

AA2016-10

**AIRCRAFT ACCIDENT
INVESTIGATION REPORT**

**FIRST FLYING CO., LTD.
J A 2 0 1 D**

December 15, 2016



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 DUE TO RUNWAY SIDE EXCURSION DURING LANDING

FIRST FLYING CO., LTD.

VIKING DHC-6-400, JA201D

AGUNI AIRPORT

AT AROUND 08:55 JST, AUGUST 28, 2015

November 18, 2016

Adopted by the Japan Transport Safety Board

Chairman	Kazuhiro Nakahashi
Member	Toru Miyashita
Member	Toshiyuki Ishikawa
Member	Sadao Tamura
Member	Keiji Tanaka
Member	Miwa Nakanishi

SYNOPSIS

< Summary of the Accident >

On Friday, August 28, 2015, at around 08:55 Japan Standard Time (JST: UTC + 9 hours. All times are indicated in JST on a 24-hour clock) a Viking DHC-6-400 registered JA201D and operated by First Flying Co., Ltd. departed from the side of the runway during landing at Aguni Airport for the purpose of passenger transport, collided with the airport perimeter fence and lateral groove and damaged aircraft.

There were 14 people on board the Aircraft, consisting of a PIC, a crewmember and 12 passengers (including one company employee). Of these, a crewmember and ten passengers suffered minor injuries.

The aircraft suffered substantial damage, but there was no outbreak of fire.

< Probable Causes >

It is highly probable that this accident occurred because, when the aircraft landed, the First Officer, as the PF in charge of flying, could not properly control the aircraft as it started to deflect after touchdown, as a result of which the aircraft departed from the side of the runway and collided with a fence on the airport perimeter.

It is probable that the aircraft started to deflect after touchdown because the PF forgot to perform the checklist, while the PIC, as the PM in charge of duties other than flying, did not properly monitor the situation or did not perform the necessary pointed out, as a result of which the aircraft touched down with the nose wheel deflected to the right.

It is somewhat likely that the PF could not properly control the aircraft as it started to deflect after touchdown, because his knowledge concerning the aircraft system of the aircraft was inadequate, as a result of which he did not fully understand situations that cause deflection to start. It is somewhat likely, moreover, that the insufficient response by the PIC when an unforeseen situation arose contributed to this.

It is probable that the knowledge of the PF was inadequate and he did not fully understand situations that cause deflection to start, because the company had not properly confirmed the effectiveness of ground school training that should be undertaken prior to route training and training related to establishing knowledge.

< Safety Recommendations >

It is somewhat likely that this accident was partly caused by the inadequate knowledge of the First Officer concerning the aircraft system. It is also somewhat likely that the insufficient response by the PIC when an unforeseen situation arose contributed to the occurrence of the accident. It is probable that these were due to the fact that the ground training and flight training stipulated by the company had not been carried out properly.

In order to contribute to the prevention of recurrence of similar accidents, based on the result of investigation of the accident, the Japan Transport Safety Board recommends, in accordance with the provisions of Article 27 Paragraph 1 of the Act for Establishment of the Japan Transport Safety Board, that First Flying Co., Ltd. give careful consideration to the following and take necessary measures thereof:

Ascertain the current situation of ground training and flight training correctly, and then improve its system for training to enable the stipulated training to be carried out properly.

Abbreviations and Acronyms used in this report include the following:

CAS: Crew Alerting System
CVR: Cockpit Voice Recorder
FDR: Flight Data Recorder
FMS: Flight Management System
KIAS Knot Indicated Air Speed
LVR: Lever
MAC: Mean Aerodynamic Chord
MSG: Message
NWS: Nose Wheel Steering
PF: Pilot Flying
PIC : Pilot in Command
PM: Pilot Monitoring
PTM: Pilot Training Manual
TSB: Transportation Safety Board

Unit Conversion Table

1lb: 0.4536kg
1ft: 0.3048m
1nm: 1,852km
1kt: 1.852km/h
1in: 2.54cm

1. PROCESS AND PROGRESS OF THE AIRCRAFT ACCIDENT INVESTIGATION

1.1 Summary of the Accident

On Friday, August 28, 2015, at around 08:55 Japan Standard Time (JST: UTC + 9 hours. All times are indicated in JST on a 24-hour clock) a Viking DHC-6-400 registered JA201D and operated by First Flying Co., Ltd. departed from the side of the runway during landing at Aguni Airport for the purpose of passenger transport, collided with the airport perimeter fence and lateral groove and damaged aircraft.

There were 14 people on board the Aircraft, consisting of a PIC, a crewmember and 12 passengers (including one company employee). Of these, a crewmember and ten passengers suffered minor injuries.

The aircraft suffered substantial damage, but there was no outbreak of fire.

1.2 Outline of the Accident Investigation

1.2.1 Investigation Organization

On August 28, 2015, the Japan Transport Safety Board designated an investigator-in-charge and two investigators to investigate this accident. Later, one investigator was additionally designated on September 9, 2015.

1.2.2 Representatives from the Relevant State

An accredited representative of Canada, as the State of Design and Manufacture of the aircraft involved in this accident, participated in the investigation.

1.2.3 Implementation of the Investigation

August 28 to September 1, 2015	Aircraft examination, on-site investigation, interviews and examination of relevant documents
November 17, 2015	Functional test of nose wheel steering mechanism (implemented by the aircraft manufacturer under the supervision of the accident investigation authority (TSB of Canada))

1.2.4 Comments from Parties Relevant to the Cause of the Accident

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

1.2.5 Comments from the Relevant State

Comments on the Draft Final Report were invited from the relevant State.

2. FACTUAL INFORMATION

2.1 History of the Flight

On August 28, 2015, a Viking Air DHC-6-400 registered JA201D (hereinafter referred to as “the Aircraft”) and operated by First Flying Co., Ltd. (hereinafter referred to as “the Company”) took off from Naha Airport and approached Aguni Airport (hereinafter referred to as “the Airport”) for its first passenger transport on the day.

The flight plan for the Aircraft was outlined below:

Flight rules:	Visual Flight Rules (VFR)
Departure aerodrome:	Naha Airport
Estimated off-block time:	08:30
Cruising speed:	140 kt
Cruising altitude:	VFR
Route:	SANDO (visual reporting point)
Destination aerodrome:	The Airport
Total estimated elapsed time:	25 min
Fuel load expressed in endurance:	2 h 30 min
Persons on board:	14 persons

In the cockpit of the Aircraft, the Pilot in Command (hereinafter referred to as “the PIC”) sat in the right seat as the PM*1 and instructor, and the First Officer (hereinafter referred to as “the FO”) sat in the left seat as the PF*1 and trainee for promotion to PIC.

The flight history up to the time of the accident is outlined below, based on the record of the flight data recorder (hereinafter referred to as “FDR”) and cockpit voice recorder (hereinafter referred to as “CVR”), and statements from the PIC, the FO, the company employee who was on board, and passenger A.

2.1.1 History of the Flight Until the Accident, Based on FDR and CVR Records

08:37:53	The FO, as the PF, ordered the BEFORE TAKEOFF checklist to be performed, and had a conversation with the PIC to confirm that the nose wheel steering mechanism*2 (hereinafter referred to as “NWS”) was in the center position.
08:38:09	The Aircraft commenced takeoff.
08:39:02	The PF ordered the AFTER TAKEOFF checklist to be performed, and had a conversation with the PIC to confirm that the NWS was in the center position.
08:40:54	Vertical acceleration decreased temporarily from about 1.0 G to 0.57 G. Airspeed decreased temporarily from 142 kt to 133 kt. The left bank angle of the aircraft changed from 6.4° to 3.4°, thereafter decreasing to 0°. Immediately after this, there was a conversation between the PIC and the PF to the effect that the Aircraft had entered the wake turbulence of another aircraft.

*1 PF (Pilot Flying) and PM (Pilot Monitoring) are terms used to identify pilots by their different roles in aircraft controlled by two persons. The PF is mainly responsible for maneuvering the aircraft. The PM mainly monitors the flight status of the aircraft, cross-checks operations by the PF, and undertakes other non-operational work.

*2 “Nose wheel steering mechanism” refers to a mechanism that enables the direction of the nose wheel to be changed and the direction of the aircraft to be controlled by operating a nose wheel control lever when an aircraft is taxiing. The Aircraft is equipped with a control lever that controls the direction of the nose wheel on the same axis as the left control wheel. (See 2.13.1 NWS)

08:46:37	There was a conversation in which the PF carried out landing briefing* ³ that flaps would be used at 20° when landing, Vref* ⁴ would be 77 kt and others, and then the PIC acknowledged this.
08:48:00	A conversation between the PIC and PF on the situation of clouds around the airfield traffic pattern was recorded.
08:53:21	After the PF had ordered flaps 20°, the PIC made pre-landing announcements to the passengers.
08:54:27	The Aircraft passed the threshold of Runway 19 at an airspeed of 75 kt.
08:54:31	After the sound of the wheels touching down had been recorded, the noise of tires screeching was recorded until immediately before the noise of the collision. The heading was 189°, the bank angle was 0.5° to the left, and the ground speed was 76 kt.
08:54:32	The PIC issued the instruction “Don’t brake.” The heading was 190°, the bank angle was 1.3° to the left and the ground speed was 76 kt.
08:54:36	The PIC issued the instruction “No, don’t brake.” The heading was 195°, the bank angle was 2.6° to the left, and the ground speed was 62 kt.
08:54:38	The aircraft started to depart from the right side of the runway. The heading was 201°, the bank angle was 0.1° to the left and the ground speed was 59 kt.
08:54:40	The Aircraft started to enter the grass area on the right of the runway, and the final position was recorded on the FDR. The heading was 209° (it had continued to change to the right every second from 54:31 until 54:40), the bank angle was 0.6° to the left and the ground speed was 49 kt.
08:54:41	The collision noise was recorded.

2.1.2 Statements of the PIC, the FO, the company employee on board and passenger A

(1) PIC

The PIC was in normal physical condition on the day of the accident, and was sitting in the right seat in order to charge PM duties as well as the duty of instructing the FO during his training for promotion to PIC.

The PIC conducted a pre-flight inspection together with the PF and confirmed that there was no abnormality in the aircraft. The Aircraft took off from Naha Airport on schedule on a Visual Flight Rules (VFR) and headed for the Airport.

Because the PF had long experience as an airline transport pilot, and moreover because his training for promotion to PIC was in its final stages and his flying was stable, the PIC was monitoring the operational status with reassurance. The PF approached the Airport using flaps at 20°, and although there was a light crosswind from the left, carried out corrective operation properly; accordingly, touched down about 1 m to the left of the runway centerline near the aiming point marking after passing the Runway 19 threshold at an airspeed of 77 kt, in accordance with the Vref set before the approach.

After touching down, the PIC heard a screeching noise, while an abnormal deflection to the right started at the same time. Therefore, he thought that the PF had applied the brake

*3 “Landing briefing” refers to the PF sharing information related to landing by explaining the weather, the approach method, the flap angle used, the approach speed, procedures after landing, and other details to the PM before landing.

*4 “Vref” refers to an airspeed set as standard when an aircraft passes the runway threshold for landing.

on one side and so cautioned him not to apply the brake. At this time, the PIC had not held his foot on the rudder pedal.

Since the PF appeared unable to correct the deflection, the PIC operated the rudder together and put his hand on the power lever over the PF's hand from the point when the Aircraft departed from the side of runway and entered the grass area, but could not control the direction by using reverse* 5 to decelerate and power differential control* 6 after deceleration.

The deflection to the right did not stop, and the Aircraft collided with the fence on the perimeter of the airport (hereinafter referred to as "the Perimeter Fence") and came to a halt; accordingly the PIC to stop the engine. When he subsequently looked at the passenger cabin to give instructions for the passengers to evacuate, he confirmed that the company employee who was boarding there to support operations at the Airport was guiding the passengers to evacuate from the Aircraft.

(2) FO

The FO, who was training for promotion to PIC, was in normal physical condition on the day of the accident, and was in charge of PF duties in the left seat.

The Aircraft took off from Naha Airport on schedule and started its approach to the Airport. Given the scattered cloud condition, the PF set the downwind leg at an altitude of 600 ft instead of flying at 700 ft, and with a light crosswind from the left, touched down mostly normal using flaps at 20°. However, deflection to the right started immediately after the nose wheel touched down, and there was a sensation as if the nose was being held by something.

Under normal circumstances, the PF would have initiated reverse operation immediately after touchdown, but had no time to respond to the aircraft deflection that had suddenly started, and because the situation did not change even after applying the left rudder, he thought that he had applied the left brake several times. When the deflection to the right started, he was instructed by the PIC to apply the brakes. Finally, he thought that he applied both hard brakes but was unable to stop the Aircraft; consequently it collided with the Perimeter Fence.

After the accident, the PF thought that there would be no subsequent change in the direction of the nose wheel, due to the procedure for confirming that the NWS control lever was in the center position before landing. However, since the position of the control lever, which should have been in the center position based on marking after takeoff, had previously been known to move from the center in the before landing check, he thought that it may also have moved slightly in the time between the before landing check and the touchdown in the same way.

When the accident occurred, the PF was applying the rudder to control the direction of the Aircraft and did not touch the NWS control lever to the last. Moreover, the PF thought that the rudder and NWS were mechanically connected, and that the nose wheel also moved

*5 The "reverse" of the Aircraft refers to the mechanism whereby an aircraft decelerates as a result of reverse thrust arising when the pitch angle of the propeller is changed to the reverse direction after landing. This is operated by unlocking the grip of the power lever being held by rotating it forwards, then pulling it toward the operator. The volume of reverse thrust is controlled by the degree to which the power lever is pulled.

*6 "Power differential control" refers to the method of controlling the direction of an aircraft by using the yawing moment that arises when the right and left engine outputs are made asymmetrical after using reverse to decelerate.

when the rudder was operated.

The PF did not feel any abnormality in the Aircraft (including the flight control system) until it touched down.

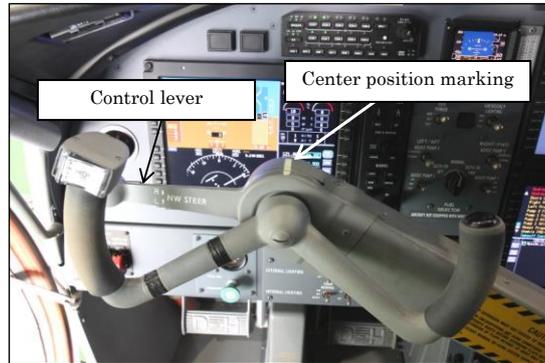


Photo A NWS control lever

(3) Company employee on board Male

The company employee was normally responsible for guiding passengers on the ground at the Naha Airport branch of the Company, but on the day, he boarded the Aircraft at the left rearmost seat in order to support operations at the Airport, and when it touched down, was looking toward the front of the cockpit through the entrance to the cockpit.

Just as the company employee was thinking it strange that no reverse sound could be heard after touchdown, the Aircraft started deflecting to the right. As the deflection did not stop after that, he thought that it would depart from the side of the runway, and advised the passengers to lower their heads.

When the Aircraft came to a halt after the impact, the company employee looked at his watch to see that the time was 08:55. When he looked at the two pilots it seemed that they had fainted and were facing down; therefore, he advised the panicking passengers to remain calm while opening the left door of the passenger cabin. There was no outbreak of fire and the propellers had stopped; accordingly, he guided the passengers out of the Aircraft.

On leaving the Aircraft, he saw that fuel was leaking from the bottom of the fuselage; therefore, he first guided the passengers to a place away from the aircraft, and then made telephone contact with the company, returned inside and reported to the PIC that the evacuation of the passengers was complete.

He guided the passengers to the company office, where he requested that the ambulance and fire services should be notified.

(4) Passenger A Male

Passenger A was sitting in the aisle side right seat, near the center of the passenger cabin. When the Aircraft was in level flight about five minutes after taking off, passenger A felt a sudden loss of altitude with an impact accompanied by a banging sound.

After this, the Aircraft entered the airspace over the Airport, and having made a left turn, it touched down on the runway.

Passenger A saw the Aircraft gradually deflecting to the right after touchdown, and felt that it would be dangerous if the situation continued unchecked. Because the Aircraft subsequently entered the grass area, he told the child sitting to his right to duck down, immediately after which there was a large impact accompanied by a loud reverberating

noise. When the aircraft had come to a halt, passenger A evacuated from the Aircraft under the guidance of the company employee. After this, he went to a clinic in Aguni village together with the other passengers and others, and was diagnosed with a minor injury.

This accident occurred at the Perimeter Fence on the west side of the Airport runway (Latitude 26° 35' 31" N, Longitude 127° 14' 24" E) at around 08:55 on August 28, 2015. (See Fig.1: Estimated Flight Route and Accident Site, Photo: Accident Aircraft)

2.2 Injuries to Persons

One crewmember and 10 passengers were suffered minor injuries.

2.3 Damage to the Aircraft

2.3.1 Extent of Damage

Substantially damaged

2.3.2 Damage to the Aircraft Components

- (1) Underside of nose: Damaged
 - (2) Right engine: Damaged
 - (3) Right propeller: Blades deformed and damaged
 - (4) Nose landing gear: Strut deformed and nose wheel fallen off
 - (5) Right main landing gear: Strut deformed and right main wheel damaged
 - (6) Underside of fuselage: Outer skin damaged and fuel tank damaged
- (See Photo: Accident Aircraft)

2.4 Other Damage

Part of the Perimeter Fence on the west side of the runway (length about 20m) was damaged. (See Photo: Accident Aircraft)

2.5 Personnel Information

2.5.1 Competence Certificate and Other Information

- (1) PIC Male, Age 57

Commercial Pilot Certificate (Airplane)	September 5, 1988
Type rating for multiple engines (land)	July 1, 1987
Instrument flight certificate	October 13, 1994
Class 1 Aviation Medical Certificate	
Validity	April 13, 2016
Total flight time	5,685 h 19 min
Flight time in the last 30 days	84 h 00 min
Total flight time on the type of aircraft	196 h 32 min
Flight time in the last 30 days on the type of aircraft	84 h 00 min
Internal qualifications	Flying Instructor, Flight Captain
- (2) FO Male, Age 62

Airline Transport Pilot Certificate (Airplane)	April 13, 1999
Type rating for multiple engines (land)	May 7, 1977
Class 1 Aviation Medical Certificate	

Validity

December 26, 2015

At the time of the accident, the FO had not taken the additional test stipulated in “Standards on Employing Aircraft Crewmembers Aged 60 or Over in Aircraft Used for Air Transport Services” (enacted January 28, 2000 (Ku Ko No.100 / Ku Jo No.23)). Noted that he successfully took the requisite test after the accident, on January 18, 2016.

Total flight time	16,323 h 16 min
Flight time in the last 30 days	39 h 23 min
Total flight time on the type of aircraft	61 h 22 min
Flight time in the last 30 days on the type of aircraft	39 h 23 min
Internal qualification	FO

2.5.2 Situation of Training

2.5.2.1 Experience of the PIC and training as a flight instructor

(1) Experience as a pilot

The PIC had experience as an FO at a scheduled air transport service, as well as experience as a flight captain and instructor at a company in air transport business using Britten-Norman BN-2B-20 light twin-engine aircraft (single pilot).

(2) Training as a flying instructor

According to the Company, the PIC had undergone training compliant with the standards stipulated in “Air Crew Training Qualification Manual Bulletin DHC-6-400 Model Transition, Provisional Version” (hereinafter referred to as “the Provisional QM”), an annex to the flight regulations manual of the Company, in order to become a PIC and flight instructor.

The training consisted of 48 hours of ground school training in Japan, 35 hours of ground school training in Canada and 16 hours of simulator training, followed by about 18 hours of practical flight training in Japan by a Canadian instructor. After this, he had been appointed as PIC and flight instructor for this type of aircraft.

According to the Company, of this training, he had undergone flight training in the right seat four times during practical flight training in Japan from June 1 to 12, 2015 (about 6 hours). As part of this training in the right seat, he had undergone corrective training including takeover of control from the trainee, which is necessary for qualification as a flight instructor. Yet this item was not included in the subjects completed in the record of training implementation, while there was no sign of any evaluation concerning his corrective operations in the right seats or others, in the space for comments by the instructors in charge of the training.

2.5.2.2 Experience of the FO and training for promotion to PIC

(1) Experience as a pilot

The FO had experience as a PIC and flight instructor as well as other roles for a scheduled air transport service.

(2) Training of the FO for promotion to PIC

The FO was in training (PH-1 and PH-2) for promotion to PIC of the type of aircraft, in accordance with the “Air Crew Training Qualification Manual” (hereinafter referred to as “the QM”), an annex to the flight regulations manual of the Company. He had completed PH-1, which mainly involves training in performing PM duties in the right seat as

necessary until the issuance of FO qualification, and the FO qualification had been issued.

In PH-1, he had undergone about seven hours of flight training and ten legs or about five hours of route training in compliance with the QM, but he had only completed 16 of the regulation 48 hours of ground school training; therefore, he had not satisfied the criteria. According to the Company, this was because the originally planned ground school program was deferred due to preparations for commencement of line flying, among other factors; therefore, it was not completed, but it was regarded as completed as it was intended to be carried out at a later date.

PH-2 involves training in performing PF duties in the left seat. According to the QM, the trainee first becomes familiar with operations in the left seat in six flights totaling nine hours of flight training, followed by route training for familiarization with route operation. The FO had undergone a total of six flights with about ten hours of flight training in compliance with this standard, had already undergone 41 legs totaling about 21 hours of route training, and was due to be examined for qualification as a PIC at the point when the route training reached the requisite 25 flight hours.

Of the total of six flights of flight training undertaken before the route training, the FO had received training on a total of four flights from the PIC as the instructor in charge.

2.6 Aircraft Information

2.6.1 Aircraft

Type	Viking DHC-6-400
Serial number	915
Date of manufacture	December 13, 2014
Certificate of airworthiness	Dai <i>Tou</i> -27-041
Validity	April 26, 2016
Category of airworthiness	Aircraft Normal N
Total flight time	218 h 27 min
Flight time since last periodical check	
(250 hours check: carried out on August 14, 2015)	22 h 2 min
(See Fig.2: Three Angle View of a Viking DHC-6-400)	

2.6.2 Weight and Balance

At the time of the accident, the weight of the Aircraft is estimated to have been 11,467 lb and the position of the center of gravity 30.6% mean aerodynamic chord (MAC)⁷, both of which are estimated to have been within the allowable range (maximum landing weight of 12,300 lb, range of position of center of gravity corresponding to the weight at the time of the accident, 22.0-36.0% MAC).

2.7 Meteorological Information

Aeronautical weather observations at the Airport around the time of the accident were as follows.

09:00 Wind direction: 130°, Wind velocity: 7 kt, Prevailing visibility: 10 km or more

⁷ “30.6% MAC” refers to a position 30.6% from the front of the mean aerodynamic chord representing the aerodynamic properties of the wings.

Cloud: Amount FEW, Cloud base 1,000 ft
Amount SCT, Cloud base 2,500 ft
Amount BKN, Cloud base unknown
Temperature: 27°C, Altimeter setting (QNH): 29.81 inHg

2.8 Information on the Flight Recorder

The Aircraft was equipped with an FDR and a CVR, both manufactured by Honeywell of the United States of America, and records at the time of the accident were retained. In addition, records from the previous two flights besides the time of the accident (when the FO and another PIC (instructor) were on board for route training) were retained in the CVR, and voice recordings proved that all checklists had been accomplished without omission.

The time calibration was conducted by comparing the time signals recorded in the air traffic control communication records with the VHF keying signals recorded in the FDR and ATC communication recorded in the CVR.

2.9 Information of the Accident Site

The accident site was at the Perimeter Fence on the west side of the Airport runway.

The Airport has a paved runway that is 800 m long and 25 m wide, and has a magnetic bearing of 189.7° and 009.7°. About 30 m to the west of the runway is the Perimeter Fence, constructed of wire netting and concrete struts.

The Aircraft crossed the lateral groove on the inside of the Perimeter Fence at a position about 510 m from the Runway 19 threshold, and came to a halt on the Perimeter Fence with its nose pointing south-southwest.

The tire marks of the nose wheel extended from near the aiming point marking on Runway 19 where the Aircraft touched down, the tire marks of the left main wheel extended from near the runway centerline marker about 90 m south from the south end of the aiming point marking, and the heavy tire marks of the right main wheel extended from near the runway deviation location (north end of the taxiway), respectively, to the stop position of the Aircraft. As shown in Fig.A, the tire marks of the nose wheel and left main wheel remained as gentle curves that looked like straight lines (angle of deflection to the right about 4°: deflection of about 13 m to the right while traveling about 207 m) up to near the north end of the taxiway where the thick tire marks of the right main wheel started. From that point on, the degree of deflection to the right of marks of the nose wheel and both main wheels gradually increased; moreover, after entering the grass area about 420 m from the Runway 19 threshold, the tire marks of the left main wheel also became thick and deep with continuous gouge marks on the grass so that the ground underneath was visible, and the nose wheel tire marks were wider than they had been on touchdown. Furthermore, the gap between marks of the nose wheel and both main wheels just before entering the grass area was wider on the left side than on the right, showing that the longitudinal axis was pointing further to the right than the direction of travel.

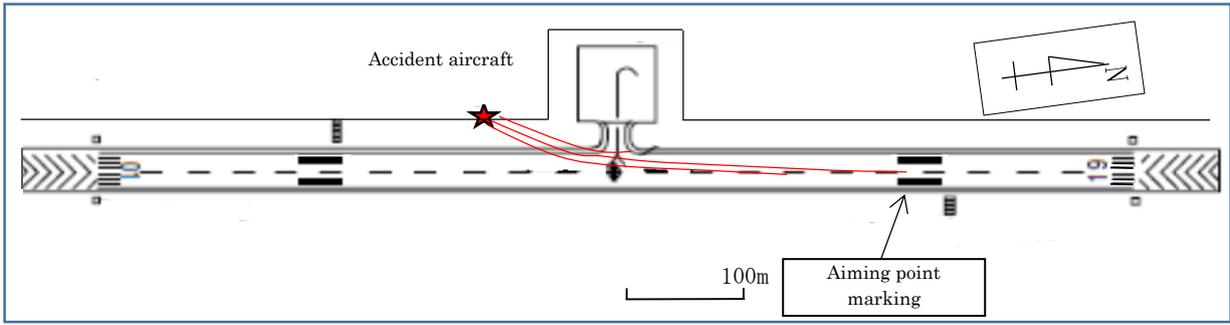


Fig. A State of tire marks



Photo B Situation when the Aircraft stopped

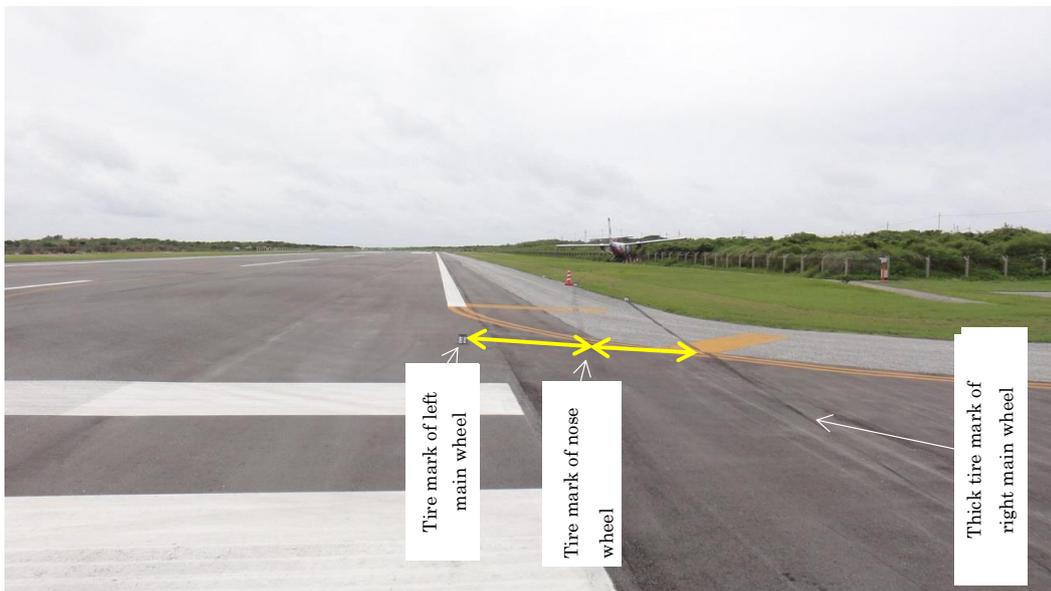


Photo C Tire marks near the runway deviation



Photo D Tire marks just before the collision with the Perimeter Fence
(See Annex Fig.1: Estimated Flight Route and Accident Site, Photo: Accident Aircraft)

2.10 Aircraft Examination at the Accident Site

(1) Landing gears

In the collision of the Aircraft and the lateral groove and the Perimeter Fence, the nose landing gear became deformed from the strut mounting, external damage and deformity was visible on the NWS, and the nose wheel had fallen off.

The cable connecting the NWS control lever in the cockpit with the actuator section of the nose landing gear had become loose; however, but abrasion, breakage or other damage was not visible on the cable itself.

The strut of the right main landing gear was significantly deformed in the collision with lateral groove, and the main wheel was damaged.

No external abnormality was visible on the left main landing gear, as it had not been involved in the collision.

(2) Flight control system

Due to the collision with the Perimeter Fence, the underside of the cockpit was deformed, the rudder pedal and the forward and backward direction of the control stick were mostly jammed; however, the rudder and elevator flight control systems were both connected to the control stick. It was confirmed that the ailerons were working properly without jamming.

(3) Engines

No external abnormality was visible on the left engine. The right engine had been damaged in the collision with the Perimeter Fence, and the propeller was jammed.

(4) Fuselage

Due to the collision with the Perimeter Fence, cracks and deformity had appeared in the outer skin on the underside of the fuselage, and the fuel tank was damaged.

(See Photo: Accident Aircraft)

2.11 Functional Test of the NWS

The results of the functional test for the Aircraft NWS conducted in the facilities of the Aircraft manufacturing company (hereinafter referred to as “the Manufacturer”) with the cooperation of the Transportation Safety Board of Canada were as follows.

- (1) The deflection angle to the right by the NWS, which was removed from the Aircraft after the accident, was about 31.5°.
- (2) In the functional test conducted under the provisions of the Maintenance Manual while supplying hydraulic pressure from a test device and comparing with a serviceable product, the following facts were found.
 - 1) When hydraulic pressure was supplied in order to input steering commands*8 into the Aircraft NWS, it worked up to the maximum limit in both right and left directions. The operating range and operating were mostly the same level as a serviceable product.
 - 2) When the prescribed force was applied in the direction for turning the nose wheel to right and left, and then released without steering command input, the serviceable product retained that position; however a phenomenon of a creep which swing gently was observed in the Aircraft NWS.
- (3) Opinion of the Manufacturer

The NWS of the Aircraft was working mostly the same as a serviceable product, except for the phenomenon of a creep.

It is probable that the cause of a creep phenomenon was internal damage to the hydraulic pressure working mechanism, but this could not be identified during this test.

Since the phenomenon of a creep seen after applying force without steering commands input only arose when the nose wheel was not subject to force, and the extent was very limited and not uniform, it is probable that there is no problem in the directional control mechanism after landing.

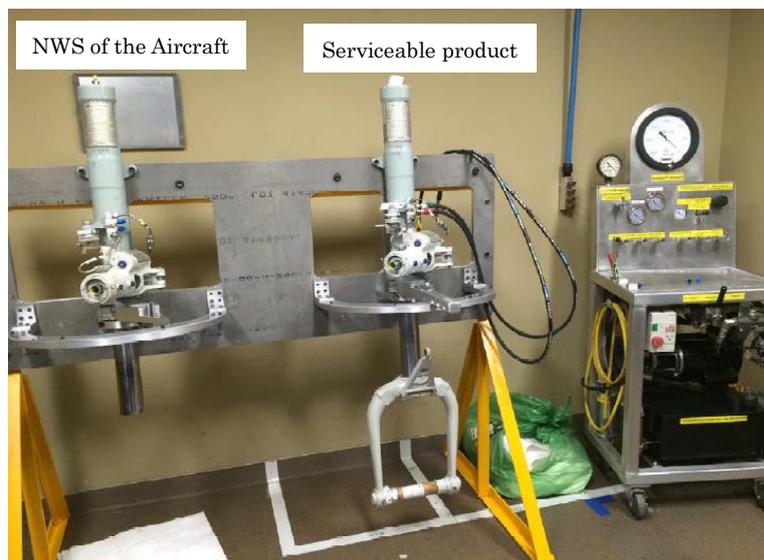


Photo E Situation of the NWS functional test

2.12 Information on Fire and Firefighting

Although the Aircraft suffered substantial damage, there was no fire.

*8 “Steering command” refers to a command to change the direction of the nose wheel to right or left.

The Manager of the Airport Management Office, who was engaged in firefighting and rescue duties at the Airport (hereinafter referred to as “the Manager”) and the staff of the Airport Management Office (hereinafter referred to as “Management Office Staff”) noticed something abnormal due to the collision noise at the time of accident, whereupon the Manager rushed to the accident site and confirmed that the evacuated passengers were being moving toward to the terminal building.

After confirming the accident site, the Manager mobilized two firefighting vehicles and assigned them to watch over the site. Because there were injured persons, meanwhile, the Management Office Staff requested an ambulance and also notified the Naha Airport office that an aviation accident had occurred. After this, to confirm the state of injuries, the passengers and crewmembers were transported to a clinic by an ambulance and other vehicles from Aguni Village Office.

2.13 Additional Information

2.13.1 NWS

2.13.1.1 Mechanism

The Aircraft has NWS whereby directional control during taxiing is performed by the nose wheel. The composition of this is as shown in the figure below.

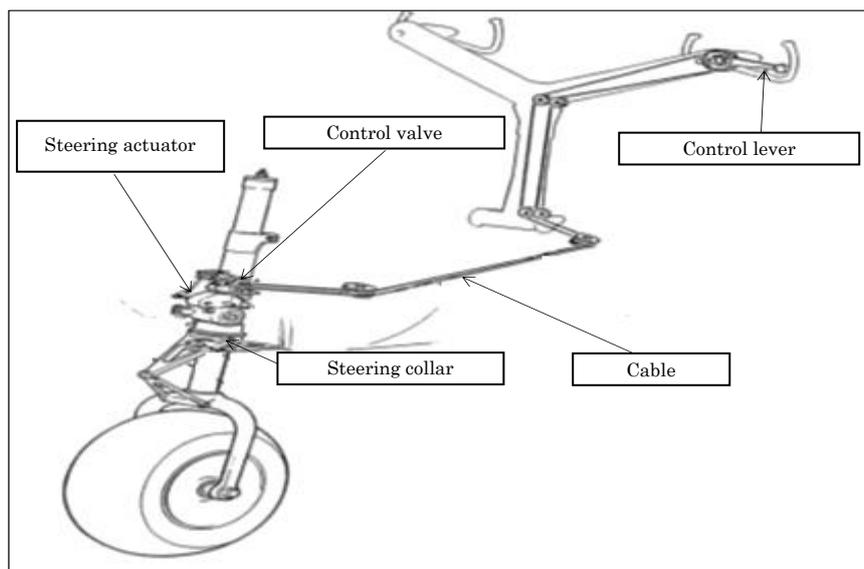


Fig B NWS system

The NWS control lever, equipped on the left control wheel only, is connected to the control valve of the steering actuator with a cable, and is kept in a position corresponding to the direction of the nose wheel. Thus, when the control lever in the pilot’s seat is turned to the right (upwards), the control valve connected via the cable supplies hydraulic pressure to the steering actuator, and then the steering collar rotates to the right. The movement of the steering collar is transmitted to the mechanically connected nose wheel, and the direction of the nose wheel changes to the right. The change in direction of the nose wheel is transmitted to the control lever in the pilot’s seat via the connecting cable, and the position of the lever moves to the right (upwards) in conjunction with the direction of the nose wheel.

When the pressure applied to a control lever in the cockpit is extracted, a spring

action causes the control valve to return to the neutral position, thus stopping the supply of hydraulic pressure. The rotation of the steering collar and nose wheel then stops and hydraulic pressure causes the direction of the nose wheel at that time to be maintained.

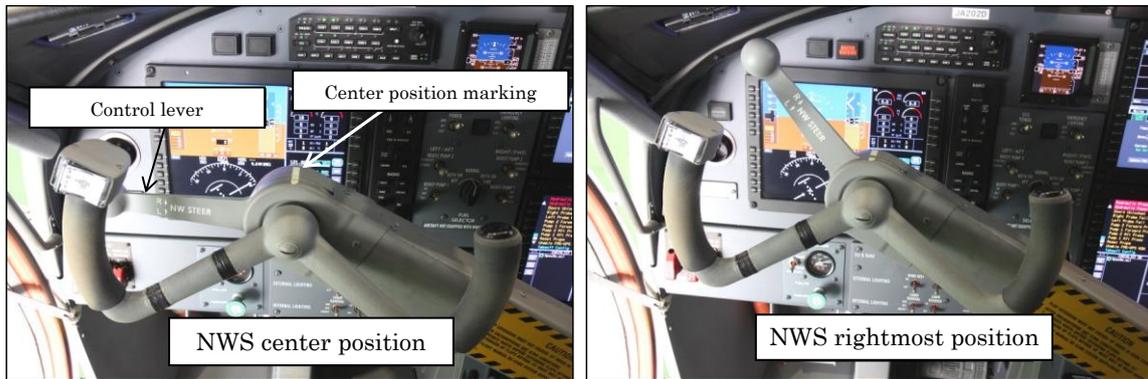


Photo F NWS control lever

After an aircraft takes off with the nose wheel centered, the strut will extend and the torque links will open due to the dead weight of the nose wheel. The centering latch attached to the torque links will then engage with a slot on the airframe side and the NWS will be locked in a position (center) with the nose wheel centered.

Markings on the control lever in the cockpit can be used to confirm that the NWS is in the center.

There is no mechanical connecting mechanism between the NWS and the rudder flight control system.

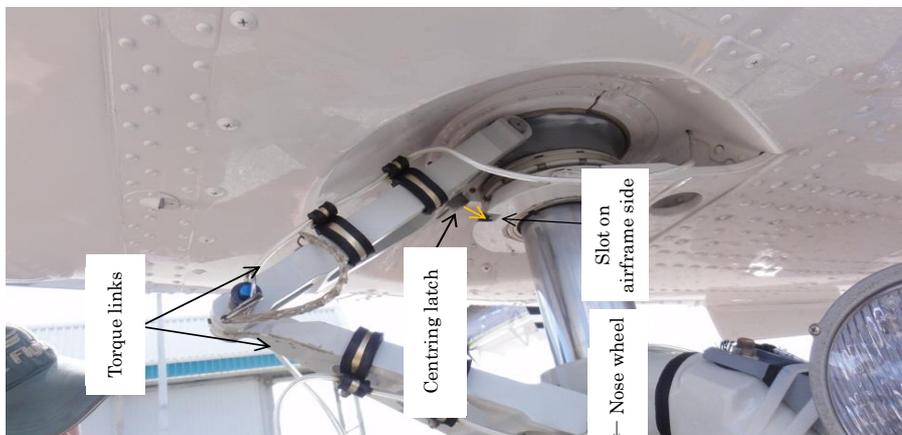


Photo G Centering latch

2.13.1.2 NWS Operation

(1) Pilot Training Manual (hereinafter referred to as “PTM”)

The “DHC-6 Twin Otter Series PTM pp17-7” issued by the Company in charge of training for the Aircraft implemented by the Company included the following description of NWS operation.

However, there was no statement of this content in the training manual of the Company prescribed for the purpose of standardizing operations and others.

(Excerpt)

The pin will not engage properly if the nose wheel is not centered at takeoff, a condition

that sometimes occurs when taking off during strong crosswinds or on rough surfaces.

The nose wheel must be centered after every takeoff by moving the NW STEER tiller towards centre until the pin locks in the centre position and resistance is felt.

(2) Aircraft Operation Manual (hereinafter referred to as “the AOM”)

Chapter 4 “Normal Procedures” of the AOM of the Company included the following description of the use of checklists.

(Excerpt)

4-1-1 General

(omitted)

(5) Normal procedures shall be performed by memory in principle, and after completion of the procedures, the completion of important procedures shall be reconfirmed by referring to the relevant normal checklist.

(rest omitted)

1. Crew Designations

(first section omitted)

LP: Pilot in Left Seat

RP: Pilot in Right Seat

PF: Pilot Flying (Pilot in charge of flying)

PM: Pilot Monitoring (Pilot in charge of duties other than flying)

ALL: All Pilots PF and PM

(rest omitted)

It was also stated that the NWS control lever center position should be confirmed with the BEFORE TAKEOFF checklist, the AFTER TAKEOFF checklist and the DESCENT & APPROACH checklist.

In addition, STEERING LVR refers to the NWS control lever.

4-5-1 BEFORE TAKEOFF

(first section omitted)

• BEFORE TAKEOFF CHECKLIST PERFORM (ALL)

(first section omitted)

CAS MSG ----- CHECK (ALL)

STEERING LVR ----- CENTER (L)

4-5-2 TAKEOFF

• Line up with the RWY, confirm steering lever in neutral position, use foot brake to stop. (PF)

Confirm all CAS MSG off. (PF, PM)

TAKEOFF after receiving T/O clearance CALLOUT (PF)

(middle section omitted)

• CLIMB POWER ORDER (PF)

• Nose wheel Steering Lever CENTER (PF)

Center steering lever, align with index mark.

(middle section omitted)

• AFTER TAKEOFF CHECKLIST PERFORM (ALL)

FLAP 0/10(PM)

STEERING LVR CENTER (L)

(rest omitted)

4-7-1 DESCENT & APPROACH PREPARATION

(first section omitted)

• *Nose wheel Steering Lever* *CENTER (PF)*

(middle section omitted)

• *Landing Briefing* *ACCOMPLISH (ALL)*

• *CAS MSG* *CHECK (ALL)*

• *DESCENT & APPROACH CHECKLIST* *PERFORM (ALL)*

(first section omitted)

FMS *SET (PM)*

STEERING LVR *CENTER (L)*

Landing Briefing *COMPLETE (PF)*

CAS MSG *CHECK (ALL)*

2.13.2 Regulations on Landing

(1) Chapter 2 “Operating Limits” of the AOM included the following description of flaps used when landing.

• *When landing at an aerodrome with a runway length of 800 m, flaps at 37° shall be used in principle.*

(2) Chapter 4 “Normal Procedures” of the AOM included the following description of landing procedures.

4-8-3 LANDING ROLL

• *Zero Thrust or Reverse* *PERFORM (PF)*

Thrust reverse is most effective at 60 KIAS or higher, but has little effect at less than 40 KIAS. Should be activated immediately after main wheel touchdown.

• *Brake* *APPLY (PF)*

After the nose wheel has touched down, use brake as necessary. As no anti-skid system is equipped, take care not to brake too hard.

• *Directional Control*..... *MAINTAIN (PF)*

Use rudder pedal for directional control.

• *"FOURTY"*..... *CALL OUT (PM)*

• *Zero Thrust or Reverse*..... *STOW (PF)*

(rest omitted)

(3) The Supplement to the AOM included the following description of directional control during landing. (Excerpt)

S-4-5 APPROACH & LANDING

(middle section omitted)

7. DIRECTIONAL CONTROL DURING LANDING

The rudder must be used to maintain control while landing. To counter the weathercock effect when the aircraft decelerates due to crosswind, asymmetrical thrust may also be used. (middle section omitted) Nose wheel steering must not be used until the aircraft has decelerated to taxi speed.

2.13.3 Performances on Landing of the Aircraft

(1) Landing distance at the time of the accident

Calculated from Fig. 5-34 in Chapter 5 “Aircraft Performance” of the AOM.

- 1) Conditions Aircraft weight: 11,467 lb, outside air temperature: 27°C, airport pressure altitude: 148 ft, headwind component: 3kt, Vref: 77 kt, flaps: 20°, output: idle from 50 ft AGL, maximum brake (until just before tires skid)

From 50 ft AGL to full stop: about 554 m (1,820 ft)

- 2) Conditions Flaps at 37°, otherwise same as 1)

From 50 ft AGL to full stop: about 427 m (1,400 ft)

(2) Landing distance when using flaps at 20° and reverse under conditions close to (those of) at the time of the accident

Calculated by the Manufacturer from flight test data (accuracy: ±10%)

- Conditions Aircraft weight: 11,400 lb, outside air temperature : 15°C, airport pressure altitude: 0ft, headwind component: 0kt, Vref: 77kt, flaps: 20°, output: idle from 50 ft AGL, using both engines, reverse, and maximum brake

From 50 ft AGL to full stop: about 440 m (1,440 ft)

(3) Required Runway length at the time of the accident

According to the Detailed Regulation of Evaluation for Operation Manual stipulated by the Civil Aviation Bureau, Ministry of Land, Infrastructure, Transport and Tourism (hereinafter referred to as “MLIT”), the landing distance for aircraft operating on set routes in air transportation business (up to 5,700 kg) is supposed to be no more than 60% of the effective runway length in the destination aerodrome. From this, the required runway length when using flaps at 20° under conditions at the time of the accident was about 923m, and the required runway length when using flaps at 37° was 712 m.

This means that the required runway length when using flaps at 20° exceeded the Airport runway length of 800 m.

2.13.4 Regulations on Flying by the Company

The Regulations for the Implementation of Flight Operations of the Company included the following description of the scope and method used when the FO flies an aircraft in the right seat, but included no description concerning flying in the left seat.

2-3 Scope and method used when the FO flies in the right seat (excerpt)

(first section omitted)

(3) Important notes when flying

1) The PIC shall supervise the flight in the left seat.

2) When flying in the right seat, the FO shall convey his intentions to the PIC each time, and shall not fly contrary to the instructions or intentions of the PIC.

3) The PIC shall accurately monitor the situation of flying by the FO, the weather and other matters, shall always be in a state of readiness to take over control, shall keep hands and feet on control devices and power levers while supervising takeoffs and landings, and shall immediately carry out corrective actions when feeling such operations to be necessary.

4) If the PIC, during a flight, judges that it inappropriate to allow the FO to

continue flying, due to the situation of flying by the FO, deterioration in the weather, the occurrence of abnormal circumstances, or some other eventuality, he shall take over the control.

2.13.5 Situation of Ground School Training on the Flight Control System

(1) PIC

The ground school training attended by the PIC during instructor training was as described in 2.5.2.1. Of this, according to the ground instructor in charge of ground school training on the flight control system in Japan, the Maintenance Training Manual (hereinafter referred to as “MTM”) was used as a textbook rather than the PTM. As a result, the guidelines on confirming the NWS center position and the fixed mechanism of the centering latch included in the PTM were not explained. The PIC subsequently attended ground school training on the flight control system using the PTM in Canada.

(2) FO

According to the FO, ground school attended while training for promotion to PIC was as described in 2.5.2.2.

According to the ground instructor in charge of ground school training on the flight control system, the MTM was used as a textbook. It explained that the NWS and rudder are not mechanically connected; however, the guidelines on confirming the NWS center position and the fixed mechanism of the centering latch included in the PTM were not explained. Moreover, this FO was not the only trainee attending the ground school training at this time, but the format used was that the same content was given repeatedly, and the trainees would find time to attend classes as and when convenient during busy preparations for commencement of line flying. For this reason, the ground instructor did not confirm at what point the FO attended classes.

3. ANALYSIS

3.1 Qualifications of Personnel and Others

The PIC and FO had both valid airman competence certificates and valid aviation medical certificates.

As described in 2.5.1(2), prior to the accident, the FO had not taken the additional test needed when employing aircraft crewmembers aged 60 or over in aircraft used for air transport business. Since the FO stated that he was in normal physical condition on the day of the accident and he successfully took the requisite test after the accident, it is probable that this did not affect the occurrence of the accident; however, it is probable that the FO was employed without taking the additional test stipulated in the regulations because he did not have knowledge of the additional test and because crew qualifications were not managed properly by the company.

3.2 Airworthiness Certificate

The Aircraft had a valid airworthiness certificate, and had been maintained and inspected as prescribed.

3.3 Relationship with Meteorological Conditions

As described in 2.7, at the time of the accident, there was a light wind at the Airport, visibility was good, there was no precipitation or other similar phenomenon, and there were scattered clouds with a cloud base of 1,000ft, and it is probable that these did not affect the landing. However, as described in 2.1.1 and 2.1.2 (2), there was a conversation between the PIC and the FO (as PF) on clouds affecting the airfield traffic pattern, and the PF stated that the downwind leg was flown at an altitude 100 ft lower than normal at 600 ft. In view of this, it is probable that there were areas where the cloud base altitude was slightly below 1,000 ft, and it is somewhat likely that there was a period when both pilots were distracted by this.

3.4 Damage to the Aircraft

Based on the aircraft examination described in 2.10, it is highly probable that the damage to the Aircraft described in 2.3 occurred when it collided with the Perimeter Fence and lateral groove.

As described in 2.1.2 (2), the PF stated that he did not feel any abnormality in the Aircraft including the flight control system until the Aircraft touched down. Considering the state of damage to the NWS at the time of the accident, it is somewhat likely that the phenomenon of a creep arising at the functional test of the NWS, as described in 2.11, was caused by internal damage to the hydraulic pressure working mechanism due to the impact of the accident. However, even if this had occurred before the accident, this phenomenon is very limited and does not occur if steering commands have been input. Consequently, it is highly probable that there was no problem with the directional control function of the nose wheel.

In view of these facts, it is highly probable that there was no abnormality that would cause an accident to occur in the Aircraft.

3.5 Situation from Commencing Approach until the Collision with the Perimeter Fence

3.5.1 Situation Upon Approach

As described in 2.13.1.2 (2), according to the procedures in the AOM 4-7-1 DESCENT & APPROACH PREPARATION, a landing briefing is to be held and CAS messages checked, after which a DESCENT & APPROACH CHECKLIST is to be performed and a final confirmation made that the NWS is in the center position (nose wheel is faced forward) before landing.

As described in 2.1.1, the PF had a conversation with the PIC concerning the state of scattered cloud around the Airport at 08:48:00, immediately after finishing the landing briefing at 08:46:37. However, there was no record that the DESCENT & APPROACH CHECKLIST and LANDING CHECKLIST had been performed by the time of touchdown at 08:54:31, while there is also no record of a conversation confirming the NWS position without using the checklists.

In view of these facts, it is highly probable that the Aircraft made its approach without the procedure for confirming that the nose wheel is centered and the checklist being performed before landing.

3.5.2 Situation from Touchdown to Depart from the Side of the Runway

As described in 2.1.2 (2), the PF stated that deflection to the right started immediately after the nose wheel touched down, and that there was a sensation as if the nose was being held by something.

As described in 2.9, nose wheel tire marks extended from near the aiming point marking on Runway 19 to the stop position of the Aircraft. In addition, tire marks of the nose wheel and left main wheel remained as gentle curves that looked mostly like straight lines (angle of deflection about 4°) up to near the north end of the taxiway where the thick tire marks of the right main wheel started, and these were thinner marks compared to the thick tire marks left by the right main wheel.

As described in 2.1.1, from the FDR and CVR records, the Aircraft touched down at 08:54:31, then performed a landing roll while gradually deflecting its heading to the right in a state of slight banking to the left until it departed from the right side of the runway at 08:54:40.

In view of these facts, it is probable that the tire marks of the left main wheel remained on the runway surface as a result of friction with the runway arising while traveling, because it became the main wheel on the outside of the turn supporting the centrifugal force that arose when the Aircraft turned slowly to the right while inclining to the left. Moreover, the continuous tire scuff marks of the nose wheel, which are not seen when landing normally, started from near the touchdown point; therefore, it is probable that the marks resulted from friction with the runway arising because the nose wheel deflected somewhat to the right and had an angle of intersection vis-à-vis the direction of travel of the Aircraft when the nose wheel touched down. Furthermore, it is probable that the thick tire marks of the right main wheel starting from just before the deviation from the runway were brake marks caused by friction with the runway due to the activation of the hard right brake.

It is highly probable that the Aircraft touched down near the runway centerline with the nose wheel slightly deflected to the right, then rolled with the nose gradually turning to the right, and started deviating to the right when it was near the halfway position on the runway.

3.5.3 Situation of the Collision

As described in 2.1.2 (2), the PF stated that he thought that he finally applied both brakes, and that it collided with the Perimeter Fence without being able to finish stopping. Moreover, as described in 2.1.2 (1), the PIC stated that he stopped the engine because the deflection to the right did not stop, and the Aircraft collided with the Perimeter Fence.

As described in 2.9, from the point where the thick tire marks of the right main wheel started, the degree of deflection to the right of marks of the nose wheel and both main wheels gradually increased; moreover, after entering the grass area, the tire marks of the left main wheel also became thick and deep up to just before the Perimeter Fence, with continuous gouge marks on the grass so that the ground underneath was visible. Moreover, the gap between marks of the nose wheel and both main wheels on deviating from the runway was wider on the left side than on the right, and the nose was deflecting further to the right than the direction of travel.

In view of these facts, it is probable that the Aircraft entered the grass area while skidding with its nose pointing slightly further to the right than the direction of travel due to the activation of the right hard brake that started just before the deviation from the runway, after which maximum brakes were applied to both main wheels but could not stop the Aircraft, which first collided with the lateral groove, then collided with the Perimeter Fence and came to a halt.

3.6 Situation After the Collision

As described in 2.1.2 (1), the PIC stated that, after stopping the engine, he looked at the passenger cabin to give instructions for the passengers to evacuate, and confirmed that the company employee who was boarding there to support operations at the Airport was guiding the passengers to evacuate from the Aircraft.

As described in 2.1.2 (3), the company employee stated that, once the Aircraft came to a halt after the impact, when he looked at the two pilots it seemed that they had fainted and were facing down; therefore, he advised the passengers to remain calm while opening the left door of the passenger cabin, and because there was no outbreak of fire and the propellers had stopped, he guided the passengers out of the Aircraft.

As described in 2.3.2, the underside of the nose was damaged.

In view of these facts, it is probable that, after the crewmembers who were close to the nose section that was damaged as a result of the accident had recovered from the impact of the collision and had carried out procedures such as stopping the engine, it took some time until they could start instructions for emergency evacuation of the passengers.

It is probable that, during this time, the company employee who was on board the Aircraft in order to support operations at the Airport judged that the crewmembers had fainted, and having confirmed that the propellers had stopped while calming the passengers, guided and evacuated the passengers in place of the crewmembers as an emergency response.

It is highly probable that after this, as described in 2.12, the passengers and crewmembers were transported to a clinic by an ambulance and other vehicles arranged by the Management Office Staff, and were examined and treated there.

3.7 Situation of NWS

(1) Characteristics of NWS

As described in 2.13.1.1, there is no mechanical connecting mechanism between the NWS of the Aircraft and the rudder flight control system. If an aircraft takes off with the

nose wheel centered, the dead weight of the nose wheel will cause the centering latch to engage with a slot on the airframe side and the nose wheel will be locked in a position (center) with the nose wheel centered.

As described in 2.13.1.2 (1), the PTM explained that the nose wheel must be centered after every takeoff by moving the NWS control lever towards the center until the centering latch locks in the center position and resistance is felt, because the centering latch will not engage properly if the nose wheel is not centered at takeoff. But there was no statement of this content in the training manual of the Company.

As described in 2.1.2 (2), the PF stated that the control lever, which should have been in the center position based on marking after takeoff, had previously been known to move from the center in the before landing check.

In view of these facts, it is probable that the PF and the PIC did not have a detailed understanding of the system involving the centering latch that locks the nose wheel after takeoff, and even in the flight training undertaken by them both before route training, had only confirmed the marking of the center position visually, but had not moved the control lever to confirm that resistance is felt. It is probable that this is the reason why situations in which the centering latch did not engage with the slot on the airframe side and the nose wheel was not locked in the center position during flight had occurred in the past.

(2) Situation of NWS at the time of the accident

1) Situation after takeoff

As stated in (1), it is probable that the PF confirmed the centering of the NWS by only visually confirming the marking of the center position after takeoff, while the PIC also monitored that operation as PM, and had no particular doubts about it.

For this reason, it is somewhat likely that, the centering latch of the NWS did not engage properly and the nose wheel was not locked after takeoff.

2) Deflection of the NWS

As described in 2.1.1 and 2.1.2 (4), the Aircraft encountered turbulence that was probably the wake turbulence of another aircraft while cruising after takeoff, vertical acceleration and airspeed changed significantly, albeit momentarily, and passenger A also felt this impact.

It is somewhat likely that when this happened, something caused the NWS control lever equipped on the same axis as the left seat control wheel to move, whether it was a momentary change in vertical acceleration, an action to recover normal attitude after the turbulence, or some other cause, and the unlocked nose wheel thus deflected to the right.

Since it is highly probable that, as stated in 3.5.1, the procedure for confirming that the nose wheel is centered and the checklist were not performed before landing, it is probable that the Aircraft touched down with its nose wheel deflected to the right, and that it started deflecting to the right along with it.

Moreover, because the touchdown marks of the nose wheel grew wider and thick after the Aircraft entered the grass area, it is probable that the angular difference between the direction of its travel and the direction of the nose wheel gradually widened while rolling on the grass. It is probable that the nose wheel, having been significantly damaged by the collision with the lateral groove and the Perimeter Fence, thereafter finally deflected by up to about 31.5° to the right as a result of the impact at

this time, as described in 2.11.

3.8 Landing Procedures of the PF

(1) Procedures after touchdown

As described in 2.13.2 (2), the procedures after touchdown follows the sequence 1) zero thrust or reverse, 2) brake, 3) directional control using rudder, 4) finish zero thrust or reverse at 40 kt.

Also, based on the description in 2.13.2 (3), it is probable that the rudder must be used for directional control after touchdown while decelerating by reverse, that when nose deflection occurs due to wind or other factors after deceleration when the effectiveness of the rudder has diminished, asymmetrical thrust (power differential) may also be used as an emergency response, and finally NWS may be used when the aircraft has decelerated to taxi speed.

(2) Deceleration procedures

As described in 2.1.2 (2), the PF stated that he normally performs reverse operation immediately after touchdown, but had no time to respond to the Aircraft deflection that had suddenly started.

As stated in 3.5.3, it is probable that the maximum brakes on both main wheels were only applied once the Aircraft entered the grass area on the right of the runway.

In view of these facts, it is probable that the deceleration procedures using reverse and brakes, as the first procedure performed by the PF after touchdown, was not performed, and that maximum brakes of the right and left main wheels were only performed just before the collision when the Aircraft entered the grass area (about one second before the collision).

It should be noted, reverse operation merely involves pulling the gripped power lever toward the operator while rotating it, and does not obstruct rudder control to correct aircraft deflection. Although it is somewhat likely that the PF was shaken by the unexpected deflection, it is probable that he should have activated reverse after touchdown, then applied the brakes to perform deceleration procedures, in accordance with the AOM.

(3) Directional control

1) Directional control using the rudder

As described in 2.1.2 (2), the PF stated that as the situation did not change even after applying the left rudder to deal with the deflection, he thought that he applied the left brake several times.

As described in 2.7, the wind at the time of the accident was a crosswind from the left and slightly from ahead, and due to the weathercock effect when the aircraft heads windward, the nose was prone to face left. In spite of this, as described in 2.1.1, after touching down with a heading of 189°, almost the same as the magnetic bearing of the runway (189.7°), the Aircraft did not change the direction of the nose to the left even momentarily before entering the grass area on the right of the runway with a heading of 209° nine seconds later, but continued to change to the right.

As described in 2.9, the tire marks of the nose wheel and the left main wheel on the runway remained a gentle curve to the right, and continued without even temporarily changing to the left.

Since the rudder position is not recorded in the FDR of the Aircraft, it was not possible to ascertain the situation of rudder control by the PF in detail, but from the

above, it is probable that directional control by the PF using the rudder was not effective in preventing deviation from the runway.

2) Directional control using the brake

As stated in 3.5.3, although brake marks remain on the right just before the deviation from the runway, no conspicuous brake marks of the left main wheel are visible on the runway, and the brake marks start after the Aircraft entered the grass area on the right of the runway. In view of this, it is probable that hardly any directional control was made by the PF by using the left brake only.

Additionally, the brake marks of the right main wheel that started just before the deviation from the runway extended to the accident site. It is somewhat likely that this was because the PF applied the right brake slightly early when he applied both maximum brakes just before the collision.

3) Directional control based on power differential control

Since the PF did not perform reverse operation, as stated in 2.1.2 (2), it is highly probable that he did not perform directional control based on power differential control, performed as a subsequent emergency operation.

4) Directional control based on NWS

It is highly probable that the PF did not perform the NWS based on directional control stated in (1), because, as described in 2.1.2 (2), he has stated that he did not touch the NWS control lever until the end.

Moreover, it is probable that the PF misunderstood that directional control by NWS is performed at the same time while performing directional control by the rudder, since, as described in 2.1.2 (2), the PF stated that he thought that the rudder and NWS were mechanically connected, and the nose wheel would move when the rudder was operated.

(4) Comparison with landing performance

As described in 2.1.1, the Aircraft passed the runway threshold at a speed more or less as planned.

As described in 2.13.3 (1), the landing distance using flaps at 37° in accordance with the AOM and using maximum brake just before the tires skid was about 427 m. In addition, the landing distance estimated by the Manufacturer based on flight test data, with flaps at 20° and reverse and maximum brake activated in conditions close to those at the time of the accident, was about 396-484 m (440 m error $\pm 10\%$).

Since these landing distances are flight test data under the conditions stated in 2.13.3, and sudden deceleration operation such as in flight tests is not performed on passenger flights, the actual landing distance will be somewhat longer. However, it is somewhat likely that if the Aircraft had landed with flaps at 37° in accordance with regulations and maximum brakes had been used to decelerate, or if landing with flaps at 20° as at the time of the accident, if deceleration had been performed by reverse and maximum brake after touchdown, it could have been brought to a halt before the collision with the Perimeter Fence, or even if colliding, the impact could have been mitigated, even if were not possible to correct the deflection.

Moreover, as described in 2.1.1, the Aircraft entered the grass area on the right of the runway in the short time of about nine seconds after touchdown, but it is probable that, if it had decelerated to taxiing speed after touchdown by using reverse and brakes in accordance

with the regulations, directional control using the NWS would also have been possible.

Furthermore, as described in 2.13.3 (3), according to the Detailed Provisions of the Examination Guidelines for Aviation Regulations, the landing distance for aircraft operating on set routes (up to 5,700kg) is supposed to be no more than 60% of the effective runway length in the destination aerodrome. This provision has been stipulated in consideration of safety when operating on scheduled routes. However, since flaps at 20° were used at the time of the accident, the required runway length exceeded the runway length of the Airport.

When landing at the Airport, it would have been appropriate to use flaps not at 20° but at 37°, in accordance with the regulations.

(5) Judgments and operation by the PF

It is somewhat likely that the PF could not fully understand the situation when the nose started deflecting to the right after touchdown, because he did not have sufficient knowledge concerning the aircraft system of the Aircraft, and was unable to properly perform deceleration using reverse thrusts and brakes as he was distracted by the deflection.

Moreover, it is somewhat likely that he was under the misconception that the rudder moved in connection with the NWS and that when using the rudder for directional control, it is also being performed by the NWS at the same time, and thus departed from the side of the runway in a short time without being able to perform proper directional control.

3.9 Judgments and Actions Taken by the PIC

(1) Confirmation using checklists

As described in 2.13.1.2 (2), according to the AOM, Normal Procedures shall be performed by memory in principle, and after its completion, it shall be performed by referring to checklists. However, it is highly probable that, as stated in 3.5.1, the Aircraft had made its approach without it being confirmed that the NWS was in the center position before landing.

It is probable that this was because the PF was distracted by the situation of clouds around the Airport and had thus forgotten to perform the procedures to be done by memory and to give instructions for the checklist to be performed, and also because the PIC, as the PM, did not properly monitor the situation of checklist accomplishment by the PF or did not perform the necessary pointed out.

(2) Readiness for unforeseen situations

As described in 2.1.2 (1), the PIC has stated that the PF had long experience as an airline transport pilot, his training for promotion to PIC was in its final stages, and his flying was stable; accordingly, he was monitoring the operational status with reassurance, and he had not held his foot on the rudder pedal when the deflection of the Aircraft started.

It is somewhat likely that this was because the PIC was thinking of the experience of the PF, the fact that his training was in its final stages and his flying was stable, but he did not have sufficient awareness of responding in readiness for unforeseen situations as the PIC.

(3) Judgments and actions taken by the PIC

As described in 2.1.2 (1), the PIC has stated that he heard a screeching sound before the PF performed reverse operation after touching down, while an abnormal deflection to the right started at the same time. Therefore, he therefore thought that the PF had applied the brake on one side, and that cautioned him not to apply the brake. After that, since the PF

appeared unable to correct the deflection, the PIC controlled the rudder together and put his hand on the power lever over the hand of the PF from the point when the Aircraft departed from the side of the runway and entered the grass area, but he could not deal with the contingency by means such as controlling the direction by using reverse to decelerate and power differential control after deceleration.

As described in 2.1.2 (2), the PF has stated that he was instructed by the PIC to apply the brake when the deflection started.

In view of these facts, it is highly probable that the PIC judged that the PF had applied one of the brakes at the point when the deflection started and he felt an abnormality, and gave the instruction “Don’t brake” with the intention of verbally warning the PF not to apply one brake only, but this was not conveyed correctly to the PF.

It is highly probable that the PF could not correct the deflection of the Aircraft after this, and the PIC took control of the rudder in order to support handling by the PF at the point when it departed from the side of the runway, but did not take over control from the PF until it finally collided with the Perimeter Fence.

In this situation, the PIC was not anticipating the NWS deflection, and gave verbal instructions because he judged that the PF had applied on the right brake; however, it is probable that if the situation was not corrected even then, it would have been appropriate for him to take over immediately and perform controls such as decelerating and stopping the Aircraft himself.

Thus, it is somewhat likely that the inadequate response of the PIC in the event of an unforeseen situation contributed to the fact that he could not properly control the aircraft when it started deflecting and it collided with the Perimeter Fence.

3.10 Training in the Company

(1) Ground training for the FO (PF)

As described in 2.5.2.2 (2), the company had deferred the originally planned ground school training program due to preparations for commencement of line flying, among other factors; therefore, the program was not completed. However, it was regarded as completed as it was intended to be carried out at a later date, in order that the PF was awarded the qualification as FO after completing only 16 of the prescribed 48 hours of ground school training.

As described in 2.13.5, the ground instructor used the MTM as a textbook in ground school training to train the PF for promotion to PIC, but guidelines on confirming the NWS center position and the system regarding the centering latch that locked the nose wheel of an aircraft after takeoff, which were included in the PTM, were not explained. Moreover, the PF was not the only trainee attending the ground school training at this time, but the format used was that the trainees would find time when they were free to attend classes whenever convenient during busy preparations for commencement of line flying; therefore, the ground instructor did not confirm at what point the PF attended classes.

In view of the statements in 3.8(3)4, it is probable that the PF misunderstood that the rudder and NWS were mechanically connected, and that if the rudder were used for directional control, the direction of the NWS would also be controlled at the same time.

In view of these facts, it is probable that the company had not properly confirmed the effectiveness of ground school training that should be held prior to route training and

training on the establishment of knowledge. It is probable that the fact that the company placed priority on achieving this on the day scheduled for commencement of line flying contributed to this.

It was inappropriate for the company to award the qualification as FO without the requisite hours being satisfied.

(2) Instructor training

As described in 2.5.2.1(2), according to the company, as well as the requisite ground school training, the PIC had also undergone flight training for takeover of control, which is necessary for qualification as a flight instructor, in line with the Provisional QM. However, this item was not included in the subjects in the record of implemented training, while there was also no record of any evaluation concerning this training by the flight instructor in charge of the training.

It is highly probable that, as stated in 3.9 (3), the PIC merely gave a verbal instruction of unclear content, even when sensing an abnormality, and did not take over control from the PF.

In view of these facts, it is probable that, of the instructor training implemented by the Company, the training on takeover and other response to unforeseen situations was not properly implemented.

(3) System of training

It is somewhat likely that one cause of this accident was that the FO undertook PF duties without adequate knowledge of the aircraft system, because the Company did not properly confirm the effectiveness of ground school training and training on the establishment of knowledge given to the FO. It is also somewhat likely that the insufficient awareness by the PIC of readiness for unforeseen situations and his inadequate response in the event of such situations, because the instructor training given to the PIC was not properly carried out, contributed to the occurrence of this accident.

In view of these facts, it is required that the Company must correctly ascertain the present state of ground training and flight training, and improve the situation of training in order that the stipulated training can be carried out properly.

3.11 Provisions on Flying in the Left Seat by the FO

As described in 2.13.4, the Regulations for the implementation of flight Operations of the Company included provisions on flying by the FO in the right seat, but no provisions on flying in the left seat.

It is somewhat likely that the lack of provisions on the method of implementation when the FO flies in the left seat contributed to the inadequate response of the PIC in the event of unforeseen situations, as described in 3.9 (3) .

In view of this, it is desirable that the Company should also provide for the method of implementation when the FO flies in the left seat, under guidance from the West Japan Civil Aviation Bureau, the Ministry of Land, Infrastructure, Transport and Tourism (MLIT), which has jurisdiction over operations by the Company, in order that the PIC can respond to unforeseen situations without hesitation.

3.12 Compliance with the Regulations

As stated in 3.9 (1), it is probable that it was not confirmed that the nose wheel was centered

before landing, because not only did the PF in training for promotion to PIC forget the operations to be done by memory and the instructions for the DESCEND & APPROACH checklist to be performed as stipulated in the AOM, but also because the PIC, as the PM, did not properly monitor the situation of checklist accomplishment or did not perform the necessary pointed out. It is also probable that this was why the nose deflected after the nose wheel touched down in this accident.

Based on the fact that non-compliance with regulations pertaining to such basic operation has arisen during training for promotion to PIC, which should be implemented in observance of the basics, it is desirable that the company should take corrective measures after ascertaining the actual situation of operation related to compliance with regulations.

4. CONCLUSIONS

4.1 Findings

(1) The FO had a valid aviation medical certificate, but was flying without taking the additional test stipulated in the regulations. Although it is probable that this did not influence the occurrence of the accident, it is probable that this resulted from the fact that the FO did not have knowledge of the additional test and that the company did not properly manage crew qualifications. (3.1) *9

(2) It is highly probable that there was no abnormality that would cause an accident to occur in the Aircraft. (3.4)

(3) Situation on approach

It is highly probable that the Aircraft made its approach without the procedure for confirming that the nose wheel is centered before landing. (3.5.1)

(4) Situation from touchdown to departed from the side of the runway

It is highly probable that the Aircraft touched down near the runway centerline with the nose wheel slightly deflected to the right, then rolled with the nose gradually turning to the right, and started deviating to the right when it was near the halfway position on the runway. (3.5.2)

(5) Situation of the collision

It is probable that the Aircraft entered the grass area while skidding with its nose pointing slightly further to the right than the direction of travel due to the activation of the right hard brake that started just before the deviation from the runway, after which the maximum brakes were applied to both main wheels but could not stop it, which first collided with the lateral groove, then collided with the Perimeter Fence and came to a halt. (3.5.3)

(6) Situation after the collision

It is probable that, after the crewmembers who were close to the nose section that was damaged as a result of the accident had recovered from the impact of the collision and had carried out operations such as stopping the engine, it took some time until they could start instructions for emergency evacuation of the passengers.

It is probable that the company employee who was on board the Aircraft in order to support operations at the Airport judged that the crewmembers had fainted, and having confirmed that the propellers had stopped while calming the passengers, guided and evacuated the passengers in place of the crewmembers as an emergency measure.

It is also highly probable that after this, the passengers and crewmembers were transported to a clinic by an ambulance and other vehicles arranged by the Management Office Staff, and were examined and treated there. (3.6)

(7) Situation of NWS

It is somewhat likely that the nose wheel was not locked because the PF confirmed the centering of the NWS by only visually confirming the marking of the center position after takeoff.

It is somewhat likely that after this, something caused the NWS control lever to move, whether it was a momentary change in vertical acceleration, an action to recover normal

*9 The numerals appearing at the end of each sentence in this section refer to the main section numbers in "3 ANALYSIS" related to the description in question.

attitude after the turbulence, or some other cause, and the unlocked nose wheel thus deflected to the right.

It is probable that because the procedure for confirming the direction of the nose wheel and the checklist were not performed before landing, the Aircraft touched down with its nose wheel deflected to the right and it started deflecting to the right. (3.7)

(8) Landing Procedures of the PF

It is somewhat likely that the PF could not fully understand the situation when the nose started deflecting to the right after touchdown, because he did not have sufficient knowledge concerning the aircraft system of the Aircraft, and was unable to properly perform deceleration using reverse thrusts and brakes as he was distracted by the deflection.

Moreover, it is somewhat likely that he was under the misconception that the rudder moved in connection with the NWS and that when using the rudder for directional control, it was also being performed by the NWS at the same time, and thus departed from the right side of the runway in a short time without being able to perform proper directional control.

Furthermore, since the flaps at 20° at the time of the accident, the required runway length exceeded the runway length of the Airport; therefore, it would have been appropriate to use flaps at 37°, in accordance with the regulations. (3.8)

(9) Judgments and actions taken by the PIC

It is probable that the PIC, as the PM, did not properly monitor the situation of checklist accomplishment regarding NWS or did not perform the necessary pointed out.

It is somewhat likely that the PIC was thinking of the experience of the PF, the fact that his training was in its final stages and his flying was stable, but he did not have sufficient awareness of responding to unforeseen situations.

It is highly probable that the PIC did not take over control from the PF until the Aircraft finally collided with the Perimeter Fence.

The PIC was not anticipating the NWS deflection, and gave verbal instructions because he judged that the PF had applied the right brake; however, it is probable that if the situation was not corrected even then, it would have been appropriate for him to take over immediately and perform controls such as decelerating and stopping the Aircraft himself.

It is somewhat likely that the inadequate response of the PIC in the event of an unforeseen situation contributed to the fact that he could not properly control the aircraft when it started deflecting and it collided with the Perimeter Fence. (3.9)

(10) Training in the company

1) Ground training for the FO (PF)

It is probable that the company had not properly confirmed the effectiveness of ground school training that should be held prior to route training and training on the establishment of knowledge. It is probable that the fact that the company placed priority on achieving this on the day scheduled for commencement of line flying contributed to this.

2) Instructor training

It is probable that, of the instructor training implemented by the company, training on takeover and other response to unforeseen situations was not properly implemented.

3) System of training

It is somewhat likely that one cause of this accident was that the FO undertook PF duties without adequate knowledge of the aircraft system, because the Company did not

properly confirm the effectiveness of ground school training and training on the establishment of knowledge given to the FO. It is also somewhat likely that the insufficient awareness by the PIC of readiness for unforeseen situations and his inadequate response in the event of such situations, because the instructor training given to the PIC was not properly carried out, contributed to the occurrence of this accident.

In view of these facts, it is required that the Company must correctly ascertain the present state of ground training and flight training, and improve the situation of training so that the stipulated training can be carried out properly. (3.10)

(11) Provisions on flying

It is somewhat likely that the lack of provisions on the method of implementation when the FO flies in the left seat contributed to the inadequate response of the PIC in the event of unforeseen situations.

It is desirable that the company should also provide for the method of implementation when the FO flies in the left seat, under guidance from the West Japan Civil Aviation Bureau, MLIT, which has jurisdiction over operations by the Company, in order that the PIC can respond to unforeseen situations without hesitation. (3.11)

(12) Compliance with the regulations

It is probable that it was not confirmed that the nose wheel was centered before landing, because not only did the PF forget the instructions for the checklist to be performed as stipulated in the AOM, but also because the PIC, as the PM, did not properly monitor the situation of checklist accomplishment or did not perform the necessary pointed out. It is also probable that this was why the nose deflected after the nose wheel touched down in this accident.

Based on the fact that non-compliance with regulations pertaining to basic operation has arisen during training for promotion to PIC, which should be implemented in observance of the basics, it is desirable that the company should take corrective measures after ascertaining the actual situation of operation related to compliance with regulations. (3.12)

4.2 Probable Causes

It is highly probable that this accident occurred because, when the Aircraft landed, the PF could not properly control the aircraft that had started to deflect after touchdown, as a result of which it departed from the side of the runway and collided with the Perimeter Fence, and the aircraft was damaged.

It is probable that the Aircraft started to deflect after touchdown because the PF forgot the checklist and the PIC as PM did not properly monitor or did not perform the necessary pointed out, as a result of which the Aircraft touched down with the nose wheel deflected to the right.

It is somewhat likely that the PF could not properly control the Aircraft that had started to deflect after touchdown because he did not have sufficient knowledge concerning the aircraft system of the Aircraft, as a result of which he could not fully understand the situation when the deflection started. It is somewhat likely that the inadequate response of the PIC in the event of an unforeseen situation contributed to this.

It is probable that PF had insufficient knowledge and could not fully understand the situation when the deflection started, because the Company had not properly confirmed the effectiveness of ground school training that should be held prior to route training and training on the establishment of knowledge.

5. SAFETY ACTIONS

5.1 Safety Actions

5.1.1 Safety Actions Taken by the Civil Aviation Bureau, Ministry of Land, Infrastructure, Transport and Tourism

After the accident, the West Japan Civil Aviation Bureau, MLIT carried out the special safety audit of the Company. It then issued the following business improvement orders to the Company with a view to improving problem areas found in the audit.

- (1) Radically revise the training system for flight crew members.
- (2) Reinforce safety awareness and provide compliance education.
- (3) Overhaul the safety management system.

5.1.2 Safety Actions Taken by the Company

After the accident occurred, the Company planned and partially implemented the following safety actions.

(The completion date of implemented items is shown in parentheses.)

- (1) Stipulation of implementation guidelines on pre-flight briefing
Revision of the Regulations for the Implementation of Flight Operations to ensure no omissions in pre-flight checks, including the purpose of flight, allocation of duties between pilots, and response in the event of emergencies.
- (2) NWS confirmation guidelines
Guidelines on confirming centering latch activation in the PTM to be incorporated in the AOM and training manuals.
- (3) Re-education on flight regulations
Re-education on the content of the AOM and others, and on the importance of complying with matters stipulated (completed on August 28, 2016).
- (4) Familiarization training
 - 1) NWS operation
 - 2) Instructor takeover guidelines
- (5) Formulation of guidelines on takeover during route training and standards for judgment.
Revision of the Regulations for the Implementation of Flight Operations and the Air Crew Flight Operations manual.
- (6) Radical revision of the training system for air crew
 - 1) Revision of the QM.
 - 2) Creation of a new Training Section in charge of formulating training plans, monitoring progress, managing proficiency, and other work with a view to strengthening the training system (completed on May 1, 2016).
 - 3) Creation of the Operation manual for the Training Section (completed on July 20, 2016).
 - 4) Enhancement of training materials for instructors.
Creation of the Instructor's Guide and the Route Training Guide (completed on October 6, 2016).
- (7) Reinforcement of safety awareness and compliance education
 - 1) President's briefing document on "Safety First" circulated to all employees (completed on March 24, 2016).

- 2) Employee education carried out to improve safety awareness (completed on April 7, 2016).
 - 3) Stipulation that this education should continue on a regular basis (completed on June 14, 2016).
- (8) Reconstruction of the safety management system
- 1) Safety managers replaced by staff familiar with airline transport business safety management promotion duties (completed on May 17, 2016).
 - 2) System created to reflect employees' views more fully (completed on June 14, 2016).

5.2 Safety Actions Considered Necessary for the Company in Future

The Company must correctly ascertain the current situations of ground training and flight training and improve its system for training to enable the stipulated training to be carried out properly.

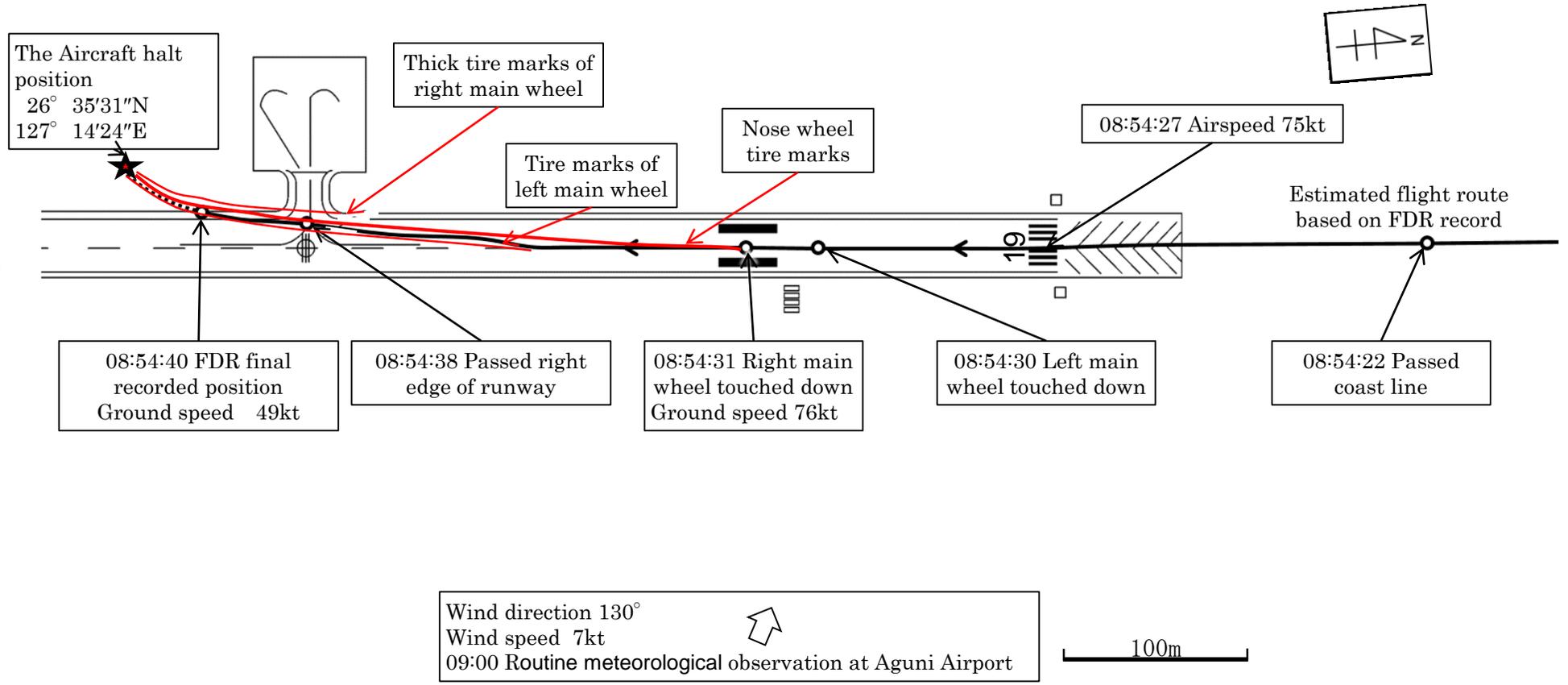
6. SAFETY RECOMMENDATIONS

It is somewhat likely that one cause of this accident was that the FO did not have adequate knowledge of the aircraft system. It is also somewhat likely that the inadequate response of the PIC in the event of an unforeseen situation contributed to the occurrence of this accident. It is probable that these resulted from the fact that ground training and flight training stipulated by the Company were not carried out properly.

In order to contribute to preventing the recurrence of similar accidents, based on the result of investigation of the accident, the Japan Transport Safety Board recommends, in accordance with the provisions of Article 27 Paragraph 1 of the Act for Establishment of the Japan Transport Safety Board, that First Flying Co., Ltd. give careful consideration to the following and take necessary measures thereof:

Ascertain the current situation of ground training and flight training correctly, and then improve its system for training to enable the stipulated training to be carried out properly.

Fig. 1 Estimated Flight Route and Accident Site



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Fig. 2 Three Angle View of Viking DHC-6-400

Unit: m

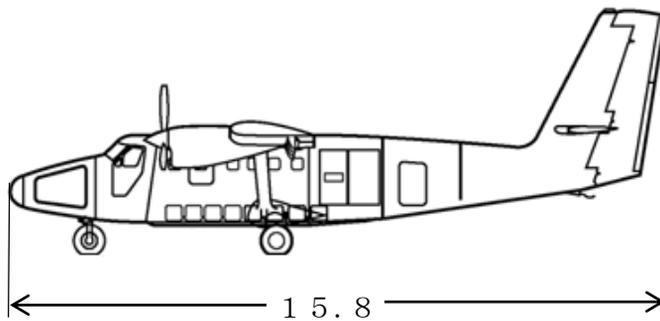
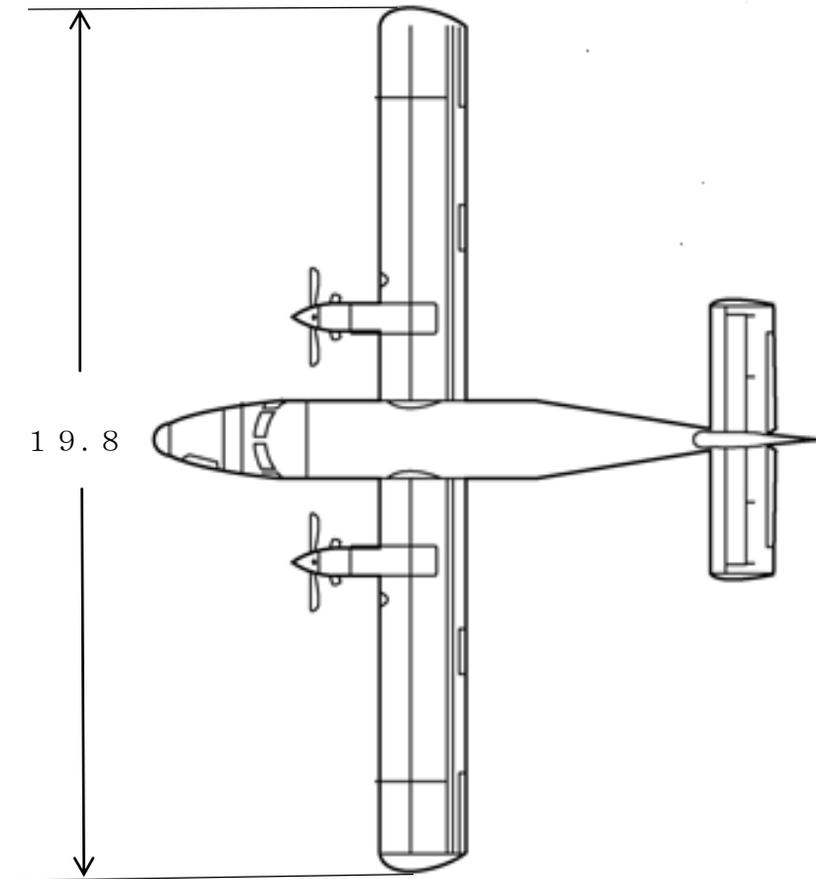
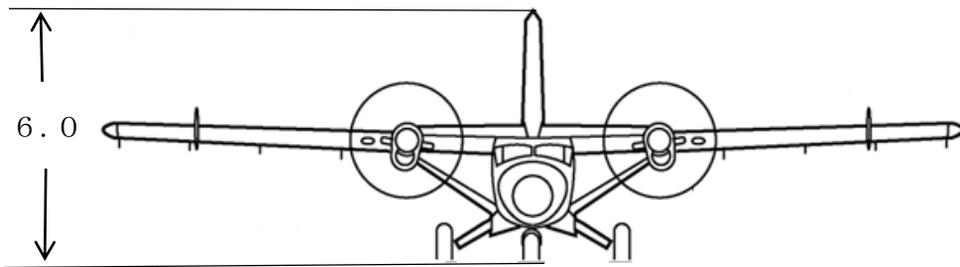


Photo Accident Aircraft

