AA2014-4

AIRCRAFT ACCIDENT
INVESTIGATION REPORT

PRIVATELY OWNED

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July 25, 2014

JTSB 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 determine the causes of an accident and damage incidental to such an accident, thereby preventing future accidents and reducing damage. It is not the purpose of the investigation to apportion blame or liability.

Norihiro Goto
Chairman,
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.

AIRCRAFT ACCIDENT INVESTIGATION REPORT

DAMAGE TO AIRCRAFT DURING EMERGENCY LANDING
PRIVATELY OWNED
FUJI HEAVY INDUSTRIES FA-200-160, JA3492
OSAKI, YACHIYO CITY, CHIBA PREFECTURE, JAPAN
AT ABOUT 14:25 JST, SEPTEMBER 23, 2013

June 13, 2014
Adopted by the Japan Transport Safety Board

Chairman	Norihiro Goto
Member	Shinsuke Endoh
Member	Toshiyuki Ishikawa
Member	Sadao Tamura
Member	Yuki Shuto
Member	Keiji Tanaka

1 PROCESS AND PROGRESS OF THE INVESTIGATION

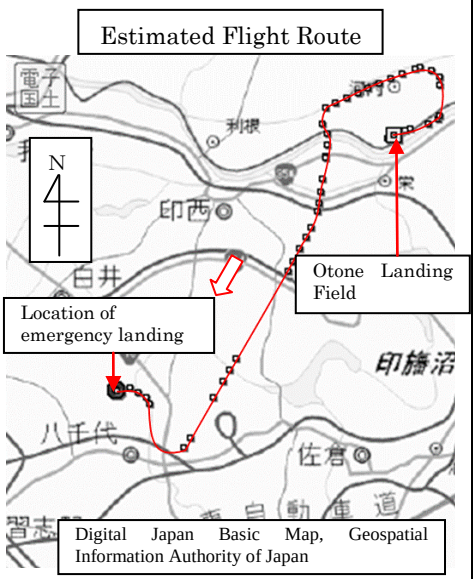
On September 23, 2013, the Japan Transport Safety Board designated an investigator-in-charge and one investigator to investigate this accident.

Comments were invited from the parties relevant to the cause of the accident.

2 FACTUAL INFORMATION

2.1 History of the Flight

According to the statements of the captain, the passengers, and the witnesses, and GPS data recorded in the mobile phone, the history of the flight up to the time of the accident is summarized below.



At 14:15 Japan Standard Time (JST, UTC+9hrs), Monday, September 23, 2013, a privately owned Fuji Heavy Industries FA-200-160, registered JA3492, took off on a sightseeing flight from Otone Landing Field located in Inashiki County, Ibaraki Prefecture, with pilot A, the captain, in the left front seat, pilot B in the right front seat, and two passengers in the rear seats. Pilot A left take off to pilot B and took control afterwards. During the flight over Yachiyo City, Chiba Prefecture en route to Makuhari, Chiba City, Chiba Prefecture, at an altitude of 1,500ft, the aircraft engine began to

malfunction. Pilot A turned the aircraft to the right in a northwesterly direction, away from a residential area and in the direction of a large rural area. Pilot A attempted to rectify the engine problem using the fuel carburetor heater, the electrically assisted fuel pump and throttle, but conditions did not improve. Pilot B remembered that the engine stopped upon completing the right turn.

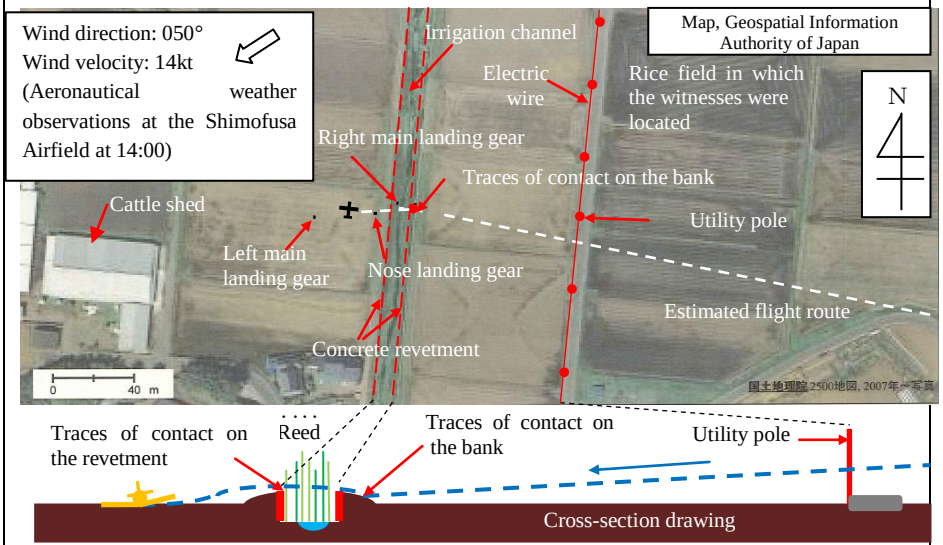
The aircraft made an emergency landing in a harvested rice field in Osaki, Yachiyo City, Chiba Prefecture at around 14:25 after following the estimated flight route illustrated in the figure below. During the emergency landing, one of wheels was seen to break off and hit to the vertical stabilizer on the tail of the aircraft.

The accident occurred during the third flight by the aircraft that day taking off from and landing at Otone Landing Field.

The first flight was one hour and 25 minutes in length, included touch-and-goes and aerobatic maneuvers, with pilot B in the left seat as captain and another pilot in the right seat.

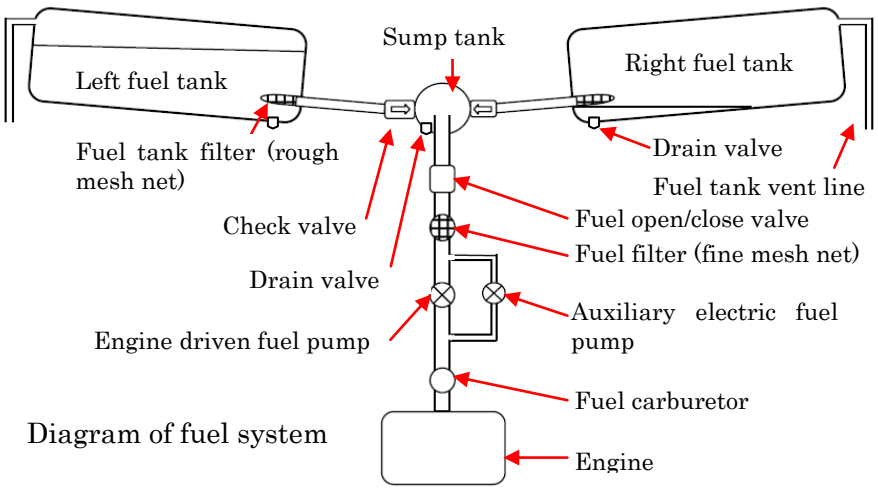
The second flight was a familiarization flight approximately 15 minutes in length by also captained by pilot B for pilot A, who was flying this type of aircraft for the first time, with two passengers in the same seats as at the time of the accident. Pilot B handled takeoff and landing while pilot A controlled the aircraft mid-flight. No malfunctions occurred during the first or second flights.

For the third flight, in which the accident occurred, the aircraft took off after reporting the flight plan, making pilot A captain, to an aeronautical information officer at the Hyakuri Airport Office by mobile phone without stopping the engine after the second landing.

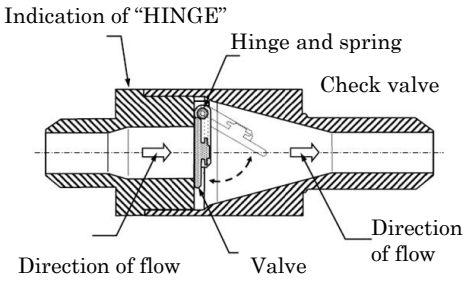


2.2 Injuries to Persons	One person sustained a minor bruise on the nose.
2.3 Damage	Extent of damage: Substantial ・The nose landing gear and right and left main landing gear broke off.

	・The right and left wing flaps were deformed. ・The fuselage skin cracked. ・The front of the vertical stabilizer was bent to the right. ・One of the two propeller blades was bent rearwards.
2.4 Personnel Information	(1) Pilot A Male, Age 47 Private pilot certificate (Airplane) Type rating for Single-engine Land March 1, 2004 Class 2 aviation medical certificate Validity: October 29, 2014 Total flight time 350 hours 39 minutes Total flight time on the type of aircraft 0 hours 00 minutes (2) Pilot B Male, Age 58 Private pilot certificate (Airplane) Type rating for Single-engine Land January 25, 2012 Class 2 aviation medical certificate Validity: February 14, 2014 Total flight time 177 hours 48 minutes Total flight time on the type of aircraft 89 hours 51 minutes
2.5 Airplane Information	Aircraft type: Fuji Heavy Industries FA-200-160 Serial number: FA-200-60 Date of manufacture: September 29, 1969 Certificate of airworthiness No. Dai-2012-391 Validity: October 21, 2013 Category of airworthiness Airplane, Normal, Utility or Acrobatic Total flight time 10,672 hours 47 minutes Flight time since the last periodical check (50hrs check on May 19, 2013) 30 hours 17 minutes
2.6 Meteorological Information	Aeronautical weather observations as of 14:00 at the Shimofusa Airfield, located about nine km northwest of the site of the accident, were as follows: Wind direction 050°; Wind velocity 14 kt; Prevailing visibility: 10 km or more Clouds: Amount 2/8, Type: Stratus, Cloud base: 2,500ft Amount 5/8, Type Stratocumulus, Cloud base: 4,500ft Temperature 24°C; Dew point 15°C Altimeter setting (QNH) 30.09 inHg
2.7 Fuel Supply	According to pilot B, who conducted a visual check of the fuel supply before and after the first flight, the onboard fuel supply before the flight was 70-80% (about 70-80 ℓ) in the left fuel tank and 40-50% (about 40-50 ℓ) in the right fuel tank. After the flight, the onboard fuel supply in the right fuel tank was reduced to about 30% (about 30 ℓ), while the fuel supply in the left fuel tank remained at about 70% (about 70 ℓ). Therefore, pilot B consulted with other pilots and a mechanic on another aircraft who were in the vicinity, and confirmed that the left tank vent line was not clogged using compressed air. Although pilot B had intended to refuel the aircraft after checking the remaining fuel quantity, after consulting with other pilots, he did

	not refuel it because he judged the fuel imbalance to be a temporary and a routine phenomenon shortly after a flight, considering the aircraft's tendency to consume fuel from the tanks asymmetrically, the weight increase due to the additional two passengers on the next flight, and the adequacy of the remaining fuel for a one-hour flight. Pilot B had flown the aircraft for about 60-70 hours in 2013, and he stated that the phenomenon in which little fuel remained in the right tank and much more remained in the left tank had been checked repeatedly and was a feature of the aircraft. After the emergency landing, pilot B conducted a visual check of the fuel supply, and remembers that the right fuel tank was empty while the left fuel tank remained at the pre-flight level. Pilot B stated that the fuel consumption rate of the aircraft was about 34 ℓ (nine gal) per hour. Pilot A remembered that the right tank fuel level gauge indicated nearly zero and that the left fuel level gauge indicated about 70-80% before the second flight, and felt that this was strange. However, he trusted pilot B's greater familiarity with the aircraft and did not cancel the flight.
2.8 Fuel Supply Confirmation Method	Pilot B and the other pilots stated that the fuel level gauges were not very accurate and that there were swings in the indicator needles, and that as a result they tended not to place much trust in the indications of the fuel level gauges. The aircraft fight manual includes a "visual confimation of fuel level" among the preflight check items. Therefore, the pilots had conducted a visual confirmation of the fuel supply during the preflight check. The proper functioning of the fuel level gauge is tested every 50 flight hours. The aircraft had a 50 hour check about four months before the accident, and the fuel level gauge was tested at that time as well.
2.9 Fuel System	 Diagram of fuel system - Aircraft fuel is drawn from the right and left fuel tanks to the sump tank via the respective fuel tank filters (rough mesh nets) and check valves, and is then supplied to the engine via the fuel open-close valve, the fuel filter (fine mesh net), fuel pump, and fuel

	carburetor. There was no trace of fuel leakage in this system. - The capacity of the each fuel tank is about 98 ℓ (26 gal), respectively. - The capacity of the sump tank is about two ℓ (0.54 gal). - The amount of fuel remaining in the right fuel tank was 0.146 ℓ (0.0386 gal). - The amount of fuel remaining in the left fuel tank and sump tank were about 75 ℓ (20 gal) in total. - No fuel remained in the fuel carburetor. - There was no clogging in any of the fuel tank filters, fuel filters, or fuel tank vent lines. - Each of four engine cylinders has two ignition plugs, at its top and bottom. The ignition plug at the bottom of the second cylinder was wet with oil, but the other seven plugs only showed traces of normal combustion. - Maintenance for the aircraft was as follows: maintenance was entrusted to specific mechanics only at scheduled maintenance times and upon inspection for renewal of the airworthiness certificate. Daily maintenance did not include the engagement of specific mechanics or maintenance companies, and no mechanics familiar with the condition of the aircraft were available. - The aircraft had a tendency to consume fuel from the right and left fuel tanks asymmetrically. - The check valves to the right and left of the sump tank were not mounted with the hinge positions up in accordance with the manual, and had moved down from the hinges under their own weight, but were not fixed in position. In addition, there were post-mounting slippage marks on the check valves different from the marks from the time of manufacture. - Although foreign substances were not discovered when extracting the remaining fuel from the sump tank via the drain valve, a large amount of mud and foreign substances, such as dust, were extracted from the interior of the sump tank when it was cleaned after removal from the airframe.  Discovered foreign substances
2.10 Adjustment Time of Asymmetrical Fuel Consumption	According to the service notice entitled, "Adjustment for balanced fuel flow from right and left fuel tanks," published by the designer and manufacturer of the aircraft on January 26, 1970, asymmetrical consumption of the fuel should be adjusted when the right and left fuel guages indicate a difference greater than 1/4 of a tank, and when the difference in the levels of fuel remaining in the right and left fuel tanks is greater than 50 mm. The notice also states that the indication difference between the right and left fuel

	level gauges should not exceed 1/2 of a tank in any flight.
2.11 Inspection of Check Valve	The designer and manufacturer of the aircraft conducted the following functional inspections of the check valve. (1) Pressure drop inspection During the pressure drop inspection, which injects a certain volume of fuel into the inside of a check valve, the left check valve had a larger pressure drop and opened less than the right check valve.  Moreover, the left check valve did not satisfy operating standards established for the time of shipment during the pressure drop inspection. (2) Functional inspection of the closing mechanism In the functional inspection of the closing of the valve due to the difference in static pressure in front of and behind the check valve, the closing force of the left check valve was weaker than that of the right check valve. The left check valve, in particular, could not fully close because of the incorrect angle at which it had been mounted at the time of the accident, resulting in no pressure difference. (3) Effects of the mounting angles The check valves were not mounted with the hinge positions up in accordance with the manual. The "HINGE" indications were at angles of 93.6° and 104.0°on the center axis of the pipe for the left and right valves, respectively. As a result of the above inspections conducted at each angle, it was discovered that valves were difficult to open and close. However, the valves did not become stuck during the functional inspections.

3. ANALYSIS

3.1 Involvement of Weather	None
3.2 Involvement of Pilots	Yes
3.3 Involvement of Airplane	Yes
3.4 Analysis of Findings	(1) Reasons for engine stop It is highly probable that the aircraft engine stopped due to an interruption of the fuel supply, considering that there was no remaining fuel in the fuel carburetor. In addition, it is highly probable that the fuel supply between the left fuel tank and the

sump tank had been interrupted because the right fuel tank was almost empty whereas the left fuel tank remained at the pre-flight level. A fuel tank filter and a drain valve are mounted on each pipe between each fuel tank and the sump tank. Since foreign substances which could cause obstructions were not discovered in the left fuel filter or the left pipe, it is probable that the left check valve stuck in the closed position, interrupting the fuel flow. It is probable that the left check valve became stuck in the closed position since the first flight of the day of the accident, because the amount of fuel in the left fuel tank did not change during the first flight. It is possible that the left check valve became stuck in the closed position both because it failed to satisfy the pressure drop standards due to age-related degradation of the left check valve and because of the presence of foreign substances, but this could not be determined.

As for the fuel remaining in the sump tank at the time of the aircraft examination, it is probable that the left check valve was released by the impact of the emergency landing, permitting fuel to flow from the left fuel tank.

(2) Effects of the mounting angles of the check valves

Although the right and left check valves were not mounted in accordance with the manual, it is probable that the mounting positions were not involved in the obstruction of the fuel supply because they resulted in weaker closing force in the valves compared with their original positions. Moreover, the slippage marks on the right and left check valves were different from those at the time of manufacture, therefore, it is probable that the valves had been removed and re-installed after manufacturing.

(3) Asymmetrical fuel consumption

The fuel supply was found to be 70-80% in the left fuel tank and 40-50% in the right fuel tank during the pre-flight check nearly exceeding the 1/4 tank asymmetrical fuel consumption triggering the need for adjustment under the service notice. Moreover, after the first flight, it was confirmed that the difference in indications between the right and the left fuel level gauges was almost 1/2 of a tank, which should not be exceeded in any flight, with 70% in the left fuel tank and 30% in the right fuel tank. Therefore, it is highly probable that the flight should have been cancelled and troubleshooting should have been performed at this time.

Estimating the fuel consumption rate from pilot B's statements and a total flight time of about two hours for the three flights, it is highly probable that a total of approximately 70 ℓ of fuel was consumed during the three flights on the day of the accident. In addition, pilot B remembered that the fuel level in the

	left fuel tank remained unchanged before the flight and after the emergency landing, and therefore it is probable that the asymmetrical fuel consumption increased markedly after the 1 hour and 25 minutes first flight. (4) Reasons for flight with asymmetrical fuel consumption It is probable that the aircraft had a pre-existing tendency to asymmetrical fuel consumption, and this condition was left unresolved. Although extremely asymmetrical fuel consumption existed after the first flight on the day of the accident, which included aerobatic maneuvers, it is somewhat likely that the decision to fly was made due to incorrect interpretation of this condition as a temporary and ordinary phenomenon. (5) Determination regarding fuel supply interruption It is probable that the existence of a fuel supply interruption from the left fuel tank of the aircraft could have been ascertained with knowledge of the fuel system structure based on a visual confirmation of the actual fuel levels in the tanks before and after the first flight and the fuel level gauges. (6) Technical documents issued by the designer and manufacturer The designer and manufacturer described adjustments to balance fuel flow from right and left fuel tanks in the service manual and service notice. Although it is probable that the aircraft should have received appropriate maintenance in line with these documents, it is somewhat likely that the owner and pilots of the aircraft did not understand their contents. Therefore, it is desirable that the designer and manufacturer of the same type of aircraft with the same fuel system remind owners and pilots of the contents of these documents.

4. PROBABLE CAUSES

It is highly probable that this accident occurred due to the check valve mounted between the left fuel tank and the sump tank of the aircraft becoming stuck in the closed position, resulting in the consumption of fuel only from the right fuel tank, leading to an engine stop due to interruption of the fuel supply by depletion of the fuel in the right fuel tank, compelling the making of the emergency landing, and resulting in damage to the aircraft during said emergency landing.

It is somewhat likely that the left check valve became stuck in the closed position due to both age-related degradation of the left check valve and the presence of foreign substances, but this could not be determined.

It is somewhat likely that misinterpretation of the asymmetrical consumption of the fuel during the preflight check as a temporary and ordinary phenomenon contributed to the accident.