



सत्यमेव जयते

**FINAL INVESTIGATION REPORT ON ACCIDENT TO
M/s CARVER AVIATION PVT LTD CESSNA -172S
VT-RDX AT BARAMATI ON 05 FEB 2019**



**AIRCRAFT ACCIDENT INVESTIGATION BUREAU
SAFDARJUNG AIRPORT, AUROBINDO MARG
NEW DELHI - 110003**

Foreword

In accordance with Annex 13 to the Convention on International Civil Aviation Organization (ICAO) and Rule 3 of Aircraft (Investigation of Accidents and Incidents), Rules 2017, the sole objective of the investigation of an accident shall be the prevention of accidents and incidents and not to apportion blame or liability.

This document has been prepared based upon the evidences collected during the investigation, opinion obtained from the experts and laboratory examination of various components. Consequently, the use of this report for any purpose other than for the prevention of future accidents or incidents could lead to erroneous interpretations.

INDEX

Para	Content	Page No.
	SYNOPSIS	01
1	FACTUAL INFORMATION	02
1.1	HISTORY OF THE FLIGHT	02
1.2	INJURIES TO PERSONS	03
1.3	DAMAGE TO AIRCRAFT	03
1.4	OTHER DAMAGE	03
1.5	PERSONNEL INFORMATION	04
1.6	AIRCRAFT INFORMATION	04
1.6.1	GENERAL DESCRIPTION	04
1.6.2	AIRCRAFT TECHNICAL INFORMATION	06
1.6.3	WEIGHT AND BALANCE	08
1.6.4	FUEL SYSTEM	09
1.7	METEOROLOGICAL INFORMATION	11
1.8	AIDS TO NAVIGATION	12
1.9	COMMUNICATIONS	12
1.10	AERODROME INFORMATION	12
1.11	FLIGHT RECORDERS	13
1.12	WRECKAGE AND IMPACT INFORMATION	13
1.13	MEDICAL AND PATHOLOGICAL INFORMATION	16

1.14	FIRE	16
1.15	SURVIVAL ASPECTS	16
1.16	TESTS AND RESEARCH	16
1.17	ORGANISATIONAL & MANAGEMENT INFORMATION	17
1.18	ADDITIONAL INFORMATION	17
1.18.1	FUELING	17
1.18.2	FUEL QUANTITY INDICATION	18
1.18.3	FUEL SYSTEM EXAMINATION	18
1.18.4	FLIGHT MANUAL	19
1.18.5	HAZARDS AT ACCIDENT SITE	20
1.18.6	MINIMUM FUEL REQUIREMENT FOR GENERAL AVIATION AIRCRAFT	21
1.19	USEFUL AND EFFECTIVE TECHNIQUES	22
2	ANALYSIS	22
2.1	SERVICEABILITY OF AIRCRAFT	22
2.2	LAST FLIGHT	22
2.2.1	FLIGHT PREPARATION	22
2.2.2	SHORTCOMING OF PREFLIGHT INSPECTION	23
2.2.3	INADEQUATE FUEL MANAGEMENT IN FLIGHT	23
2.2.4	EMERGENCY LANDING	24
2.3	FUEL USAGE AND ENDURANCE	24
2.4	FUEL RECORDS	24
2.5	FUEL QUANTITY INDICATION	24

3	CONCLUSION	24
3.1	FINDINGS	24
3.2	PROBABLE CAUSE OF THE INCIDENT	25
4	SAFETY RECOMMENDATIONS	25

GLOSSARY

AAIB	Aircraft Accident Investigation Bureau, India
ADC	Air Defence Clearance
AME	Aircraft Maintenance Engineer
AMM	Aircraft Maintenance Manual
API	Assistant Pilot Instructor
ARC	Airworthiness Review Certificate
ATD	Actual Time of Departure
ATC	Air Traffic Control
AUW	All Up Weight
BHP	Brake Horse Power
C of A	Certificate of Airworthiness
CAR	Civil Aviation Requirement
CFI	Chief Flying Instructor
CG	Centre of Gravity
CVR	Cockpit Voice Recorder
DFDR	Digital Flight Data Recorder
DGCA	Directorate General of Civil Aviation
ELT	Emergency Locator Beacon
FAA	Federal Aviation Administration
FAB	Flight Authorization Book
FIC	Flight Information Centre
FRTOL	Flight Radio Telephone Operators License
FTO	Flying Training Organization
Gal/Hr	Gallons/ Hour
Hrs	Hours
ICAO	International Civil Aviation Organization
IFR	Instrument Flight Rules
IST	Indian Standard Time
KIAS	Knots Indicated Air speed
Lat	Latitude
Long	Longitude
Ltr/Hr	Litre/Hour
METAR	Meteorological Terminal Aviation Routine
MTOW	Maximum Takeoff Weight
NM	Nautical Miles
NSOP	Non- Scheduled Operating Permit
PI	Pilot Instructor
PIC	Pilot in Command
POH	Pilot's Operating Handbook
PSWS	Pilot Safety and Warning Supplement
RPM	Rotation Per Minute
RT	Radio- Telephony
RTR	Radio- Telephony Restricted
SOP	Standard Operating Procedure
TSN	Time Since New
VFR	Visuals Flight Rules
VOR	VHF Omnidirectional Range
UTC	Coordinated Universal Time

SYNOPSIS

Date and hour : 05Feb 2019 at 1215 IST
Aircraft : Cessna 172 S
Accident location : 18°10'21.7"N 74°51'15.2"E
Aircraft owner : M/s Academy of Carver Aviation
Type of flight : Cross-country Solo training flight
Phase : Cruise
Last point of Departure : Baramati (ICAO Code: IN-0024)
Point of intended landing: Baramati (ICAO Code: IN-0024)
Persons on board : One

Abstract

The PIC had reported to the base at 0900hrs. As per the statement of PIC, the pre-flight checks were performed by him and confirmed the quantity of fuel and oil was confirmed to be 200Ltrs and 8 Quarts (Approx. 8 Ltrs) respectively. Aircraft departed at 1030 Hrs for cross country training flight from Baramati to Akalkot. During the return leg towards Baramati, at approximately 17 nm from the destination, the PIC experienced a sudden drop in the performance of the engine (drop in RPM) during which the aircraft lost a considerable altitude. The engine power came back to normal for a few seconds on opening of power and then again dropped to the minimum and finally the engine stopped. The PIC decided to land in an open field as per the SOP. During emergency landing, the port wing brushed a tree and later aircraft hit the ground.

There was no fire. Eye witnesses stated that the engine was not "ON" when the aircraft crashed and PIC was conscious but in shock when they went for his rescue. The PIC was then moved to a local hospital for first aid and then later moved to another hospital for treatment. The PIC suffered a fracture in his right arm and multiple abrasions all over his face & hands.

Probable Cause

The cause of the accident was fuel exhaustion leading to loss of engine power.

Hazard identified during the investigation

Incomplete pre-flight inspection leading to an inadequate evaluation of the fuel on board.

Consequence

Fuel Starvation and consequent forced landing.

1. FACTUAL INFORMATION

1.1 History of flight

On 05/02/2019, Cessna 172S aircraft VT-RDX belonging to Academy of Carver Aviation was operating a cross country flight on Baramati-Akalkot-Baramati sector. The aircraft was involved in an accident and forced landed in the village area in Indapur Taluka, Baramati, Maharashtra. The aircraft was under the command of a student pilot qualified on type.

As per the Flight Authorisation Book, this was the first sortie of the day for VT-RDX. ATD for the sortie was 1030 Hrs (Local Time) and expected duration of the flight was 150 minutes. Student Pilot (PIC) reported to the base around 0900hrs (Local Time). Thereafter, he collected METAR and other relevant information pertaining to the flight including FIC and ADC. Student Pilot was subjected to Breath Analyser Test before he went to the aircraft. Local clearance had been taken from Pune Radar at 0910 hrs (Local Time) by Baramati Tower Controller and flying operation clearance was given till sunset. On the day of accident, all cross-country flights were planned solo and trainees were provided with local METAR of 1030 Hrs (Local Time).

Before proceeding for the flight, PIC took clearance from DyCFI and as per the laid down procedures, signed the FAB (Flight Authorisation Book) and proceeded towards the aircraft. The pre-flight preparations were completed under the supervision of DyCFI. As per the statement of PIC, during pre-flight checks fuel and oil quantity was observed to be 200 litres and 8 Qtz respectively. After going through the cockpit checklist, PIC took the clearance from ATC for start up. Post clearance by ATC, the engine was started and aircraft took off at 1030 hrs local time for solo cross-country training flight from **Baramati to Akalkot**.

After take-off, local ATC instructed the pilot to maintain FL35. During the sortie, PIC reported all check-points enroute as per the procedure, including overhead Akalkot to local ATC. As per him, the engine parameters were in green zone during every report point onwards and back from Akalkot. While the aircraft was inbound to Baramati, PIC again transmitted his position at 80nm, 50nm as well as 30nm distance as per existing laid down procedure. However, when the aircraft was at 30nm inbound, he was instructed to report position next at 15nm.

When the aircraft was at approximately 17nm inbound, he observed a sudden drop in engine performance. Immediately, he transmitted to Baramati ATC. Tower controller

asked him to report observed RPM indications. PIC reported that Tachometer reading less than 1600rpm, which had further dropped to 1000 rpm. In addition to this, PIC also felt that the engine power had started deteriorating. To increase engine power, PIC increased the throttle and engine started to respond but couldn't succeed in increasing the engine power and finally engine stopped. Although, aircraft was on finals, 16 nm from touchdown point, PIC decided to carry out a forced landing in an open field, after engine had shut down and aircraft was losing height.

After engine shutdown, PIC decided to carry out a forced landing in an open field. He saw a road crossing in the landing path. The curvy road featured ditches on one side and a single story house on the other side. While continuing approach to the open field, parallel to road, the left wing of aircraft brushed a tree in the landing path. Thereafter, the aircraft hit the ground and turned 90 degrees due to impact and ground contour before coming to halt. After crash landing, PIC evacuated the aircraft with the assistance of local people.

There was no post impact fire. Eye witnesses stated that the engine was not working when the aircraft crashed. PIC was conscious but in a state of shock when they went to his rescue. The PIC was then moved to a local hospital for first aid and later to another hospital for treatment. The PIC had suffered a fracture in the right arm and multiple abrasions all over his face and hands. PIC immediately passed the information to the Dy CFI at around 1245 hrs. ELT was activated.

1.2 Injuries to Persons

INJURIES	Crew	Passengers	Others
Fatal	NIL	NIL	NIL
Serious	01	NIL	NIL
Minor/None	NIL	NIL	NIL

1.3 Damage to Aircraft

The aircraft was damaged beyond economical repair.

1.4 Other Damage

Nil

1.5 Personnel Information

Pilot-in-Command (Student Pilot)

Age	:	32 years
Licence	:	Student Pilot License
Date of Issue	:	08.11.2011
Valid up to	:	16.06.2019
Category	:	Aeroplane
Class	:	Single Engine Land
Endorsements as PIC	:	CESSNA - 172
Date of Med. Exam.	:	05.03.2018/ Class – I
Med. Exam valid upto	:	04.03.2019
FRTD Date of issue	:	20.11.2012
FRTD Valid up to	:	19.11.2022
Total flying experience	:	131:25 Hrs
Experience on type	:	131:25 Hrs
Experience as PIC on type	:	71:50 Hrs
Total flying experience during last 180 days	:	73:05 Hrs
Total flying experience during last 90 days	:	23:55Hrs
Total flying experience during last 30 days	:	20:10 Hrs
Total flying experience during last 07 Days	:	6:00 Hrs
Total flying experience during last 48 Hours	:	2:30 Hrs
Total flying experience during last 24 Hours	:	NIL Hrs

1.6 Aircraft Information

1.6.1 General Description

Cessna 172S is a four-place, high wing monoplane of all metal semi-monocoque construction, single engine and is designed for general utility and training purposes. The aircraft is equipped with fixed tricycle type landing gear with tubular spring steel main landing gear struts. The Nose Landing Gear is steerable and equipped with an Air/Hydraulic fluid shock strut. The aircraft is powered by a horizontally opposed, direct drive, four-cylinder, overhead valve, air-cooled, fuel injected engine with wet sump lubrication system. The Engine is an AVCO-Lycoming Model IO-360 L2A with a horse Power rating of 160 BHP at 2700 RPM. The aircraft is equipped with a two bladed, fixed pitch metal Maculey Propeller, Model 1A170E/JHA7660. The aircraft is certified for single pilot operation.

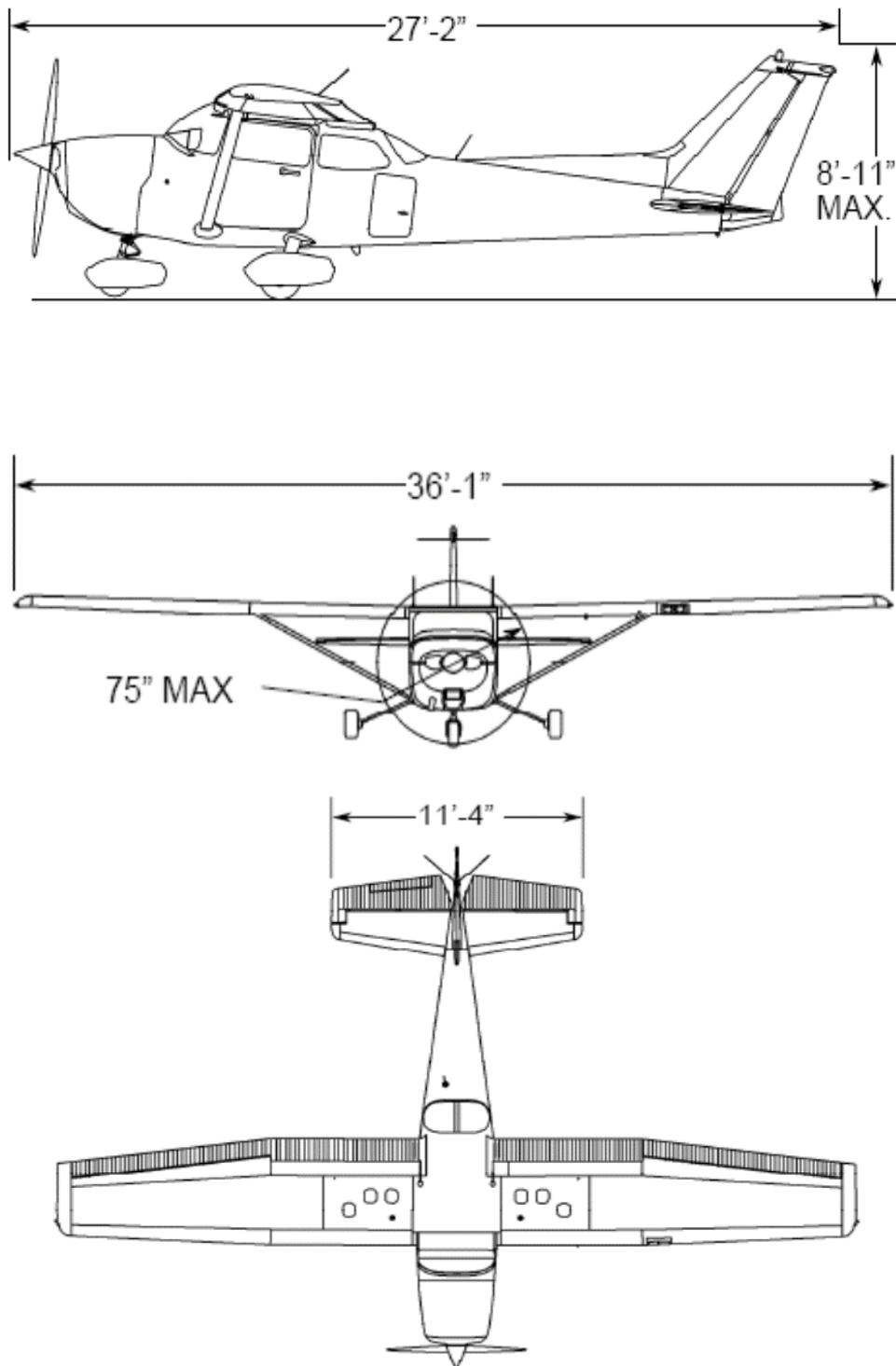


Fig 1: Cessna 172S Aircraft Dimensions

The airplane's flight control system consists of aileron, rudder and elevator control surfaces. The control surfaces are manually operated through a series of sprockets, chains, pulleys, cables, bell cranks, and pushrods. The ailerons receive input from the pilot or copilot control wheel. The elevators are operated by power transmitted through forward and aft movement of the control yoke. Rudder control is maintained through use of conventional rudder pedals which also control nose wheel steering. The elevator trim tab

on the right elevator is controlled by a trim wheel in the pedestal. The wing flap control system has an electric motor and transmission assembly, drive pulleys, push-pull rods, cables, and a follow-up control.



Fig 2: Typical Front View Cessna 172S

Characteristics

- Minimum Crew : 1
- Length : 27 ‘ 2”
- Height : 8’ 11”
- Wingspan : 36’ 1’
- Landing Gear Track Width : 3.45m
- Fuel : Two Tanks of 26 US gallons each
(200 Ltr Approx.) – Avgas

1.6.2 Aircraft Technical Information

Aircraft Model	: Cessna 172 S
Aircraft S. No.	: 172S8045
Year of Manufacture	: 1998
Certificate of Registration No.	: 3718, CAT-A
Certificate of Airworthiness No.	: 4027
C of A Validity	: Valid at the time of accident
Date of issue of Airworthiness Review Certificate (ARC)	: 02 Nov 2018

ARC valid up to	: 01 Nov 2019
Engine Type	: AVCO Lycoming – IO-360 – L2A
Engine Sl. No.	: RL-21519-51E
Propeller Type	: McCauley 1A170E/JHA 7660
Propeller Sl. No.	: TF-050
Date of Aircraft weighment	: 03 May 2007
Total Aircraft Hours	: 3869 Hrs
Engine Hours Since New	: 2797:40 Hrs
Engine Hours (Since Overhaul)	: 598:20 Hrs

The Aircraft is registered in “Normal” category & Sub Division - “Passenger Aircraft”. The C of A remains valid subject to validity of Airworthiness Review Certificate. The Aircraft was holding a valid Aero Mobile License No. A-009/010/WRLO-08 at the time of accident. The Aero Mobile license was initially issued on 28 Dec 2017 and renewed with validity till 31 Dec 2022.

The aircraft was weighed on 01 Oct 1998 at Cessna Aircraft Company, and the weight schedule was re-computed on 03 May 2007, which was duly approved by the office of Director of Airworthiness, DGCA, Mumbai. As per the approved weight schedule the Empty Weight of the aircraft is 764.13 Kgs and Maximum Take-Off Weight (MTOW) of the aircraft is 1157.70 Kgs. Maximum usable fuel quantity is 144.43 Kgs (206 Ltrs). Maximum payload with fuel tanks full is 164.14 Kgs. Empty weight CG is 100.30cm aft of datum (Front face of firewall). As the MTOW of the aircraft is below 2000 Kgs, there is no requirement **as per Civil Aviation Requirement (CAR Section 2, Series ‘X’, Part II, para 4) for re-weighing of the aircraft on periodic basis.**

Aircraft had logged 02:15 Hrs since the last Scheduled Servicing till the time of accident. Last scheduled inspection carried out on the aircraft was inspection operation 03 & 24 at 14234:20 airframe hours (TSN) on 04 Feb 2019. **The aircraft had logged 00:00Hrs since the last Scheduled Inspection. Pre-flight Inspection was carried out by the AME before the first flight on the day of accident. Prior to the accident flight, the aircraft had flown for 00:00hrs with Nil landing on the day of accident.**

As on the date of accident, the aircraft engine had logged 598:30 Hrs since it’s last overhaul. Last scheduled inspection carried out on the engine was inspection operation 03&24 at 2797:40 engine Hours (TSN) on 04 Feb 2019.

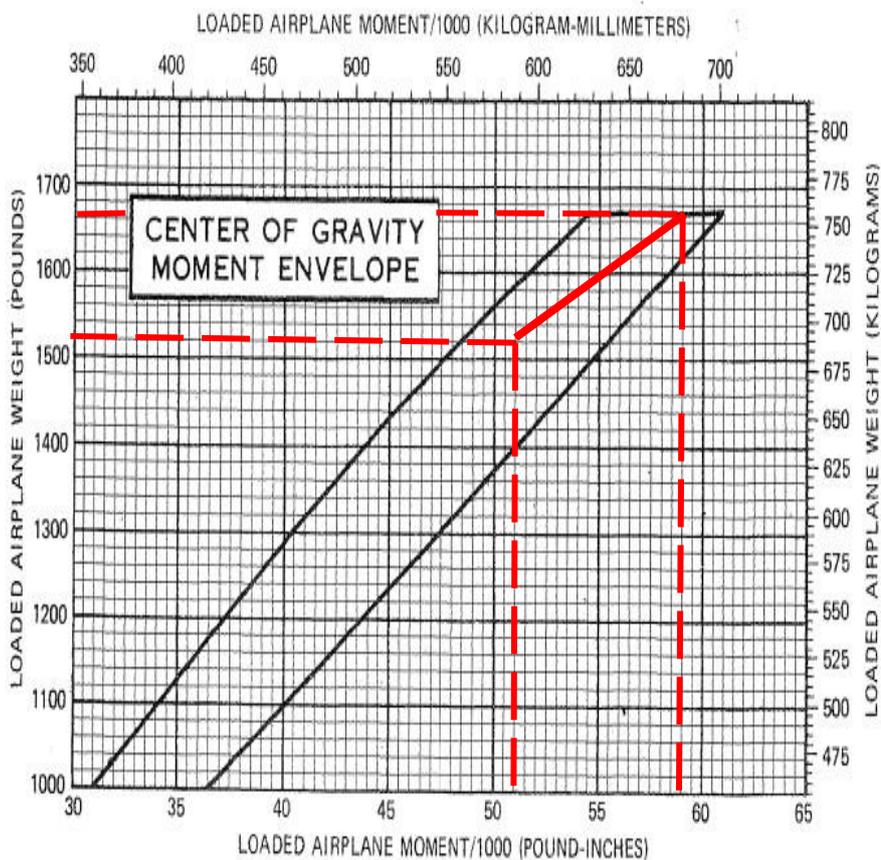
All concerned Airworthiness Directives, mandatory Service Bulletins, DGCA Mandatory Modifications on this aircraft and its engine have been complied with.

Scrutiny of the snag register revealed that, there was no snag pending on the aircraft prior to the accident flight. The last snag recorded in the snag register was on 25th September 2018 and the snag was “Oil Pressure Reading Not Registered”. The rectification action carried out was “Ground Pin Wire on the transducer repaired”.

After the accident, ELT was found activated at **1225 hrs** and was later switched off by the engineering personnel of the operator.

1.6.3 Weight and Balance

As per the statement of Deputy CFI, Load & Trim sheet was prepared prior to the flight. Original sheet was taken onboard by the student pilot. **However, after the accident, it could not be found onboard. Even the copy of the document was also not retained / available in the operator’s office.** As per CAR Section 8 Series ‘D’ Part-I para15.8, a final copy of Load and Trim sheet should have been carried on board as well as a copy should have been retained with the operator.



1.6.4 Fuel System

The Cessna 172S has a wet wing fuel storage system. The system has two integral fuel tanks (one in each wing), a three-position selector valve, a fuel reservoir tank, an electrically-driven auxiliary fuel pump, a fuel shutoff valve and a fuel strainer.

Components subsequent to fuel strainer include the engine-driven fuel pump, the fuel injection servo and the fuel distribution valve.

The fuel quantity gauge and fuel flow meter is installed in the cockpit to assist the PIC to continuously monitor the residual fuel and fuel flow to the engines for his planning and monitoring.

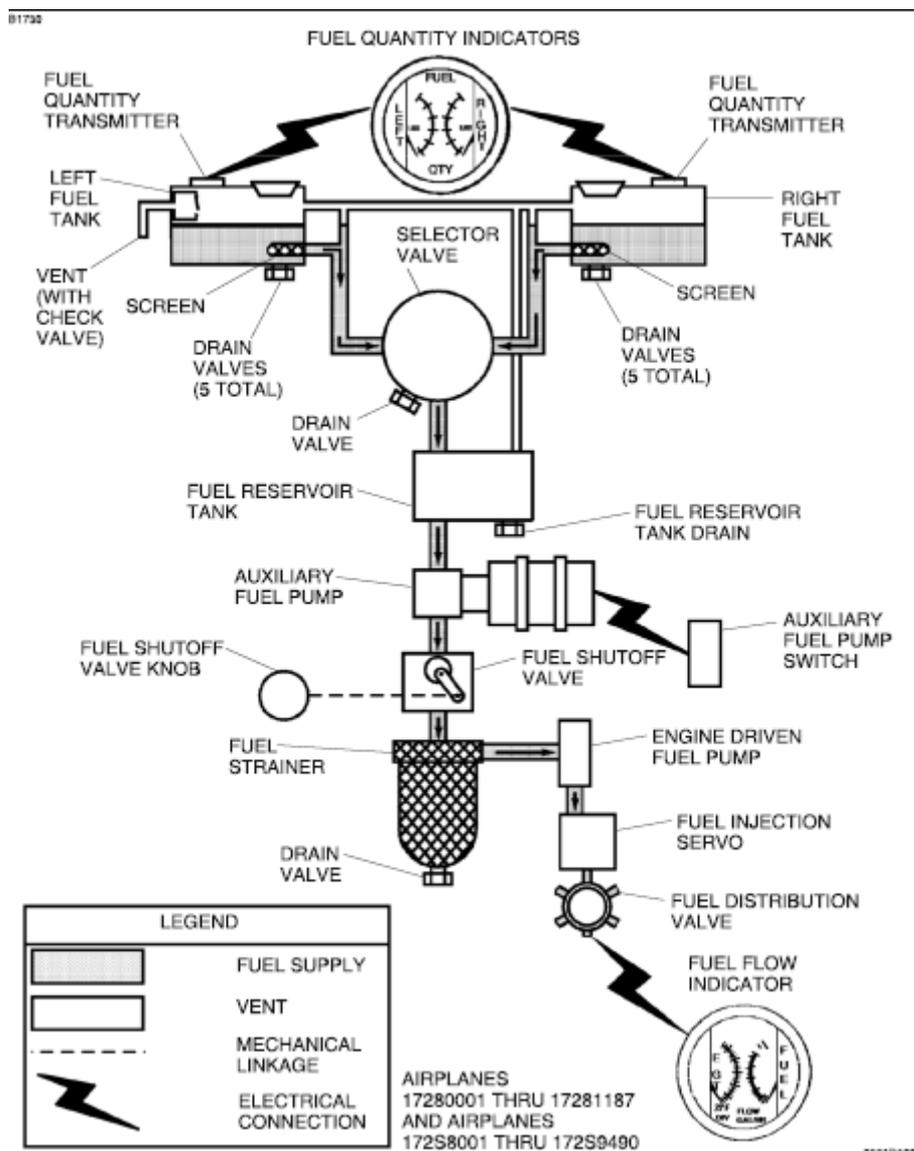


Fig: The schematic diagram of Fuel Metering

(1) The **Fuel Injection System** is a low pressure, multi nozzle, continuous flow system which injects raw fuel into the engine cylinder heads. The injection system is based on the principle of measuring engine air consumption to control fuel flow. More air flow through

the venturi will result in more fuel being delivered to the engine, and less air flow through the venturi results in a decreased flow of fuel to engine.

System components consist of the fuel/air control unit, the fuel distribution valve (flow divider), injection nozzles (4 total) and pipelines required to connect the components. A description of the components is as follows:

(a) **Fuel / Air Control Unit** - The fuel/air control unit, also known as the 'servo regulator,' is located on the underside of the engine. The fuel/air control unit is comprised of an integrated airflow sensing system, a regulator section and a fuel metering section. Operation of the fuel injection system is based on the principle of measuring airflow and using the airflow signal to operate a servo valve. The accurately regulated fuel pressure established by the servo valve, when applied across the fuel control system, makes fuel flow proportional to airflow.

(b) **Fuel Distribution Valve** - The fuel distribution valve, also known as a 'spider' or a flow divider, is located on top of the engine and serves to distribute fuel evenly to the four cylinders once it has been regulated by the fuel/air control unit. Also attached to the fuel distribution valve is a rigid line which feeds into a pressure transducer. This transducer measures fuel pressure and translates that reading into fuel flow at the cockpit indicator.

(c) **Injection Nozzles** - Each cylinder contains an injection nozzle, also known as an air bleed nozzle or a fuel injector. This nozzle incorporates a calibrated jet that determines, in conjunction with fuel pressure, the fuel flow entering each cylinder. Fuel entering the nozzle is discharged through the jet into an ambient air pressure chamber within the nozzle assembly. This nozzle assembly also contains a calibrated opening which is vented to the atmosphere, and allows fuel to be dispersed into the intake portion of the cylinder in an atomized, cone-shaped pattern.

From the engine-driven fuel pump, fuel enters the fuel/air control unit, passes through the fuel distribution valve, and is routed to individual injection nozzles at each cylinder.

(2) **THE AIRFLOW SENSING SYSTEM** consists of a throttle body which houses the air throttle valve, the venturi, servo valve and fuel control unit. The differential pressure between impact air and the venturi throat pressure is a measurement of the velocity of the air entering the engine. These pressures are vented through drilled channels in the throttle body to both sides of an air diaphragm and create a force across the diaphragm. A change

in air throttle position or a change in engine speed will change the air velocity, which in turn changes the force across the air diaphragm.

(3) **THE REGULATOR SECTION** contains the air diaphragm mentioned in the preceding paragraph and a fuel diaphragm. Fuel inlet pressure is applied to one side of the fuel diaphragm. The other side of the fuel diaphragm is exposed to fuel that has passed through the metering jet (metered fuel pressure). The differential pressure across the fuel diaphragm is referred to as the fuel metering force.

(a) The air metering force applied to the air diaphragm is transmitted through the regulator stem and tends to move the ball valve in the opening direction. The fuel metering force across the fuel diaphragm acts to oppose the air metering force and tends to close the ball valve. Because the air forces are very low in the idle range, a constant head idle spring is provided to maintain an adequate fuel metering force at low rpm.

(b) As the air metering force increases, the spring compresses until the spring retainer touches the air diaphragm and acts as a solid member. The constant effort spring produces a force which provides a smooth transfer from idle to low power cruise operation. Whenever the air metering, fuel metering and spring forces are balanced, the ball valve maintains a fixed position.

(4) **THE FUEL METERING SECTION** is contained within the throttle body casting and consists of an inlet fuel screen, a rotary idle valve and a rotary mixture valve. Both idle speed (closed throttle position) and idle mixture (relationship between throttle position and idle valve position) may be adjusted externally to meet individual engine requirements.

(a) The idle valve is connected to the throttle valve by means of an external adjustable link. The idle valve controls fuel flow through the low speed range of operation and is adjustable to obtain good idling characteristics without affecting fuel metering in the high power range.

(b) The mixture control valve gives full rich mixture on one stop and a progressively leaner mixture as it is moved toward idle cutoff. The full rich stop defines sea level requirements and the mixture control provides for altitude leaning.

1.7 Meteorological Conditions

The METAR at 1000 hrs prior to take off from the Baramati airstrip was winds 150°/06 knots, visibility 5 Km, Temp 22deg and sky clear. At 1200 hrs, meteorological condition at Baramati was reported to be prevailing wind 140°/06 knots, visibility 6 Km, clear sky and temp 27degree.

It is inferred that the weather was above minima and was not the contributory factor to the accident in any manner.

1.8 Aids to Navigation

There is no Navigational aid available at Baramati airfield other than the Runway end lights and markings.

1.9 Communication

The Baramati Airfield is an “Uncontrolled Airfield”. However, the operator has set up its own temporary ATC Tower on the Top Floor of the Building for maintaining flight coordination in air. Prior to accident, aircraft was in positive two-way communications with the Carver ATC.

As per the ***Training and Procedure Manual*** of the operator, the following is relevant:

(a) ACAPL (Academy of Carver Aviation Private Limited) is allocated with its own radio frequency 129.275 MHz.

(b) Ministry of communication has also allocated ACAPL with licensed base station.

LICENSE NUMBER: FP-06/01.

(c) Standby VERTEX and ICOM Handheld are also available in the ATC.

(d) Air Traffic Controller is always present in the ATC tower during the Operational flying.

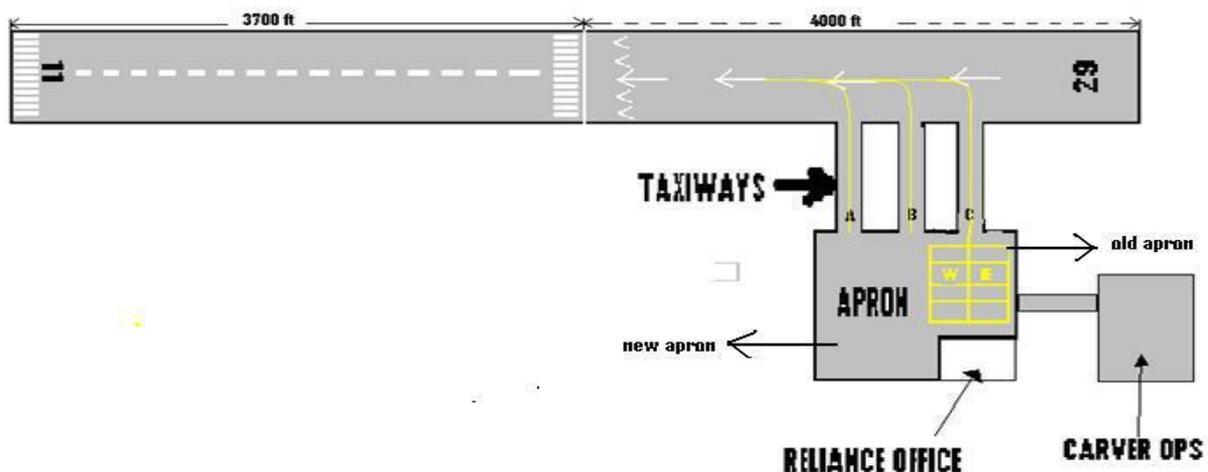
(e) All the aircraft flying in the vicinity of Baramati are to be in contact with the ATC on the designated frequency.

The tower is generally manned by an operator having valid RTR license and is responsible for two-way communication all the time wherever aircraft are flying.

Based on the statements of Dy. CFI, and other organizational personnel monitoring RT, there was always a two-way communication maintained and ensured all the time.

1.10 Aerodrome Information

Basic Runway Layout at Baramati Runway 11/29.



- (a) As per pictorial runway layout presented above, 7700ft of total runway is available out of which 3700ft is in operational use which is sufficient for imparting training on type of Aircraft available with ACAPL.
- (b) Runway centreline is marked with broken white line.
- (c) Threshold markings are as per guidelines for Runway of width 150ft.
- (d) Displaced threshold is marked with chevron marking on runway which is not in use for Takeoffs and Landings.
- (e) End of displaced threshold is indicated by series of Chevron marking as indicated in runway layout diagram.
- (f) There are three taxiways named as 'A' 'B' 'C'.
- (g) The width of each taxiway is 45ft respectively.
- (h) Taxiways are painted with yellow colour centreline as per guidelines in CAR section-4 Aerodrome Standards and Licensing.
- (j) All taxiways are well connected with the Runway by a yellow colour guideline.
- (k) The apron area at ACAPL is divided into two sections named as Old Apron and New Apron as shown below.

SR. NO.	APRON	LENGTH (MTR)	WIDTH (MTR)	AREA (SQ. MTR.)
1.	New Apron	100	180	18000
2.	Old Apron	100	75	7500

(l) The old apron consists of the parking area connected to taxiway "C" Divided as East (E) and West (W).

(m) Parking Bay consists of Ten Parking slot on new apron clearly marked are available for parking of aircraft.

1.11 Flight Recorders

Aircraft is not equipped with a DFDR or a CVR and it is also not a mandatory requirement.

1.12 Wreckage and Impact Information

The aircraft crashed in a barren field in the village area in Indapur Taluka, Baramati (N 18°10'21.7" - 74°51'15.2"E) approx 16 nm from the threshold of RWY 29 of Baramati.

While attempting forced landing, left wing of the aircraft touched a tree before touching the ground. During forced landing roll after touchdown on an undulated field,

nose wheel got stuck in a small pit. The nose landing gear suffered extensive damage. Due to momentum and nose landing gear in stuck position, aircraft turned to 90 Degrees. Finally, aircraft stopped in engine ploughed into the ground and tail up position as shown in the figure below.



Fig: Final rest position of Aircraft



Fig: Accident Site

Condition of Aircraft Wreckage

The nose landing gear was broken by impact which caused severe external damage to the engine compartment. The windshield was exploded, the Nose section crushed and right wing twisted. The propeller blades were only slightly damaged, also confirming that the engine delivered no power during impact.

- (a) The quantity of fuel remaining in the fuel tank were assessed.
- (b) The overall fuel quantity remaining in the fuel tank was estimated to be around 1.1Ltrs (Only in Port wing and Nil Fuel in Starboard wing).

- (c) The fuel tanks weren't ruptured.
- (d) The position of the aircraft was such to retain most of the fuel inside.
- (e) There was no strong odour of fuel felt by the police or eyewitnesses present shortly after the crash.



Fig: Impact on Aircraft Nose



Fig: Rubbing marks on Blades



Fig: Broken Engine mount

The engine and fuel system were further examined to ascertain any other damage.

- (a) The fuel filter was opened and inspected but no clogging or obstruction or slug formations were found. The carburettor was removed and opened. Due to the impact and the turnover of the aircraft, no fuel could be found in the float chamber. Nevertheless, the chamber was free of damage and debris. The throttle valve was difficult to move but this was because the valve shaft was damaged during impact. The nozzle was removed but no blockage was found. The general condition of Engine was good.
- (b) The rocker valve cover of one cylinder was removed to check the movement of the crank and camshaft. While rotating the propeller blades, it could be seen that the inlet and outlet valves moved up and down, showing that the shafts were still intact and connected.
- (c) All 8 spark plugs were removed and checked for their serviceability on test bench and found fully serviceable and functional.
- (d) All fuel pipelines in the engine were intact and in good condition.



Fig: External Engine condition

1.13 Medical and Pathological Information

The PIC had sustained minor injuries on his face due to splinters of the busted windshield flying around and broke his right hand due to impact. Since PIC was wearing shoulder harness, the extent of injury was minimal. After the wound was sutured and right hand was plastered, PIC was released from the hospital after recovery.

1.14 Fire

There was no pre or post impact fire.

1.15 Survival Aspects

The accident was survivable. However, the accident resulted into hull loss and injury to the crew.

The PIC was wearing the shoulder harness during the impact. The PIC suffered a serious injury due to the splinters of the busted windshield and impact, which could not be avoided.

At the time of occurrence, the PIC was conscious and could untighten himself and climb out of the airplane with the help of local villagers. With his mobile phone, the PIC immediately informed the rescue team at Baramati.

1.16 Tests and Research

The Fuel Quantity Indicator and Fuel Flow Indicator were removed from the aircraft on 04 May 2019 to inspect their working. During the removal, no abnormality was noticed.

Removed Fuel Quantity Indicator and Fuel Flow Indicators were tested on a serviceable aircraft (VT- ICE) and tested on ground with running engine. During ground running, both meters were found fully functional.



Fig: Fuel gauges

1.17 Organizational and Management information

M/s Academy of Carver Aviation Pvt. Ltd. is a Flying Training Academy established in the year of 1995 which is located at Baramati, Pune. The approval of Flying Training Organization is valid till 30-04-2020. The flying training academy has one (01) Dy. CFI and five (06) API for imparting training to the trainee pilots. The academy has a total of 08 aircraft i.e 01 Cessna 152, 06 Cessna 172, and 01 P-68 C. All aircraft are registered in the Normal Category, subdivision Passenger.

The M/s Carver Aviation has in house maintenance setup which is approved as per CAR 145 and valid upto 31/12/2020.

1.18 Additional Information

1.18.1 Fueling

The “Refuelling Entry” in Tech Log Book indicated that the aircraft was last refuelled with 75 Lts on 04 Feb 2019 totalling to 200 Lts. However, the refuelling entry has neither been authenticated by the Pilot nor by the AME in the Tech Log Book. Further, entry of data in Tech Log Book indicates that some other pilot has accepted the aircraft instead of PIC of the flight as stipulated in CAR Section 8. The maintenance of Technical Log Book requires special care while filling the records. The Refuelling records in Tech Log book indicate casual approach toward making and authenticating entries.

1.18.2 Fuel Quantity Indication

For each fuel tank, the fuel quantity is indicated in the cockpit on a moving magnet type Rochester fuel gauge, located left of the left control wheel.

The gauge is used in conjunction with a float-operated variable transmitter. The full position of float produces a maximum resistance through transmitter causing maximum pointer deflection when fuel is full in the tanks. As fuel level drops, resistance in the transmitter is decreased, producing a smaller pointer deflection (tank wise). When resistance is zero, the pointer indicates 'E' (empty).

Maintenance

Fuel quantity gauge (S. No. 597, OEM P/N S3281-2) manufactured on 25 Jul 1997 and EGT & Fuel Flow Indicator (S. No. 099, OEM P/N S3277-4) manufactured on 01 Aug 1998 are fitted on the aircraft since its inception. Routine maintenance was regularly been done. No snag had been reported on the said components or on fuel system of the aircraft since its inception into operation. ***As per AMM, the gauges are to be repaired and serviced "On Condition".***

1.18.3 Fuel System Examination

Examination of the aircraft did not reveal any evidence of fuel leakage from the aircraft fuel lines or fuel system components. Both fuel tank caps were securely fitted with no evidence of in-flight seepage. The aircraft fuel filter was clear of obstruction and there no were evidence of fuel spillage on the ground from the filter assembly as it was intact.

The manufacturer has not specifically imposed any caveats on the flight profile or types of manoeuvre performed with low fuel loads for the Cessna 172 aircraft, other than advising that the unusable fuel listed was applicable under 'reasonable flight conditions'.

The Cessna Pilot Safety and Warning Supplement (PSWS) Section 6, Fuel Management – Flight Coordination versus Fuel Flow provides the following guidance:-

"It is important to observe the uncoordinated flight or side slip limitations listed in the respective operating handbook. As a general rule, limit uncoordinated flight or sideslip to 30 seconds in duration when the fuel level in the selected fuel tank is ¼ full or less. Airplanes are usually considered in a sideslip anytime the turn and bank "ball" is more than one-quarter ball out of the centre (coordinated flight) position. Unusable fuel quantity increases with the severity of the sideslip in all cases."

The manufacturer did not provide any advice on asymmetric fuel delivery due to the aircraft tank venting configuration. However, the PSWS warns:-

“In certain manoeuvres, the fuel may move away from the fuel tank supply outlet. Pilots can prevent inadvertent uncovering of the tank outlet by having sufficient fuel in the tank selected and avoiding manoeuvres such as prolonged uncoordinated flight or sideslips which move fuel away from the feed lines.”

1.18.4 Flight Manual

The Flight Manual that was found in the aircraft is called the **Pilot’s Operating Handbook (POH) & FAA approved Flight Manual** and has Serial Number 172S8045. It is applicable for the said Aircraft with a date of issue 08 Jul 1998.

Some relevant extracts from POH are as follows

From SECTION 3: EMERGENCY PROCEDURES

Emergency Landing without Engine Power

- Passengers Seat Backs – Most Upright Position.
- Seats and Seat Belts - Secure
- **Airspeed - 70 KIAS (Knots Indicated Air Speed) (flaps UP).**
- **65 KIAS (Flaps DOWN).**
- Mixture – IDLE CUT OFF.
- Fuel Shutoff Valve – OFF (Pull Full Out).
- Ignition Switch – OFF
- Wing Flaps – As required (30° recommended).
- Master Switch – OFF (when landing is assured).
- Doors – Unlatch prior to touchdown.
- Touchdown – Slightly tail low.
- Brakes – Apply heavily.

The checklist procedures assume that adequate time exists to secure the fuel and ignition systems prior to touchdown. After an engine failure in flight, the most important course of action is to continue flying the airplane. Best glide speed as shown in figure below should be established as quickly as possible. While gliding toward a suitable landing area, an effort should be made to identify the cause of the failure. If time permits, an engine restart should be attempted as shown in the checklist. If the engine cannot be restarted, a forced landing without power must be completed.

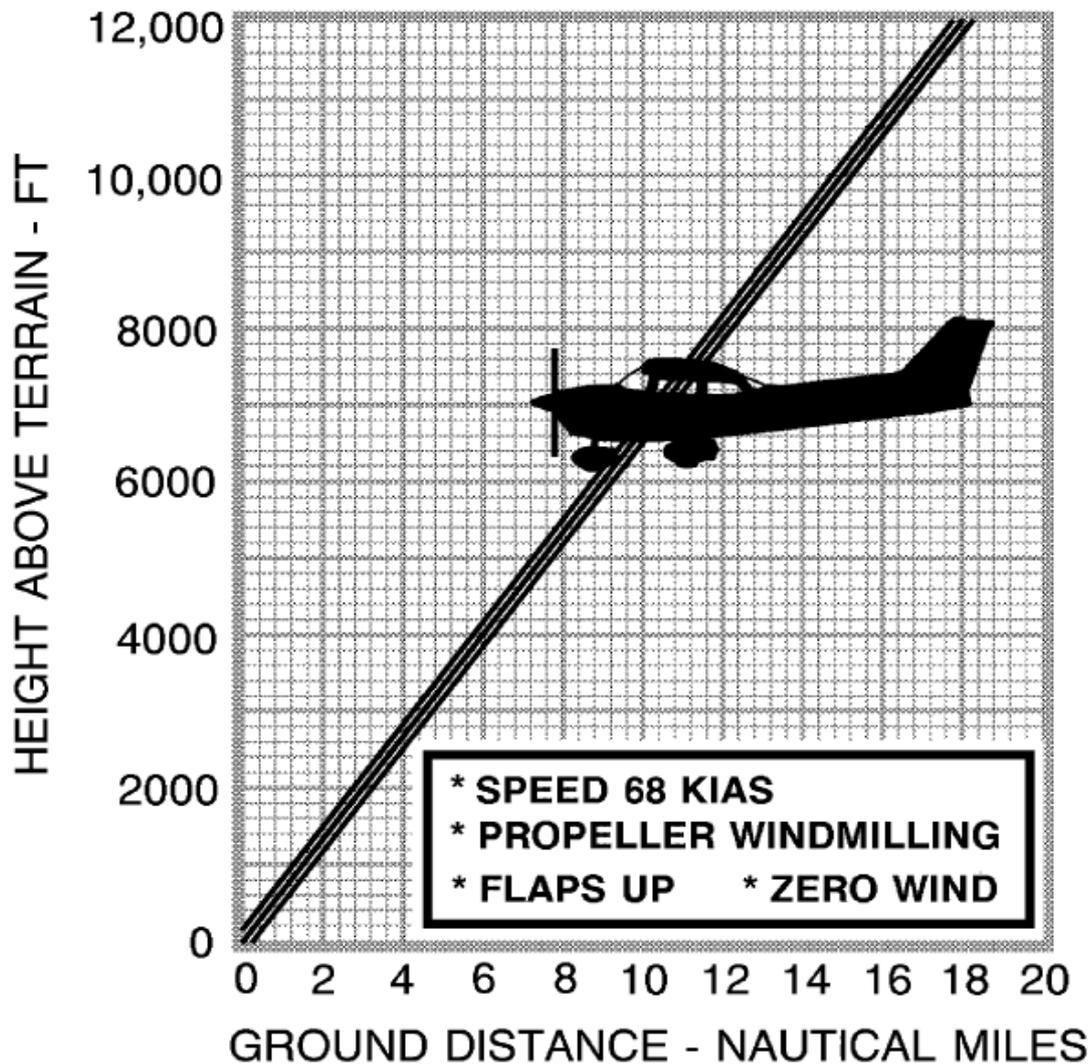


Fig.3: Maximum Glide (Distance) Chart

1.18.5 Hazards at Accident Site

The aircraft battery was fitted in a box mounted on the right forward side of the firewall. Due to the crash landing and aircraft nose down position, this box was separated from the firewall and its cover opened. Some Battery spillage was noticed by Investigators at the accident site.

This situation contained two risks:

- Establishment of a short-circuit leading to a fire.
- Causing burn to technicians or persons around.

1.18.6 Minimum Fuel Requirement for General Aviation Aircraft

As per DGCA CAR Section 8 Series O Part III dated 24th July 2017, Following are the requirements:

Para 2.2.3.6 - on "Fuel and Oil Requirements" states that:

A flight shall not be commenced unless, taking into account both the meteorological conditions and any delays that are expected in flight, the aeroplane carries sufficient fuel and oil to ensure that it can safely complete the flight.

The amount of fuel to be carried as per the regulations is as follows:-

- When the flight is conducted in accordance with day VFR, flight to the aerodrome of intended landing, and after that, have a final reserve fuel for at least 30 minutes at normal cruising altitude; or
- When the flight is conducted in accordance with night VFR, flight to the aerodrome of intended landing and thereafter have a final reserve fuel for at least 45 minutes at normal cruising altitude.

Para 2.2.4.7 on "In-flight fuel management" states that:

- The PIC shall monitor the amount of usable fuel remaining on board to ensure that it is not less than the fuel required to proceed to an aerodrome where a safe landing can be made with the planned final reserve fuel remaining.
- The pilot-in-command shall advise ATC of a minimum fuel state by declaring MINIMUM FUEL when, having committed to land at a specific aerodrome, the pilot calculates that any change to the existing clearance to that aerodrome, or other air traffic delays, may result in landing with less than the planned final reserve fuel.
- The pilot-in-command shall declare a situation of fuel emergency by broadcasting MAYDAY MAYDAYMAYDAY FUEL, when the calculated usable fuel estimated to be available upon landing at the nearest aerodrome where a safe landing can be made is less than the planned final reserve fuel.

Para 3.4.3.5- on "Fuel Requirements" has stated following requirements:

An aeroplane shall carry a sufficient amount of usable fuel to complete the planned flight safely and to allow for deviations from the planned operation.

- The amount of usable fuel to be carried shall, as a minimum, be based on:

(a) Fuel consumption data:

- (i) Provided by the aeroplane manufacturer; or
- (ii) If available, current aeroplane specific data derived from a fuel consumption monitoring system; and

(b) The operating conditions for the planned flight including:

- (i) Anticipated aeroplane mass;
- (ii) Current meteorological reports or a combination of current reports and forecasts;
- (iii) Air traffic services procedures, restrictions and anticipated delays; and

Where no specific fuel consumption data exist for the precise conditions of the flight, the aircraft may be operated in accordance with estimated fuel consumption data.

1.19 Useful and Effective Techniques

Nil

2. ANALYSIS

2.1 Serviceability of Aircraft

Aircraft was fully serviceable and no snag was reported / pending before the flight commenced.

2.2 Last flight

2.2.1 Flight Preparation

The student pilot prepared his flight and calculated the expected flight time with the forecasted wind speed. Total flight time was calculated to be 2 hours and 30 minutes. As per DGCA CAR Section 8 Series O Part III dated 24th July 2017, 30 minutes of reserve fuel should be carried when flying in day VFR conditions. This brings the total flight time to 3 hours (including 30 minutes of reserve fuel) when using a safe fuel consumption value of 30 Ltrs/hour. However, the average fuel consumption of the fateful aircraft was 27 Ltrs / Hrs. This means that the aircraft should have had at least 90 Ltrs on board.

On further analysis of the Tech Log Book, it was noticed that fuel uplift records were mostly signed by PIC whereas aircraft are taking off from the base where qualified AME's were available.

It was also observed that trainee pilots/PIC are signing fuel upliftment column in the Tech Log Book, however, acceptance column is not signed by the same trainee pilots/PIC. This signifies that trainee pilots are doing the refuelling whereas acceptance column is either left blank or somebody else is signing and accepting the aircraft for the sortie.

Further, as per POH, PIC was supposed to calculate CG (Trim & Load Sheet) before the flight. However, Trim & Load sheet was not found in the aircraft which could have given status of fuel carried onboard. As per PIC's statement, load and trim sheet was carried onboard, however, it was not found in the aircraft along with other onboard documents. ***Dy. CFI also could not produce a copy of Load & Trim Sheet.***

2.2.2 Shortcoming of Pre-flight Inspection

As per the statement of the Student Pilot, the fuel quantity was checked with the help of Dip Stick during the preflight preparation, ***however, no dip Stick was found from the fateful aircraft after crash landing.*** In addition to this, as per the checklist procedures of the POH, PIC shall also check visually both fuel tanks. However, PIC could not explain the absence of dip stick in the aircraft and probably, he may not had checked the fuel in the tanks physically. Moreover, during sample check of fully serviceable aircraft VT-LEO, it was noticed that dip stick was also not available in VT-LEO.

As per Student Pilot, the aircraft was refuelled before the flight. However, he has not even accepted the aircraft in the Tech Log Book as evident from the non-availability of his signature at Pilot Acceptance Certificate. Further, he was not carrying "Certificate of Release to Service" of the fateful aircraft since aircraft was released after servicing and that was the first sortie of the fateful aircraft. However, according to him the fuel quantity gauges indicated full tanks. ***In reality, the aircraft had already 1 hour and 50 minutes flown before engine shut down in air due to fuel starvation.*** If we take the safe fuel flow value of 30 ltr/h, this means that the aircraft must have already burnt 55 Ltrs of fuel before it's engine shut down (It shows aircraft was having only close to 55 Ltrs of fuel on board). As per PIC, the fuel gauges would have indicated fuel quantity around a total of 145 Ltrs or 72.5 Ltrs per tank on board at the time of accident, whereas, only 200 ml of fuel was available in the tanks.

2.2.3 Inadequate Fuel Management in Flight

According to the Student Pilot, the cross-country leg of the flight was timed and compared with the calculated results. During course of Investigation, in fact PIC was unable to calculate fuel for the sortie and faced difficulty in fuel management calculation. The PIC was also not aware of the existing rule position of Fuel Management.

At the crash site 200ml (approx.) of fuel was found from the starboard tank only and nil fuel from port. Also, the fuel strainer assembly installed at the firewall was found to be intact.

2.2.4 Emergency Landing

The engine stopped delivering power in its final leg at about 2000 ft AGL and 18 nm from the runway threshold. The weather was perfectly fine, PIC decided to land on a road first. Since, the road was curvy and some houses were close to road, PIC changed his mind to perform an emergency landing in the neighbourhood field.

The maximum glide distance is as per POH can be calculated. It can be seen from POH glide distance graph that the altitude needed to reach a distance of 17nm is approx. 11000 ft. However, this is only valid under the condition that flaps are up and there's zero wind. In this case, flaps were already selected to 20° and there was an upwind between 5 to 11 knots. The aircraft would have never reached the runway and the PIC took the right decision to choose forced landing area.

2.3 Fuel Usage and Endurance

The minimum fuel required for the Baramati – Akalkot-Baramati flight was calculated and is as under:-

1. Average fuel consumption of VT-RDX= 27 litres/ hr approx.
2. Taxi Fuel required= 5 ltr
3. Fuel for Flight duration of 02 hr 30 min x 27 litres/hr = 69.5 litres
4. Fuel for reserve 30 min = 13.5 ltr

Minimum Fuel required for flight = 88litres.

Minimum fuel required for the fateful flight was 88 litres but aircraft actually carried less fuel.

2.4 Fuel records

The past refueling records have not been recorded and maintained in standard format. Since, most of the operations are planned Ex- Baramati, refuelling entries should have been made by AMEs and not by the Pilots as evident from Tech Log Book.

2.5 Fuel Quantity Indication

The test of the fuel quantity indicators didn't show any anomaly. The fuel quantity Indicator were tested on a serviceable aircraft and found fully functional. It is generally known that the fuel quantity indicators are reliable and that they are only calibrated (On condition) to give a representative value in a straight and level flight.

3. CONCLUSIONS

3.1 Findings

- (a) The airplane was in airworthy condition.
- (b) The student pilot held a valid Student Pilot License.

- (c) The airplane was regularly maintained in a DGCA approved hangar by M/s Academy of Carver Aviation.
- (d) By not inspecting visually the fuel tanks, the pre-flight inspection was not completely performed and fuel quantity was not correctly evaluated.
- (e) The PIC did not monitor fuel at regular interval during the flight. Even during RPM drop, coughing of Engine and subsequent shut down of Engine, the fuel indication were never reported. This indicated lack of training imparted about fuel management.
- (f) PIC was not confident of fuel calculation and onboard fuel requirement.
- (g) There was no calibrated dip stick inside the airplane.
- (h) Fuel and oil records are not maintained as per the guidelines specified in CAR.
- (j) The engine was examined in the hangar (DGCA approved) and visual inspection was carried out and no significant damage was observed on the engine. However, engine mount bracket found damaged at 02 places due to impact.
- (k) There was no significant damage noticed on the propeller blades other than rubbing marks.
- (l) The Load and trim Sheet was not found in the aircraft as well as in the operation office. The said sheet could have given a clear picture of Fuel on board.
- (m) Fuel selector knob was in right position. The reason for the same could not be explained by PIC.

3.2 Probable Cause

The cause of the accident was fuel starvation leading to a loss of engine power.

Contributing factors

Not performing a complete pre-flight inspection leading to an inadequate evaluation of the fuel on board.

4. Safety Recommendations

4.1 AAIB should conduct a safety study on functioning of flying clubs with special emphasis on fuel planning and management.

(Dinesh Kumar)
Investigator

(Anil Tewari)
Investigator-in-Charge

Place: New Delhi
Date: 15/05/2019