AI2022-1

AIRCRAFT SERIOUS INCIDENT INVESTIGATION REPORT

PRIVATELY OWNED

J A 3 6 H K

January 20, 2022

Japan Transport Safety Board

The objective of the investigation conducted by the Japan Transport Safety Board in accordance with the Act for Establishment of the Japan Transport Safety Board (and with Annex 13 to the Convention on International Civil Aviation) is to prevent future accidents and incidents. It is not the purpose of the investigation to apportion blame or liability.

TAKEDA Nobuo
Chairperson
Japan Transport Safety Board

Note:

This report is a translation of the Japanese original investigation report. The text in Japanese shall prevail in the interpretation of the report.

《Reference》

The terms used to describe the results of the analysis in "3. ANALYSIS" of this report are as follows.

i) In case of being able to determine, the term "certain" or "certainly" is used.
ii) In case of being unable to determine but being almost certain, the term "highly probable" or "most likely" is used.
iii) In case of higher possibility, the term "probable" or "more likely" is used.
iv) In a case that there is a possibility, the term "likely" or "possible" is used.

AIRCRAFT SERIOUS INCIDENT INVESTIGATION REPORT

CONTINUED LOSS OF POWER OF ENGINE
PRIVATELY OWNED
DIAMOND AIRCRAFT
HK36R SUPER DIMONA (TWO-SEAT MOTOR GLIDER)
JA36HK
AT MATSUYAMA AIRPORT, JAPAN
ABOUT 12:11 JST, DECEMBER 21, 2019

December 17, 2021
Adopted by the Japan Transport Safety Board
Chairperson TAKEDA Nobuo
Member MIYASHITA Toru
Member KAKISHIMA Yoshiko
Member MARUI Yuichi
Member NAKANISHI Miwa
Member TSUDA Hiroka

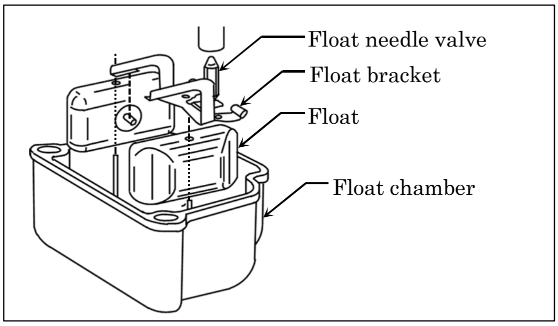
1. PROCESS AND PROGRESS OF THE AIRCRAFT INVESTIGATION

1.1 Summary of the Serious Incident	On Saturday, December 21, 2019, due to the reduced engine power during takeoff climb from Matsuyama Airport, Ehime Prefecture, Diamond Aircraft HK36R Super Dimona, registered JA36HK, returned to the airport and landed back on parallel taxiway. The captain and one passenger were on board and there was no injury to them.
1.2 Outline of the Serious Incident Investigation	The occurrence covered by this report falls under the category of "Continued loss of power of engine" as stipulated in Clause 7, Article 166-4 of the Ordinance for Enforcement of the Civil Aeronautics Act of Japan and is classified as a serious incident. On December 21, 2019, the Japan Transport Safety Board (JTSB) designated an investigator-in-charge and an investigator to investigate this serious incident. Although this serious incident was notified to the Republic of Austria as the State of Design and Manufacture of the aircraft involved in this serious

	incident, the State did not designate its accredited representative. Comments were invited from parties relevant to the cause of the serious incident and the relevant State.

2. FACTUAL INFORMATION

2.1 History of the Flight	According to the statements of the captain and passenger, the history of the flight is summarized as follows:  Figure 1 Incident aircraft On December 21, 2019, Diamond Aircraft HK36R Super Dimona, registered JA36HK, took off from runway 14 at Matsuyama Airport with the captain and one passenger on board. During takeoff climb, the engine power of the aircraft suddenly reduced and there occurred vibrations approximately 50 ft above the runway. The strength of vibrations periodically fluctuated. The captain attempted to activate the fuel pump but the engine power did not recover. Considering the performance of the aircraft, the captain decided to return to the airport. The aircraft commenced 180° circling to the left to land on runway 32. During circling, the captain requested clearance for landing from air traffic controller. The controller judged that the aircraft was in an emergency and immediately issued the landing clearance. Then, the captain judged that the altitude of the aircraft was too low to reach the runway, and the aircraft landed on the parallel taxiway.  Figure 2 Estimated flight route The aircraft fiercely touched down inclining to the left and sustained damage to the left main wing tip and tail wheel. After the aircraft had landed and had come to a halt, the reduced engine power and vibrations were restored. According to the captain and passenger, there was no sign of engine malfunction including pre-flight engine check until vibrations occurred after takeoff. This serious incident occurred at Matsuyama Airport (33°49'19"N, 132°42'36"E) on December 21, 2019, about 12:11 JST (JST: UTC+9 hours; unless otherwise noted all times are indicated in JST in this report on a 24-hour clock).
2.2 Injuries to Persons	None
2.3 Damage to the Aircraft	Deformation to the tail wheel, rubbing marks to the left main wing tip and damage to the wing tip light.

2.4 Personnel Information	(1) Captain: Age 73 Private pilot certificate (Motor glider) October 18, 1967 Type rating for motor glider July 24, 1998 Pilot competence assessment Expiry of practicable period for flight March 8, 2020 Class 1 aviation medical certificate Validity: May 22, 2020 Total flight time (Motor glider) 4,047 hours Total flight time on the type of motor glider 1,190 hours
2.5 Aircraft Information	(1) Aircraft Aircraft type: Diamond Aircraft HK36R Super Dimona Serial number: 36349 Date of manufacture: November 6, 1991 Certificate of airworthiness: No. 2019-49-01 Validity: January 18, 2020 Category of airworthiness: Motor glider Utility U Total flight time: 23,911 hours 15 minutes When the serious incident occurred, the weight and the position of the center of gravity of the aircraft were within the allowable range. (2) Engine Engine type: Rotax 912S2-01 Serial number: 9563648 Date of manufacture: November 4, 2015 Date of installation: December 5, 2015 Total flight time: 351 hours 25 minutes
2.6 Additional Information	(1) Float-type carburetor of the aircraft engine (see Figure 3) The aircraft engine was four-stroke, four-cylinder, horizontally-opposed piston engine with two sets of float-type carburetors each installed on the left and right sides. Float-type carburetors mix the fuel stored in the float chambers and air and thereby create appropriate air-fuel mixture that is supplied to the engine. The air-fuel mixture is supplied to number 1 and 3 cylinders on the right side of the engine from the right carburetor and the same is supplied to number 2 and 4 cylinders on the left side of the engine from the left carburetor.  Figure 3 Float relationship diagram Two floats made of foamed rubber in the float chamber of each carburetor, which are positoned by passing the pin fixed to the float chamber through to the insert (a guide tube) in the float, keep floating on the fuel in the float chamber by buoyancy and move vertically in response to the changes of the fuel level. Vertical motion of the float opens or closes the float needle valve by means of the linked float bracket and thereby the amount of the fuel supplied to the float chamber is adjusted and the fuel level in the float chamber is kept constant at a predetermined level. (see Figure 4)

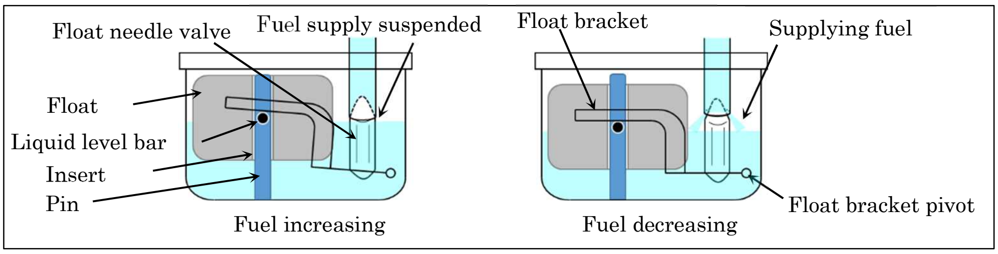
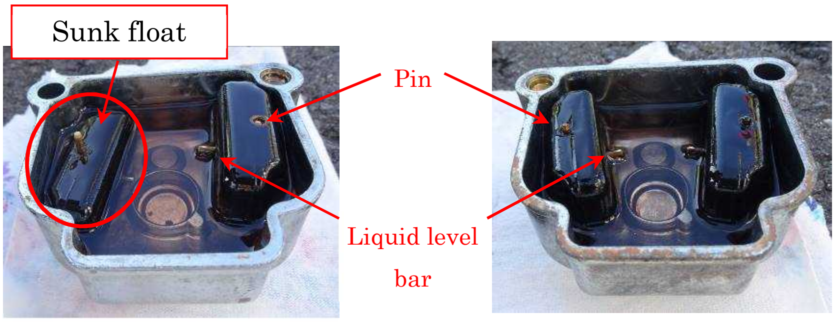


Figure 4　Motion when fuel increasing/decreasing (For image only)

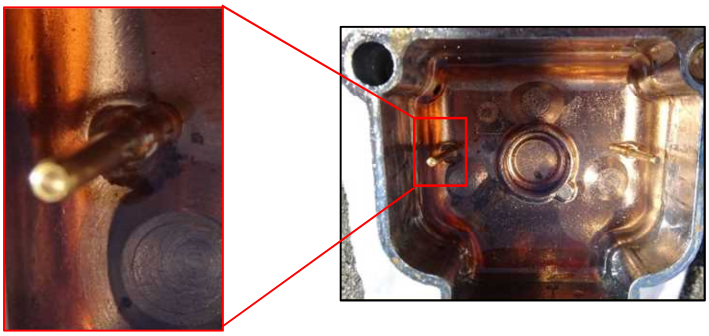
During the inspection the engine after landing, it revealed that one of the floats in the left carburetor sank in the fuel. (see Figure 5)



(Left carburetor)　(Right carburetor)

Figure 5　Floats in carburetors of incident aircraft

The pin of the abnormal float sunk in the fuel was not bent or adhered by foreign substance. (see Figure 6)



Close-up photo of left pin　Inside of float chamber

Figure 6　Float chamber of left carburetor

Result of verifying spark plug condition conducted in the on-site investigation showed no remarkable anomaly in the electrode. The periphery of the electrode of the lower spark plugs of number 2 and 4 cylinders to which the fuel was supplied from the left carburetor was in wet condition.

Engine run-up and ground run conducted varying attitudes after replacing two floats in the left carburetor with new ones did not reproduce the engine malfunction.

(2) Fuel examination

The fuel was taken from the aircraft for ingredient analysis. As a result of the analysis, the fuel was free from anomaly.

(3) Float examination

i) Appearance

Appearance of the abnormal float sunk in the fuel and the float normally working in the left carburetor (hereinafter referred to as “the Normal float”) was compared. (see Figure 7)

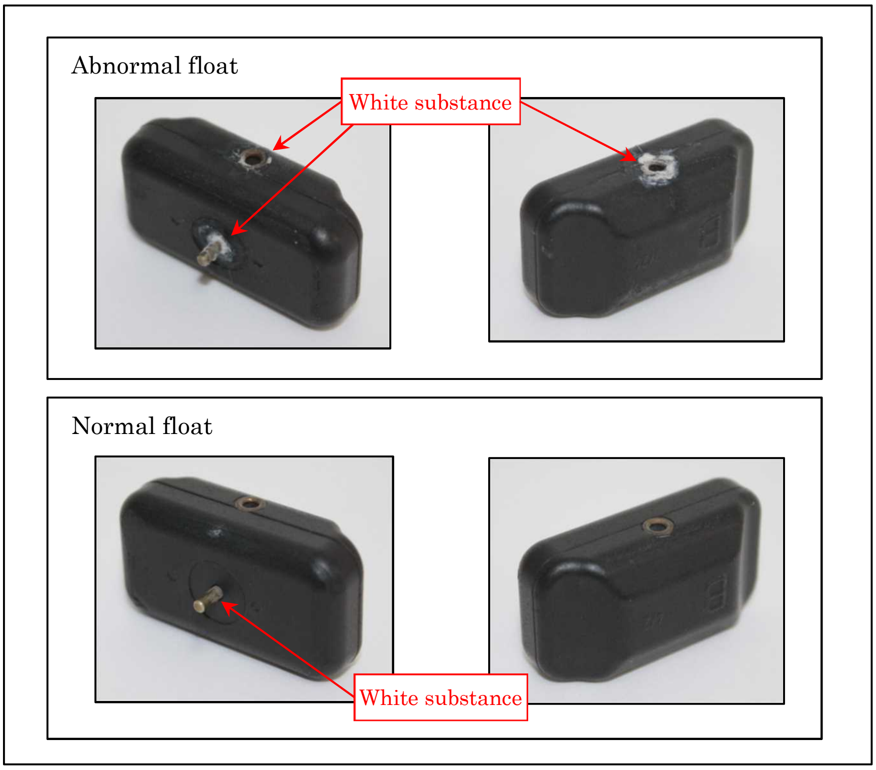


Figure 7 Float comparison

・Abnormal float

A white substance was adhered to both ends of the insert to which the pin of the float chamber was passed through and a bar that indicated the liquid level (hereinafter referred to as “the Liquid level bar”). Particularly, a large amount of the white substance was adhered to the lower hole of the insert and the Liquid level bar.

・Normal float

A very little amount of the white substance was adhered to the Liquid level bar although it was not observed on both ends of the insert as was observed in the abnormal float.

ii) Nondestructive testing

X-ray CT examination was conducted as nondestructive testing.

・Foamed portion

A foreign substance was observed in the foamed portion of both floats with no deviation in distribution. In addition, there was no difference in foam density of both floats.

・Insert (see Figures 8 and 9)

The insert in the float was an integrated type with wall thickness of approximately 0.3 mm. The insert in the abnormal float was warped in S-shape. Computation by CT image showed that the width of the warp was 0.2 mm. Besides, the end of the upper hole of the insert in the abnormal float had a remarkable change in its shape with cracks generating along the whole circumference of the end of the upper hole.

The insert in the Normal float was straight with no cracks generating. There were some changes in the shape near the lower hole.

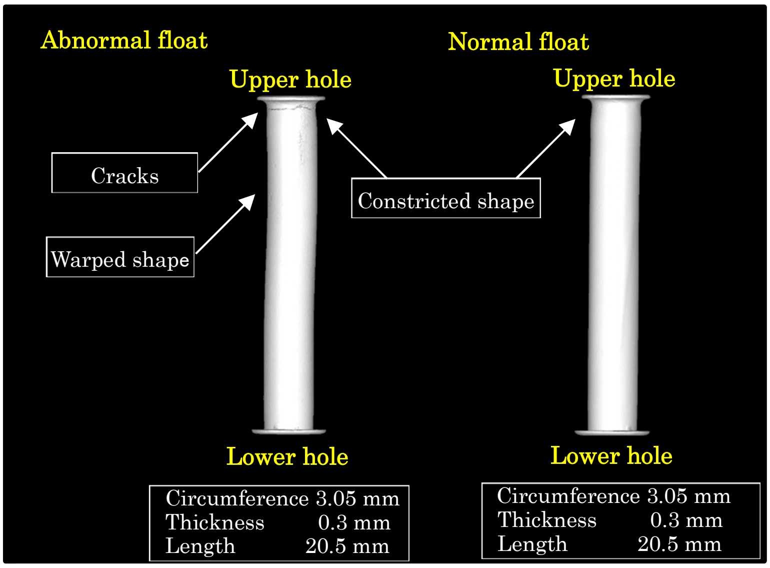


Figure 8 Insert shape (X-ray CT image)

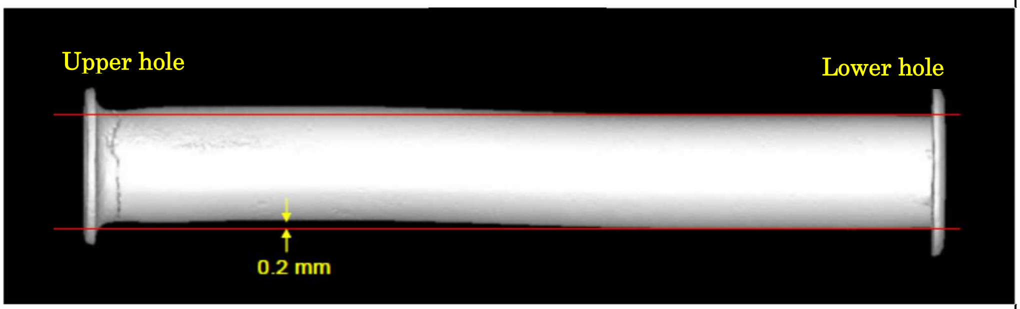


Figure 9 Warped insert in abnormal float

iii) Optical microscope observation (see Figures 10 and 11)

Appearance observation using optical microscope was conducted.

・Foamed portion

Observation by magnifying the foamed portion revealed that both floats partially had unevenness. A transparent or white substance was observed to be adhered to the periphery of the upper hole of the abnormal float, part of which linearly stretched to the lower hole tracing along the surface of the foamed portion. Besides, the transparent substance was linearly stretched on the lower hole and the Liquid level bar.

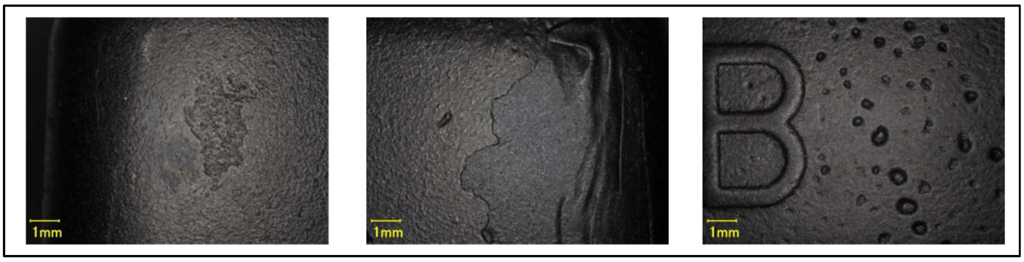


Figure 10 Uneven surfaces of foamed portion (representative portions)

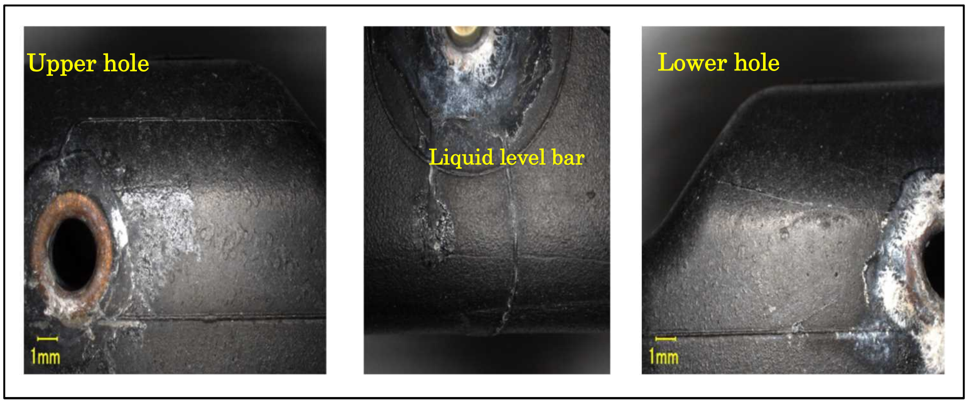


Figure 11 Adhered condition of transparent or white substance (abnormal float)

・Insert hole and Liquid level bar

A transparent or white substance was observed in the periphery of the upper hole of the abnormal float and a white substance was observed to be adhered to the periphery of the lower hole and the Liquid level bar. Difference in color tone between both substances is presumed to be attributable to different shapes of adhering and different amounts of air contained; both substances are considered to be the same. Besides, these substances were not adhered to the inner wall of the insert.

Inner diameters of the insert holes were as shown in the table below.

Hole	Abnormal float	Normal float
Upper hole	2.42 mm	2.41 mm
Lower hole	2.25 – 2.31 mm	2.43 mm

iv) Abnormal floating reproduction experiment

An experiment to float the abnormal float and the Normal float on the fuel was conducted. From the information of a manufacturer that the pin in the float chamber had a diameter of 2.00±0.04 mm, a pin with a diameter of 2 mm was alternatively used. As a result of the experiment, both the abnormal float and the Normal float floated on the fuel.

The reproduction experiment was conducted in horizontally stationary condition.

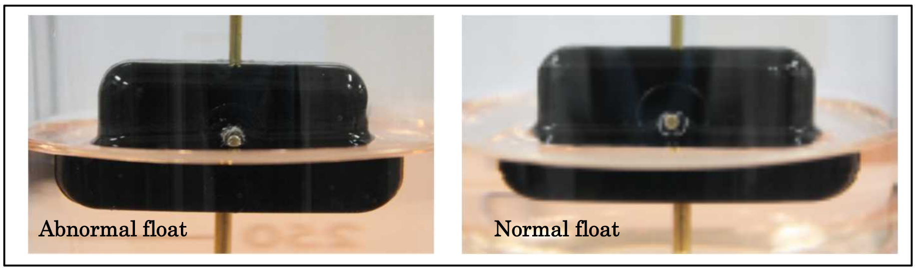


Figure 12 Float with pin passing through (no change for several hours)

v) Mass change

After both floats had wholly been soaked in the fuel for two days, mass change between before and after soaking was measured with lightly wiping the surface of the floats. The result was as shown in the table below.

Specimen	Mass measured (g)	
	Dry	After wholly soaked
Abnormal	3.0902	3.1728
Normal	2.8730	2.9102

iv) Ingredient analysis of the white substance

To identify the ingredients of the white substance adhered to the periphery of the hole of the abnormal float, analysis by the methods of Elemental analysis, Fourier-transform infrared spectroscopy (FTIR) and Pyrolysis-gas chromatography-mass spectrometry (GCMS) was conducted. The white substance was adhered to the upper and lower holes and the Liquid level bar, and the one adhered to the periphery of the lower hole was used as a representative specimen. As a result, the principal ingredients of the white substance were identified as carbon and oxygen and ingredients used in an adhesive, etc. were also detected.

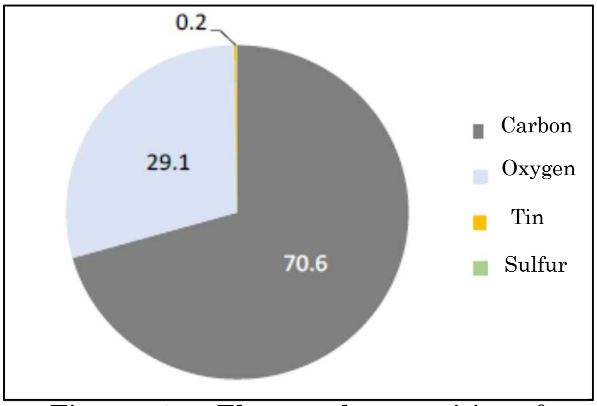


Figure 13 Elemental composition of white substance

According to the engine manufacturer, an adhesive was not used in manufacturing processes and maintenance procedures using an adhesive were not set forth.

(4) Engine maintenance manual of the aircraft

The engine maintenance manual of the aircraft contained the following regarding float inspection:

	・conduct float weight inspection in every 200-flight hour or annual inspection, and ・maximum total weight of two floats attached to one carburetor is 7 g. The engine maintenance manual of the aircraft did not stipulate any maintenance work using an adhesive for float maintenance. (5) Engine maintenance record of the aircraft According to the engine maintenance record of the aircraft, engine maintenance of the aircraft had been conducted in accordance with the flight hours set forth in the engine maintenance manual. According to the captain, there had occurred imbalance in float sinking when cleansing the float chamber that the captain considered was attributable to the fuel that was soaked from the joint of the float and had pasted an adhesive to the joint of the float.

3. ANALYSIS

3.1 Involvement of Weather	None
3.2 Involvement of Pilots	None
3.3 Involvement of Aircraft	Yes
3.4 Analysis of Findings	(1) Factors of the engine malfunction Neither fuel system nor ignition system is probable to have been the factor of the engine malfunction from the findings that the test run conducted after replacing the floats of the left carburetor with new ones did not reproduce the engine malfunction, the ingredient analysis of the fuel showed no anomaly, and there did not occur such a remarkable anomaly in the electrode as faulty ignition when the spark plug was verified. (2) Faulty motion of the float The JTSB concludes that after the floats had been soaked (wholly soaked) in the fuel, mass of the abnormal float was heavier by approximately 0.26 g than the Normal float. However, the larger mass of the abnormal float is probable not to have been the factor of the faulty motion of the float (abnormal floating) that caused the engine malfunction because it was verified through the abnormal floating reproduction experiment of the floats that the abnormal float also floated on the fuel. In the abnormal float, it was verified that there occurred deformation and cracking in the insert and the inner diameter of the lower hole became narrow due to the white substance. Whereas the float chambers fixed to the engine incline in response to the pitch change of the aircraft attitude during takeoff climb or in some other occasions, the floats act to maintain the horizontality so does the fuel level that causes the floats to incline against the float chambers. (see Figure 14) It is probable, at this point, that a gap between the insert and the pin of the float chamber was narrowed by deformation or cracking, etc. in the insert of the float and thereby smooth vertical motion of

the float was impeded.

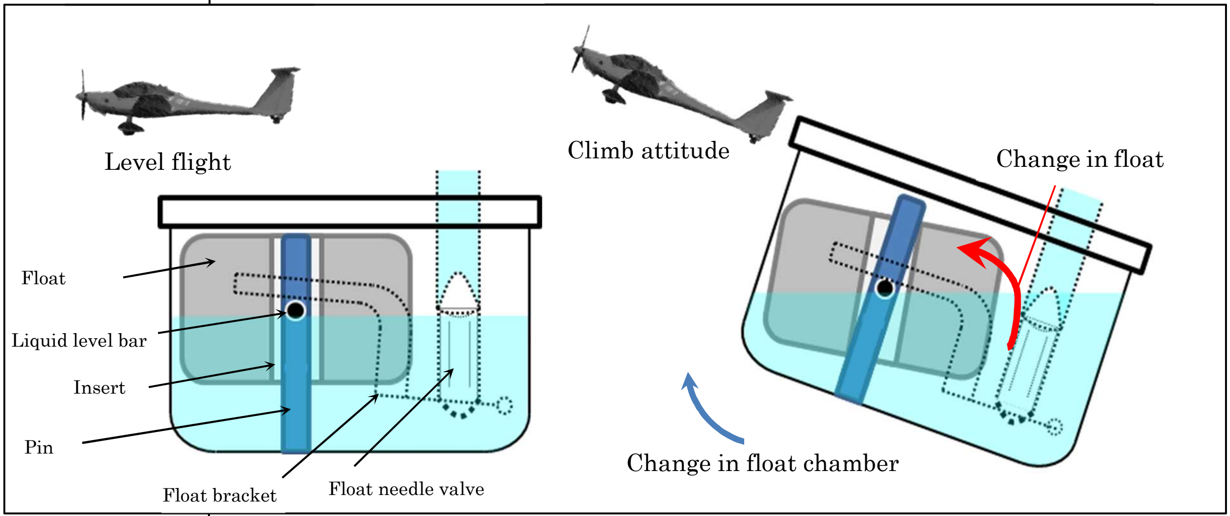


Figure 14 Motion of float chamber and float

Although deformation in the insert of the abnormal float is probable to have been caused by some external force added such as inappropriate handling in the manufacturing processes or maintenance work, etc., it could not be determined.

(3) Engine malfunction

During takeoff climb, the engine power of the aircraft was suddenly reduced. It is probable that the occurrence of the engine malfunction like this during takeoff climb was attributable to the motion of the abnormal float that had smoothly been working in response to the changes in the liquid level and temporarily stuck due to the inclined attitude of the aircraft and thereby the amount of fuel supply was not appropriately controlled.

Namely, it is probable that, due to the temporary sticking of the abnormal float, which had smoothly been moving until the engine malfunction, did not move downward even though the fuel in the float chamber was running short, the fuel level in the float chamber moved downward excessively with the float needle valve narrowed by the float bracket, and the fuel supply to the cylinders was impeded thus leading to the commencement of the reduced engine power.

When the fuel level in the float chamber moved downward to the level that did not allow the fuel to be supplied to the cylinders, the fuel level then moved upward again to the level that allowed the fuel to be supplied to the cylinders by continuing supply of a very little amount of the fuel to the float chamber. It is probable that this was repeated. Due to this, it is probable that the strength of the vibrations generated in association with the reduced engine power was periodic.

As described above, it is probable that there occurred the faulty motion of the float inside the carburetor that impeded the appropriate fuel supply from the carburetor, caused the engine malfunction and led to the continuous loss of the engine power.

(4) Float sinking

It is verified that the abnormal float sank after the occurrence of the event. From such a fierce landing of the aircraft as one that was accompanied by damage to the airframe, it is likely that the abnormal float moved downward at landing and stuck again.

From the engine malfunction that was restored after the aircraft had landed and come to a halt, it is probable that, even in the case that one of the two floats in the carburetor sank, the fuel could be adjusted by the other float and the engine normally operated.

(5) Engine maintenance

The JTSB concludes that the white substance adhered to the abnormal float is probable to have been the adhesive that was used in an attempt to solve imbalance of float sinking. When a malfunction such as abnormal imbalance of float sinking is detected during carburetor inspection, the repair method of which is not stipulated in maintenance manual, it is important for ensuring the safety of flight to replace with serviceable parts in good quality or inquire manufacturers and follow their instructions for repair work not using repair methods based on own judgement.

4. PROBABLE CAUSES

The JTSB concludes that the probable cause of this serious incident was that the engine malfunction occurred during takeoff due to the failure in appropriate supply of the fuel from the left carburetor of the engine that led to continuous loss of the engine power.

From the deformed insert of the float inside the carburetor, the failure in appropriate supply of the fuel from the left carburetor is likely to have been caused by the faulty motion of the float.