AIRCRAFT ACCIDENT INVESTIGATION REPORT

DAMAGE TO THE AIRFRAME DURING LANDING

PRIVATELY OWNED

PIPER PA-46-350P, JA4077

SENDAI AIRPORT

AT ABOUT 11:33 JST, AUGUST 1, 2021

August 30, 2024

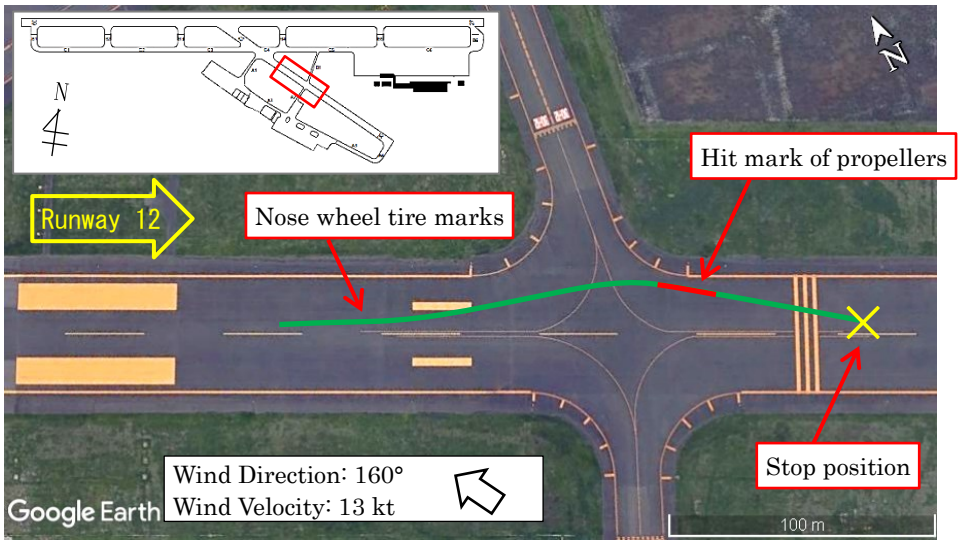
Adopted by the Japan Transport Safety Board

Chairperson TAKEDA Nobuo
Member SHIMAMURA Atsushi
Member MARUI Yuichi
Member SODA Hisako
Member NAKANISHI Miwa
Member TSUDA Hiroka

1. PROCESS AND PROGRESS OF THE AIRCRAFT ACCIDENT INVESTIGATION

1.1 Summary of the Accident	On Sunday, August 1, 2021, at about 11:33 Japan Standard Time (JST: UTC + 9 hours, all times are indicated in JST on a 24-hour clock), a privately owned Piper PA-46-350P, JA4077, sustained substantial damage when landing at Sendai Airport during the landing roll because it tilted forward with the nose down, the propellers and the lower forward fuselage contacting with the runway surface. A total of two persons on board the aircraft, including a captain and a passenger, and there were no injuries.
1.2 Outline of the Accident Investigation	On August 1, 2021, the Japan Transport Safety Board (JTSB) designated an investigator-in-charge and an investigator to investigate this accident. To analyze the fractured portion at the engine mount of the aircraft, the Japan Aerospace Exploration Agency (JAXA) had conducted the examination. Although this accident was notified to the United States of America, as the State of Design and Manufacture of the aircraft involved in this accident, the State did not designate its accredited representative. Comments on the draft Final Report were invited from the parties relevant to the cause of the accident and the Relevant State.

2. FACTUAL INFORMATION

2.1 History of the Flight	According to the statements of the captain and an air traffic controller, the history of the flight is summarized as follows: On Sunday, August 1, 2021, at 10:47, a privately owned Piper PA-46-350P, JA4077, took off from Sendai Airport for a familiarization flight with the captain in the left pilot seat and the passenger in the right pilot seat, and conducted the touch-and-go four times. At the time of landing on Runway 12 after completing the touch-and-go, the captain extended the landing gears, confirmed all the gears were down-locked, and made an approach with the flaps fully extended so as to maintain 80 to 85 kt. The wind information informed from the air traffic controller when issuing a landing clearance to the aircraft was such that the wind direction was 160° and the wind velocity was 13 kt, and thus the aircraft made an approach with a wind blowing from the right front. The aircraft did not drift with the wind, therefore, the captain flared the aircraft as usual by moving the rudder to a neutral position to have the aircraft touch down on near the runway centerline without any strong impact. At 11:33, the nose wheel touched down following the main wheel, and the aircraft largely veered off to the left after initiating the landing roll, therefore the captain applied the right rudder pedal to make a directional control. As the captain applied corrective rudder, the aircraft started veering to the right but tilted forward with the nose down immediately after veering to the right, and the tips of three propellers and the lower forward fuselage made contact with the runway surface. The aircraft progressed through inertia in a posture tilted forward and came to a stop in the middle of the runway.  Figure 1: Estimated Landing Roll Route This accident occurred at about 11:33 on August 1, 2021, on Runway 12 at Sendai Airport (38° 08' 14" N, 140° 55' 13" E).
2.2 Injuries to Persons	None
2.3 Damage to the	(1) Extent of damage: Substantially damaged

Aircraft	(2) Damage of the Aircraft Component a) Firewall: Deformed b) Engine mount: Deformed and fractured c) Nose landing gear (NLG) door and strut: Damaged d) Propeller Blade: Tips damaged (3 blades)
2.4 Personnel Information	Captain: Age 63 Private pilot certificate (Airplane) August 26, 1999 Pilot Competency Assessment Expiration date of piloting capable period: December 28, 2022 Type rating for single-engine(land) August 26, 1999 Class 2 aviation medical certificate Validity: November 17, 2021 Total flight time 247 hours 26 minutes Flight time in the last 30 days 9 hours 27 minutes Total flight time on the type of the aircraft 21 hours 16 minutes Flight time in the last 30 days 9 hours 27 minutes
2.5 Aircraft Information	Aircraft type: Piper PA-46-350P Serial number: 4622017 Date of manufacture: March 6, 1989 Certificate of airworthiness: No.DAI-2020-499 Validity: November 29, 2021 Total flight time: 1,892 hours 42 minutes Flight time since last periodical check (100-hour inspection on November 23, 2020) 31 hours 48 minutes When the accident occurred, the weight and the position of the center of gravity of the aircraft were within the allowable range.
2.6 Meteorological Information	Aviation Routine Weather Report (METAR) at the Airport 11:00 Wind direction: 150°, Wind velocity: 10 kt, Prevailing visibility: 10 km or more Clouds: Amount 1/8, Type Stratus, Cloud base 1,000 ft Clouds: Amount 6/8, Type Cumulus, Cloud base 5,000 ft Clouds: Amount 7/8, Type Altocumulus, Cloud base 8,000 ft Temperature: 28 °C, Dew point: 23 °C Altimeter setting (QNH): 29.57 inHg
2.7 Additional Information	(1) Damage to the Aircraft As the retractable NLG collapsed in the retracted direction, the aircraft tilted forward, the lower forward fuselage made contact with the runway surface, which caused the tips of three propellers to be damaged, and the NLG strut and door, and part of the skin of the lower front fuselage to be damaged and deformed.

Figure 2: The Aircraft at Time of Accident

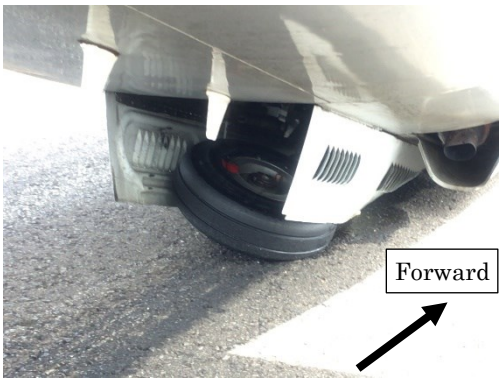


Figure 3: NLG Condition

In addition, in the forward fuselage, part of the engine mount was broken and deformed. (Figure 4 to Figure 6)

The engine mount of the aircraft is a base-like part to fix not only the engine but also the NLG strut and NLG actuator. The NLG actuator is bolted being sandwiched from the left and right sides via the actuator attachment feet, which is part of the engine mount. The engine mount of the aircraft was found deformed where the right actuator attachment foot area was fractured, only the left foot was supporting the actuator, and the tip of actuator had been found hit the firewall, deforming part of the firewall. (Attached Figure 1)

The aircraft is equipped with a retractable landing gear and its NLG is designed to be swung out from the rear to the forward using the NLG trunnion attachment installed on the engine mount as the pivot. The NLG is designed to be swung out when the actuator is extended, and down-locked when the actuator is locked with the actuator in the extended position. It was found that the aircraft's actuator was in the extended and down-locked position and hit the firewall.

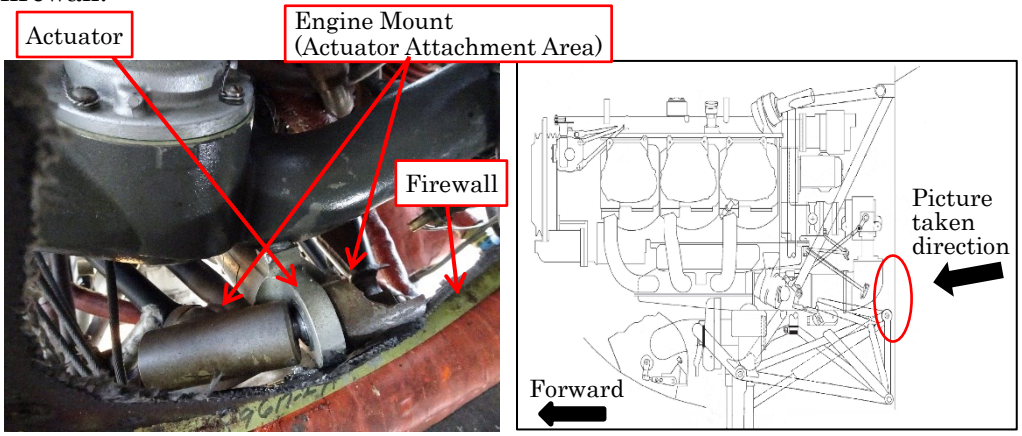


Figure 4: Actuator Attachment Area and Firewall
(See Appended Figure 1 for details)

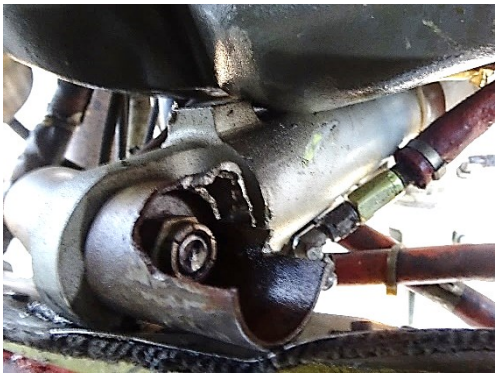


Figure 5: Fractured Portion A (Actuator Side)

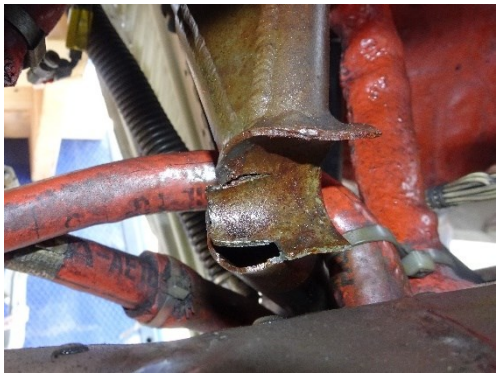


Figure 6: Fractured Portion B (Engine Mount Side)

(2) Fractures of the Right Actuator Attachment Foot

Removal and examination of the Fractured Portion A (Figure 5) revealed partial corrosion on the fracture surface and blisters *1 had occurred on the back side of the welded part.

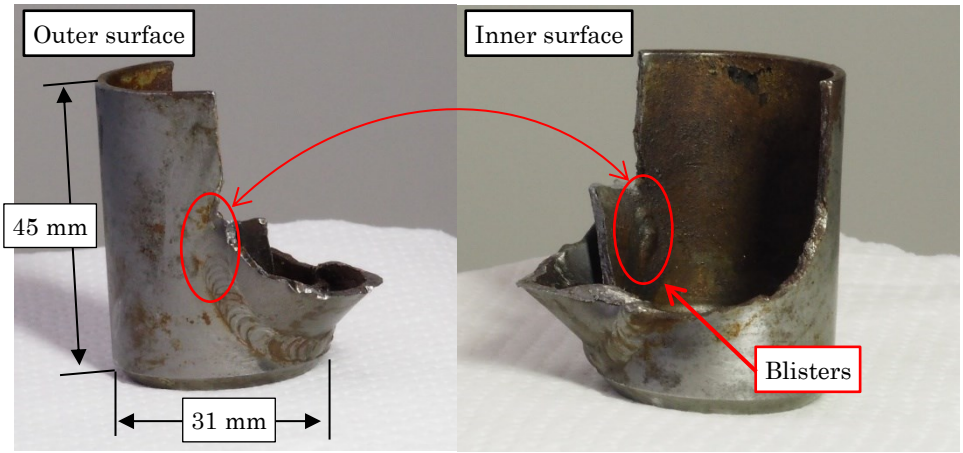


Figure 7: Blisters on Fractured Portion A

(3) Past Similar Incidents or Accidents and Responses Taken by the Design and Manufacturing Company

In the past, there had frequently occurred the incidents or accidents involving same model airplanes and its similar models that resulted from cracks and fractures in the actuator attachment areas with the same shape as in the aircraft.

In response to the failure cases, the design and manufacturing company issued Service Bulletin (SB) 1103 on April 22, 2002 (the latest version at the time of the accident was issued on September 1, 2015 as the SB 1103F), to instruct fluorescent penetrant inspection at each 100 hours time in service for the actuator attachment area. (Figure 8)

The company analyzes that the cracking in the actuator attachment foot areas usually occurs on the outer surface of cylindrical foot along the weld joining due to a one-time overload event such as a hard landing, and propagates through according to the repetitive landing cycles, slowly leading to fatigue

*1 "Blisters" refer to the formation of blister-like surface bulges, resulting from metal corrosion.

cracking and eventually to fractures. In addition, the company also express their opinion that cracking can take a long period of time from occurrence leading to fracture, during which corrosion may occur on the fractured surface of cracks where the metal surface is exposed.

The company has redesigned the actuator attachment foot and currently provides the redesigned engine mount that each attachment foot is a one-piece machined part (Figure 9). The airplanes whose engine mounts were replaced with the redesigned ones can eliminate the fluorescent penetrant inspection at each 100 hours time in service.

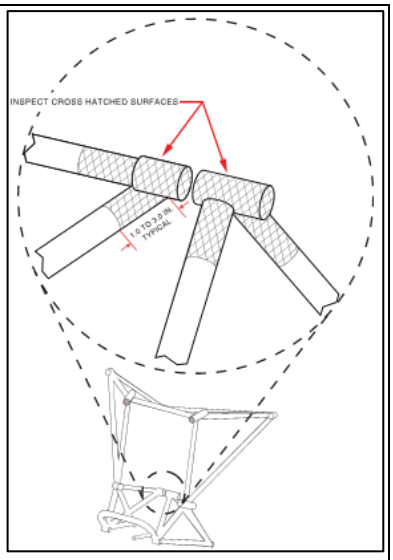


Figure 8: Fluorescent Penetrant Inspection Areas

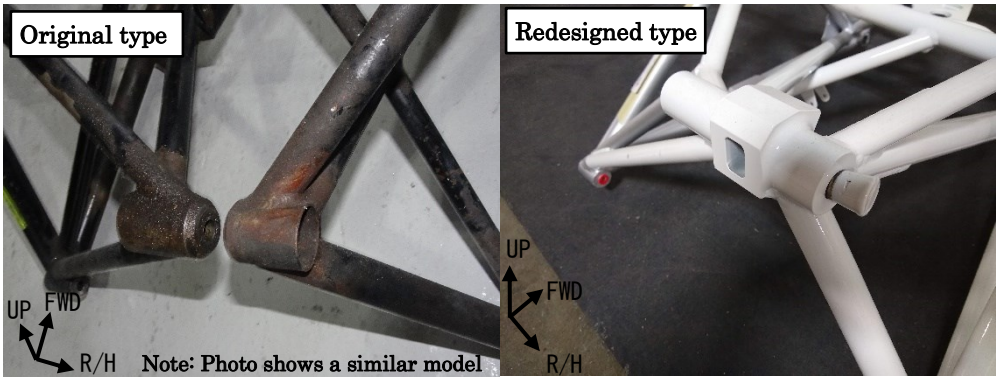


Figure 9: Configuration Comparison between Two Actuator Attachment Areas

(4) Maintenance History of the Aircraft

On November 23, 2020, the aircraft underwent a 100hr periodic inspection (equivalent to an annual inspection), including an inspection of the engine mount actuator attachment areas during the maintenance work for airworthiness certification inspection.

According to the mechanics who performed the relevant maintenance work, the visual inspection of the actuator attachment areas revealed no anomalies such as cracks, therefore they did not perform the fluorescent penetrant inspection instructed by SB 1103F.

In addition, it could not be confirmed whether anticorrosive measures were taken periodically in the past maintenance work.

(5) Custodial Conditions of the Aircraft

After the captain purchased the aircraft in November 2020, the aircraft usually parked outdoor on an apron at its homebase, Sendai Airport.

The Airport is located at an elevation of 5.6 ft (1.7 m) along the coastline facing the Pacific Ocean.

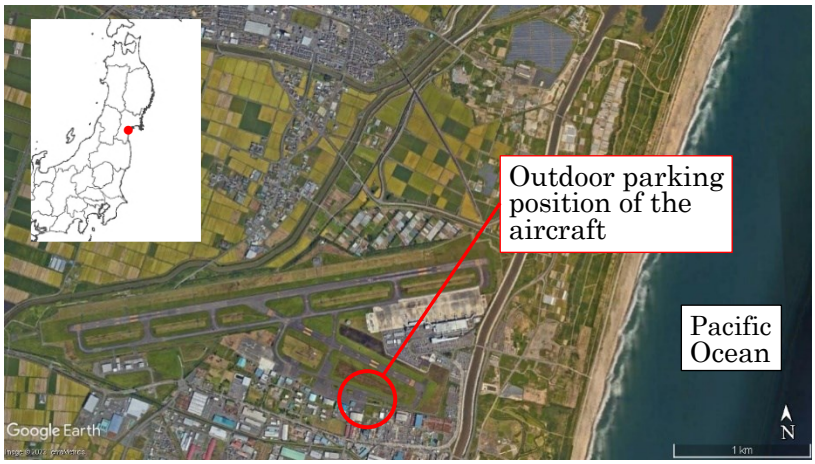


Figure 10: Location of Sendai Airport

3. ANALYSIS

(1) Damage to the Aircraft

The JTSB concludes that it is certain that because the NLG collapsed in the retracted direction during the landing roll, the aircraft tilted forward, the propellers and the lower forward fuselage contacting with the runway surface to be damaged as well as the actuator in the extended position hit the firewall, deforming it.

From the fact that the NLG of the aircraft had collapsed in the retracted direction with the actuator in extended and down-locked position, it is certain that during the landing roll, fractured was the right one of the left and right actuator attachment feet fixing the actuator that had retained the NLG in the down-locked position, thus loads from the NLG concentrated on the left attachment foot, which deformed the engine mount that could no longer support the actuator, leading to the collapse of the NLG in the retracted direction.

(2) Fractures of the Right Actuator Attachment Foot

The JTSB concludes that it is certain that as partial corrosion occurred on the fracture surface of the right actuator attachment foot, the cracking had occurred before this accident occurred and it had progressed over the repeated flights, leading to the fractures.

The analysis of the fractured surface revealed that the right actuator attachment foot fractured, because blisters around the inner surface of the cylindrical foot along the weld joining occurred due to corrosion, it is probable that in the blister part, non-through cracks originating from the inner surface were formed, developed into through cracks later, and progressed to its end further. (Attached Figure 2)

(3) Onset of Cracks

The JTSB concludes that cracks originating from the inner surface of the right actuator attachment foot more likely had occurred in the past due to impacts at the time of landings and others. As the corrosion occurred on the inner surface of the right actuator attachment foot, the corroded part was likely weakened, which possibly contributed to the cracks originating on the inner surface. However, as corrosion occurred on the fracture surface, striation (Striped traces indicating fatigue failure due to repetitive stress) was unable to be observed with a scanning electron microscope, it was unable to estimate the progressing speed of the cracks. Accordingly, it was unable to estimate when the cracks originating from the blister formed.

Besides, component analysis was conducted on the sample taken from the right actuator attachment foot with an Energy Dispersive X-ray Spectroscopy to calculate the proportion of each

element in the base metal and welded part using the sum of carbon, oxygen, silicon, chromium, and iron as 100%. As a result, it was confirmed that the proportion of chromium, which contributes to the corrosion resistance of iron steel, was 0.90 to 1.09 % in the base metal, but 0.49 to 0.73 % in part of the welded portion, and there was a deficiency in chromium. Chromium-deficient area more likely had lower corrosion resistance than that in the base metal due to their lower chromium content, which likely caused corrosion to occur and blisters to be formed in the welded part. Chromium was deficient in part of the welded portion was probably because the precipitation of the chromium contained in alloy was generated by influences of the heat temperature and hours at the time of welding.

Regarding the corrosion that occurred on the inner surface of the welded part, it is probably that in addition to the corrosion resistance property in the welded part, several factors contributed to such as the custodial environment and conditions of the aircraft, characteristics of cylindrical shape whose inner surface is considered to be prone to residual moisture due to condensation and others. Therefore, it was unable to determine when and how the corrosion occurred. Japan has a humid climate with a lot of precipitation, making it an environment with a high risk of corrosion. And when using the airport located in coastal areas as its homebase as in the case of the aircraft, it is susceptible to the influence of sea breeze, therefore, careful attention should be paid to corrosion.

In addition, according to the analysis of the company, in the past similar case, the cracks of actuator attachment area occurred on the exterior of the cylindrical foot along the weld joining. Accordingly, this accident of the aircraft where the cracks more likely occurred originating from the inner surface is probably a unique case.

(4) Maintenance Work

The JTSB concludes as follows:

In this investigation, it was unable to determine when the cracks and corrosion occurred, therefore, it was unable to identify the context between the maintenance work conducted on November 23, 2020 and the time when the cracks and corrosion occurred on the right actuator attachment foot.

For the actuator attachment area, it is possible to confirm the presence of cracking by appropriately conducting the fluorescent penetrant inspection that the company instructs at each 100 hours time in service, therefore, when cracks are confirmed during maintenance work, appropriate actions can be taken before leading to fractures. Besides, as anticorrosive measures are included in the inspection procedure, with periodical inspections, continuous anticorrosive effect can be expected.

Furthermore, replacing the original engine mount with the redesigned one is probably effective to prevent cracks in the actuator attachment area from occurring.

It is required for personnel engaged in aircraft maintenance work to conduct appropriate maintenance work in accordance with the methods and procedures instructed by the design and manufacturing company.

4. PROBABLE CAUSES

The JTSB concludes that the probable cause of this accident was certainly that during the landing roll, fractured was the right foot of the left and right actuator attachment feet fixing the actuator that retained the NLG in the down-locked position, therefore, loads from the NLG concentrated on the left attachment foot, which deformed the engine mount that could no longer

support the actuator, leading to the collapse of the aircraft's NLG in the retracted direction. It is certain that because the NLG collapsed in the retracted direction, the aircraft tilted forward, the propellers and the lower forward fuselage contacting with the runway surface to be damaged as well as the actuator in the extended position hit the firewall, deforming it.

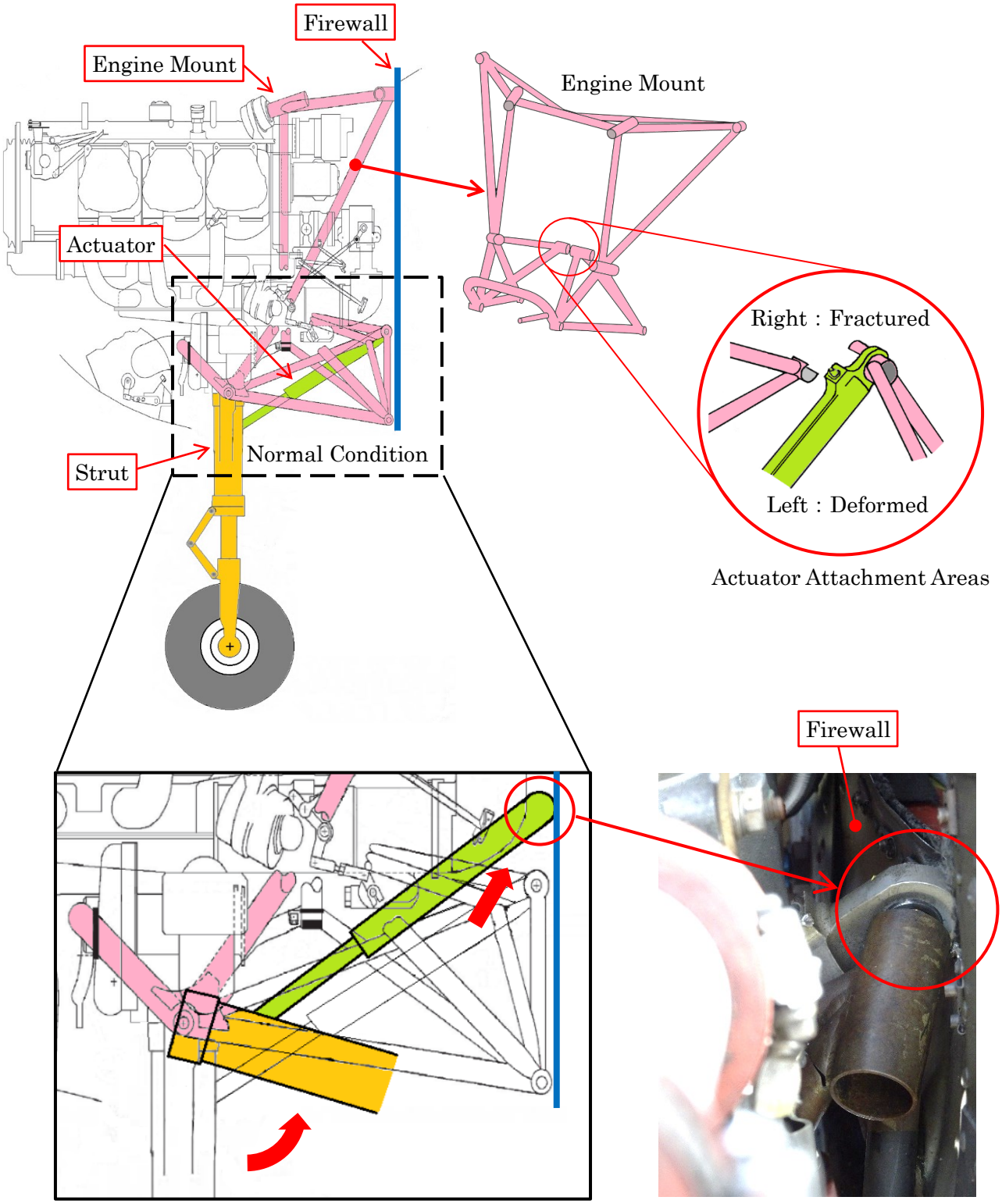
The right actuator attachment foot fractured was probably because cracks originating from the inner surface of the right actuator attachment foot had occurred in the past due to impacts at the time of landings and others and progressed over the repeated flights.

Regarding the occurrence of the cracks that originated from the inner surface of the right actuator attachment foot, the corrosion that occurred on the inner surface possibly contributed to it.

5. SAFETY ACTIONS

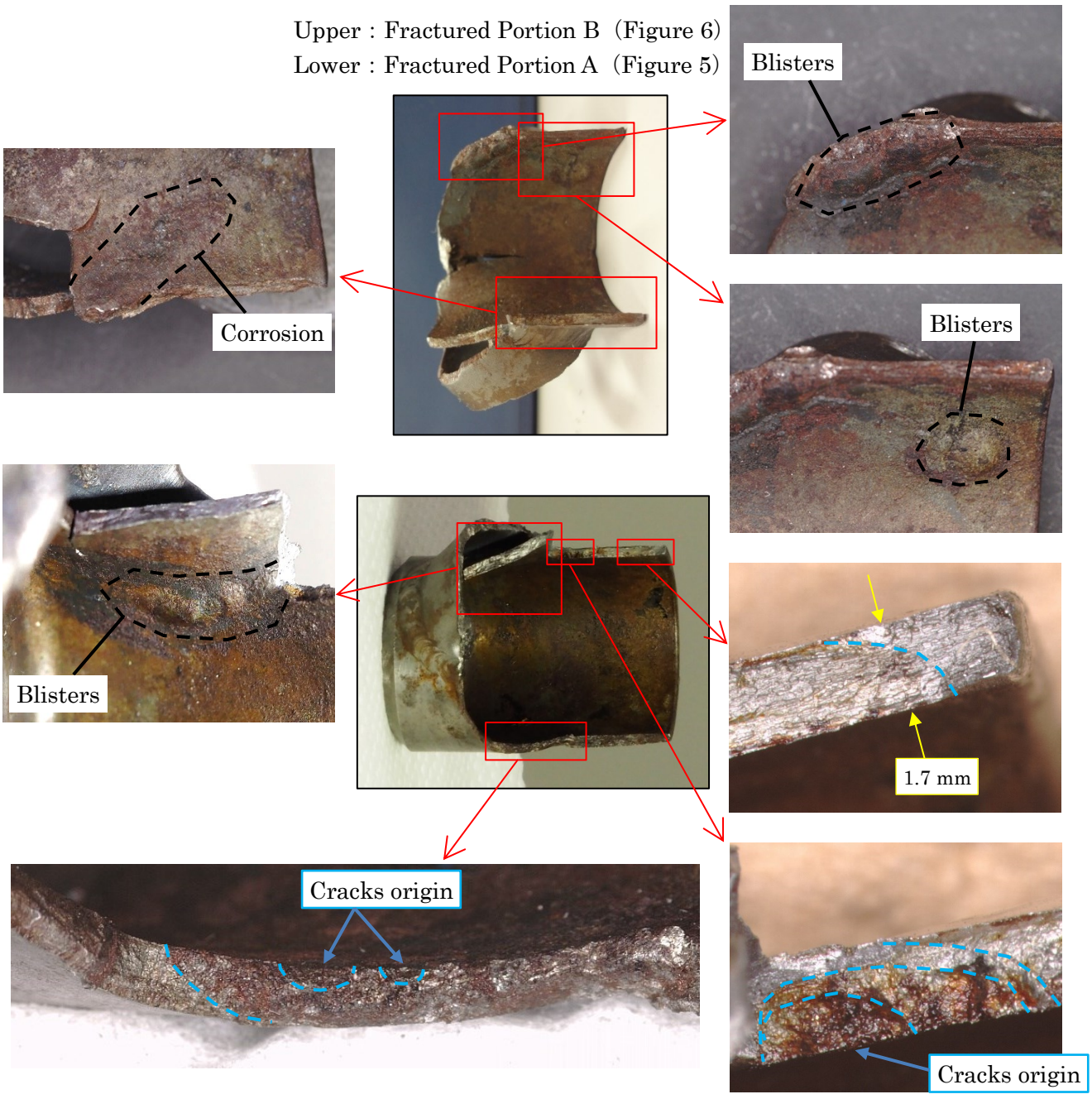
As described in ANALYSIS, it is probably effective for same model airplanes as the aircraft, equipped with the original engine mount to appropriately conduct the fluorescent penetrant inspection instructed by the Service Bulletin and/or replace the original engine mount with the redesigned one in order to prevent recurrence of similar accidents.

Image Diagram of Damage to Firewall and Engine Mount



The engine mount was deformed, and the actuator hit to deform the firewall.

Visual Examination of Right Actuator Attachment Foot



Note: The light blue dashed line indicates the crack tip in the stepwise progression of the crack.