pilot to incorrectly select from the RIGHT MAIN to the LEFT MAIN tank instead of the intended AUX tank. It can be argued that it is unlikely for the pilot to turn the selector valve from RIGHT MAIN (handle facing right of aircraft) to LEFT MAIN ((handle facing left of aircraft) while the AUX tank position is facing rear of aircraft at the fuel selector panel.

Pilot interview statement states that the aircraft engine encountered a loss of power 5 minutes after switching tanks. It is highly probable for the pilot to incorrectly select the selector valve to LEFT MAIN tank which had very low fuel quantity and inadvertently run the tank dry in flight. With reference to the Bonanza 35 Shop Manual in Figure 21 which states that when the tank is dry, there is a possibility that air has entered the fuel system causing the engine to lose power.

The above statement is supported by the fact that the cruise fuel consumption is about 11 gallons per hour while the excess fuel return from the carburettor to the left main tank is at 3 gallons per hour regardless which tank is selected. Therefore, regardless of any tank selected, there will be an additional of 3 gallons every hour returning to the left tank. Hence, for the left main tank to be completely empty of usable fuel, the engine must be consuming fuel from the left main tank as any other tank selected will increased the fuel quantity in the left main tank.

The immediate emergency procedure carried out by the pilot as discussed in paragraph 1.17.5 by switching to other tanks and using the electrical fuel boost pump and auxiliary (wobble) pump would had probably kept the engine running with minimum power momentarily after encountering fuel starvation. Subsequently, after the immediate emergency procedure actions and with limited time, the pilot's attention was diverted to look for a safe place to land and to prepare the aircraft for an emergency landing. Credit is given to the pilot for executing a perfect emergency landing on the PLUS Highway without any injuries to anyone and damage to any public property.

The pilot who is also the owner of the aircraft had agreed to replace the present fuel selector system to a simplified version and to relocate the fuel selector to position it in between the pilot and co-pilot bottom seat rest. The simplified version and relocation will enable the pilot to have a better view and easier access to select the required fuel selector valve corresponding to the desired fuel tank during flight. The proposed fuel selector modification is to enhance the system thereby minimising or eliminating opportunity for errors and also to improve flight safety. The proposed modification is subjected to FAA's approval.

The above analysis is supported by circumstantial evidence only. It has to be clarified that there is no conclusive evidence to establish that the pilot had actually selected the selector valve from RIGHT MAIN to the LEFT MAIN tank as there are no recording facilities available in the aircraft to provide evidence.

In conclusion, the above analysis shows that there is a high probability that the pilot had inadvertently by mistake selected the selector valve from RIGHT MAIN to LEFT MAIN tank instead of AUX tank. This probable unintended action is the most probable cause of this incident.

2.4.3 Fuel Planning and Management in Flight

The fuel log entry in Figure 18 only shows the reading of fuel remaining on the fuel indicator at various time interval. The pilot did not do a proper fuel planning log and calculate for the plan fuel consumption for every leg of the plan flight as the plan flight involved 5 sectors for the day. Without a proper fuel planning log, the pilot is unable to cross check and verify the fuel consumption and fuel remaining for every sector to make comparison with the fuel indicator which is providing inaccurate indication to the pilot.

Without a proper fuel planning log to systematically manage tank switching in flight, the pilot relies totally on the fuel indicator to provide the fuel quantity information. The pilot assumed that there is a lot of fuel remaining in the left main tank as indicated on the fuel indicator and continue to utilize the

left main tank before switching to other tanks (refer paragraph 1.6.7) without realizing that the left main tank fuel indicator is actually overreading. The inadvertent over utilized of the left main tank had resulted in very low quantity of fuel remaining in the tank.

The above analysis is supported by the pilot statement which read “I specifically reduced the use of right main tank for most part of the flights as the plan was to reserve it for take-off and landing or when not flying straight and level, and for the final return flight from Malacca to Seletar” in other words the more frequent utilization of the left main tank especially for take-off and landing. These actions are in accordance with the Beechcraft Bonanza F35 Pilot’s Operating Handbook which states that take-off should made using the left main tank and landings should be made using the main tank that is more nearly full. It also states that auxiliary tanks are to be used for straight and level flight only.

In conclusion, the absent of a fuel planning log and the over reliance of fuel quantity information from the faulty fuel indicator was a contributing factor to this incident.

2.5 Regulatory Regulations and Requirements for Foreign Registered Aircraft Entering Malaysia

Pilots for foreign registered aircraft must comply to the CAAM flight permit request requirements as stated in AIP Malaysia Part 1 General 1.2 – Entry, Transit and Departure of Aircraft. The request for flight permit to CAAM must include details of route, all point of departure, landing in Malaysia and final destination as specify in the permit request form. The approved permit number must also be correctly included in the flight plan under item 18 when submitting a flight plan to ATC.

It was observed that there is discrepancy between the approved flight permit routes and the plan flight routes stated in the flight plan. There is no request from the pilot and approval from CAAM to fly into Senai Airport as the request and approval are only to Malacca Airport on the day of the flight. It was also observed that the permit number furnished under item 18 in the flight plan as CAAM/ATM/0241/11/20 differs

from the flight permit number approved for the flight on 22 November 2020 (CAAM/ATM/0245/11/20).

The Senai ATC and Malacca ATC did not verify the approved route in the flight permit and permit number furnished by the pilot in the flight plan to ensure that the flight is permitted to fly to the approved destination only. It was observed that the flight was cleared to fly from Malacca to Senai by Malacca ATC and Senai ATC as per flight plan although there was no flight permit approval from CAAM to fly to Senai.

In conclusion, there is a need for CAAM to review the air traffic clearance process to ensure flight plan is submitted for destination as approved in the flight permit for a foreign registered aircraft and ATC clearance is granted to fly to an approved destination only in Malaysia unless in an emergency situation during flight.

2.6 Aircraft Maintenance Practices

Proactive actions and adherence to preventive maintenance guide by the AMP is important to ensure the aircraft is in airworthy condition and is safe to fly especially for an old aircraft. There is a period of about 8 months between the annual inspection in March 2020 and the incident date in November 2020 when the corrosion was observed on the nose gear shock strut by the investigating team.

There is no evidence to suggest that the annual inspection for corrosion on the nose gear shock strut was not carried out properly. There is a high probability that the corrosion appeared due to storage conditions as the aircraft did not fly for about 7 months after being certified airworthy due to the COVID-19 pandemic flying restriction imposed by the government of Malaysia and Singapore. However, this does not relinquish the AMP from the responsibilities of ensuring preventive maintenance are carried out when signs of corrosion are observed during daily maintenance checks. Nevertheless, corrosion treatment had been carried out and the nose gear shock strut had been rectified after the observation made by the investigating team.

It was also observed that there was a wrong recording of the engine model in the aircraft annual inspection certificate after the annual inspection was carried out.

The wrong recording of the engine model in the Aircraft Engine Logbook is an administrative oversight by the AMP and had been amended.

In conclusion, the observation made by the investigating team on the corrosion on the nose gear shock strut and the wrong recording of engine model are as safety concerns. Improvement on maintenance practices is needed to ensure the aircraft is airworthy and safe to fly.

3.0 CONCLUSIONS

System investigation was used to analyse all possible factors that led to the engine losing power in flight. To check for the possible malfunction of the engine and ignition system, the first engine ground run functional check was carried out upon the completion of reassembling the aircraft at Senai in the presence of the investigating team. The ground run results show all engine parameters were normal and the engine was running smoothly at various power setting. It rules out any possible factors on the engine and ignition system which might had caused the engine to lose power in flight.

The next possible factor was malfunction on any of the components in the fuel system. The investigation team conducted investigation on the various fuel system components and sent these components for inspection and functional test or overhaul where applicable. The summary of the fuel components functional test and results are as follows:

a. Fuel Contamination Check – No contamination found.

b. 6 x Fuel Sender Units Inspection and Overhaul – All 6 floats found bad and dirty. Replaced float and Sender Units overhauled.

c. Fuel Selector Valve Inspection and Overhaul – No abnormalities found and selector valve overhauled.

d. Fuel Quantity Indicator Calibration – No abnormalities found.

The only abnormality found in the fuel system was the fuel sender unit. The malfunction of this component caused the overreading of the left main tank fuel indication on the fuel gauge in flight. The inaccurate fuel quantity information and over reliance on the inaccurate fuel quantity information had affected the pilot's fuel planning and management decision which was a contributing factor in this incident.

All fuel system components were refitted to the aircraft after the completion of inspection, functional test and overhaul. A second engine ground run functional check was carried out in the presence of the AAIB investigating team. The ground run results show all engine parameters were normal and the engine was running smoothly at various power setting. All fuel system components were observed to be functioning normally.

The investigating team further looked into the human factor related issues ie the pilot's actions and the management of the fuel system in flight. Two possibilities were investigated that required pilot's action to manage the fuel system in flight.

First, the possibility of the pilot not setting the selector valve to the detent position when switching tanks. It was concluded that this is unlikely as the evidence do not support this possibility. The pilot stated that the engine started losing power 5 minutes after switching tank during cruise. It must be emphasized that there is no supporting evidence to verify the accuracy of the 5 minutes duration as stated by the pilot. Ground run conducted shows the engine started to lose power at about 10 to 15 seconds after selecting the fuel selector valve at selected tank but not fully in the detent position. Therefore, this human factor possibility is ruled out.

Second, there is a possibility of the pilot inadvertently selecting the fuel selector valve from right main tank to the left main tank (which had very little usable fuel left) instead of the intended auxiliary tank during cruise flight. Evidence support this possibility as it is highly probable for the engine to be running on the left main tank for about 5 minutes after tank switch before the tank went dry and caused the engine to lose power.

Circumstantial evidence to support this possibility is the returning excess fuel from the carburettor (3 gallons/hour) which will cause the left main fuel tank to increase in fuel quantity if any other tank is in used. The only possibility for the left tank to be empty is when it is selected and in use during cruise flight as this will deplete the fuel quantity in the left main tank as the rate of cruise fuel consumption (11 gallons/hour) is higher than the rate of returning excess fuel. Other evidence supporting this analysis is the pilot's fuel management plan which intentionally reduced the use of right main tank for most part of the flights ie the primary use of left main tank had also contributed to the left main tank having very low fuel quantity.

The selection of the electrical fuel pump and the use of wobble pump, coupled with switching to other tanks immediately by the pilot as stated in the Emergency Checklist after the engine lost power had momentarily brought the engine back to life at minimum power. Due to time factor and insufficient height, the pilot concentrated on flying the aircraft to make an emergency landing.

The unavailability of a fuel planning log which was the only tool for the pilot to monitor the fuel consumption of the aircraft against the fuel quantity reading provided by the fuel indicator had led the pilot to falsely believe that the left main fuel indicator was giving a correct reading. This caused the pilot to wrongly managed the fuel quantity in each tank. It was analysed that if the left main tank did not provide an overread indication, the inadvertent wrong selection to the left main tank will not cause the engine to lose power as the fuel remaining entered in the fuel log was more than sufficient for the sector from Senai to Malacca.

In summary, there is no evidence to indicate engine and ignition system problem had caused the incident. The most probable cause of this incident is the inadvertent selection of the fuel selector valve to the left main fuel tank by the pilot. The left main tank which had very low fuel quantity eventually went dry and caused the engine to lose power.

The contributing factors are the malfunction of the left main tank fuel sender unit and the unavailability of a fuel planning log. The malfunction of the fuel sender unit had provided the pilot with inaccurate indication information on the actual amount

of fuel remaining in the left main tank. The unavailability of a fuel log had resulted in the failure to provide a check and balance to identify the inaccurate indication information and take appropriate actions to carefully monitor and manage the fuel consumption in flight safely.

3.1 Findings

3.1.1 The Pilot was properly licensed to fly this leisure flight. The Pilot's medical certificate was valid at the time of the incident.

3.1.2 The aircraft was maintained and documented in accordance to Bonanza 35 Series Shop Manual and was airworthy for the flight as required in the FAA Standard Airworthiness Certificate.

. 3.1.3 The pilot reported no abnormalities during the preceding sector from Seletar – Malacca - Senai.

3.1.4 On-scene investigation at the incident site observed that the Left Main Tank fuel gauge indicates zero. Physical inspection of the Left Main Tank found the tank was empty.

3.1.5 Engine ground run carried out after aircraft recovery from incident site found no abnormalities on the engine and ignition system.

3.1.6 All 6 floats of the fuel sender unit in all the 6 fuel tanks were found to be bad and dirty during inspection and overhaul.

3.1.7 Engine ground run and functional check carried out found no abnormalities on the engine and fuel system after the replacement of the fuel sender unit and inspection on all other fuel system components.

3.1.8 The Pilot did not prepare a fuel planning log for this multiple sector flight to manage fuel consumption in flight.

3.1.9 The Pilot did not submit a request for flight permit to fly into Senai Airport but submitted a flight plan and flew the aircraft to Senai Airport which is contrary to regulatory regulations and requirements for foreign registered aircraft entering Malaysia.

3.1.10 Safety observation during investigation found nose gear shock strut badly corroded and the engine model incorrectly entered in the annual inspection certificate of the engine logbook.

3.2 Causes/Contributing Factors

3.2.1 The incident was most probably caused by the pilot inadvertently switching the fuel selector valve to LEFT Main tank during cruise flight inadvertently by mistake. The pilot ran the left main fuel tank dry which caused the engine to lose power in flight.

3.2.2 There are two contributing factors to this incident.

a. The faulty left main tank fuel sender unit caused an overreading of the fuel indicator thus providing an inaccurate fuel quantity indication to the pilot. It had affected the pilot's fuel management decision in flight.

b. The unavailability of a fuel planning log to provide check and balance to the pilot on the actual fuel used and remaining in flight. It resulted in the pilot not realising the inaccuracy of the left main tank fuel quantity indication.

4.0 SAFETY RECOMMENDATIONS

4.1 The Owner (Pilot) is to carry out the following safety recommendations:

4.1.1 To carry out the preventive maintenance in accordance to the Bonanza 35 Series Shop Manual when corrosion is observed on any part of the aircraft.

4.1.2 To ensure the request of flight permit approval to CAAM must include details of route, all point of departure, landing in Malaysia and final destination as required by AIP Malaysia Part 1 General 1.2 – Entry, Transit and Departure of Aircraft.

4.1.3 To prepare a fuel planning log for long or multi sector routes for accurate fuel planning and proper fuel management in flight.

4.2 CAAS is to remind the general aviation pilots to ensure the request of flight permit approval to CAAM must include details of route, all point of departure, landing in Malaysia and final destination as required by AIP Malaysia Part 1 General 1.2 – Entry, Transit and Departure of Aircraft.

4.3 CAAM to review the air traffic clearance process to ensure all ATC personnel verify the flight permit approval as indicated in the flight plan submitted before ATC clearance is granted to any foreign aircraft intending to fly into Malaysia.

4.4 Hawker Beechcraft Corporation to consider a review to the current inspection hours on the fuel sender unit from ‘on condition’ item to an appropriate inspection hours interval and include the reviewed inspection hours into the Periodic Inspection Schedule of the Bonanza 35 Series Shop Manual.

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, a copy of the Draft Final Report was sent to Civil Aviation Authority of Malaysia (CAAM) as State of Occurrence, Transport Safety Investigation Bureau (TSIB) of Singapore as State of Operator, National Transportation Safety Board (NTSB) of United States as State of Manufacturer/Registry and the Operator 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
Civil Aviation Authority of Malaysia	Report accepted and no comments.
Transport Safety Investigation Bureau (TSIB) of Singapore	Two Zoom Meetings Video Conference were held on 10 and 17 June 2021 between AAIB and TSIB to discussed on the safety recommendation at paragraph 4.2. AAIB does not agree to delete the safety recommendation at paragraph 4.2 although TSIB had substantiated its comments. AAIB's view is that a reminder issued by CAAS as a regulatory authority specifically to General Aviation pilots will carry significant weight in reminding them to comply strictly with flight and regulatory requirements when flying to another state for flight safety reasons. TSIB had requested that the substantiated comments on safety recommendation at paragraph 4.2 be appended in full to the

	Final Report (Refer to paragraph 6.0) if paragraph 4.2 is retained in the Final Report.
National Transportation Safety Board (NTSB) of United States	Report accepted and no comments.
Textron Aviation, United States (Hawker Beechcraft Corporation)	Report accepted and no comments.
Operator	Report accepted and no comments.

Figure 36: Status of significant and substantiated comments

6.0 FULL COMMENTS BY THE TRANSPORT SAFETY INVESTIGATION BUREAU (TSIB) OF SINGAPORE ON THE DRAFT FINAL REPORT SI 08/20

6.1 The Transport Safety Investigation Bureau of Singapore (TSIB) has reviewed the Aircraft Serious Incident Draft Final Report and requests the deletion of paragraph 4.2 on page 49 (extracted below) under the section "**4.0 SAFETY RECOMMENDATIONS**".

> 4.2 CAAS is to remind the general aviation pilots to ensure the request of flight permit approval to CAAM must include details of route, all point of departure, landing in Malaysia and final destination as required by AIP Malaysia Part 1 General 1.2 – Entry, Transit and Departure of Aircraft.

6.2 TSIB notes the following paragraphs in the Draft Final Report —

a. The last paragraph on page 24 of the draft Final Report under section "**1.17.6 Regulatory Regulations and Requirements for Foreign Registered Aircraft Entering Malaysia"** which states as follows:

"The Permit for Foreign Registered Aircraft / General Aviation Operations in Malaysia Form **(Appendix T)** in paragraph D clearly requires the pilot to specify details of route, point of departure, landing in Malaysia and the final destination. It was observed that there is discrepancy between the approved flight permit routes and the flight plan routes. There was neither a request from the pilot nor an approval from CAAM to fly into Senai Airport as the request and approval were only for Malacca Airport for the flight on 22 November 2020."

b. The first paragraph on page 43 of the draft Final Report under section "**2.5 Regulatory Regulations and Requirements for Foreign Registered Aircraft Entering Malaysia**" which states as follows:

"Pilots for foreign registered aircraft must comply to the CAAM flight permit request requirements as stated in AIP Malaysia Part 1 General 1.2 –

Entry, Transit and Departure of Aircraft. The request for flight permit to CAAM must include details of route, all point of departure, landing in Malaysia and final destination as specify in the permit request form. The approved permit number must also be correctly included in the flight plan under item 18 when submitting a flight plan to ATC."

6.3 From these two paragraphs, TSIB notes that the flight permit requests are to be made to the Civil Aviation Authority of Malaysia (CAAM) and the approval for such permits would be from CAAM. The information on who must comply with the flight permit request requirements would therefore be stipulated by and should be obtained from CAAM.

6.4 TSIB notes that, in providing air traffic services within the areas under its responsibility, the Civil Aviation Authority of Singapore (CAAS) acts in accordance with the applicable ICAO rules to ensure the safety, regularity and efficiency of international air navigation, taking into account the flight plans received. This responsibility does not extend to ensuring operators' compliance with flight permit request requirements of another State or reminding them of such requirements.

6.5 The responsibility for compliance and familiarity with CAAM's flight permit request requirements (as set out in the AIP Malaysia Part 1 General 1.2 – Entry, Transit and Departure of Aircraft) lies with the pilots. In this regard, we refer to Standards 2.1.1.1 and 2.1.1.2 of Annex 6 to the Convention on International Civil Aviation (Chicago Convention) – Operation of Aircraft, Part II – International General Aviation – Aeroplanes, which states that:

"2.1.1.1 The pilot-in-command shall comply with the laws, regulations and procedures of those States in which operations are conducted.

2.1.1.2 The pilot-in-command shall be familiar with the laws, regulations and procedures, pertinent to the performance of his or her duties, prescribed for the areas to be traversed, the aerodromes to be used and the air navigation facilities relating thereto…"

6.6 We would also like to highlight that AIP Singapore GEN 1.2 Entry, Transit and Departure of Aircraft paragraph 1.3 already informs aircraft operators[3] as follows:

> "Notwithstanding the regulations relating to civil aviation over Singapore territory, aircraft operators should consult the respective AIPs for other documentary and / or permit requirements for flights intending to enter, depart, and / or overflying the sovereign airspaces of States along the planned flight routes".

6.7 Following from the above, TSIB requests that paragraph 4.2 on page 49 of the Draft Final Report (extracted below) under the section "**4.0 SAFETY RECOMMENDATIONS**" be deleted.

4.2 CAAS is to remind the general aviation pilots to ensure the request of flight permit approval to CAAM must include details of route, all point of departure, landing in Malaysia and final destination as required by AIP Malaysia Part 1 General 1.2 – Entry, Transit and Departure of Aircraft.

6.8 However, if paragraph 4.2 is retained, TSIB requests that these comments be appended in full to the Final Report, in accordance with Standard 6.3 of Annex 13 to the Chicago Convention.

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

[3] Under the Annexes to the Convention on International Civil Aviation, "operator" is defined as "a person, organization or enterprise engaged in or offering to engage in an aircraft operation".