AA2019-2

AIRCRAFT ACCIDENT INVESTIGATION REPORT

PRIVATELY OWNED
G - B Y L P

March 28, 2019

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.

Kazuhiro Nakahashi
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

AIRCRAFT DAMAGE DURING FORCED LANDING
YANO TOWN, AIOI CITY, HYOGO PREFECTURE, JAPAN
AT AROUND 15:52 JST, JULY 11, 2017

PRIVATELY OWNED, HALES CS RAND KR-2
(AMATEUR-BUILT AIRCRAFT, TWO-SEATS)
G-BYLP (BRITISH REGISTRY)

February 22, 2019

Adopted by the Japan Transport Safety Board

1. PROCESS AND PROGRESS OF THE INVESTIGATION

1.1 Summary of the Accident	On Tuesday, July 11, 2017, a privately owned amateur-built aircraft (two-seats) HALES CS RAND KR-2, registered G-BYLP, suffered damage to the aircraft during the forced landing on the golf course in Yano Town, Aioi City, Hyogo Prefecture.
1.2 Outline of the Accident Investigation	On July 11, 2017, upon receipt of the report of the accident occurrence, the Japan Transport Safety Board (JTSB) designated an investigator-in-charge and an investigator to investigate this accident. An accredited representative of the United Kingdom, as the State of Registry of the aircraft involved in the accident participated in the investigation. Although this accident was notified to the United Kingdom as the State of Registry, and Australia as the State of Aero Engine Design and Manufacture of the aircraft involved in this accident, these States did not designate its accredited representatives. Comments were invited from parties relevant to the cause of the accident and the Relevant States.

2. FACTUAL INFORMATION

2.1 History of the Flight	According to the statement of the pilot (hereinafter referred to as “the Pilot”) as well as the records of a portable GPS receiver that the Pilot brought into the aircraft (hereinafter referred to as “the Aircraft”), the history of the flight up to the accident is summarized below.

On July 11, 2017, a privately owned amateur-built aircraft HALES CS RAND KR-2, registered G-BYLP, took off from Niigata Airport for Kounan Airfield on the next stage of around-the-world flight*1 with only the Pilot onboard.

The Aircraft was refueled at Niigata Airport before departure and the Pilot confirmed the tank was full supplied by looking through the fill opening. The Pilot conducted pre-flight check and judged that it was possible to depart as there was neither abnormality with the Aircraft, nor problem in the weather.

The flight plan of the Aircraft is summarized as follows:

Flight rules : Visual flight rules (VFR)

Departure aerodrome: Niigata Airport

Estimated off-block time: 12 : 30

Cruising speed: 110 kt

Destination aerodrome: Kounan Airfield

Total estimated elapsed time: 3 hours 30 minutes

Fuel load expressed in endurance : 5 hours

Persons on board : 1

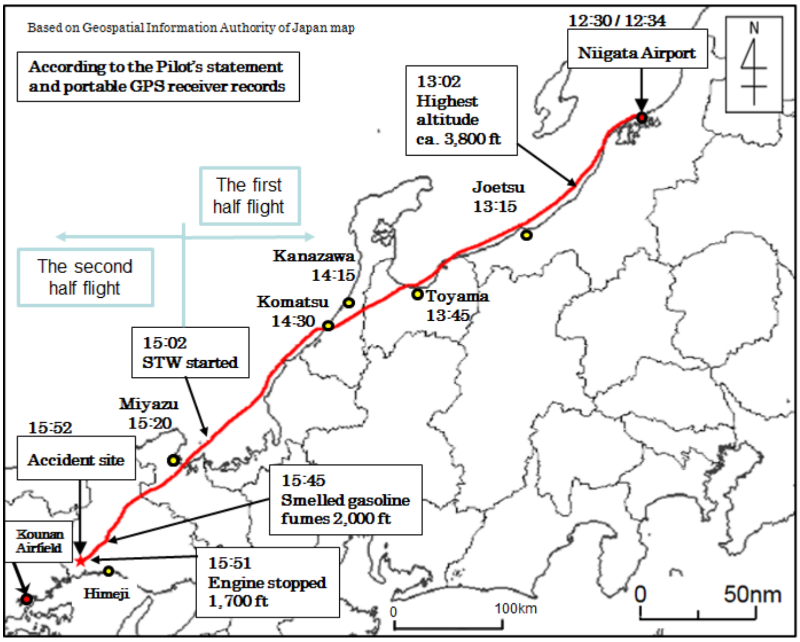

Figure 1: Estimated flight route

The Aircraft started the engine at around 12:30 Japan Standard Time (JST, UTC+9 hours, unless otherwise stated all times are indicated in JST on a 24-hour clock) and took off from Niigata Airport at around 12:34. It was planned to climb to a cruising altitude of about 5,000 ft while flying south along the coast line. With a headwind of 15 kt and low clouds, the Aircraft climbed to an altitude of about 3,800 ft at around 13:02, but after that, the Aircraft was flying between at an altitude of about 3,000 and 1,700 ft under the clouds while repeatedly climbing and descending.

*1 During the around-the-world flight, the Aircraft was flying into Japan (Niigata Airport) via Russia and continued a series of flights.

	According to the Pilot, the fuel quantity gauge of the Aircraft [hereinafter referred to as "the Fuel Gauge", described later in 2.8 (1)] was a liquid-level gauge that directly reads the fuel level position on the Fuel Gauge and stops indicating the remaining fuel quantity when the Fuel Gauge reads less than 7 gal (UK) (imperial gallon: 1 gal (UK) = 4.546 ℓ), the minimum indicated value. After that, the Pilot measured the time using a stopwatch (STW) to calculate the remaining flight time at the fuel consumption rate [described later in 2.8 (4)] that was based on his past flight experience. At around 15:02, the Pilot confirmed the fuel gauge read 8.5 gal (UK) and started to measure flight time with STW in accordance with his normal procedure, assuming that the flight time estimated from the remaining fuel would be about 2 hours. (Hereinafter, the flight up to the time of measurement is referred to as "the first half flight" and the flight thereafter is referred to as "the latter half flight.") At around 15:45, there was a sudden smell of gasoline fumes, and at around 15:50, the engine malfunctioned, but the Pilot turned the carburetor heat and the electric auxiliary fuel pump ON, and the engine recovered. With the engine recovered, the Pilot turned the carburetor heat OFF and continued the flight. The aircraft was flying over a golf course taking into account the potential for engine failure, but suddenly the engine malfunctioned again, and at around 15:51, the engine stopped completely. At that time, the remaining fuel was not indicated on the Fuel Gauge, but the Pilot assumed that there would be the remaining fuel enough to fly for about one hour and 10 minutes, estimating from the time measured by STW. After the engine stopped, the Pilot confirmed from the sky that there were no people on the ground and decided to land on the golf course. After landing, the Aircraft repeatedly bounced, lowered the nose, and stopped by hitting its fuselage on the stepped slope with a height of about 2 m in the golf course. The Pilot evacuated from the Aircraft, but returned to the Aircraft judging that there would be no risk of fire, and turned off the master switch. The fuselage was broken at its central part, both wings were fractured from the root, and parts and accessories were scattered around the Aircraft. This accident occurred at around 15:52 on Tuesday, July 11, 2017, in the golf course in Yano Town, Aioi City, Hyogo Prefecture (34° 51' 17" N, 134° 26' 29" E).
2.2 Injuries to Persons	The Pilot was seriously injured.
2.3 Damage to Aircraft	Extent of damage: Destroyed • Fuselage: Broken • Both wings: Fractured  Photo 1: The Aircraft
2.4 Personnel	(1) Pilot Male, Age 47

Information

Commercial pilot certificate (Airplane)
Issued by the U.K. Civil Aviation Authority (CAA) February 10, 2015
Aviation Medical Certificate
EUROPEAN UNION Class 2 issued
by the U.K. Civil Aviation Authority (CAA)
Validity: May 9, 2018
Total flight time ca. 1,400 hours
Flight time on the same type of aircraft ca. 750 hours

2.5 Aircraft Information

(1) Type: HALES CS RAND KR-2 (Amateur-built aircraft, two-seats)
Total flight time: 297 hours 10 minutes
Date of manufacture: April 14, 2014

(2) Engine type: JABIRU 2200A (Made in Australia)
Total time in service: 54 hours 46 minutes; Serial number: 22A-3587

(3) The weight of the Aircraft and its center of the gravity are estimated to have been within the allowable range at the time of the accident.

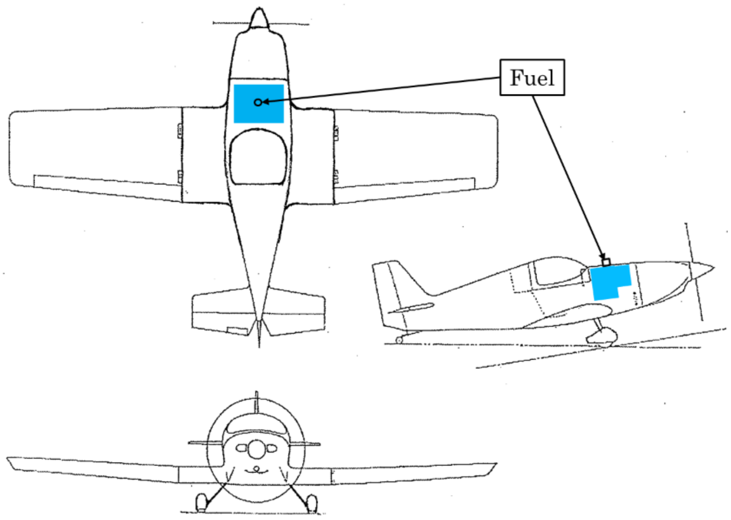

Figure 2: Three angle views and fuel loading position

2.6 Meteorological Information

(1) According to records at the Miyazu Meteorological Office and the Himeji Meteorological Office, the weather conditions were as follows (the wind velocity was converted from m/s into kt):

Meteorological Offices	Time	Temperature ℃	Wind direction	Wind velocity kt
Miyazu	15:00	34.8	South	2.0
Himeji	15:30	30.7	South	3.3

(2) The general weather outlook (July 11, 2017) issued by the Japan Meteorological Agency was as follows:

The seasonal rain front makes its way northward to the Sea of Japan, and it will be almost sunny during the day in the regions from Kinki to Tohoku. At 60 locations in the regions from Sanin to Hokuriku where the foehn phenomenon has been accompanied with the rain front, and over the Tohoku region where warm air has entered into, it is expected to be extremely hot. In Toyama, the maximum hot temperature will be at 37.3 ℃.

2.7 Permission under the Civil Aeronautics Act

Pursuant to the provisions in the proviso in paragraph 1, Article 11 (Test flight etc.), in paragraph 3, Article 28 (Out of scope of service), and in the proviso, Article 127 (Use of foreign aircraft within Japan) of the Civil Aeronautics Act (Article 231 of the Ministerial Ordinance issued in 1952), the permission required for this flight was obtained.

2.8 Additional Information

(1) Fuel tank and the Fuel Gauge

The fuel tank of the Aircraft is equipped between the fire wall in the aft part of engine compartment and the cockpit instrument panel. The fuel tank is an integrated aluminum box with no internal partition and the capacity of its bottom part is smaller than that of the upper part.

The Fuel Gauge is a liquid-level gauge that reads the fuel level position directly on a translucent vertical pipe. As the capacity of its bottom part is smaller than that of the upper part, the scale of the Fuel Gauge is unevenly spaced. Because the Aircraft is a tailwheel type airplane, the Fuel Gauge indication varies depending on the inclination of the tank, thus its indication is different between in a level flight state and in parking on the ground. From the maximum load capacity of 19 gal (UK) to the minimum indicated value of 7 gal (UK) are indicated by the scale for the level flight state, but the remaining fuel quantity will not be indicated, if the Fuel Gauge reads less than 7 gal (UK). From the maximum indicated value of 13 gal (UK) to the minimum indicated value of 4 gal (UK) are indicated by the scale for the parking state (pitch angle: about 20 degrees), but the remaining fuel quantity will not be indicated, if the Fuel Gauge reads more than the maximum indicated value of 13 gal (UK).

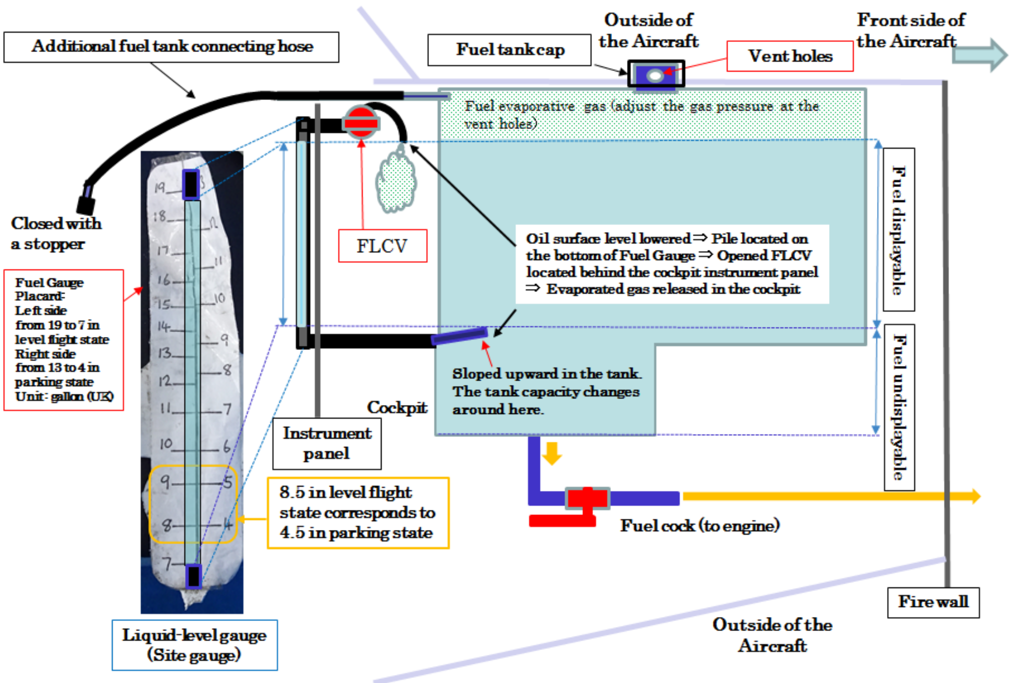

Figure 3: Fuel tank and the Fuel Gauge diagram

The fuel is supplied to the engine from the fuel cock on the bottom of the tank. There are two tank vent holes that are opened along the fill opening on the upper part of the fuel tank. The lower part of the Fuel Gauge is connected

	via a hose to the pipe on the bottom of the fuel tank. The upper part of the Fuel Gauge is connected to the hose behind the cockpit instrument panel, and to a fuel leakage check valve (hereinafter referred to as the "FLCV"). The FLCV is closed to prevent fuel leaking, when fuel is supplied, but during flight, the FLCV is opened to activate the Fuel Gauge. In addition, on the upper part of the fuel tank, there was a hose for connecting the additional fuel tank, but the stopper was shut down because it was not used. (2) Quantity of fuel loading and the Fuel Gauge calibration According to the Pilot, the fuel consumption rate was approximately 4 Gal (UK) / h with the fuel tank was full approximately 19 Gal (UK) at the time of flight planning, and the fuel load expressed in endurance would be approximately 5 hours. The Pilot refueled 80 ℓ of fuel at Niigata Airport and confirmed it was full supplied by looking at the fill opening before the flight. According to the Pilot, before measuring the flight time with STW during flight, he was confirming the fuel consumption rate by looking at the Fuel Gauge. While putting fuel into the fuel tank, the Pilot wrote down the scale of the Fuel Gauge for a level flight state and a parking state, respectively. With regard to the influence of the aircraft attitude during flight that would have on the indicated value of the Fuel Gauge, there was no problem in the past flights, since it was possible to know the fuel quantity by taking the average value of fluctuating fuel level positions in case of the pitch angle within five degrees during flight, even if the fuel level fluctuated. (3) Fuel system investigation On arrival at the accident site, although the Aircraft was destroyed, there was no major damage to the fuel tank and fuel system. The Fuel Gauge was detached. There was no remaining fuel in the fuel tank, no trace of fuel leakage nor a smell of gasoline fumes around the fuselage. There was no trace of fuel leakage in and around the fuel system. During the component investigation no fuel was collected from around the fuel system, except for a slight amount of unusable fuel in the carburetor bowl, in addition, when the fuel tank was actually filled with water, and the electric auxiliary fuel pump was pressurized to check for leakage in the fuel filter, the electric auxiliary fuel pump, the fuel pump, the carburetor and the hoses that connect them, the leakage was not confirmed The Fuel Gauge was detached, but as water was poured into the vacant tank placed horizontally, and when the fuel level reached from the minimum indicated value of 7 gal (UK) (about 32 ℓ) to further to approximately 5 gal (UK) (about 24 ℓ), water came out from the broken pipe at the bottom part of the damaged Fuel Gauge. From this fact, it was confirmed that the pipe was tilted upward in the tank at the bottom of the Fuel Gauge. (See Figure 3.) On the tank, there was a handwritten description of "19 GALLONS. 86 LITRES", and the maximum capacity of the fuel tank was also about 86 ℓ as a result of the investigation. (4) Fuel consumption rate As described in 2.8 (2), the Pilot was flying in assuming that the fuel

consumption rate of the Aircraft would be 4 gal (UK)/h (18.18 ℓ/h) to 20 ℓ/h.

According to the Pilot, the fuel consumption rate of the Aircraft was approximately 20 ℓ/h during the first half flight. At 15:02, the Pilot confirmed the remaining fuel quantity to be 8.5 gal (UK); when converting the remaining fuel quantity of 8.5 gal (UK) into approximately 38.6 ℓ and considering that the engine stopped after about 50 minutes and the remaining fuel quantity was 0 ℓ, the simple mean average of the fuel consumption rate during the latter half flight was calculated to be 46.5 ℓ/h,

Figure 4 shows the estimated fuel quantity, the ground speed and the GPS altitude based on the records of a portable GPS receiver.

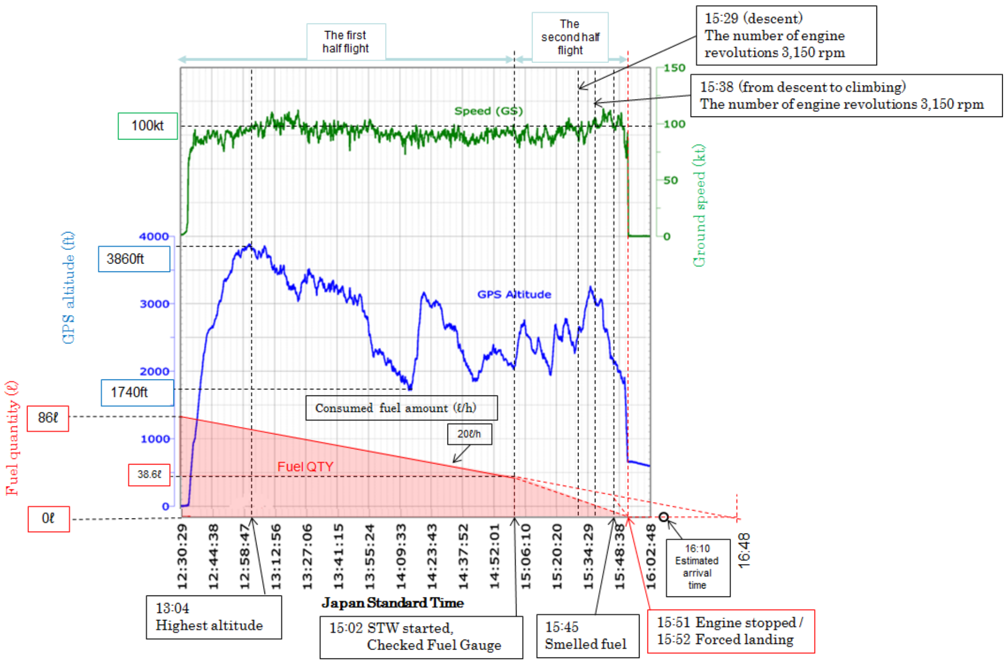

Figure 4: Estimated fuel quantity, ground speed and GPS altitude

According to the Pilot, as for the number of engine revolutions per minute during flight, he used as the targets the following values, such as about 3,100 rpm for take-off, from 2,850 to 2,950 rpm for cruising time, and from 2,950 to 3,050 rpm for descent.

The Pilot's smartphone recorded the sound and scenes where at around 15:29 the Aircraft was descending at an airspeed of 110 kt and at around 15:38 it was climbing after descending at an airspeed of 120 kt, showing that the Aircraft was flying under clouds along the ridge in the mountains while changing its attitude and altitude little by little. As a result of analyzing the video and sound, the number of engine revolutions per minute was almost constant at about 3,150 rpm while it was recorded.

(5) Fuel

The fuel used for the Aircraft was Aviation Gasoline AVGAS 100 LL.

3. ANALYSIS

3.1 Involvement of Weather	None
3.2 Involvement of Pilot	Yes
3.3 Involvement of Aircraft	Yes
3.4 Analysis of Findings	(1) Fuel tank and the Fuel Gauge It is highly probable that the Pilot did not realize that the remaining fuel was exhausted rapidly after it was less than 7 gal (UK) because the Fuel Gauge stops indicating the remaining fuel quantity when it reads less than the minimum indicated value of 7 gal (UK) during flight, in addition, the Aircraft was not equipped with the fuel gauge capable of indicating the reduced amount of fuel up to the fuel exhaustion. It is probable that the fuel tank had such a structure as to cause an error between the fuel level in the tank and the indication of the Fuel Gauge when the fuel quantity was reduced close to 7 gal (UK), because the fuel tank is an integrated aluminum box with no internal partition and the pipe at the bottom of the Fuel Gauge was tilted upward in the tank. (2) Fuel consumption rate It is highly probable that during the flight plan, the Pilot judged that the fuel consumption rate was around 4 gal (UK)/h (18.18 ℓ/h) to 20 ℓ/h based on the average fuel consumption rate estimated from his past flight experience. It is probable that the fuel consumption rate during the first half flight was approximately 20 ℓ/h, because the Pilot was checking the remaining fuel quantity with the Fuel Gauge. According to the statement of the Pilot and the records of a portable GPS receiver, the Aircraft was repeatedly climbing and descending at an average ground speed of about 100 kt in strong headwind after climbing; and from the analysis of Pilot's smartphone video images, the number of engine revolutions per minute in both of climbing and descending was almost constant at a speed of 3,150 rpm, and the Aircraft continued flying in a higher power status than the target values (2,850 to 2,950 rpm at cruising and 2,950 to 3,050 at descending) that the Pilot used; and therefore, it is somewhat likely that the fuel consumption rate during the latter half flight was higher than what the Pilot was thinking. (3) Rapid decrease in fuel during the latter half flight Judging from the fact that there was no remaining fuel in the fuel tank, no trace of fuel leakage nor a smell of gasoline fumes, when the Aircraft made a forced landing and was destroyed, it is probable that the amount of fuel equivalent to 20 ℓ was rapidly reduced during the five minutes from around15:45 when gasoline fumes were smelled to the timing when the engine stopped, or during the latter half flight; and it is somewhat likely that this might be caused by a significant fuel leakage. However, as described in 2.8 (3), it was impossible to identify the location and cause of the fuel leakage, since

	no trace of fuel leakage and fuel components in and around the fuel system were detected. (4) Situation from the engine malfunction leading up to the forced landing It is probable that after the Pilot confirmed the fuel gauge as 8.5 gal (UK) at around 15:02, the remaining fuel quantity was no longer displayed as it was less than the minimum indicated value of 7 gal (UK); however, the Pilot was measuring flight time with STW in accordance with his normal procedure; and therefore, after that, the Pilot was not able to confirm the reduction of the remaining fuel quantity with the Fuel Gauge. It is probable that at around 15:50, the engine malfunctioned, but it recovered by activating the carburetor heat and the electric auxiliary fuel pump, which caused the fuel reduction, as described in 3.4 (3); but a slight amount of remaining fuel was supplied to the engine. It is highly probable that the engine stopped because the fuel in the tank was completely exhausted soon. It is highly probable that the Pilot tried to make a forced landing on the golf course in the vicinity because the engine stopped during flight, however, the Aircraft collided with the stepped slope on the rough surface after landing, causing damage to the aircraft. (5) Measures to prevent similar accidents As the fuel consumption rate can vary depending on the operation method, weight and weather conditions, it is necessary for a pilot to accurately grasp the remaining fuel quantity during flight by keeping a careful watch on the Fuel Gauge while heeding its indication errors. In addition, on the assumption that the aircraft cannot reach the destination when the fuel consumption rate has increased more than planned, it is necessary to select an alternative aerodrome in advance.

4. PROBABLE CAUSES

It is highly probable that this accident occurred because the Aircraft collided with the stepped slope during the forced landing on the rough surface after the engine stopped due to the fuel exhaustion during flight, causing damage to the aircraft.

It is somewhat likely that the engine stopped due to the fuel exhaustion during flight, because a fuel leakage occurred. However, it was impossible to identify the location and cause of the fuel leakage.