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# AIRCRAFT ACCIDENT INVESTIGATION REPORT

AIR CENTRAL CO., LTD.  
BOMBARDIER DHC-8-402, JA849A  
KOCHI AIRPORT, JAPAN  
MARCH 13, 2007

May 28, 2008

Aircraft and Railway Accidents Investigation Commission  
Ministry of Land, Infrastructure and Transport

The investigation for this report was conducted by Aircraft and Railway Accidents Investigation Commission, ARAIC, about the aircraft accident of Air Central Co.,Ltd. Bombardier DHC-8-402 in accordance with Aircraft and Railway Accidents Investigation Commission Establishment Law and Annex 13 to the Convention of International Civil Aviation for the purpose of determining cause of the aircraft accident and contributing to the prevention of accidents and not for the purpose of blaming responsibility of the accident.

This English version report has been published and translated by ARAIC to make its reading easier for English speaking people those who are not familiar with Japanese. Although efforts are made to translate as accurate as possible, only the Japanese version is authentic. If there is difference in meaning of the texts between the Japanese version and the English version, texts in the Japanese version are correct.

Norihiro Goto,  
Chairman,  
Aircraft and Railway Accidents Investigation Commission

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AIR CENTRAL CO., LTD.  
BOMBARDIER DHC-8-402, JA849A  
KOCHI AIRPORT, JAPAN  
AT ABOUT 10:54 JST, MARCH 13, 2007

2008, May 22

To be adopted by the Aircraft and Railway Accidents Investigation Commission  
(Air Sub-committee)

Chairman	Norihiro Goto
Member	Yukio Kusuki
Member	Shinsuke Endo
Member	Noboru Toyooka
Member	Yuki Shuto
Member	Akiko Matsuo

# **1. PROCESS AND PROGRESS OF AIRCRAFT ACCIDENT INVESTIGATION**

## **1.1 Summary of the Accident**

On March 13, 2007 (Tuesday), a Bombardier DHC-8-402, registered JA849A, operated by Air Central Co., Ltd. took off Osaka International Airport at 08:21(JST) as All Nippon Airways flight 1603 on a regularly scheduled service under the arrangement of joint business of transportation, and landed at its destination, Kochi Airport, without the nose landing gear extended and received a damage of the forward lower fuselage.

There were 60 persons on board, including the pilot in command (PIC), three other crewmembers and 56 passengers, and nobody was injured.

## **1.2 Outline of the Accident Investigation**

### **1.2.1 Investigation Organization**

On March 13, 2007, the Aircraft and Railway Accidents Investigation Commission assigned an investigator-in-charge and another investigator to the investigation of the accident. In addition, an investigator was appointed on March 14, 2007. Furthermore on March 26, 2007, two investigators were appointed.

### **1.2.2 Representative and Adviser of Foreign State**

An accredited representative and a technical adviser from Canada, the state of design and manufacture of the aircraft involved in this accident, participated in the investigation.

### **1.2.3 Implementation of Investigation**

March 13 and 14, 2007	On-site investigation and interviews
March 22 and 23, 2007	Search for fall-offs at Osaka International Airport and Kochi Airport
March 29 - June 30, 2007	Parts investigation
April 11, 2007, April 20, 2007	Maintenance Record investigation
May 7, 2007 - July 11, 2007	Aircraft and Maintenance Record investigation
September 26 - 28, 2007	Manufacturing process investigation (Bombardier Inc. and Goodrich Corp.)
December 7, 2007	Interviews

### **1.2.4 Comments from Parties Relevant to the Cause of the Accident**

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

### **1.2.5 Comments from Participating State**

Comments were invited from the participating state.

## 2. FACTUAL INFORMATION

### 2.1 History of the Flight

On March 13, 2007, a Bombardier DHC-8-402, registered JA849A (hereinafter referred to as “the Aircraft”), operated by Air Central Co., Ltd. (hereinafter referred to as “the Company”), took off Osaka International Airport at 08:21 Japanese Standard Time (JST)(unless otherwise indicated, all times are JST, UTC+9h) bound for Kochi Airport as All Nippon Airways (hereinafter referred to as “ANA”) Flight 1603 on a regularly scheduled service under the arrangement of joint business of transportation\*<sup>1</sup>. The PIC took the left seat as Pilot Flying (primarily responsible for aircraft maneuvering duty) while the first officer took the right seat as Pilot Not Flying (primarily responsible for non-maneuvering duty). (When the Aircraft departed from Osaka International Airport, the first officer assumed the role of PF while the PIC assumed the role of PNF. They exchanged their roles when it became clear that the nose landing gear could not be extended.)

The flight plan submitted to the Osaka International Airport Office (JCAB) was as outlined below.

Flight rules:	Instrument Flight Rules (IFR)
Departure aerodrome:	Osaka International Airport
Estimated off-block time:	08:10
Cruising speed:	306 knots
Cruising altitude:	FL160
Route:	SETOH (Reporting point) - KTE (Kagawa VOR/DME) - KRE (Kochi VOR/DME)
Destination aerodrome:	Kochi Airport
Estimated flight time	0 hr and 41 min
Fuel loaded in terms of Endurance	2 hr and 45 min
Alternate aerodrome:	Osaka International Airport

#### 2.1.1 Flight History based on Digital Flight Data Recorder, Cockpit Voice Recorder and Air Traffic Control Communications Records

08h47m40s Kochi Aerodrome Control Facility (hereinafter referred to as “the Tower”) issued to the Aircraft a landing clearance to Runway 32 of Kochi Airport.

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\*<sup>1</sup> “Arrangement of joint business of transportation” refers to an arrangement whereby a domestic airline transportation service is jointly provided by two Japanese operators, which are jointly responsible to passengers or freight owners for transportation (including liability to customers for damages) in conformity with a Circular issued by the Director of the Aviation Industries Division, Administration Department, Japan Civil Aviation Bureau, the Ministry of Land, Infrastructure, Transport and Tourism.

08h49m50s	The Aircraft reported to the Tower that the landing gear could not be extended, so troubleshooting would be made while making holding flight over Katsura Beach <sup>*2</sup> .
09h14m00s	The Aircraft requested the Tower for permission to make a low pass at 500 feet over the runway so that mechanics on the ground could check the condition.
09h21m00s	The Aircraft carried out the 1st low pass.
09h35m05s	The Aircraft carried out the 2nd low pass.
09h57m58s	The Aircraft made an attempt to extend the nose landing gear <sup>*3</sup> by utilizing acceleration force during a steep turn.
10h19m25s	The Aircraft requested the Tower for permission to conduct a touch-and-go so as to apply an impact to the nose landing gear.
10h25m23s	The Aircraft carried out a touch-and-go.
10h34m00s	The PIC directed the cabin attendants to move some passengers to aft cabin.
10h35m00s	Fire extinguishing agent was sprayed on the runway between T-2 <sup>*4</sup> and T-3 by the airport fire service.
10h47m14s	The Aircraft requested the Tower for landing clearance.
10h52m10s	The Tower notified the Aircraft of wind direction of 120 degrees and wind velocity of 1 knot.
10h54m16s	The Aircraft landed without the nose landing gear extended, and stopped around the mid length of the runway.

Based principally on the records of the digital flight data recorder (hereinafter referred to as “DFDR”), after the Aircraft touched down on the runway at 106 knots with the main landing gears, it continued rolling maintaining its pitch attitude horizontal at first, and then lowered its nose slowly, which touched the runway (at 79 knots) 12 seconds later than the main landing gears. With its nose touching the runway surface, the Aircraft continued to decelerate maintaining on the runway centerline, and slowly came to rest at around the mid length of the runway 22 seconds after the nose touchdown.

### 2.1.2 Statements of Crewmembers

#### (1) PIC

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<sup>\*2</sup> “Katsura Beach” is located about 20 km to the southwest of Kochi Airport.

<sup>\*3</sup> “Gear” and “landing gear” have the same meaning.

<sup>\*4</sup> “T-2” and “T-3” are the names of taxiway of Kochi Airport, the numbers of which are given sequentially from the threshold of Runway 32 of the airport. (See Figure 2.)

The first officer, who was the PF at the time of departure, performed the pre-departure exterior check of the main and nose landing gears, and reported to me, “No abnormality has been found in the exterior check.”

While making a visual approach to Runway 32 of Kochi Airport, the gear lever<sup>\*5</sup> was operated to down position at an altitude of 1,500 ft as usual. Then, we confirmed that, on the landing gear control panel of the instrument panel, two green lights for the main landing gears, one amber light for the doors of the nose landing gear, and at the bottom, the red nose landing gear unsafe advisory light illuminated.

At this point, I requested the Tower, “Holding at 3,000 ft over Katsura Beach for troubleshooting.”

As the first action, I carried out the “alternate landing gear extension check list” (refer to Clause 2.16) with the gear lever in down position. I tried it twice, but the situation did not change.

Next, the first officer opened the gear alternate extension door located on the floor left aft of the right pilot seat and pulled the nose landing gear release handle, but the display on the instrument panel did not change.

The first officer said that he had felt “the operation was somewhat heavy.”

As I turned on the check switch of the Landing Gear Downlock Verification Light<sup>\*6</sup>, as written in the last part of the check list, only the two lights for the main landing gears illuminated, but the light for the nose landing gear did not illuminate.

From this point, I thought that the nose landing gear was not extended.

When we reported to the Company (mechanics stationed at Kochi Airport, the same hereinafter in 2.1.2) these actions and their results over the VHF radio, they instructed us, “Turn on the Taxi light<sup>\*7</sup> and make a low pass to show if the taxi light can be lit.” So I made a low pass at an altitude of about 300 ft, and the Company reported to us “The nose landing gear door is not open.”

When I made the first low pass, I also checked the CBs<sup>\*8</sup>, but there were no tripped CBs. After the low pass, we were holding over Katsura Beach at an altitude of 3,000 ft.

At the second low pass, we were instructed, “Operate the gear lever to up position and try the alternate extension before the low pass.” So I operated the gear lever to up position. Although the red and green lights for the main landing gears on the landing gear control panel went off, the amber light for the door of the nose landing gear was flickering. It gave me an

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<sup>\*5</sup> The word “gear lever” in this report is called “landing gear selector lever” by the aircraft manufacturer.

<sup>\*6</sup> “The Landing Gear Downlock Verification Light” is located under the alternate gear extension door; when the landing gears (NG, LH, RH) are Downlocked, corresponding green lights illuminate when the Check switch is turned on.

<sup>\*7</sup> When the Taxi light switch in the cockpit is turned on, the taxi light installed in the nose landing gear turns on if the landing gear is downlocked

<sup>\*8</sup> “CB” means a circuit breaker.



impression of illuminating for a moment and then going off.

Although I implemented the alternate gear down extension procedure, nothing changed. After I pulled the handle, I think that the amber and red lights for the nose landing gear on the landing gear control panel illuminated.

The light below the alternate extension door on the floor did not turn on even after the check switch was operated to on position.

After low passes twice, I made a steep turn with a bank angle of about 50 degrees and at a speed of about 170 knots, but the nose landing gear was not extended. Then, I applied several hard pitch changes in an attempt to extend the nose landing gear, but it did not extend.

Next the Company instructed us, "Give a shock to the gear by touch-and-go."

Upon the touchdown of the main wheels, I immediately applied power and took off, but the nose landing gear was not extended, so we headed for Katsura Beach.

Again, the Company instructed us, "Operate the gear lever to down position and then to up position as soon as the green lights for the main landing gear downlock illuminate, and repeat the operation," so I made the operation about ten times, but the nose landing gear did not extend.

At that point, the Company told us to check the CB once again. In addition, they told us, "Operate the steering tiller<sup>\*9</sup>," so I did it, but nothing changed.

Then, the Company instructed us, "Pull the nose gear alternate release handle with force as there are sticky feels twice when it is pulled," so the first officer left his seat and pulled the handle with all his might, but the nose landing gear did not extend.

We performed normal gear down and alternate extension operations at least twice after that.

Then, the Company suggested us, "Proceed with the operation with confirmation by the mechanic," so the first officer read out the checklist as he performed the operation, and the mechanic confirmed that the operation was conducted according to the procedure, but the situation remained the same.

At this point, I decided to land with the nose landing gear not extended, because the quantity of remaining fuel was getting short of 1,000 pounds. I planned to have about 700 pounds of fuel, thinking, "I want to land with fuel permitting go-around once."

We conducted the emergency landing checklist for the Aircraft, but because there was no such checklist as the nose gear up landing for the Aircraft, we started to prepare recalling that of another type of aircraft from my experience.

During periodic emergency escape training, I have twice or so undergone the training based on a scenario I wrote by myself in which the main landing gear or nose landing gear is not extended. An actual aircraft was used on the ground, and company employees assumed the role of

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<sup>\*9</sup> "Steering tiller" means the steering handle installed on the left side of the left pilot seat, and is operated during taxiing.

passengers. Recalling that training, I considered adjustment of center of gravity position. After confirming the position, I instructed the cabin crew to move five to ten passengers to aft cabin.

I decided to use the flap of 35 degrees to get the lowest  $V_{so}^{*10}$  in order to shorten the landing distance, to make touchdown before the aiming point marking, and to keep the nose afloat as long as possible to reduce the shock.

I made an announcement to the passengers, "After landing an emergency escape may be done if there is a possibility of fire. Should that happen, stay calm and follow the instruction of the CAs<sup>\*11</sup>."

I thought, "Use of reverse pitch increases drag, may bring the nose down abruptly and make it difficult to maintain heading after landing," so I decided not to use reverse pitch during landing roll, and it was after the nose touched down on the runway that I moved the power levers from Flight Idle to DISC<sup>\*12</sup> position. When the Aircraft finally came to rest, I presumed there was remaining fuel for about 20 minutes of flight.

As to the fire extinguishing agent, the Tower asked us, "Where should it be sprayed?" but, as I could not predict where the nose would touch down, so I requested, "Please spray it beyond T-2." I expected that the agent would be sprayed over a longer distance, but it was too short considering the result.

## (2) First officer

I conducted the exterior check visually at Osaka International Airport, and found no abnormality. I did not sense any abnormality after takeoff, and there was nothing unusual during the flight.

As the nose landing gear could not be downlocked, we headed for Katsura Beach for troubleshooting. We carried out the Alternate Manual Extension there, but the situation did not change.

I contacted with the Company and received advice. I conducted the checklist and reported that the verification light did not illuminate.

As the company told me, "We'd like to check if the taxi light is lit," we performed a low pass, but it was confirmed that they could not see the light from the ground.

We carried out low passes twice. The first low pass was carried out after conducted the alternate procedure with the gear lever in down position, and the second low pass was carried out after conducted the alternate procedure with the gear lever in up position at first.

Because we implemented the first Alternate Manual Extension Procedure with the gear

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<sup>\*10</sup>  $V_{so}$  means the stall speed in landing configuration (gear down, flap full down)

<sup>\*11</sup> "CA" stands for cabin attendants

<sup>\*12</sup> "DISC" means to make propeller pitch to zero degree hydraulically by operating the power lever to DISC position. Then the propellers act as discs that increase air drag and thereby creating a braking effect.

lever in down position, I moved the gear lever in up position to return to the original condition, then the amber light for the nose landing gear door started flickering (about once every two seconds).

Then we conducted the Alternate Checklist, but the situation remained the same. When the alternate handle is pulled, I usually feel two cushions, but at that time, I could pull it smoothly. I had an experience to use the alternate handle on a simulator, but the feel was different from that of the simulator.

As I was told that the nose landing gear might be extended by a steep turn, we tried at a bank angle of 50 degrees, but nothing changed.

After the second low pass, the Company instructed us, "Give a shock to the gear by touch-and-go in order for its extension", so we performed a touch-and-go, but there was no change.

Then, the Company instructed us, "Repeat to operate the gear lever up and down," so we repeated the operation ten times or more, but nothing changed.

Also, the Company instructed us, "Pull the alternate handle as hard as possible," I stood up and pulled it, but there was no change.

As we received the instruction, "Perform opening and closing of the gear door," I performed the operation to up and down the main and nose landing gear more than ten times, but nothing changed.

The Company told us, "Check the CB," so I checked it but found no problem.

Furthermore, as we were instructed, "Operate the steering tiller," the PIC operated it but there was no change.

As the remaining fuel was getting low, we considered a belly landing.

After we carried out the Alternate Manual Extension procedure by reading it out with the mechanic on the ground, we made the landing.

### (3) Two CAs

After we had prepared to land at Kochi Airport, the PIC told us over the interphone, "As the nose gear cannot be extended, we are holding and troubleshooting," so I announced to the passengers that we were holding over Kochi and it would take a while before arrival. After about 20 minutes had passed, the PIC told us over the interphone, "There is some possibility of performing STEP\*<sup>13</sup>," and the PIC made an announcement to the passengers, "We are not successful to extend the nose landing gear, and in the course of troubleshooting with the assistance of the mechanics on the ground, so please wait a while. " It seemed that some passengers were wondering what would happen, but most of them were calm without showing

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\*<sup>13</sup> "STEP" is the word commonly used among crews of the Company, which means the steps to be taken for cabin preparation performed by the CAs before emergency landing or ditching, which are stipulated by the cabin attendant duty manual byelaw of the Company.

any uneasiness.

As we were already prepared for landing, the seat belt sign remained illuminated. But some passengers asked to use the lavatory, and I conveyed their request to the PIC. Then the seat belt sign was turned off, and as many as ten passengers used the lavatory. The PIC told us over the interphone, "I'll make a steep turn and a touch-and-go to give a shock to extend the gear. In case of doing STEP, explain well about the brace position (shock resistant posture). I think it necessary to ask some passengers to move to the aft cabin." We felt that we were able to stay calm while preparing in mind to carry out STEP.

The PIC made an announcement each time we made a steep turn and a touch-and-go, so the passengers kept calm and none of them asked questions about the cause or what was going on. Then, the PIC instructed us over the interphone, "We are planning to land in 15 minutes with the gear not extended. Proceed with STEP." At that time, we confirmed with the PIC that CAs would be given notice before two minutes and before thirty seconds and that the aircraft would be in nose down attitude after landing. The PIC made an announcement to the passengers, "We will land in 15 minutes with the nose gear not extended, and we might have to make an emergency escape, but please feel safe and follow the guidance of the cabin attendants as they have had sufficient training." I checked the number of vacant seats in the aft cabin and reported it to the PIC, whereupon the PIC instructed me to move seven passengers sitting close to the wing. So I asked them and they all swiftly moved. We made an announcement to take off scarves, neckties, necklaces and sharp-edged articles, and we explained and confirmed how to take the brace position, then we turned off the unnecessary electric power in the cabin so as to prevent any possibility of fire, and took our seats. There came an announcement saying, "Two minutes before landing," followed by another announcement saying, "30 seconds before landing, take the brace position." We repeatedly yelled at passengers in loud voices to take the brace position.

When the aircraft came to rest, the passengers remained seated and everybody clapped their hands. It seemed to us that the aircraft attitude was not different from usual. Seeing that fire extinguishing agent was being sprayed, we felt relieved from the fear of fire, and waited for instructions from the PIC. The PIC made an announcement to the passengers, "We have landed. They are spraying fire extinguishing agent for precaution. Please remain seated until further instructions."

The PIC told us over the interphone, "There's no fire but they are spraying fire extinguishing agent for precaution. Buses will come later. Because the aft cabin is higher than normal, mechanics will open the forward door from the outside." We announced to the passengers that we would guide them to the lobby by bus. Meanwhile, the passengers kept cool, with some taking out from the seat pockets sharp edged articles they had taken off from themselves, and others getting ready to disembark by putting on their neckties, and so on. As the PIC told us over the interphone, "The emergency door on the right forward will open," we instructed passengers in

front of the door to move. We announced that we would guide them in order, let disembark the passengers of the forward cabin first, asked if they had suffered any injuries or sickness, but received no complaint. After we went outside, we noticed that the aircraft was apparently in nose down attitude. We think that we did it well as the passengers stayed calm and cooperative.

The accident occurred around at the mid length of Runway 32 of Kochi Airport at approximately 10:54. (Airport reference point: Latitude 33°32'34"North, Longitude 133°40'48"East)

(See Figures 1, 2, 4, 5, 6 and photos 1 and 2.)

## 2.2 Injury to Persons

None

## 2.3 Damage to Aircraft

The main structural members (such as frames, stringers, skins) of the lower part of the forward fuselage of the Aircraft were damaged. The VHF antenna (No. 2) installed in that position was also damaged.

## 2.4 Damage to Objects other than Aircraft

Runway centerline lights: eleven lights were broken.

## 2.5 Pilot Information

(1)	PIC	Male, Age 36 years	
	Airline Transport Pilot Certificate (Airplane)		February 5, 2003
	Type rating: De Havilland DHC8		October 27, 2005
	1st class Aviation Medical Certificate		
	Validity		Until June 19, 2007
	Total flight time		7,978 hr and 56 min
	Flight time in the last 30 days		84 hr and 06 min
	Flight time on the type of aircraft		897 hr and 29 min
	Flight time in the last 30 days		84 hr and 06 min
(2)	First officer	Male, Age 34 years	
	Commercial Pilot Certificate (Airplane)		July 22, 1994
	Type rating: De Havilland DHC8		August 25, 2006
	Instrument Rating		May 8, 2003
	1st class Aviation Medical Certificate		
	Validity		Until May 18, 2007

Total flight time	3,504 hr and 13 min
Flight time in the last 30 days	67 hr and 49 min
Flight time on the type of aircraft	412 hr and 49 min
Flight time in the last 30 days	67 hr and 49 min

## 2.6 Aircraft Information

### 2.6.1 Aircraft

Type	Bombardier DHC-8-402
Aircraft serial number	4106
Date of manufacture	June 12, 2005
Certificate of airworthiness	No. Dai-18-139
Validity	Until June 4, 2007
Category	Airplane, Transport category
Total time in service	2,966 hr and 52 min
Total cycles in service	4,197 cycles
Time in service since last regular inspection ("L" inspection on March 7, 2007) (See Figure 3.)	15 hr and 48 min

### 2.6.2 Weight and Balance

It is estimated that the weight and center of gravity of the Aircraft at the time of this accident were 49,210 lb and 27.3 % mean aerodynamic chord (MAC), respectively. It is estimated that both of them were within the allowable limits (the maximum landing weight is 61,750 lb and range of center of gravity is 15.7 - 34.1 % MAC corresponding to the weight at the time of the accident).

## 2.7 Meteorological Information

The observation data of the aviation weather at Kochi Airport around the time of the accident were as follows.

10:00 Direction of wind... variable; Velocity of wind... 2 knots; Prevailing visibility... 40 km; Clouds: amount... FEW, Type... unknown, Ceiling... 3,000 ft; Temperature... 10°C; Dew point... -3°C; Altimeter setting (QNH)... 30.03 inHg

10:55 Direction of wind... variable; Velocity of wind... 2 knots; Prevailing visibility... 40 km; Clouds: amount... FEW, Type... cumulus, Ceiling... 3,000ft; Temperature... 11°C; Dew point... -1°C; Altimeter setting (QNH)... 30.03 inHg

## 2.8 Information on DFDR and CVR

The Aircraft was equipped with a DFDR, manufactured by Honeywell Inc. (P/N\*<sup>14</sup>980-4700-027) of the U.S.A., and a Cockpit Voice Recorder (P/N 980-6022-011, hereinafter referred to as “CVR”), manufactured by Allied Signal Inc. (the current Honeywell Inc.) of the U.S.A.

The DFDR retained all records from when the Aircraft departed Osaka International Airport to when the Aircraft came to rest and the power was turned off after the accident. The precise time of DFDR was determined by comparing the time of the DFDR's record of the VHF transmission key, which was used for communications with the Air Traffic Control (ATC) with the time of the ATC communication records.

The Aircraft's CVR is capable of recording data for at least two hours before the equipment stops itself. The CVR retained the audio data related to the accident.

## 2.9 Accident Site Conditions

Kochi Airport has a 2,500m-long, 45m-wide runway that is oriented in the 14/32 direction and is grooved over a 2,500meter-long, 30meter-wide area.

The Aircraft came to rest on the runway centerline approximately 35 m beyond the runway halfway marking.

The contact marks made by the aircraft nose were found on the runway from about 900 m beyond the threshold up to 1,285 m, the point at which the Aircraft came to a rest.

(See Figure 2 and photos 1 and 2.)

## 2.10 Accident Aircraft Conditions

With the nose wheels retracted, the main structural members of the lower part of the forward fuselage were damaged by the contact against the runway during landing.

The airframe was jacked up during the on-site investigation conducted on March 14, 2007, and the followings were found.

- (1) The doors of the nose landing gear remained closed.
- (2) The interior of the nose gear well was inspected using a bore scope\*<sup>15</sup>, then a portion of the nose gear door was cut off for further observation, which resulted in that the spacer (called “bushing” on the manufacturer’s drawing and “spacer” on the part catalogue) protruded aftward from the hinge of the toggle links (P/N 47842-5 and 47848-3) which are part of the door linkage mechanism of the nose landing gear, interfering with the support fitting (P/N 85312193-007) located just aft of the toggle links, which is supporting the door linkage mechanism.

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\*<sup>14</sup> “P/N” means part number.

\*<sup>15</sup> “Bore scope” is an endoscope used for maintenance inspection.

As a result, because the toggle link assy was hindered from folding sufficiently upward, the door linkage mechanism didn't function and the doors of nose landing gear didn't open.

- (3) When the protruded spacer was pushed back to its correct position, the nose landing gear was extended by its own weight.
- (4) As a result of investigating the toggle link assy, the following parts were found to be missing.
  - Bolt (NAS6205-14D) 1 each
  - Washer (NAS1515M7L) 1 each
  - Washer (NAS1149F0563P) 1 each
  - Castellated nut (MS14145L5) 1 each
  - Cotter pin (MS24665-153) 1 each
- (5) Neither on the toggle link surface to be under the bolt head nor on the toggle link surface to be in contact with the castellated nut and washer, there exhibited any marks such as stains or peeling of paint that would have indicated the existence of the bolt.
- (6) After this accident had occurred, the function of PSEU (Proximity Sensor Electronics Unit)<sup>\*16</sup> was investigated using a BITE check<sup>\*17</sup>, but no abnormality was detected.  
(See Figures 7, 8, 9 and photos 3, 4, 5, 6, 7, 8, 9, 10, 11 and 18.)

## 2.11 Information on Fire Fighting

Three fire engines were dispatched, one of which sprayed 3,000 liters of fire extinguishing agent between T-2 and T-3 on the runway before the Aircraft landed.

## 2.12 Test and Research for Fact-Finding

### 2.12.1 Nose Landing Gear System

According to the Company's Airplane Operations Manual for the type of the Aircraft, the nose landing gear system of the Aircraft is outlined as follows.

- (1) There are four doors for the nose landing gear, of which the two aft doors are mechanically linked with the strut of the nose landing gear, and they close when the nose landing gear is retracted and they open when it is extended.

The two forward doors open and close hydraulically before and after the nose landing gear is retracted or extended. That is, to extend the nose landing gear, the two forward doors open, the nose landing gear UPLOCK is released, then the nose landing gear is extended, and after that the two forward doors close again.

- (2) The landing gears is operated by the No.2 hydraulic system, when the No.2 system is

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<sup>\*16</sup> "PSEU" is a computer that controls the Landing Gear, the Landing Gear Door, and the like using signals from the Landing Gear sensors (20 units).

<sup>\*17</sup> "BITE" stands for Built In Test Equipment, and is able to perform a system check by itself.



available. But should any failure occur in the hydraulic system, they can be extended by the alternate landing gear extension system.

To use the alternate landing gear extension system, at first, the INHIBIT switch located near the right hand overhead panel is operated to INHIBIT position. Setting the switch to INHIBIT isolates all hydraulic pressure from the landing gear system. Then, by pulling the RELEASE handle located on the floor behind and left of the right pilot seat, the central hinge part of the toggle link assy shown in Figure 8 is moved upward, pulling the bell crank connected to the right end of the toggle link assy to turn clockwise, further making the push rods connected to both ends of the bell crank to push open the doors and with the door opening, the gear UPLOCK is released, then letting the nose landing gear extended with its own weight, and finally gear DOWNLOCK is engaged.

- (3) The Landing Gear Advisory Lights display the positions of the hydraulic gear doors and the gear lock conditions. There are, from the top to bottom row, amber lights (door lights), green lights (gear safe lights) and red lights (gear unsafe lights). The door lights (amber) illuminate during gear door operation and go off when the operation is completed. The left and right landing gear advisory lights indicate the conditions of the respective main landing gears, while the lights in the middle indicate the condition of the nose landing gear.
- (4) Installation of the spacer in the toggle link assy

The spacer is installed into the toggle link assy in parallel with the fuselage axis, put between the bolt head and the flange of the forward flange bushing of the toggle link, and tightened with the castellated nut.

Should the bolt be absent, the spacer can move only aftward as the flange bushing prevents the spacer from moving forward. That is, in case that the bolt becomes absent, the spacer would migrate out aftward under the influence of the nose landing gear retract/extend operation, airframe vibration, aircraft acceleration, and so on.

The gap between the spacer and the support fitting positioned at the back of the toggle link assy is as close as 0.206 - 0.221 inches (the minimum gap between the bolt head and the support fitting is 0.05 inches), meaning the relative location susceptible to interference if the spacer migrates out.

A debris guard (P/N: 83220012-003) is attached on the support fitting to protect the landing gear door linkage mechanism including the toggle link assy, from debris. To access the toggle link assy the debris guard has to be removed in advance.

(See Figures 4, 5, 6, 7, 8 and 9.)

### **2.12.2 Investigation of Dirt on the Contact Surface of the Bolt/Nut of the Toggle-Link Assy**

As described in 2.10 (4) and (5), the bolt and nut were not found in the toggle link assy of the Aircraft. Moreover, there were no traces that could indicate the existence of the bolt head and

the nut/washer. Concerning this point, five other aircraft of the same type were investigated, which had the bolt and the nut/washer properly attached. On these five aircraft, on the surface of the toggle link assy surrounding the hole, there were stains which indicate the existence of the bolt head, and stains and peeling of the paint which indicate the existence of the nut/washer.

(See Photos 6, 7, 8, 9, 10, and 11.)

### **2.12.3 Investigation of Impact Marks on Mechanical Stopper**

The impact marks on the mechanical stopper of the toggle link assy measured approximately 13.5 mm in width on the Aircraft, which was wider than approximately 8.0 mm in width measured on the other aircraft that had properly assembled toggle link assy.

(See Figure 7 and Photos 16 and 17.)

### **2.12.4 Investigation of Toggle Link Assy**

To presume the circumstances under which the bolt and other parts of the Aircraft were missing, a detailed investigation of the spacer and the support fitting removed from the Aircraft immediately after the accident was commissioned to an Independent Administrative Organization, the Japan Aerospace Exploration Agency (hereinafter referred to as "JAXA") from March to June 2007.

According to its report, the results of the investigation are as follows.

- (1) Based on the analysis of the linkage mechanism, it is estimated that the load applied through the toggle link assy to the spacer was 2,350N - 10,100N, considering that the weight of the nose landing gear and its extension actuator load were added to the nose landing gear door actuator load.

Furthermore, based on the analysis by the Finite Element Method<sup>\*18</sup>, it is probable that the spacer gets deformed if the load applied to the spacer through the toggle link assy exceeds 5,000N.

- (2) The wear condition on the inner surface of the flange bushing of the toggle link assy was compared with a new flange bushing, and it is considered that at least a bolt specified on the drawing has not been installed through the toggle link assy.
- (3) The impact marks on the bottom surface of the support fitting was caused by the pressure yield<sup>\*19</sup> by the contact load from the spacer, and it is estimated that the load was 862N~2,451N.
- (4) As for the paint peeled off the side surface of the support fitting, it is probable that the paint

---

<sup>\*18</sup> "Finite element method" is a method of numerical analysis for stress or strain by applying the boundary condition, by assuming the complicated structure as a complex of tiny elements.

<sup>\*19</sup> "Pressure yield" means, in case of contact of solid materials, creation of plastic deformation caused by the load applied.

came off while the fitting was being removed, as the spacer had contacted with the support fitting besides that the repainted layer had been apt to be peeling off easily.

- (5) It is probable that the two spots within the impact marks on the mechanical stopper of the toggle link assy were made after the spacer had been deformed.

(See Figure 7 and photos 3, 4, 5, 12, 13, 14, 15 and 16.)

## **2.13 Investigation of the Toggle Link Maintenance Work for the Aircraft**

The investigation was conducted on the implementation of the maintenance work related to the toggle link.

### **2.13.1 Prior to Delivery of the Aircraft**

After the final assembly, the Aircraft made its first flight on June 12, 2005 at Bombardier Inc., conducted several test flights to correct discrepancies and was issued the airworthiness certificate of Canada on June 19, then left Bombardier Inc. on July 13, arrived at Osaka International Airport on July 16 and was delivered to the airline.

### **2.13.2 Consignment of Maintenance**

The Aircraft was operated, flight by flight, by either the Company or Air Nippon Network Co., Ltd. (hereinafter referred to as "A-net").

Because the Company consigned the maintenance management<sup>\*20</sup> to A-net, A-net was managing all of the maintenance of the Aircraft. Meanwhile, A-net consigns part of maintenance work to five companies including ANA and the Company.

### **2.13.3 Maintenance Work in Japan**

After the Aircraft arrived in Japan, the maintenance work carried out by the companies described in 2.13.2 up to the time of this accident was investigated with the use of the flight log books and MERS<sup>\*21</sup>, and it was found out that any maintenance work had not been carried out for the malfunctioned location (toggle link) related to this accident.

The investigation was conducted for the following range of maintenance work. The time for the scheduled maintenance (C maintenance: 4,000 hr), in which check items are listed after making access to the toggle link, had not reached yet.

- (1) Scheduled maintenance

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<sup>\*20</sup> "The consignment of the maintenance management" refers to an arrangement whereby companies that operate aviation transport business consign their maintenance management of aircraft to other companies, under the permission by the Minister of Land, Infrastructure, Transport and Tourism or by the Director of Regional Civil Aviation Bureau in accordance with Clause 1, Article 113-2 of the Civil Aeronautics Law.

<sup>\*21</sup> "MERS" stands for Maintenance and Engineering Resource System, the name of a maintenance management system employed by the ANA group.

- (2) Pre-departure maintenance
- (3) Maintenance according to the landing gear related SB applicable to the Aircraft
- (4) Corrective action of landing gear malfunctions that occurred of the Aircraft
- (5) Corrective action of malfunctions that occurred of parts other than the landing gear of the Aircraft
- (6) Special checks and modification works
- (7) Issuance of toggle link-related parts
- (8) Re-painting of the support-fitting

## **2.14 Investigation at Bombardier**

By visiting the factory of Bombardier Inc., the manufacturer of the Aircraft, the records of the manufacturing process of the Aircraft were investigated in the presence of the Canada Transport Safety Board (TSB of Canada). There were repair records related to the toggle link.

### **2.14.1 Records on Assembly of Toggle Link**

The nose landing gear door linkage mechanism, including the toggle link assy, was delivered by Goodrich Corp. to Bombardier Inc. in a provisionally assembled condition.

The hinge part of the toggle link assy had been assembled except for the cotter pins.

When the nose landing gear door linkage mechanism was installed on the airframe at the Bombardier Inc., the hinge part of the toggle link assy was not disassembled, and there was no record on it.

### **2.14.2 Records on Repair of Toggle Link**

When the ground function test on the landing gear was carried out on June 16, 2005 after completion of the aircraft assembly at Bombardier Inc., the door was operated by hydraulic pressure as the safety pin<sup>\*22</sup> to keep the nose landing gear doors in open position had not been sufficiently inserted, which resulted in damaging the toggle link and the support fitting. Thereupon, the toggle link and the support fitting were replaced.

Records of the work performed were available (including records of corrective action to malfunction, instruction, implementation, inspection), but there were no documents indicating the work procedures or records of specific inspections to the work, nor were there any descriptions of the bolt tightening torque value for connecting the toggle links. (The toggle link assy was disassembled, installed, then reconnected. Although the bolt tightening torque value for connection was specified in the drawings of Goodrich Corp., the supplier of the toggle link assy, this was not specified in the Assembly Manual of Bombardier Inc.)

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<sup>\*22</sup> A “safety pin” is a pin inserted into the support fitting so that the landing gear door does not close in case the hydraulic pressure is applied by mistake while work is being conducted inside the wheel well.

Moreover, although the part control record (Non-Conformance Report ) indicated that the nose landing gear door linkage mechanism, including the toggle link assy, was replaced as a whole, whereas in actual work only the toggle link assy was replaced .

(See Figure 10.)

## 2.15 Investigation at Goodrich

The manufacturing records related to the Aircraft and quality control were investigated by visiting the factory of Goodrich Corp., the supplier of the landing gear system of the Aircraft.

The lot production records of the nose landing gear door linkage mechanism including the toggle link assy that was shipped at the time when the landing gear was installed to the Aircraft was investigated, but no particular problems had been found.

2.16 "The Alternate Landing Gear Extension" checklist in accordance with the airplane operations manual of the Aircraft is given below.

### ALTERNATE LANDING GEAR EXTENSION

*Condition: Use this checklist when attempt landing gear down with LDG GEAR INOP caution light illuminates, or unable normal landing gear extension.*

***CAUTION: Landing gear cannot be retracted.***

***CAUTION: Nosewheel steering is inoperative.***

***NOTE: To control the aircraft direction during landing roll with nose wheel steering inoperative, depending on crosswind condition, differential brake or power usage together with rudder operation is required.***

***Airspeed..... 185KIAS MAX PF***

*[Max. Speed with landing gear doors open.]*

***Landing Gear Extension Inhibit Switch..... INHIBIT PNF [PF]***

*[If LDG GEAR INOP caution light was out, it will illuminate when the L/G INHIBIT switch is selected to INHIBIT.]*

***NOTE: Leave Landing Gear INHIBIT Switch at INHIBIT.***

***LANDING GEAR Lever ..... DOWN PNF***

***Landing Gear Alternate Release Door..... OPEN PNF***

***Main Gear Release Handle.....PULL FULLY DOWN PNF***

*[Check L DOOR and R DOOR amber doors open and LEFT and RIGHT green*

*locked down advisory lights illuminate.]*

***Landing Gear Alternate Extension Door..... OPEN PNF***

***NOTE: Landing Gear Alternate Release and Extension Door must stay fully open after alternate landing gear extension.***

***If LEFT and/or RIGHT green gear safe advisory lights do not illuminate:***

***Main Gear***

***Alternate Extension Hand Pump..... OPERATE PNF***

*[Insert the Hydraulic Pump handle in the socket and operate pump until LEFT and RIGHT green advisory lights illuminate.]*

***Nose Gear Release Handle..... PULL FULLY UP PNF***

*[Check N DOOR amber doors open and NOSE green gear locked down advisory lights on the landing gear control panel illuminate.]*

***Landing Gear Downlock***

***Verification Lights..... ON, CHECK, OFF PNF***

*[Check the three green landing gear downlock verification lights under the landing gear alternate extension door are on.]*

***ANTI SKID Switch..... TEST PNF***

*[Make sure INBD ANTI SKID and OUTBD ANTI SKID caution lights go off after three seconds.]*

**2.17** "The Alternate Landing Gear Extension" in accordance with the Airplane Operations Manual of the Aircraft is given below.

### ***5-13-5 Alternate Gear Extension***

*The alternate extension system (Figure 5.13-20) gives a means of extending the landing gear when:*

- LDG GEAR INOP caution light is on*
- Landing gear indication fails*
- Loss of No.2 hydraulic system pressure*

*The landing gear extension INHIBIT switch is installed in the flight compartment ceiling, adjacent to the main LANDING GEAR ALTERNATE RELEASE door. Setting the switch to INHIBIT isolates all hydraulic pressure from the landing gear system.*

*When the main LANDING GEAR ALTERNATE RELEASE door on the flight compartment ceiling is opened it mechanically opens a bypass valve in the normal hydraulic extension system, and gives access to the MAIN L/G RELEASE handle. Pulling the handle releases the main landing gear doors and uplocks. The main gear will free fall but may not fully extend. The LANDING GEAR ALTERNATE EXTENSION door, on the flight compartment floor, must then be fully opened giving access to the alternate extension handpump and the NOSE L/G RELEASE handle. Opening the door mechanically operates the MLG alternate selector valve. If the MLG does not reach the down and locked position, the extension pump handle, located behind the copilot, is inserted into the pump handle socket and operated to complete main gear extension and subsequent downlock (Figure 5.13-21). Both the LANDING GEAR ALTERNATE EXTENSION door and the MAIN LANDING GEAR ALTERNATE RELEASE door must be left fully open after alternate landing gear extension.*

*When the NOSE L/G RELEASE handle is pulled, the nose gear uplock and doors are released and the nose gear free falls to a down and locked position, assisted by the airflow to a down and locked position.*

(See Figure 5)

### 3 ANALYSIS

**3.1** The PIC and the first officer possessed adequate airman certificates and valid aviation medical certificates.

**3.2** The Aircraft had a valid airworthiness certificate and had been maintained and checked properly.

**3.3** Based on the statements by the PIC and the first officer, it is estimated that because the landing gear could be retracted without problem after taking off Osaka International Airport, they could not notice the abnormality in the landing gear system of the Aircraft until the gear down operation before landing at Kochi Airport.

**3.4** Based on the results of the investigation outlined in 2.10, it is recognized that the event in which the nose landing gear of the Aircraft was not extended before landing at Kochi Airport, was caused by that the doors of the nose landing gear remained closed though the gear down operation was made, which prevented the nose landing gear from extending.

**3.5** Based on the results of the investigation outlined in 2.10, it is recognized that the event in which the doors of the nose landing gear did not open, was caused by that, during flight with the gear retracted, the spacer migrated out aftward in excess of the limit from the hinge part of the toggle link assy, which comprises part of the door linkage mechanism of the nose landing gear, and when the gear down operation was made later, in the course of opening the doors of the nose landing gear, the toggle link assy was folding upward, the spacer interfered with the support fitting, which prevented the movement of the toggle link assy.

**3.6** It is estimated that the event in which the spacer migrated out of the toggle link assy of the Aircraft was caused by that the bolt to be installed through the spacer, had been missing, and during operations of the Aircraft (4,197 landing cycles, during which NLG door made 16,788 movements), the spacer was gradually pulled aft out of the toggle link assy under the influence of the nose landing gear retract/extend operation, airframe vibration, aircraft acceleration, and so on.

It is estimated that the spacer interfered with the support fitting because, as described in 2.12.1 (4), the spacer and the support fitting are in relative location susceptible to interference if the spacer migrates out aftward in case that the bolt is missing.

**3.7** Based on the investigation results of 2.12.2, it is estimated that the bolt and castellated



nut/washer had not been present since shortly after the manufacture of the Aircraft up until the occurrence of this accident, because there are no stains, peeled paint and the like on a surface of the toggle link which is located underside of the bolt head if the bolt is installed, and on the other surface of the toggle link, to which the castellated nut/washer would have made contact, and those conditions are different from other aircraft on which those parts are installed.

It is estimated that the bolt had been missing since early time based on the investigation of the inner surface of the flange bushing as described in 2.12.4 (2), as well. Furthermore, as described in 2.12.3, it is estimated that the impact marks on the mechanical stopper were widened because the mechanical play of the toggle link grew larger as the bolt had not been installed.

(See Photo 16.)

**3.8** With regard to the maintenance work which could result in a missing bolt, as described in 2.13.3, there are no records to show that any maintenance work involving the toggle link be performed after the Aircraft had been imported to Japan, on the other hand, a set of nose landing gear door linkage mechanism including the toggle link assy, and the support fitting were replaced as a repair in the manufacturing process, as described in 2.14.2. It is considered that at the time of this repair in the manufacturing process, only the toggle link assy was taken from the set of nose landing gear door linkage mechanism, the hinge part of the toggle link assy, which is to be installed in the airframe without prior disassembly, was disassembled once, and the toggle link assy was installed without re-attachment of the bolt, nut and the like.

**3.9** Although this was an important repair work on the mechanism related to the retraction/extension of the nose landing gear, as described in 2.14, no document to indicate the repair procedure was prepared, nor were specified definite inspection items. As the connecting bolt tightening torque value is specified on the drawings of the Goodrich Corporation, the supplier of the nose landing gear door linkage mechanism including the toggle link assy, it is considered that all parts, including the bolt, would have been re-installed if procedure document specifying such as the torque value had been prepared and if the workers had been instructed to follow the procedure.

The tightening torque of the toggle link bolt had not been specified in the assembly manual of Bombardier Inc. when the Aircraft was manufactured, however, the manual was amended after this accident and the torque value was specified.

**3.10** From the statements of the crew members, it is considered that, at the time of the occurrence of the malfunction, the Aircraft had enough fuel for two hours of flight, which enabled the crew members to consider and implement counter measures in calmness, so it is thought that

the contents and timing of the announcements and instructions to the passengers were appropriate, and it is estimated that the crewmembers' actions gained from the training helped passengers keep calmness. In addition, it is considered that the maneuver operations at the time of the landing were appropriate.

#### 4 PROBABLE CAUSE

It is recognized that this accident was caused by that, in spite of gear down operations in flight by normal and alternative procedures, the nose landing gear could not be extended because the doors of the nose landing gear remained closed, and when the Aircraft landed in this configuration, the lower part of the forward fuselage contacted the runway surface and was damaged.

It is recognized that the doors of the nose landing gear remained closed because the spacer migrated out from the hinge part of the toggle link assy, which was part of the nose landing gear door linkage mechanism, interfered with the support fitting, thereby prevented the movement of the toggle link assy, which resulted in restraining the movement of the entire nose landing gear door linkage mechanism.

It is estimated that the spacer migrated out because the bolt, nut and the like were not installed, and the spacer was gradually pulled aft out of the toggle link assy under the influence of retractions/extensions of the nose landing gear, airframe vibration, aircraft acceleration and so on, during operations of the Aircraft. Regarding that the bolt, nut and the like were not installed, it is considered that these parts were not re-installed at the time of the repair in the manufacturing process of the Aircraft.

## **5 SAFETY RECOMMENDATION**

In view of this accident, the Aircraft and Railway Accidents Investigation Commission recommends Transport Canada to take necessary measures in the following respects:

In the repair considered to have contributed to the occurrence of this accident, although the important parts were replaced, there were no documents indicating clearly the replacement procedures, which it is considered to have resulted in errors taking place during the work. Consequently, Transport Canada should encourage Bombardier Inc. to improve further their quality control system, especially concerning repairs.

## **6 SUPPLEMENT**

**6.1** The Japan Civil Aviation Bureau issued the Airworthiness Directive (TCD-7074-2007: issued and effective on March 13, 2007), in which “the prevention of malfunction which prevents the nose landing gear extension” was instructed.

**6.2** The manufacturer of the Aircraft issued the All Operator Message No. 210 (13 MAR 07) and No. 211 (14 MAR 07) to request operators of the same type of the Aircraft to provide information and conduct inspections for the malfunction.

**6.3** The Japan Civil Aviation Bureau issued a circular (KOKU-KU-KI No. 1317 dated March 15, 2007) to Japanese operators of the Bombardier DHC-8 series aircraft, and thereby instructed them to implement detailed check of the nose landing gear door mechanism at every A maintenance (400 hr check), and to include the check in their Maintenance Manuals.

**6.4** According to Bombardier Inc., there have been nine cases in which DHC-8 series aircraft have landed with nose landing gear retracted since 1987, however, the Kochi accident was the first NLG up landing involving a type DHC-8-400(hereinafter “DHC-8” is omitted). Subsequently, there has been another unrelated event where a type400 landed with its NLG retracted. The seven remaining events involve types100, 200 and 300 aircraft. The types100, 200 and 300 are different from the type400 and have a different landing gear supplier. None of these events involved missing hardware in the NLG system.

Figure 1 Estimated Flight Route

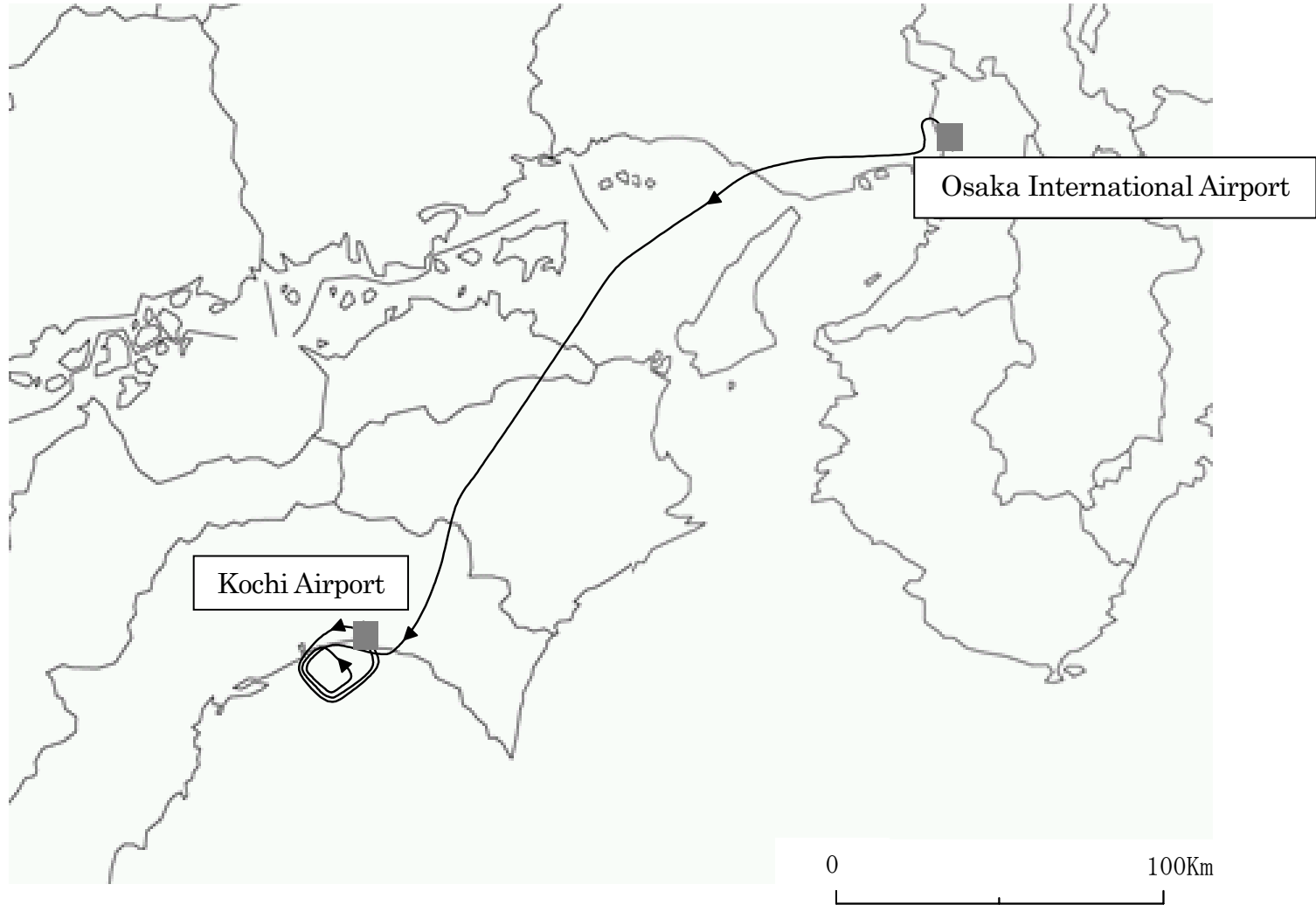
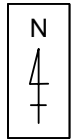
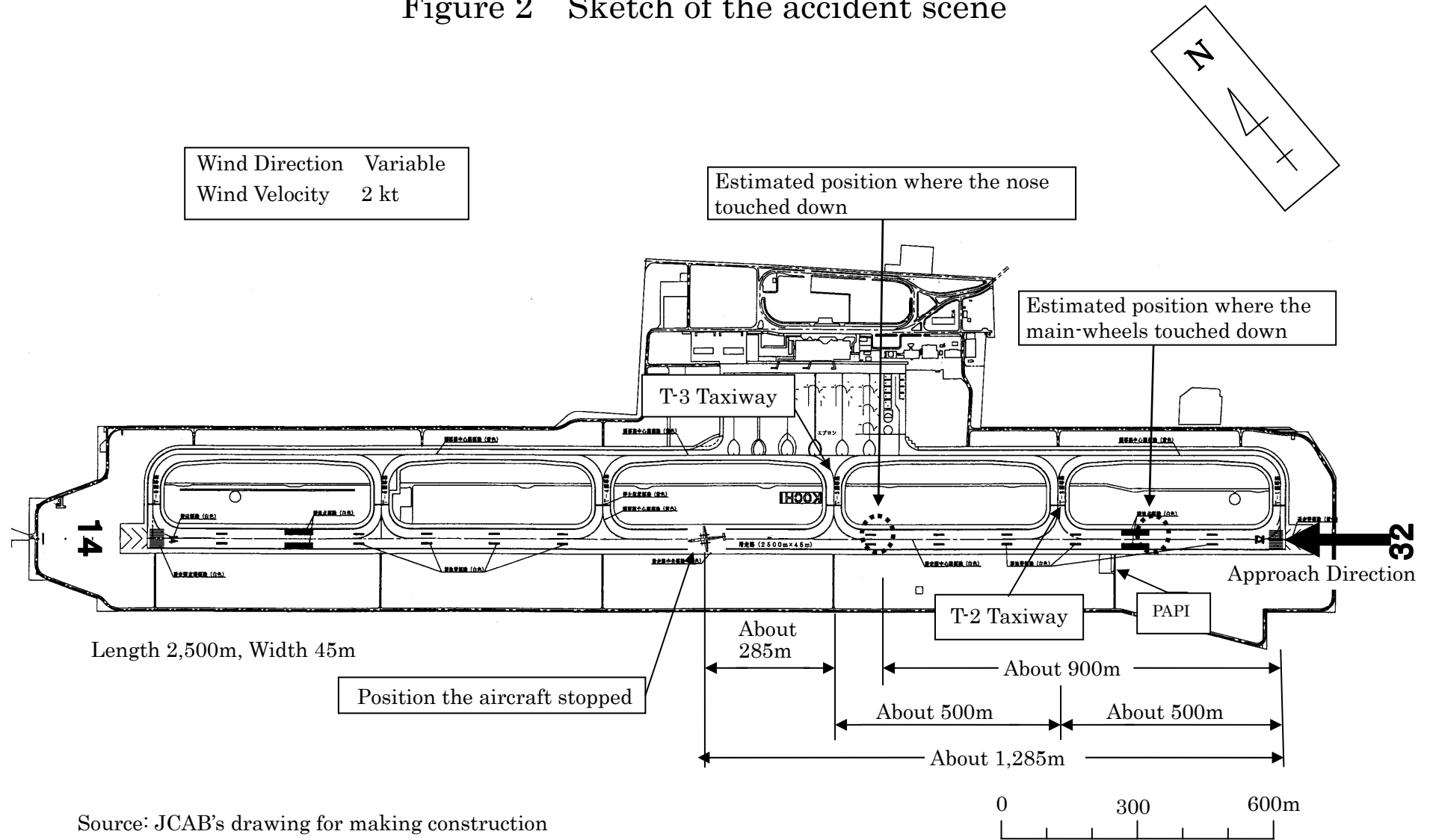


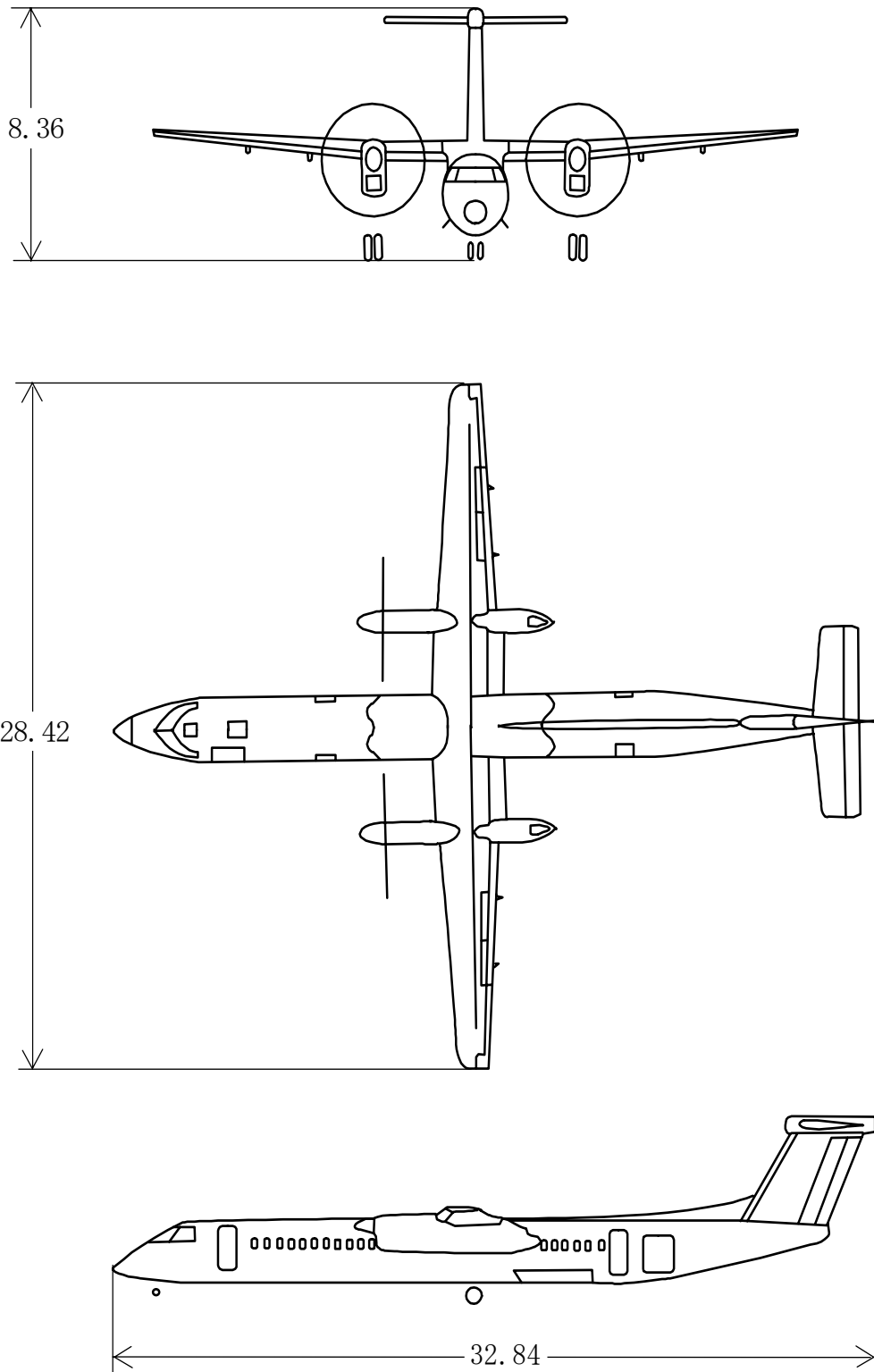
Figure 2 Sketch of the accident scene



Source: JCAB's drawing for making construction

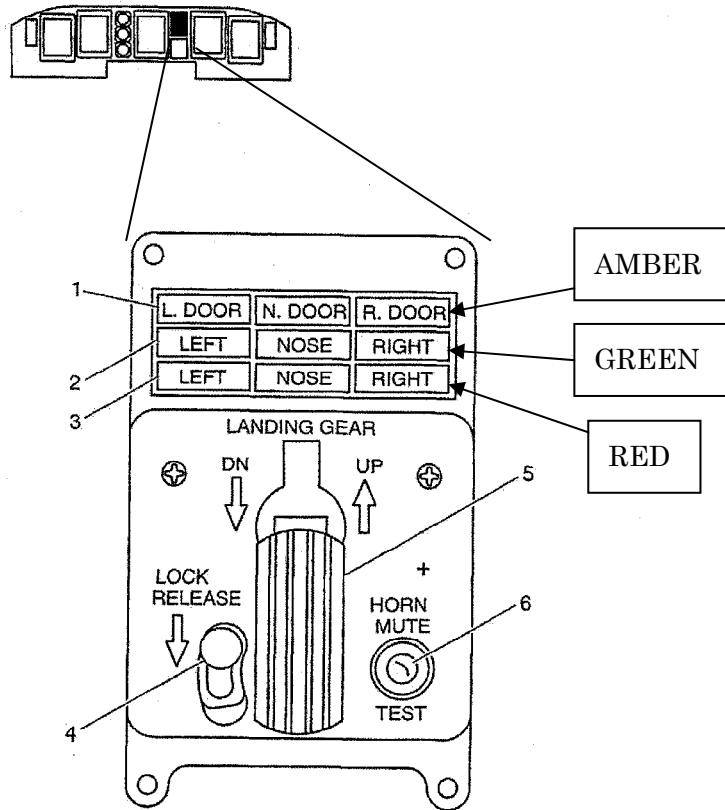
Figure 3 Three views of Bombardier DHC-8-402

Unit: m





# Figure 4 Landing Gear Control Panel Explanation



### LANDING GEAR CONTROL PANEL CALLOUTS

#### 1. GEAR DOOR ADVISORY LIGHTS

(L. DOOR, N. DOOR, R. DOOR) segment (amber) - related hydraulic gear door open  
 - hydraulic gear doors stay open with no hydraulic pressure

(L. DOOR, N. DOOR, R. DOOR) segment (blank) - related hydraulic gear door closed  
 - hydraulic gear doors close after normal gear extension and retraction

#### 2. LANDING GEAR SAFE ADVISORY LIGHTS

LEFT, NOSE, RIGHT segment (green) - related gear down and locked  
 - lights can be tested using CAUT / ADVSY LIGHTS toggle switch  
 - gear can also be checked with downlock verification lights

LEFT, NOSE, RIGHT segment (blank)  
 - related gear not down and locked or in uplock position

#### 3. LANDING GEAR UNSAFE ADVISORY LIGHTS

LEFT, NOSE, RIGHT segment (red) - related gear not locked up or down

LEFT, NOSE, RIGHT segment (blank) - related gear locked up or down or no power to lights

#### 4. SELECTOR LEVER LOCK BUTTON (momentary action)

PUSH DOWN AND HOLD - enables operation of landing gear handle

#### 5. LANDING GEAR SELECTOR LEVER/LIGHT (two position)

UP - starts landing gear retraction sequence

DN - starts normal landing gear extension sequence  
 - also select DN for alternate gear extension  
 - No Smoking signs come on automatically if not on

HANDLE (amber)

- landing gear operation does not agree with position of landing gear selector handle

#### 6. LANDING GEAR WARNING HORN MUTE/TEST SWITCH

(two position, momentary action)

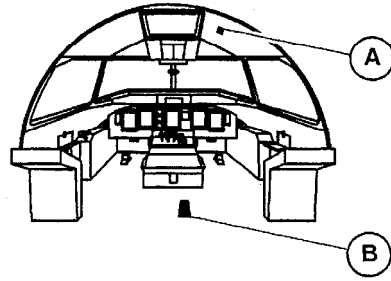
TEST - gear warning tone sounds over flight compartment speakers

HORN MUTE - gear warning tone is silenced under certain configurations

Figure 5.13-3 Landing Gear Control Panel

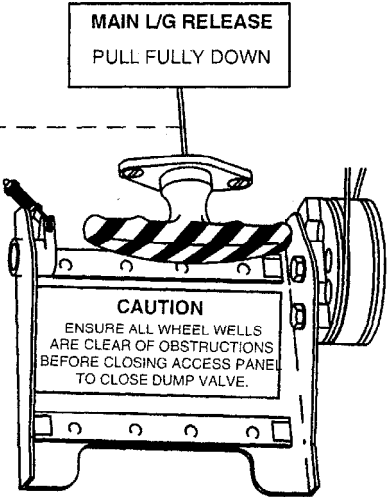
Figure 5 Alternate Gear Extension System

Quoted from Airplane Operations Manual



MAIN DOOR  
UPLOCK  
RELEASE

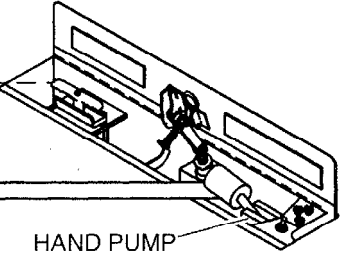
MAIN GEAR  
UPLOCK  
RELEASE



(A) LANDING GEAR ALTERNATE RELEASE DOOR (OPEN)

NOSE DOOR  
UPLOCK  
RELEASE

NOSE GEAR  
UPLOCK  
RELEASE



(B) LANDING GEAR ALTERNATE EXTENSION DOOR (OPEN)

**LEGEND**  
 CABLE CIRCUIT/ CONTROL LINKAGE   
 HYDRAULIC PRESSURE

TO MAIN GEAR  
AUXILIARY  
ACTUATORS

Figure 5.13-20 Alternate Landing Gear Extension Schematic



Figure 6 Nose Landing Gear Alternate Extension System

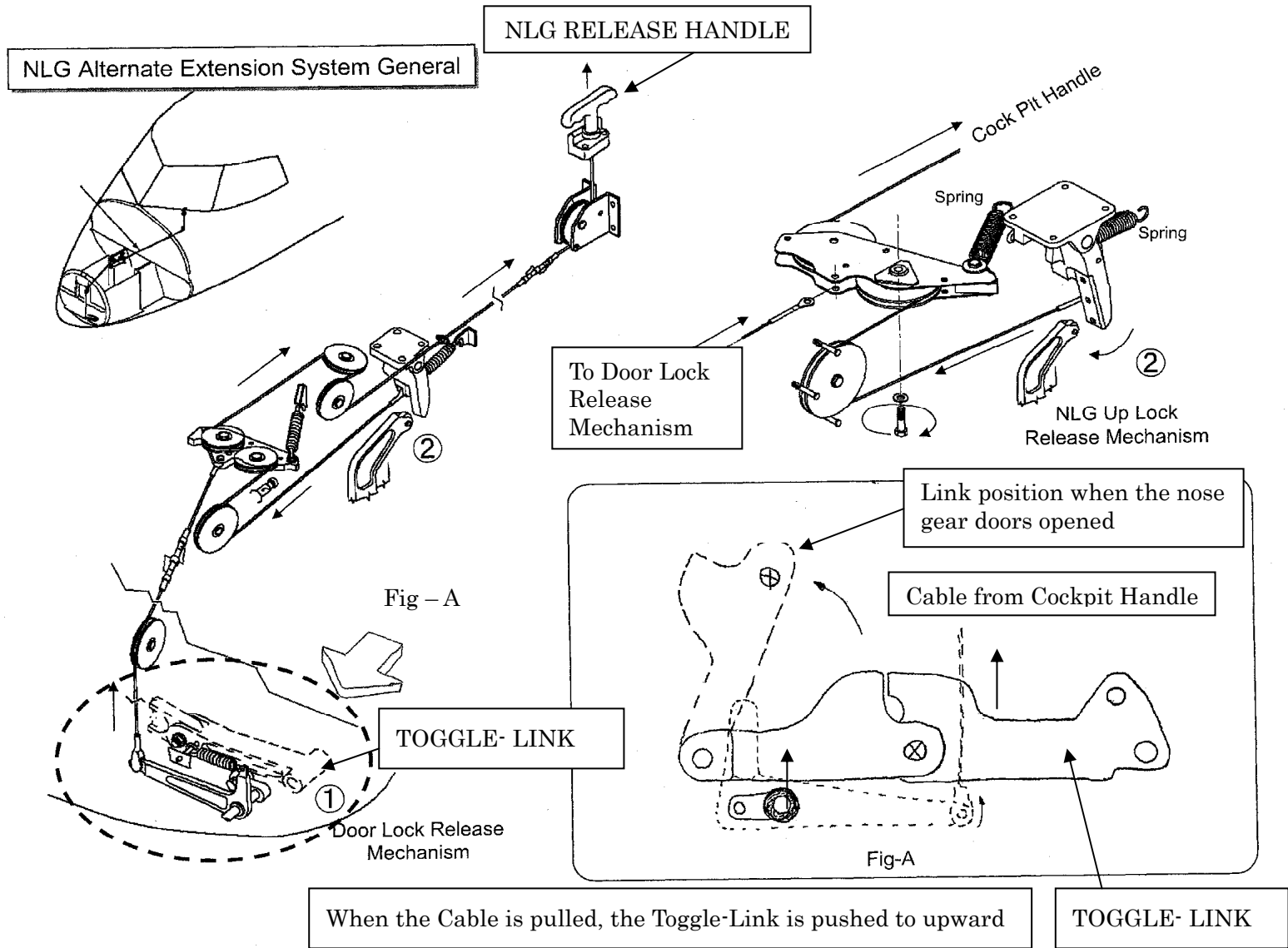


Figure 7 Details of the Toggle-Link

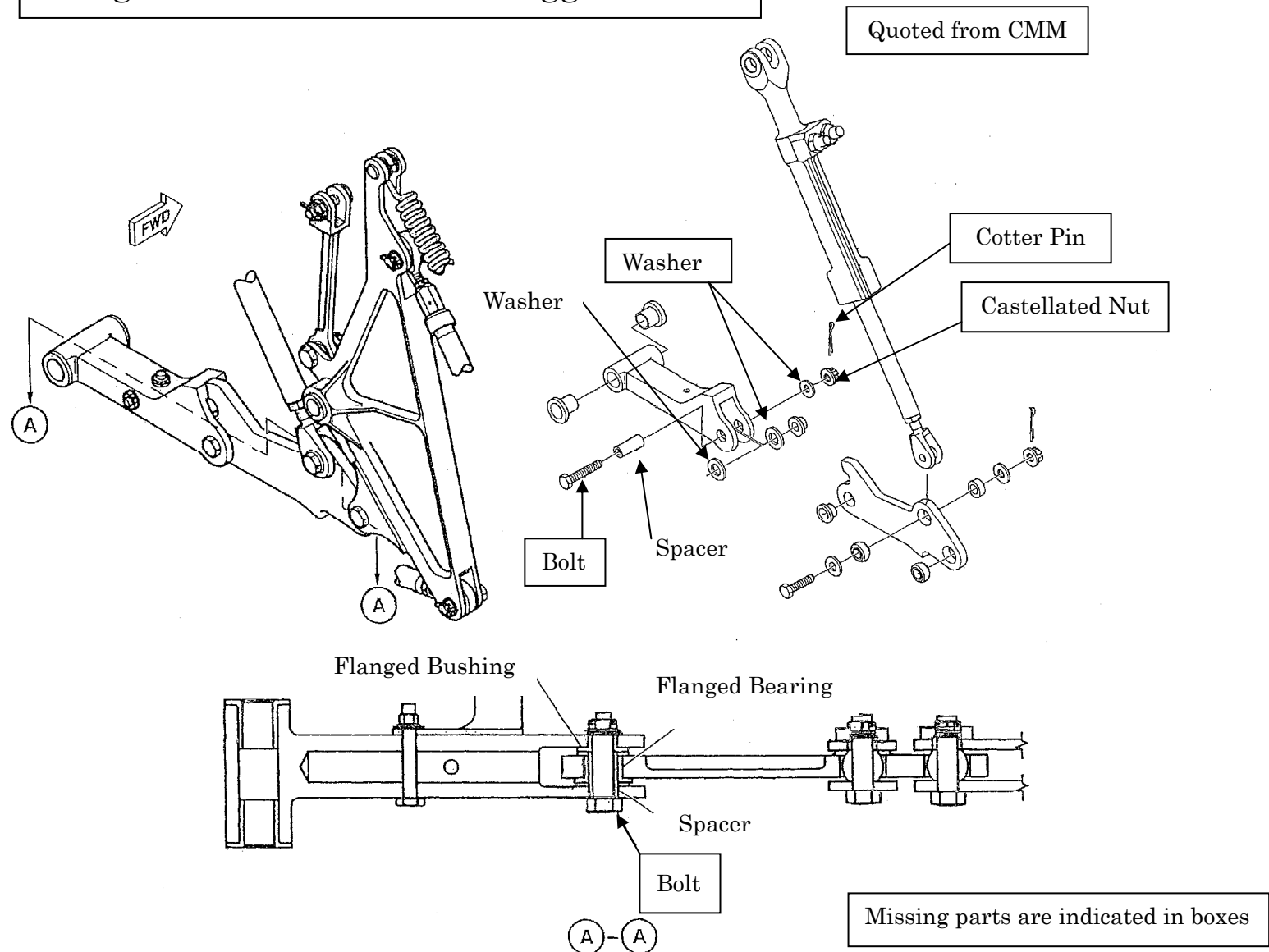
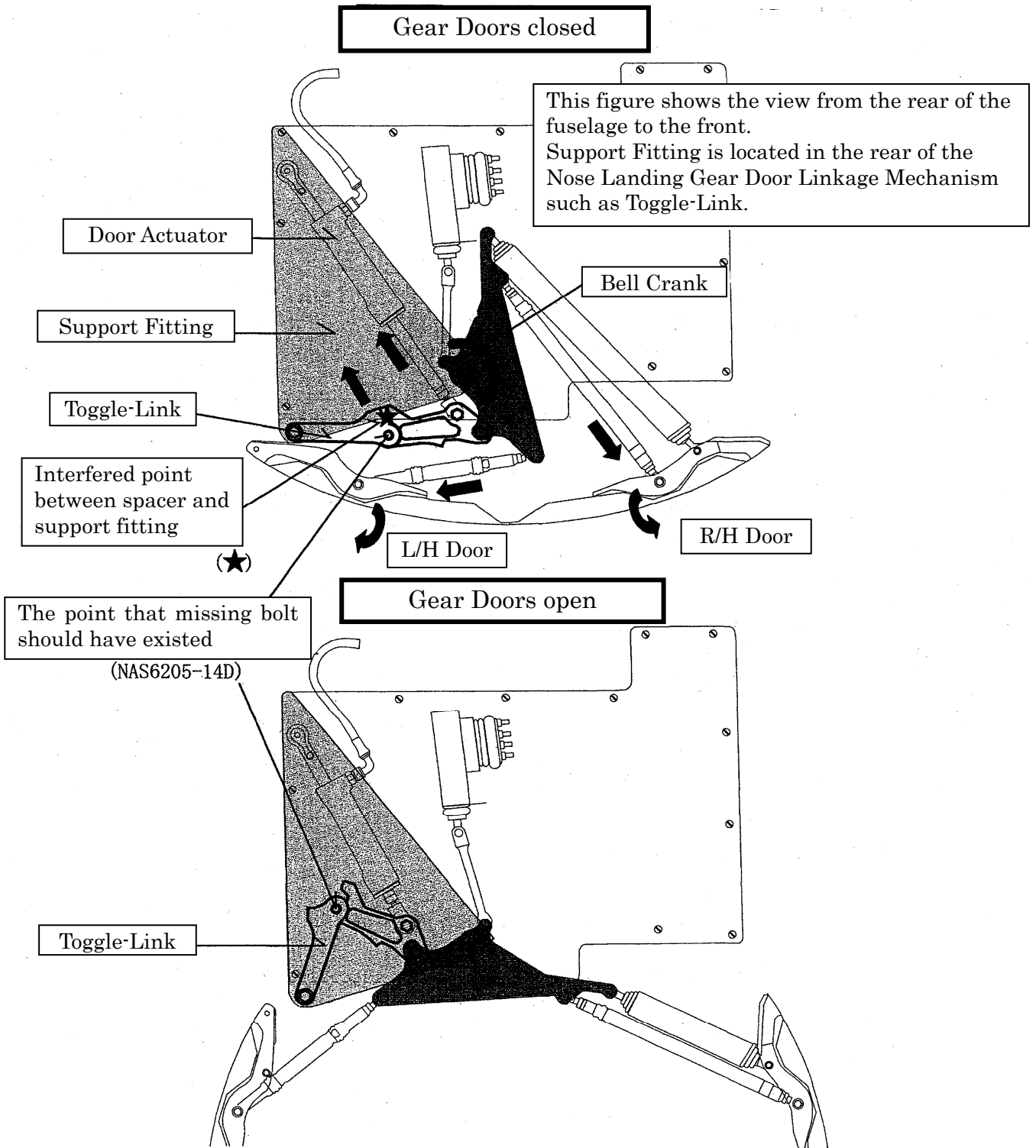


Figure 8 Nose Landing Gear Door Linkage Mechanism



This figure is drawn based on the manufacturer's documents.

**Figure 9 Nose Landing Gear Door Linkage Mechanism**

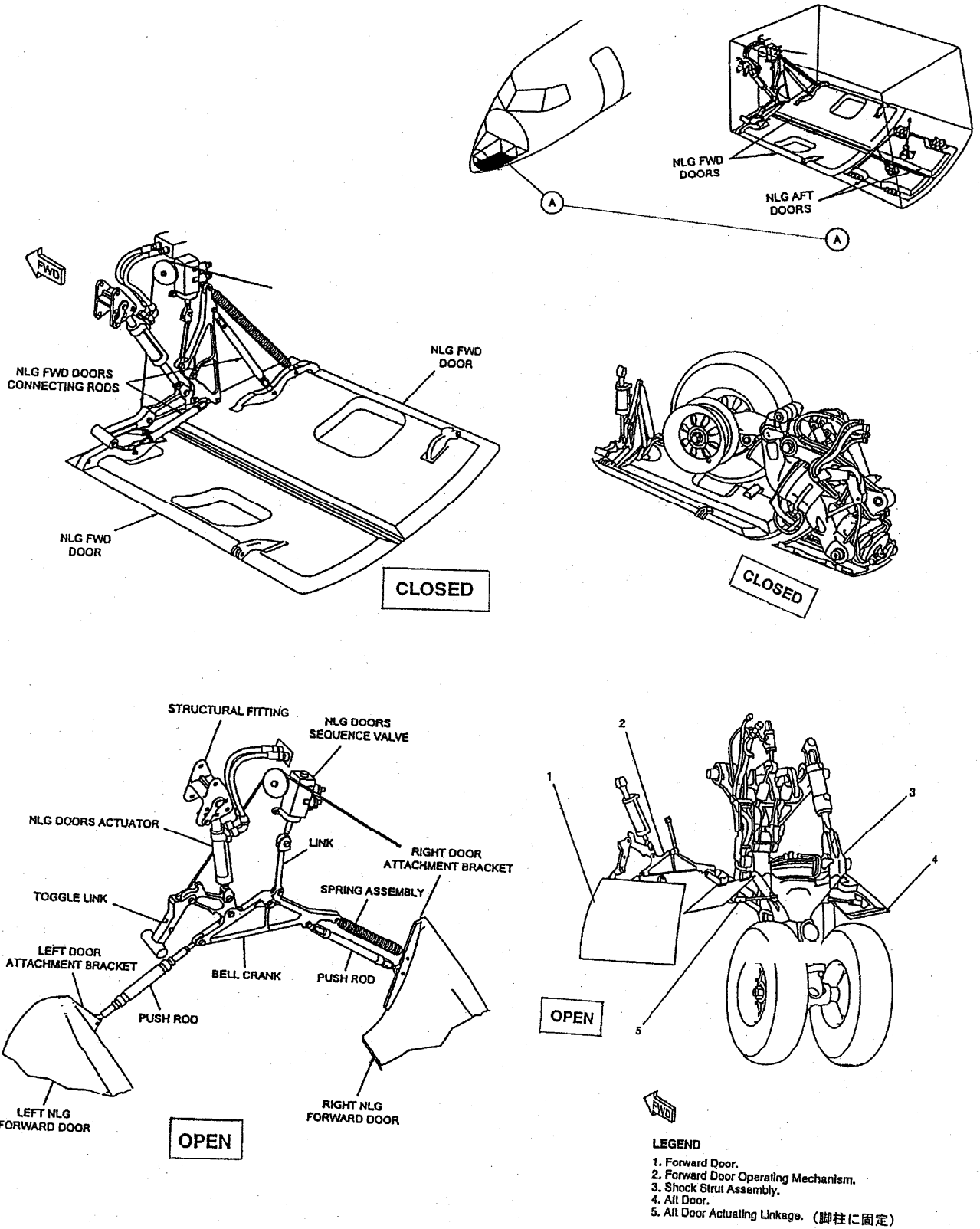
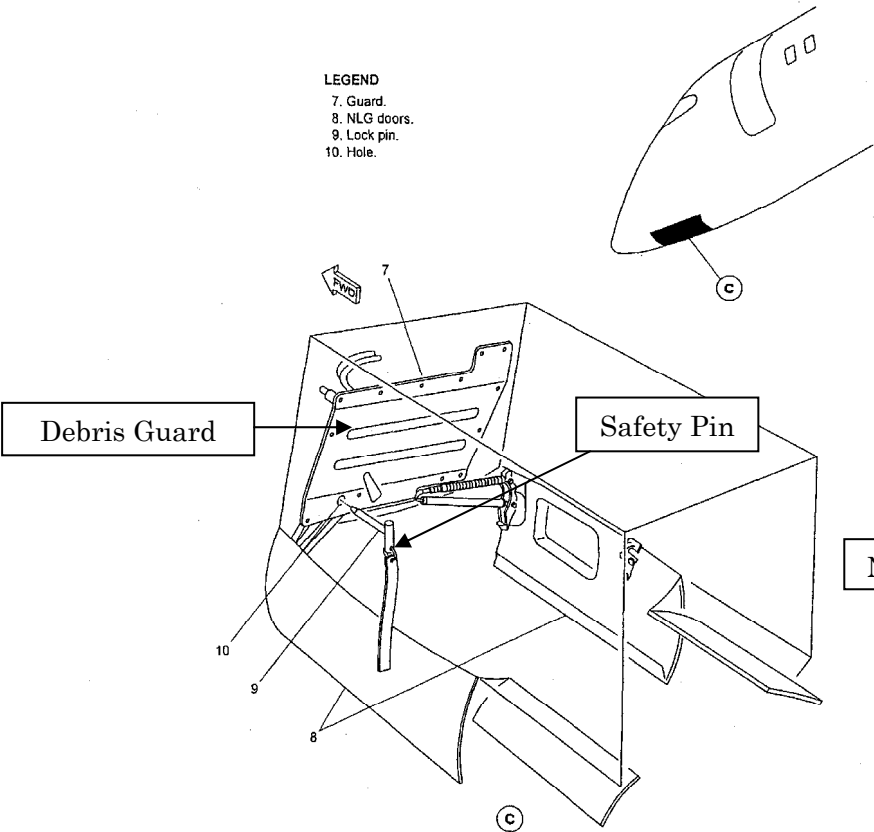
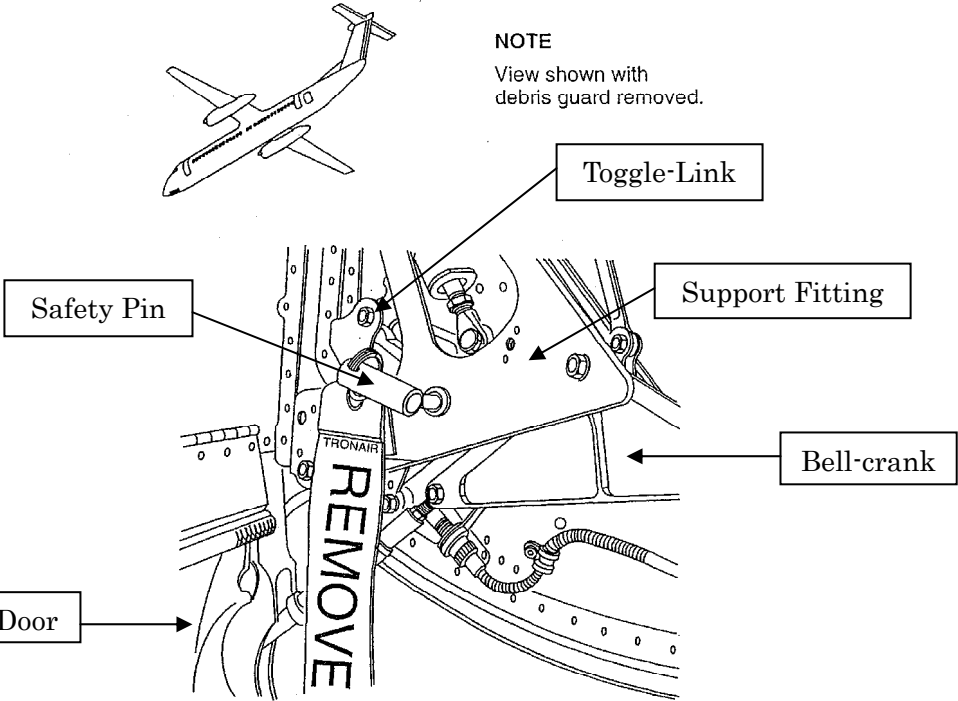


Figure 10 Method to use safety pin

Safety Pin is installed through Debris Guard



Safety Pin is installed without Debris Guard



Quoted from Manufacturer's Document

Photo 1 Accident Aircraft (1)



Photo 2 Accident Aircraft (2)

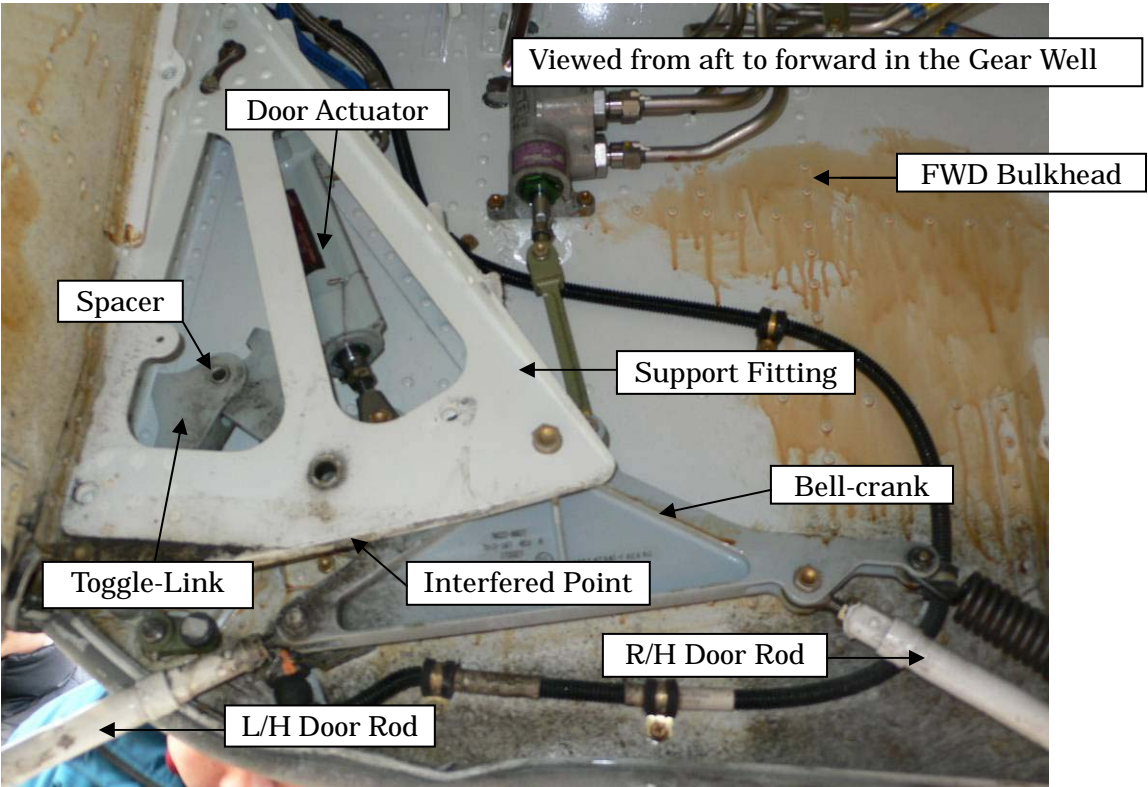




# Photo 3 Nose Gear Door Linkage Mechanism in the Gear Well

After Gear Down ( Doors are open )

Viewed from aft to forward in the Gear Well



Quoted from A MM

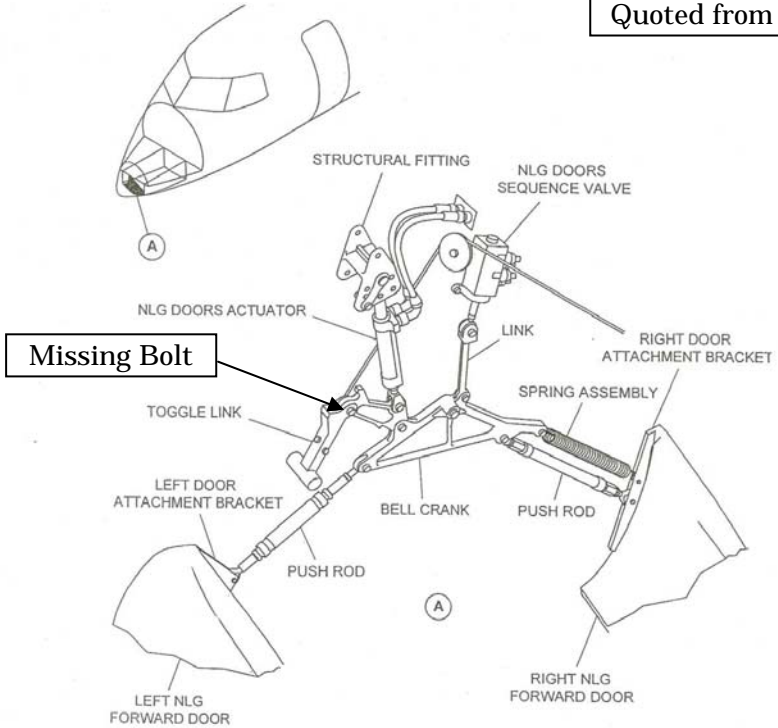


Photo 4 Spacer Interfered Point

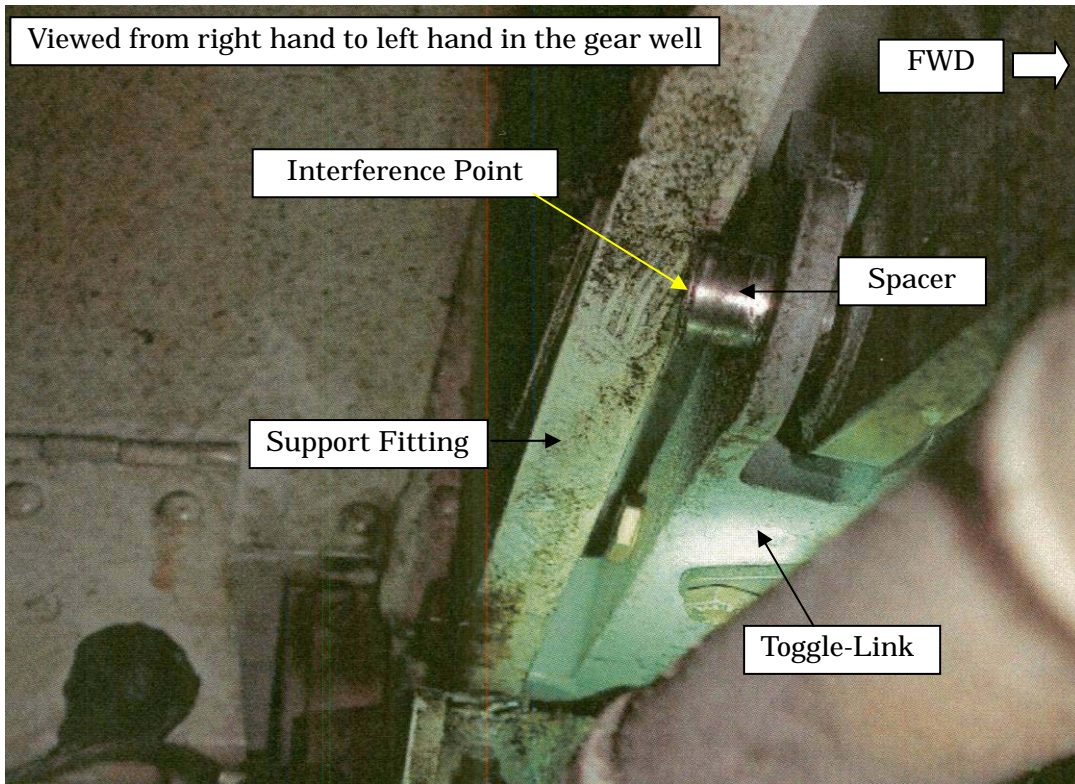


Photo 5 Spacer removed from the accident aircraft and new bolt for reference

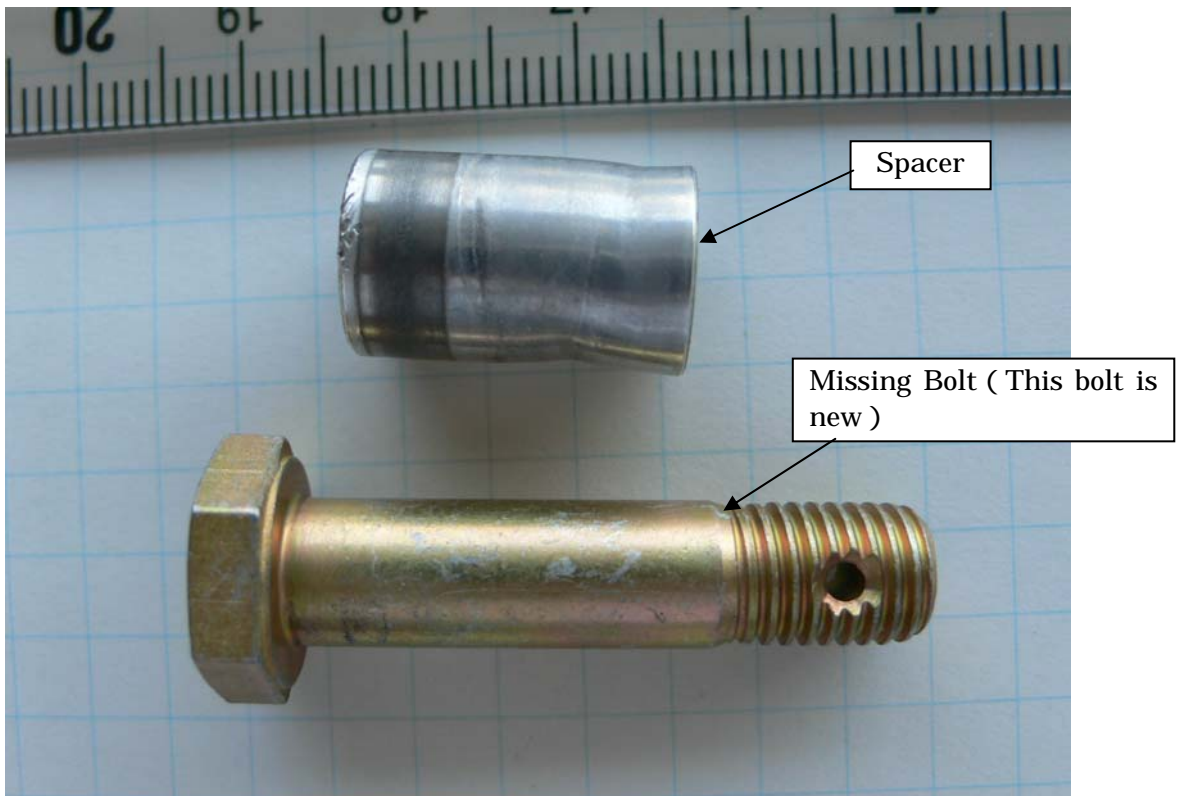


Photo 6 Toggle-Link of the accident aircraft (1)  
(Two toggle links are disconnected)

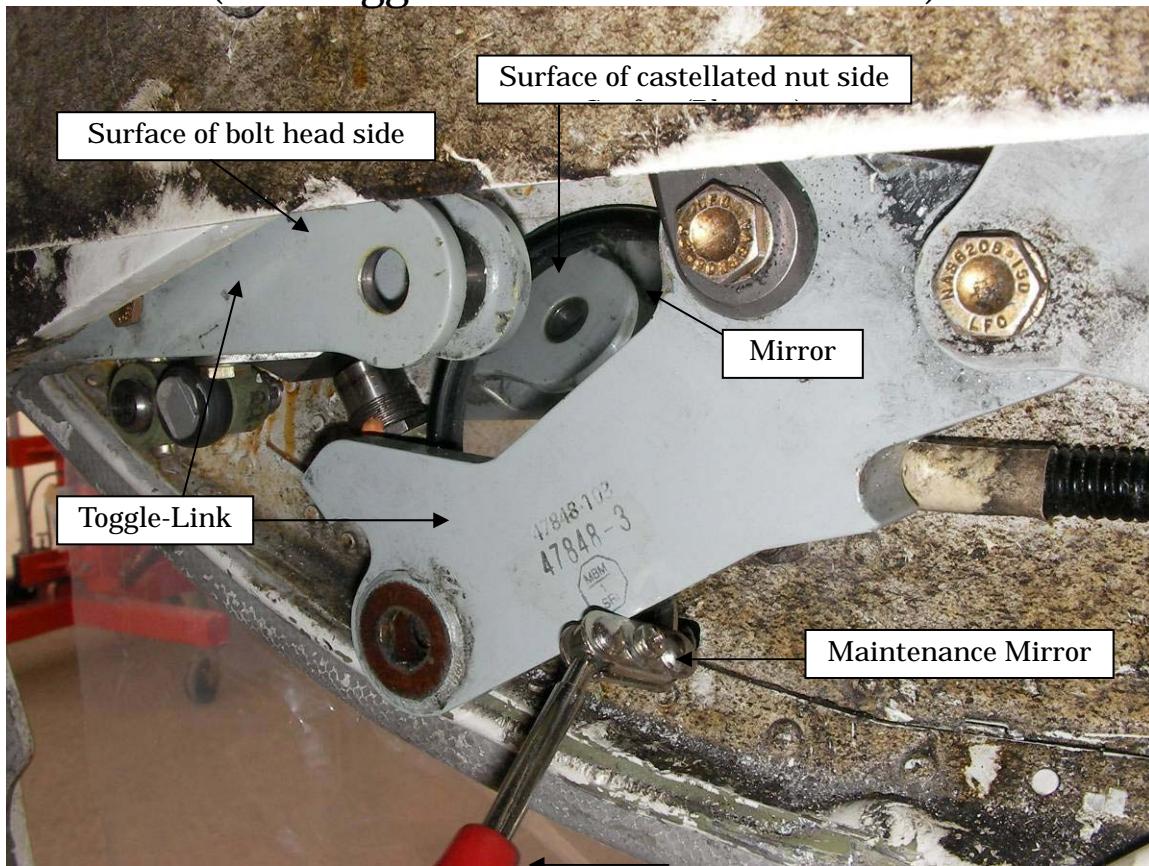


Photo 7 Toggle-Link removed from the accident aircraft (2)  
(Spacer is installed later)



Photo 8 Toggle-Link removed from the accident aircraft (3)



Photo 9 Toggle-Link of aircraft A

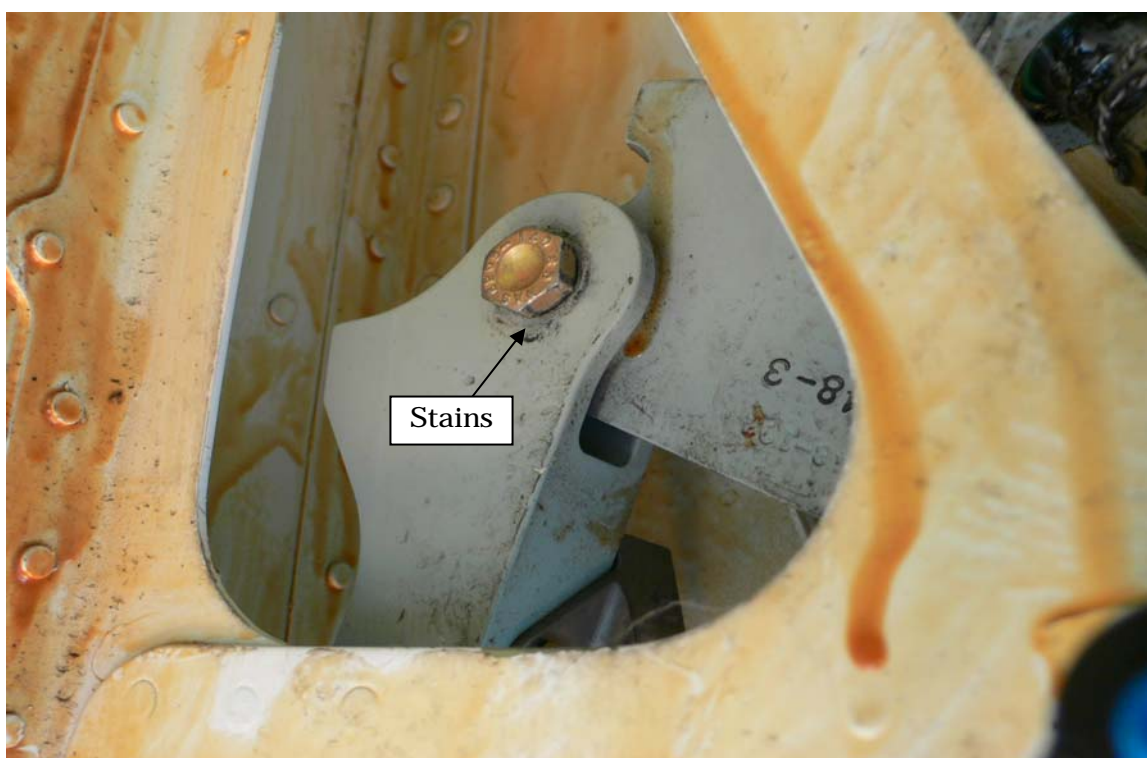


Photo 10 Toggle-Link of aircraft B



Photo 11 Toggle-Link of aircraft C



Photo 12 Inner Surface of Flanged Bushing removed from the accident aircraft

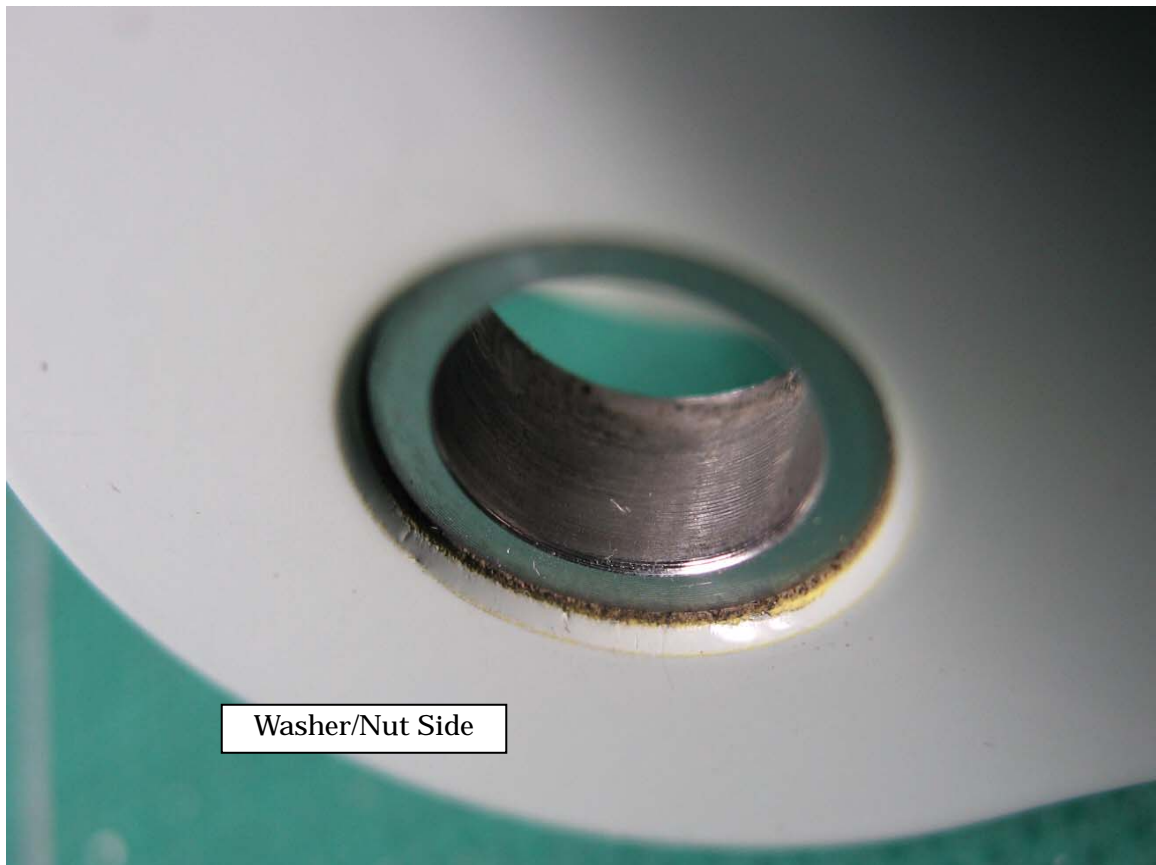


Photo 13 Inner Surface of Flanged Bushing removed from aircraft D



Photo 14 Inner Surface of new Flanged Bushing

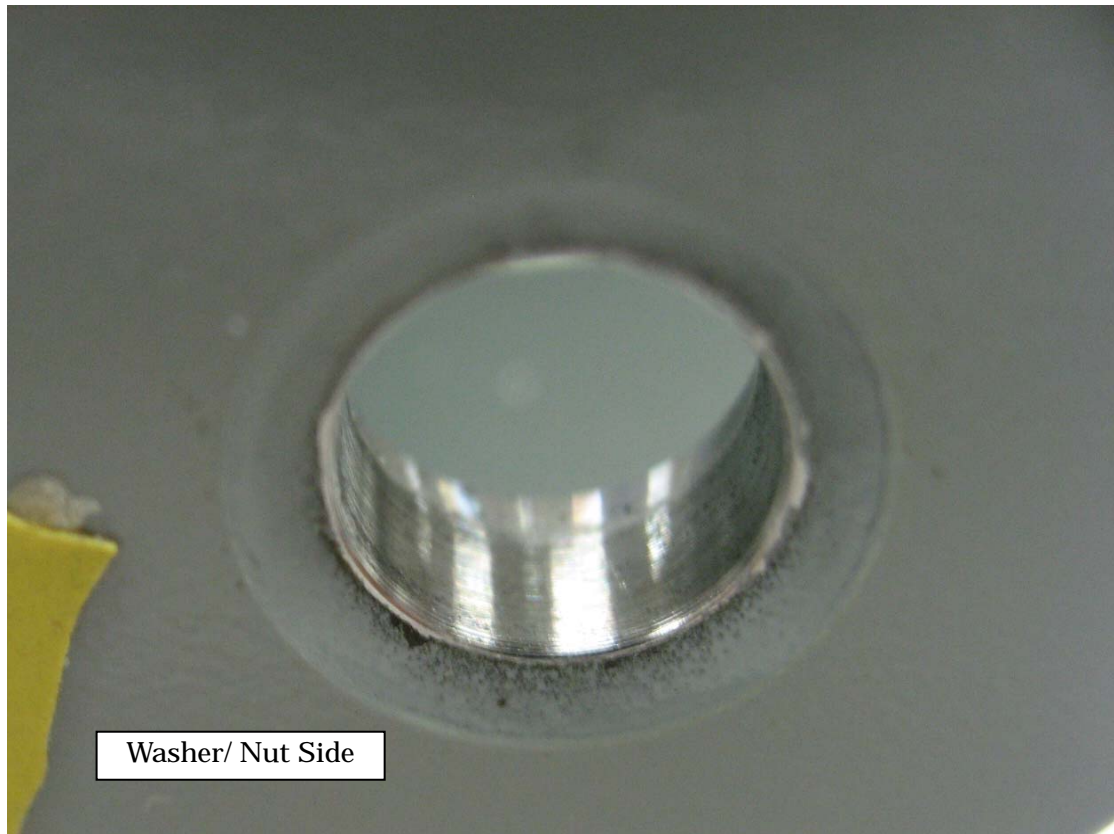


Photo 15 Peeling off of the paint of the Support Fitting

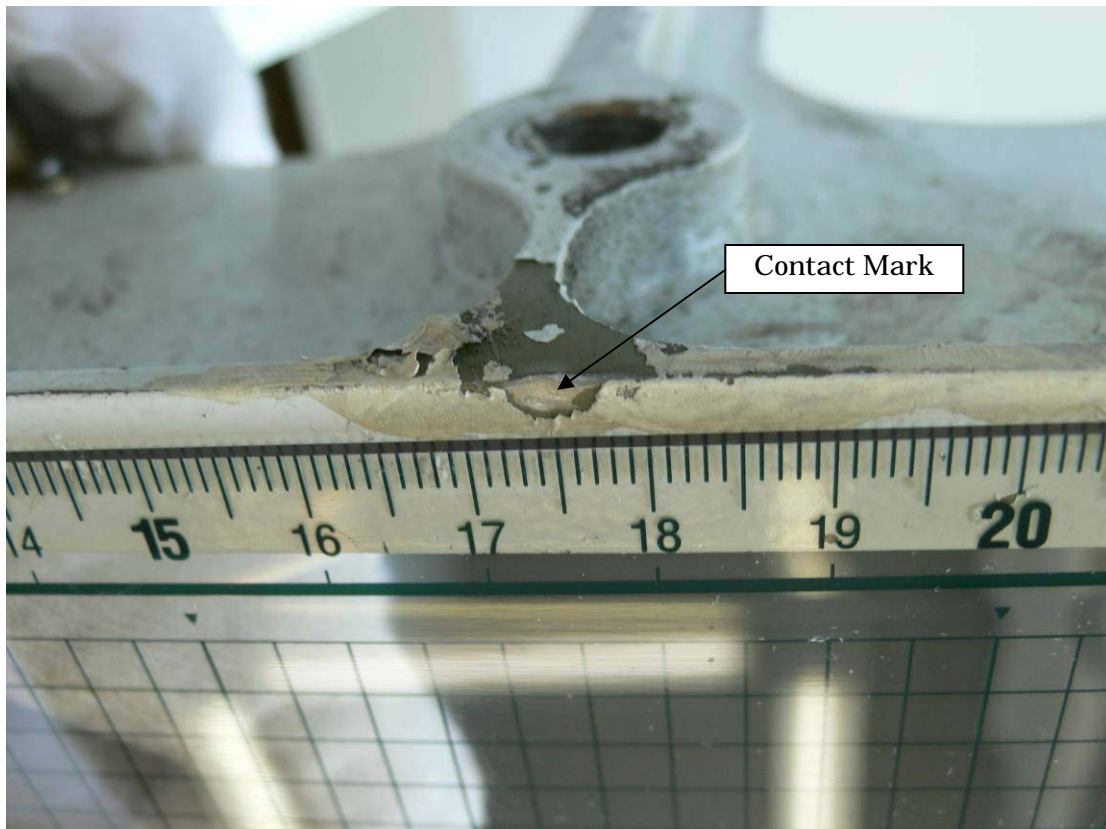


Photo 16 Impact mark on the mechanical stopper of the accident aircraft

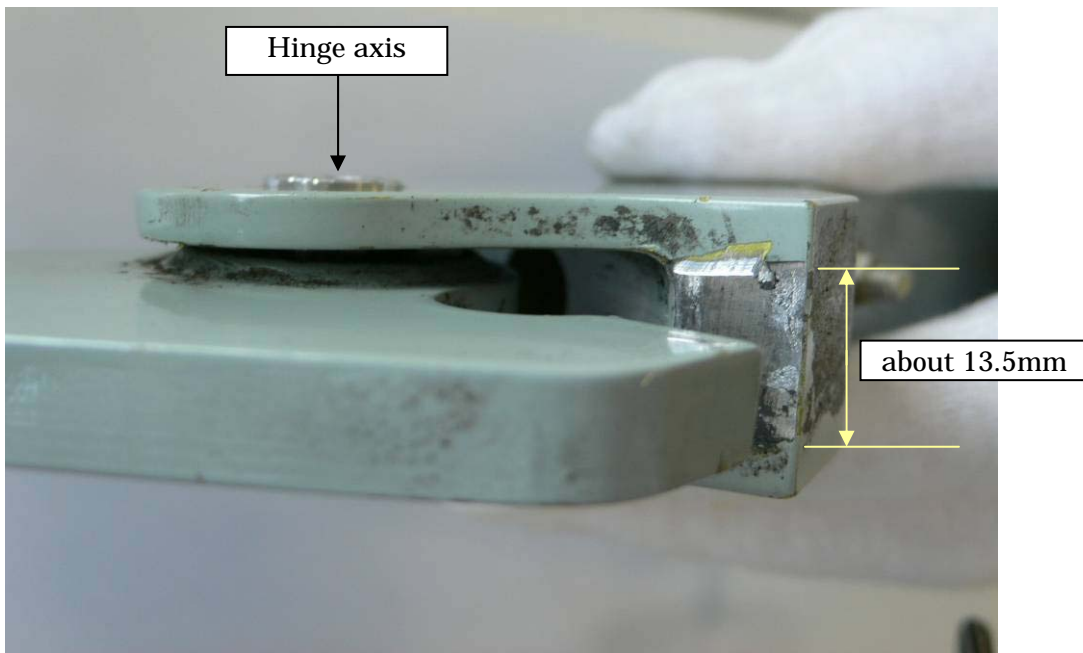


Photo 17 Impact mark on the mechanical stopper of other aircraft

