AA2016-3

AIRCRAFT ACCIDENT INVESTIGATION REPORT

SHIN NIHON HELICOPTER CO., LTD.
J A 6 7 4 1

April 28, 2016

Japan Transport Safety Board

The objective of the investigation conducted by the Japan Transport Safety Board in accordance with the Act for Establishment of the Japan Transport Safety Board and with Annex 13 to the Convention on International Civil Aviation is to determine the causes of an accident and damage incidental to such an accident, thereby preventing future accidents and reducing damage. It is not the purpose of the investigation to apportion blame or liability.

Kazuhiro Nakahashi
Chairman,
Japan Transport Safety Board

Note:

This report is a translation of the Japanese original investigation report. The text in Japanese shall prevail in the interpretation of the report.

AIRCRAFT ACCIDENT INVESTIGATION REPORT

CRASH AFTER COLLISION WITH POWER TRANSMISSION LINES DURING LEAVING FROM HOVERING SHIN NIHON HELICOPTER CO., LTD. AEROSPATIALE AS332L1 (ROTORCRAFT), JA6741 KIHOKU TOWN, KITAMURO GUN, MIE PREFECTURE, JAPAN AT AROUND 10:51 JST, MARCH 6, 2015

April 8, 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 March 6, 2015, an Aerospatiale AS332L1, registered JA6741, operated by Shin Nihon Helicopter Co., Ltd., transported loads with external sling device. Afterward, when leaving and climbing from hovering at the loading site of forward base for fuel supply in Kii-Nagashima temporary helipad around 10:51 Japan Standard Time (JST: UTC +9 hours, all times are indicated in JST on a 24-hour clock), it collided with power transmission lines and crashed into the inclined surface of mountains.

A captain and an on-board mechanic were on board and both of them were fatally injured.

The Helicopter was destroyed and a fire broke out.

<Probable Causes>

In this accident, it is highly probable that the Helicopter did not fly with sufficient distance to power transmission lines stretched in the air when it left and climbed from hovering at the loading site of the forward base, causing the collision with the power transmission lines, which damaged the fuselage and made it crash.

Regarding the fact that the Helicopter did not fly with sufficient distance to the power transmission lines, it is somewhat likely that the captain did not visually confirm the lines soon until the collision, or he could not distinguish the distance to the lines and got closer to the lines than expected.

The main abbreviations used in this report are as follows:

MRB	: Main Rotor Blade
Nf	: Power Turbine RPM
Ng	: Gas Generator Turbine RPM
Nr	: Main Rotor RPM
RPM	: Revolutions Per Minute
TB	: Tail Boom
TBM-KY	: Tool Box Meeting – Kiken (danger) Yochi (foresee)
TQ	: Torque
TRB	: Tail Rotor Blade
VHF	: Very High Frequency
VMC	: Visual Meteorological Conditions

1. PROCESS AND PROGRESS OF THE AIRCRAFT ACCIDENT INVESTIGATION

1.1 Summary of the Accident

On Friday March 6, 2015, an Aerospatiale AS332L1, registered JA6741, operated by Shin Nihon Helicopter Co., Ltd., transported loads with external sling device. Afterward, when leaving and climbing from hovering at the loading site of forward base for fuel supply in Kii-Nagashima temporary helipad around 10:51 Japan Standard Time (JST: UTC +9 hours, all times are indicated in JST on a 24-hour clock), it collided with power transmission lines and crashed into the inclined surface of mountains.

A captain and an on-board mechanic were on board and both of them were fatally injured.

The Helicopter was destroyed and a fire broke out.

1.2 Outline of the Accident Investigation

1.2.1 Investigation Organization

On March 6, 2015, the Japan Transport Safety Board designated an investigator-in-charge and two investigators to investigate this accident.

1.2.2 Representatives from the Relevant State

An accredited representative of French Republic, as the State of Design and Manufacture of the Helicopter involved in the accident, participated in this investigation.

1.2.3 Implementation of the Investigation

March 7 through 10, 2015	Interviews, examination of the Helicopter and on-site investigation
March 17, 2015	Documents investigation
March 19 through 20, 2015	Interviews
April 7, 2015	Examination of the Helicopter
May 18, 2015	Investigation of power transmission lines
May 19 through 20, 2015	Examination of the Helicopter and on-site investigation
May 21 through 22, 2015	Examination of the Helicopter
June 30, 2015	Examination of discolored part of main rotor blades

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

Comments were invited from parties relevant to the cause.

1.2.5 Comments from the Relevant State

Comments were invited from the relevant State.

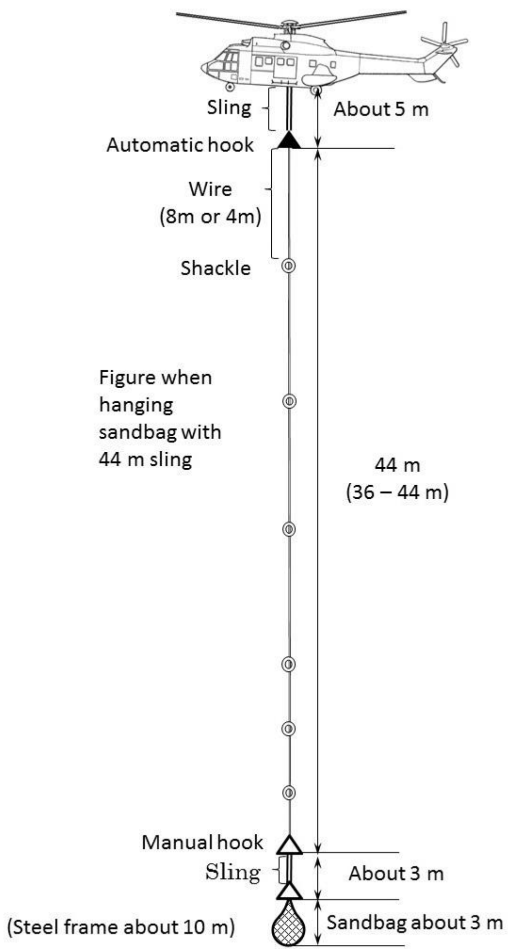
2. FACTUAL INFORMATION

2.1 History of the Flight

On March 6, 2015, at around 10:05, an Aerospatiale AS332L1, registered JA6741 (hereinafter referred to as "the Helicopter"), operated by Shin Nihon Helicopter Co., Ltd. (hereinafter referred to as "the Company"), took off from Kii-Nagashima temporary helipad (hereinafter referred to as "the Helipad") for loads transportation with external sling device, with the captain on the right seat and the on-board mechanic on the monitor seat (which was located in the left front end of the cabin for monitoring an image from an outboard camera).

The history of the flight up to the accident is summarized as follows, according to the statements of witnesses (ground workers and sales staffs).

On the day of the accident, the captain, the on-board mechanic and two ground workers boarded the Helicopter, and at 08:09, it took off from Nagoya Airfield, performed preliminary survey flight for the working site on the way, and flew towards the Helipad. In the preliminary survey flight, it hovered at the Yamato-dani valley loading site (hereinafter referred to as "Yamato-dani") in order to confirm the length of the sling and flew over the vicinity of the forward base loading site (hereinafter referred to as "the forward base") to confirm the locations of power transmission lines and supporting pylons which would be are obstacles.

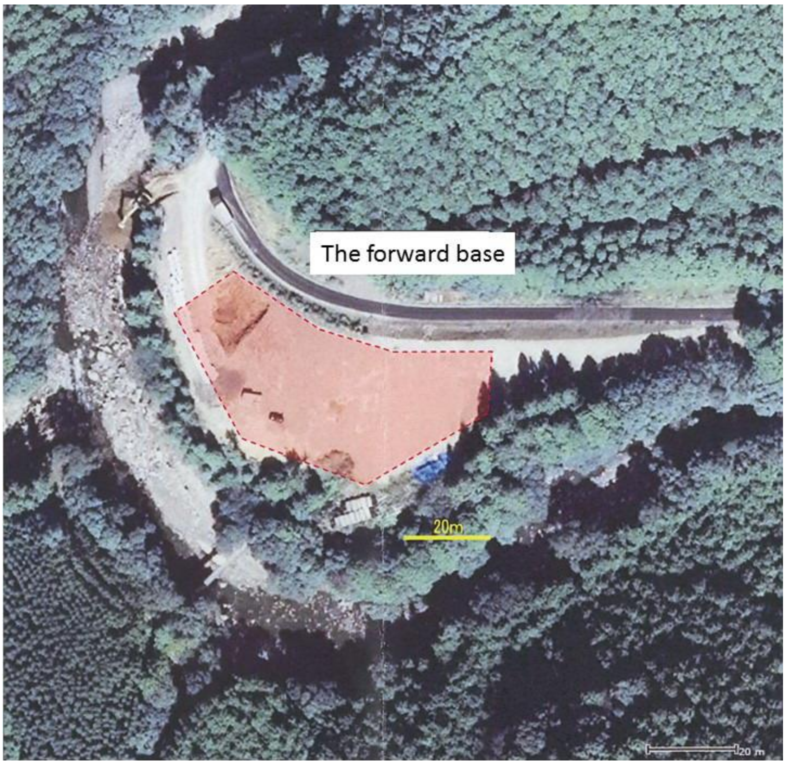


(Figure 1: Sling condition of the Helicopter)

At 08:58, the Helicopter landed the Helipad and the engines were shut down. The captain, the on-board mechanic, three ground workers, a sales staff, and a general contractor staff (a total of seven people) held a meeting about tasks of that day with TBM-KY paper*1 and other materials. The tasks of that day were to transport materials (such as sandbags) and discarded materials (such as steel frames) suspended outboard between the forward base and Yamato-dani and to fly with the sling detached when returning to the Helipad for fuel supply. Normally, in loads transportation, the Helicopter carries the fuel for a duration of one hour and 30 minutes including

*1 "TBM-KY paper" means a paper which is prescribed in the operation standards of the Company and includes items of "danger foresee" used by the captain in the meeting with ground workers and onboard workers before the start of tasks.

extra fuel for 30 minutes, and is supplied with fuel every one hour. On that day, the Helicopter took off from Nagoya Airfield with fuel for a duration of two hours and 30 minutes, flew for about one hour to land the Helipad where fuel was not supplied, and carried fuel for a duration of about one hour and 30 minutes when taking off from the Helipad.



(Photo 1: The forward base (Provided by the Company))

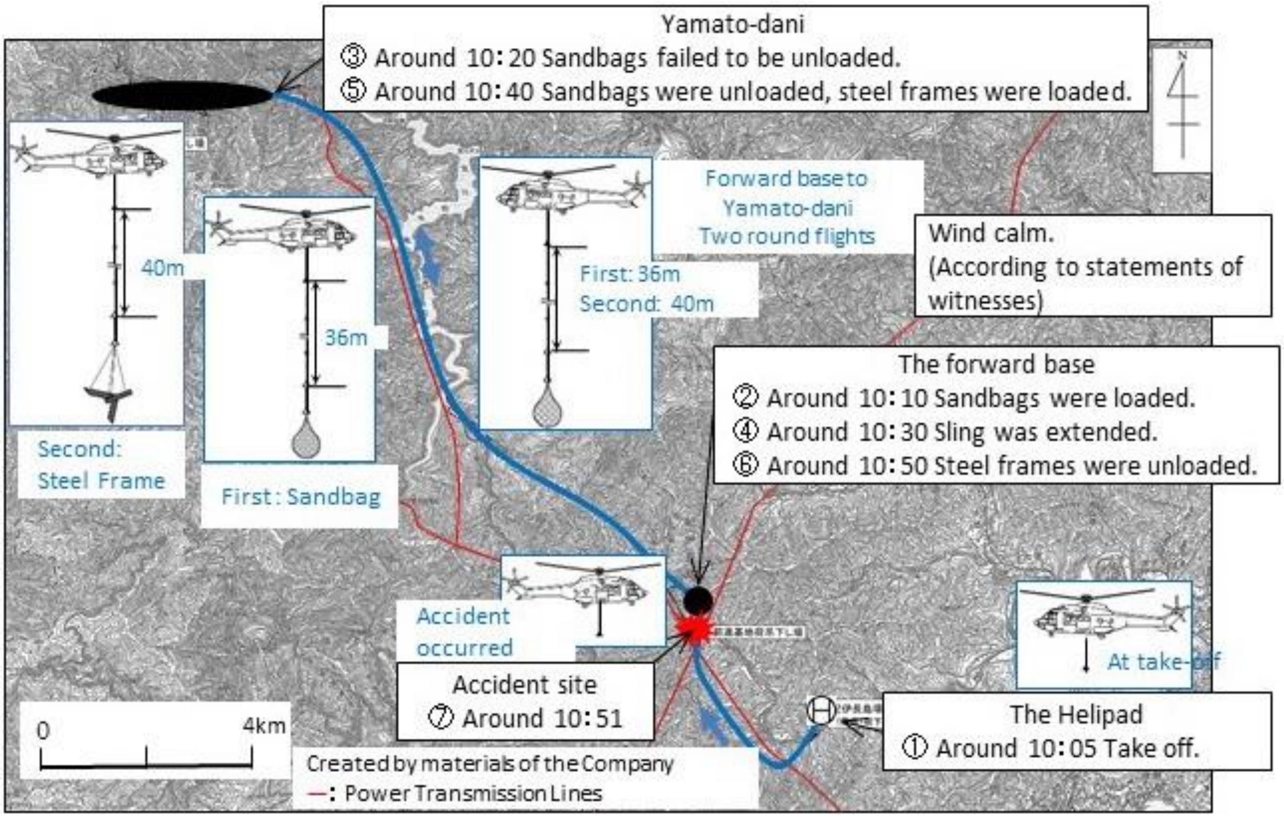
The captain and the on-board mechanic boarded the Helicopter, and at 10:05, it took off from the Helipad (①: Number of Figure 2; the same applies hereinafter), descended in the forward base, slung a sandbag to be transported first (②), and went to Yamato-dani. However, the Helicopter could not be unloaded due to the lack of the sling length (③), returned to the forward base as it was to extend the sling by four meters (④), and flew to Yamato-dani again.

The Helicopter unloaded the sandbag at Yamato-dani, slung the steel frames as discarded materials (⑤), and returned to the forward base. The on-board mechanic gave to the ground workers by radio the instructions to detach the sling in the part of the automatic hook for next fuel supply and to extend the suspension sling by another four meters for transportation after next fuel supply. The Helicopter gradually lowered hovering altitude to put the steel frames on the ground, further lowered hovering altitude to about 12 to 13 m, and detached the sling together with steel frames from the automatic hook (⑥), then raised the altitude.

When the witnesses took their eyes away off the Helicopter, they heard a large explosive sound behind them and looked back. Afterward, they heard light dry explosive sounds several times. The Helicopter collided with the power transmission lines (⑦), made the tail boom (TB) broken, and the main rotor blades (MRBs) were spinning, revealing flame and scattering pieces. After a while, TB fell off from the body, and the exhaust pipes of the engines emitted fire and black smoke. The body of the Helicopter was enveloped in flames while spinning, dropped on the ground from the nose, and the black smoke rose with explosive sound. After several explosive sounds, there was a sound as if something crumbled down. The pieces of the Helicopter fell down near the forward base. Nobody have heard strange sounds from the Helicopter before the Helicopter collided with power transmission lines.

The similar loads transportation task was scheduled also on the day after the accident.

The accident occurred among mountains (34° 12’ 42” N, 136° 14’ 16” E) at Kihoku town, Kitamuro gun, Mie prefecture, Japan at around 10:51 on March 6, 2015.



(Figure 2: Operational situation of the Helicopter)

2.2 Injuries to Persons

The captain and the on-board mechanic were fatally injured.

2.3 Damage to the Helicopter

2.3.1 Extent of Damage

Destroyed

2.3.2 Damage Situation of Helicopter Components

Body	Burned
TB	Split off from the body and broken
MRBs	Split off from the body and broken
Engines	Burned
Tail rotor blades (TRBs)	Ruptured

2.4 Damage to Objective other than the Helicopter

Two power transmission lines were cut, therefore about 18,700 households in Owase city and Kihoku town, Kitamuro gun in Mie prefecture had a power failure for about four minutes from 10:51.

2.5 Personnel Information

(1) Certificates of the Captain

Captain Male, Age 53

Commercial pilot certificate (Rotorcraft)	December 28, 1983
Type rating for Aerospatiale SA330	May 21, 2012
Class 1 aviation medical certificate	
Validity	January 7, 2016
Total flight time	6,873 hr 02 min
Flight time for the last 30 days	18 hr 32 min
Flight time on the type of Helicopter	248 hr 51 min
Flight time for the last 30 days	2 hr 30 min

(2) Recent Reviews and Flight Experiences

On May 20, 2012, the captain passed the internal examination for loads transportation by the type of the Helicopter, and on December 25, 2014, took the internal periodic examination related to the captain and pilot in charge of skill check and passed without specific comments. On November 6, 2014, the captain performed loads transportation task near the accident site by the Helicopter, but he had not used the forward base before this accident.

2.6 Helicopter Information

2.6.1 Helicopter

Type	Aerospatiale AS332L1
Serial Number	2413
Date of manufacture	November 3, 1994
Airworthiness Certificate	No.TO-26-586
Validity	March 3, 2016
Category of airworthiness	Rotorcraft Transport TA, TB or Special X
Total flight time	7,343 hr 51 min
Flight time since last periodical check (TA Check: February 24, 2015)	10 hr 39 min

(See Appendix 1: Three Angle View of Aerospatiale AS332L1)

2.6.2 Weight and Balance

When the accident occurred, the weight of the Helicopter was estimated to have been 5,248 kg and its position of center of gravity (CG) was estimated to have been 4.50 m after from the reference datum (4.67 m forward of the center of main rotor). Both of them were estimated to have been within the allowable range (the maximum take-off weight of 8,600 kg, and the CG range 4.40 to 4.90 m corresponding to the weight at the time of the accident).

2.7 Meteorological Information

2.7.1 Observations at Regional Meteorological Observatory

The observations at Kii-Nagashima regional meteorological observatory located about 8 km east from the accident site around the time of the accident were as follows:

10:50 Wind direction 112.5°, Wind Velocity 3.1 m/s, Maximum velocity 5.3 m/s,
Temperature 12.1℃, Rainfall 0 mm, Sunshine duration 10 minutes (per 10 minutes)

2.7.2 Statement of Witnesses in the Forward Base

According to the statement of witnesses who had worked in the forward base at the time of the accident, the weather at the time of the accident was as follows:

Weather Fine, Wind calm, Visibility good

2.7.3 Forecast published by Tsu Local Meteorological Office

Issued at 05:00, March 6, 2015 Mie Prefecture South

Today	North wind, Northeast wind on the sea, Slightly strong, Cloudy, Partly rain in the night
Tomorrow	North wind, Northeast wind on the sea, Slightly strong, Cloudy, Partly rain before dawn

2.7.4 Regional Aviation Weather Report Published by Kansai Aviation Weather Service Center (Kinki・Chugoku・Shikoku)

Issued at 06:30, March 6, 2015

(1) Summary of aviation weather and future prospect

① Although mid- and low-level clouds spread in this region under the influences of cold air and shear lines*2 above the sea southeast of Kyushu, each airfield is expected to be VMC (visual meteorological condition). The wind is land breeze in most areas.

② Although each airfield remains in VMC by tomorrow morning, it is expected that low-level clouds will tend to spread especially along the Japan Sea coast by today morning under the influences of cold air, and mid- and low-level clouds will tend to spread across Shikoku and central and south parts of Kinki by tomorrow morning under the influences of a trough and shear lines.

③ The wind is expected to change with diurnal variation by tomorrow morning under the influence of the northern wind.

(2) Notes on Forecast

None

2.8 The Forward Base Information

The forward base is adjacent to the river flowing along the valley in mountain area and has flat space of an about 50-meter square. The base is surrounded on all sides except for the northwest side by mountains covered with high trees, and power transmission lines of Chubu Electric Power Co., Inc. pass in the air above the vicinity, such as Chubu Electric 275 KV Owase-Ise line from northeast to south and Chubu Electric 75 KV Miyagawa line No.1 and No.2 from northwest to south.

That the forward base is located in the position as close to the unloading site as possible and with wide space accommodating vehicles in order to shorten the course of loads transportation by helicopter and reduce opportunities of crossing the power transmission lines with loads slung outboard. It is not a temporary helipad and thus landing is not permitted. (See Photo 1)

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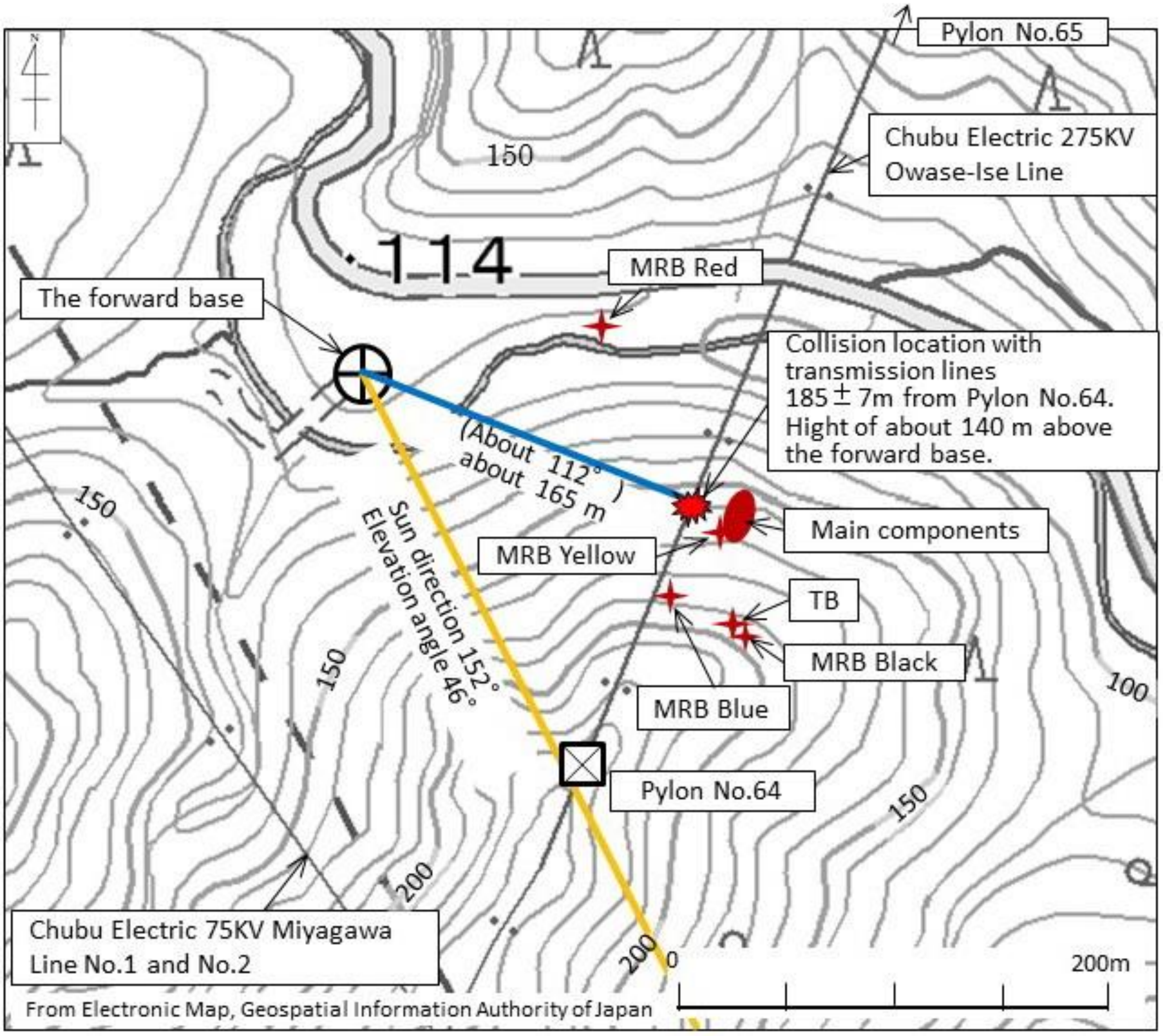
*2 "Shear lines" mean a line connecting points in which wind direction and wind velocity (or either) suddenly change.



(Figure 3: Situation near the accident site)

2.9 Information on Accident Site and Wreckage

2.9.1 Situation of Accident Site

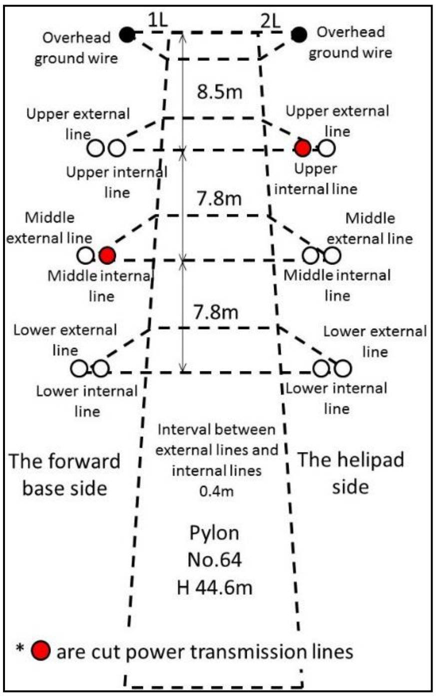
The accident site is an inclined surface with gradient of about 45° in the north, which is located southeast of the forward base. The burnt wreckage of main components such as the body, engine, main gear box, main rotor hub, landing gears, and so on remained together, and parts were scattered within the range of about 10 m in width and about 20 m in length along the inclined surface. MRB Yellow (four MRBs are distinguished by colors, such as yellow, red, black, and blue) hung on the tree in the position of main components and was affected by fire. TB completely fell off from the connection part with the body and was supported upside down by trees about 50 m south of the main components. MRB Black was in its immediate southeast, MRB Blue was in a position about 50 m southwest of the main components, and MRB Red was in an opposite shore of a river about 100 m northwest of the main components, all of which fell off from the basis. The instrument panel, canopy, engine cowling, TRBs, and so on were scattered around the main

(Photo 2: Condition of main components)

components and were not affected by fire.

2.9.2 Situation of Power Transmission Lines

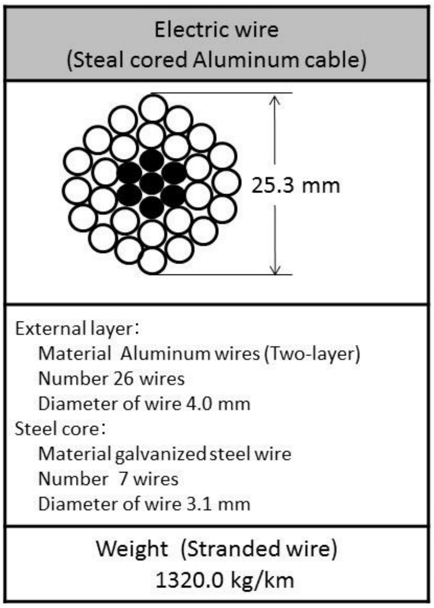
The power transmission lines stretched between Pylon No.64 and Pylon No.65 in Chubu Electric 275 KV Owase-Ise Line consists of 14 wires which are 12 electric wires and two overhead ground wires*3. The height of Pylon No.64 is 44.6 m from the ground and 263.6 m above sea level. The power transmission line group in the forward base side is referred to as 1L, and the power transmission line group in the Helipad side is referred to as 2L. The overhead ground wire, upper lines, middle lines, and lower lines of electric wires are arranged from the top, and the interval between the external lines and the internal lines is 0.4 m. Regarding the interval between top and bottom of power transmission lines in the pylon, the interval is 8.5 m between the overhead ground wires and between the electric wires on the top, and 7.8 m between other electric wires.



(Figure 4: Situation of power transmission lines)

1L middle internal line and 2L upper internal line in power transmission lines broken at the point located about 185 m from Pylon No.64 in the direction towards Pylon No.65 at the height of about 140 m from the forward base (about 240 m above sea level), and other nearby power transmission lines were also damaged.

The specification of the electric wire is shown in Figure 5. The fracture surface of ruptured electric wire is as Photo 3. The lay was untwisted in the fracture surface of the electric wire and wires were tangled. The fracture surface of external layer became thinner in the end and sharp like the edge of a chisel, and the fracture surface of steel core became slightly thinner in the end, both of which show the sign of ductile tensile fracture.



(Figure 5: Specification of electric wires)

2.9.3 Detailed Situation of Damage

(1) MRBs

All MRBs fell off from the basis and were damaged. The parts of a blade tip fairing and a leading-edge strip fell off. The leading-edge strip, and so on had dents, deformation, scratched marks, cracks, discoloration part of black, white and orange, and a small quantity of the fouling like rust. The traces of perforation, dissolution, or arc discharge of black discoloration were found in the joint, and so on of the part of the leading-edge strip.

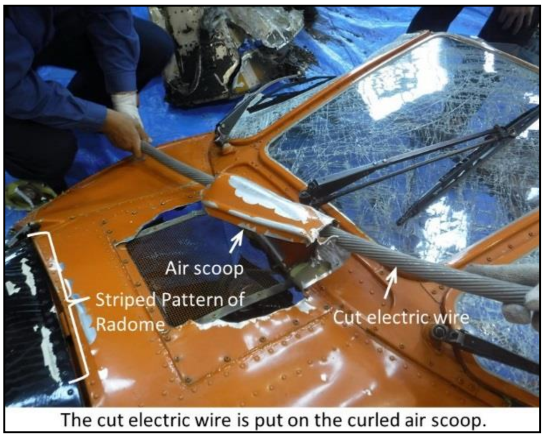
(See Appendix 2: Damage Situation of MRBs)


(Photo 3: Fracture surface of an electric wire)

*3 "Overhead ground wire" means a wire strung in the top of electric wires in order to protect the electric wires from direct lightning strikes.

(2) Body

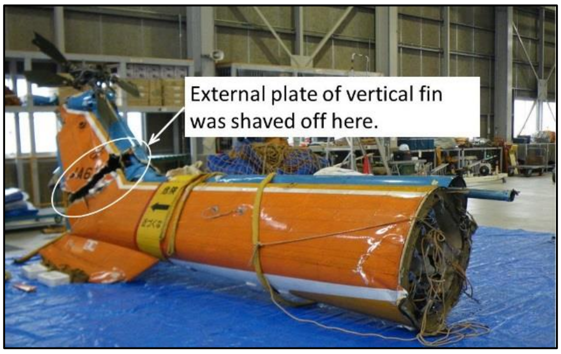
The upper surface of a radome in the nose had striped scratch marks, an air scoop in the forward upper side of the canopy (a structure covering around the cockpit) curled to the basis of the central wiper, the upper part of the canopy from there was almost undamaged, and the whole wind shield was cracked. The canopy fell off from the body in the rear of the pilot seat. The cargo mirror, receiver of meteorological radar, battery, instrumental panel, and other parts, which were equipped in the nose, fell off but were not affected by fire. The cowlings in the upper part of the body fell off, had scratch marks in the upper surface, and was not affected by fire, though aluminum wires were stuck in its part. The left sponson (the cover of main landing gear) and tail hatch (a door in the rear of the body) fell off and were not affected by fire.



(Photo 4: Upper part of canopy)

(3) TB

TB fell off from the connection part with the body. Regarding the ruptured part of TB, the right rivets were all ruptured from the basis and the left was ruptured so as to be compressed. Tail rotor drive shaft consisting of seven stages was ruptured in the flexible coupling of connection part between the third stage and the fourth stage. In the right lower part of the vertical fin, an external plate of 14 to 40 cm in width was shaved off from the lower rear to the upper front. The tail rotor of the Helicopter is pusher type which rotates anticlockwise when viewed from the right. The five TRBs were all ruptured in the almost middle.



(Photo 5: TB)

2.10 Medical Information

According to Mie Prefectural Police Headquarters, the cause for the fatal injury of the captain was traumatic shock from bone fractures, and so on, and the cause for the fatal injury of the on-board mechanic was oxygen deficiency and burn shock due to fire.

Alcohol was not detected from blood of the captain and the on-board mechanic, and the results of drug testing were negative.

2.11 Fire, Firefighting and Rescue Information

According to Kii-Nagashima Fire Station in Mie Kihoku Fire Union, the activities on fire, firefighting, and rescue related to this accident are as follows:

10:54 Local residents near the accident site reported "Large sound and black smoke".
10:56 Ambulances and fire fighting pump cars were dispatched.
11:04 An emergency medical service (EMS) helicopter was requested to be dispatched.
11:13 A disaster prevention helicopter was requested to be dispatched.
11:16 Firefighters arrived at the forward base.
11:32 Firefighters arrived at the accident site.
11:48 The captain was discovered.

11:49 The on-board mechanic was discovered.

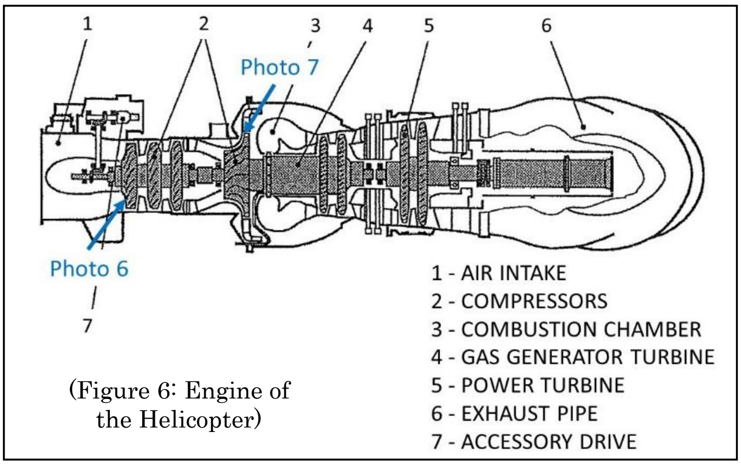
12:34 The captain and the on-board mechanic were carried to Owase Police Station, and the EMS helicopter returned.

15:39 It was confirmed that the fire went off (after 10-time water spray by the disaster prevention helicopter and firefighting activities on the ground).

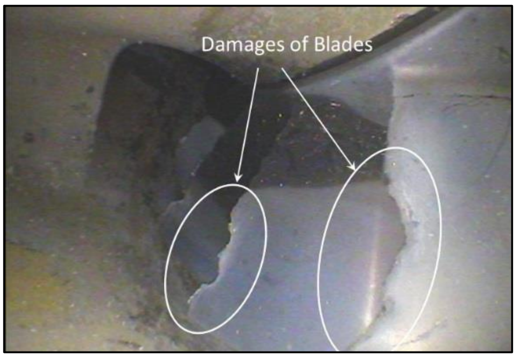
2.12 Test and Study Information

2.12.1 Investigation on the Inside of Engines with Borescope

The Helicopter is equipped with two Turbomeca Makila 1A1 engines. The engine consists of compressors with three axial stages and one centrifugal stage, a two-stage gas generator turbine and a two-stage power turbine. Free wheels for each engine, which are in the inside of a main gear box, enable the main rotor, the tail rotor and so on to continue to rotate with aerodynamic force without restriction of engine rotation even if the engine output is decreased. If the external force is added to stop the rotation of the main rotor in engine operation, the engagement of free wheels is kept, therefore the power turbine is stopped but the gas generator turbine and the compressors, whose axles are independent, continue to rotate.

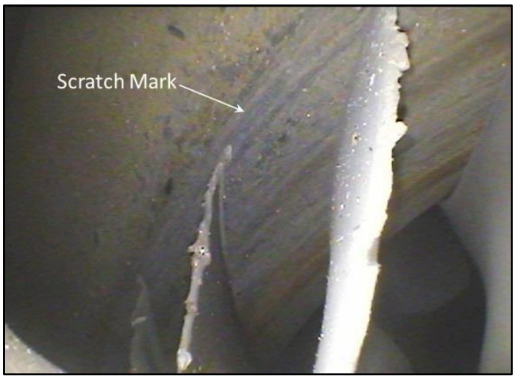


(Figure 6: Engine of the Helicopter)



(Photo 6: No.1 Engine Axial Compressor)

Although it was inspected from the compressor side whether or not the engines can be rotated by hand, both of the engines could not be rotated by hand. When the inside of the engine was observed with borescope, the leading edge of blades in the first stage of the axial compressor were damaged and the inner surface of casing of the centrifugal compressor had scratch marks by impellers in both engines.



(Photo 7: No.1 Engine Centrifugal Compressor)

2.12.2 Inspection on the Indicators

The indication of indicators in the Helicopter was inspected at the accident site as shown in Table. All of these indicators keep the indication at the time when power supply to them was cut, unless some external forces are added.

Pitch indicator indicates the position of fixed swashplate sent by electric signal as the angle of collective pitch. Pitch 15.2° is a value of allowing the Helicopter, which was light-weight in the accident, to climb even at low speed.

Main rotor RPM (Nr) and power turbine RPM for each engine (Nf1, Nf2) are indicated in one triple-needle tachometer. In normal operation, these three needles overlap and indicate 265 rpm (100%). The indications of 250 rpm in Nr and 254 rpm in both Nf are values within operation limit but lower than the values in normal operation, and Nr is lower than Nf.

The torque indicator has dual-needle indication including a needle whose indication can be switched in any order between the total torque of both engines (TQ1+2) and the torque of No.1 engine (TQ1), and a needle of indicating the torque of No.2 engine (TQ2). The indications are different between the left seat and the right seat: TQ1+2 was 75 % and TQ2 was 40 % in the right torque indicator, while TQ1 was 17 % and TQ2 was 48 % in the left torque indicator.

Indicator		Indication	Operation Limit	Unit
Pitch		15.2	16.5 (horizontal) 17.5 (Climb)	°
Nr		250	245～275	rpm
Nf1,Nf2		254※	292※	
TQ	1+2(R)	75	81(MCR) 100(5 min)	%
	2(R)	40	66(MCR) 69(2 min 30 sec) 74(20 sec)	
	1(L)	17		
	2(L)	48		
Ng	No.1	327	323(MCR) 333.5(5 min)	*100 rpm
	No.2	320		
T4	No.1	770	735(MCR) 795(Take-off rating)	℃
	No.2	720		

※ Nf is rotation speed corresponding to Nr. 22,850rpm(Nf) corresponds to 265rpm(Nr)(100%)

※ Red Letter displays exceeding limit of maximum continuous rating (MCR)

(Table: Indication of indicators)

Gas generator turbine RPM (Ng) and engine temperature (T4) for each engine are indicated separately. The indications of Ng and T4 for No.1 engine exceed the limits of maximum continuous rating but is lower than the limit of 5 minutes or take-off rating.

Regarding these values, the comments from design/manufacturer were invited and the answer is as below. (Excerpts)

The position of the needles on both engine parameter indicators are coherent with engines operating and delivering power when the electrical power has been lost or when the aircraft has impacted the trees/ground.

The electrical supply loss could have occurred not at the same time for each of these indicators (but in all the case in the accident sequence so with some parameters already affected by the aircraft trees and ground impacts).

Furthermore the needle position on all these indicators could have also been affected after or during the electrical loss by the effect of the impact (shock). It is for these reasons that the information resulting from these indicators are not sufficient and relevant to determine the consistency of these parameters with a specific and unknown flight phase.

These parameters need to be associated with a detailed wreckage examination which will allow determining if the damage observed on the dynamic assemblies and engines are also consistent with a powered aircraft during the impact phase.

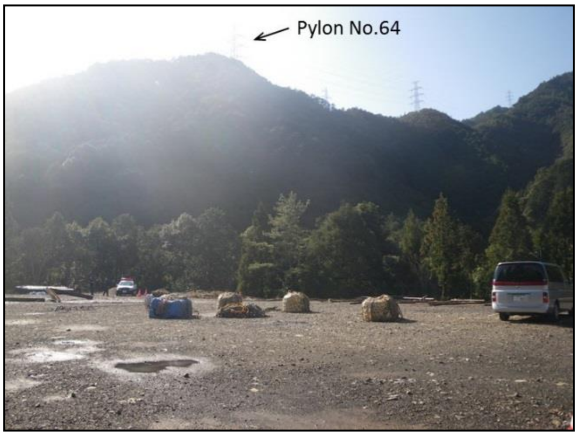
2.12.3 Examination on Discoloration Part of MRB Yellow

The discoloration part of white, black and orange, and the fouling like rust, which were attached in the leading-edge strip of MRB Yellow, were observed by energy dispersive X-ray spectrometry. Aluminum was mainly detected from the discoloration part of white. Aluminum and oxygen were detected from the discoloration part of black. Lead, silicon, carbon, and chromium were detected from the discoloration part of orange. Iron, oxygen, and carbon were mainly detected from the fouling like rust.

2.12.4 Elevation Angle and Direction of Sun and Pylon No.64 from the Forward Base

The direction (all of directions in this report are true bearing) and height of the sun relative to the forward base at the time of the accident were calculated based on the nautical almanac issued by Hydrographic and Oceanographic Department, Japan Coast Guard, and found to be direction of 152° and elevation angle of 46°.

The direction of Pylon No.64 from the forward base is about 150°, and the horizontal distance between them is about 200 m. The height difference is about 150 m between the forward base and the top of Pylon No.64, and thus the elevation angle is about 37°. (See Figure 3)



(Photo 8: View of Pylon No. 64 from the Forward Base (Photographed at 09:22, March 8, 2015))

2.13 Additional Information

2.13.1 Rules of the Company on Loads Transportation

Chapter 2 "Loads Transportation" of Operational Standard in internal rules of the Company describes the following contents.

(excerpts)

3. Loads Transportation

(1) General

(Omitted) *The task should be performed after a meeting was held with TBM-KY paper before the start of tasks.*

(Omitted)

(6) Danger Sign for Obstacles

(Omitted)

② If liner shaped obstacles are unremovable from the flight route, it shall be reported to heliport offices and made known to all pilots. Whenever captains are taken over, the situation shall be reported.

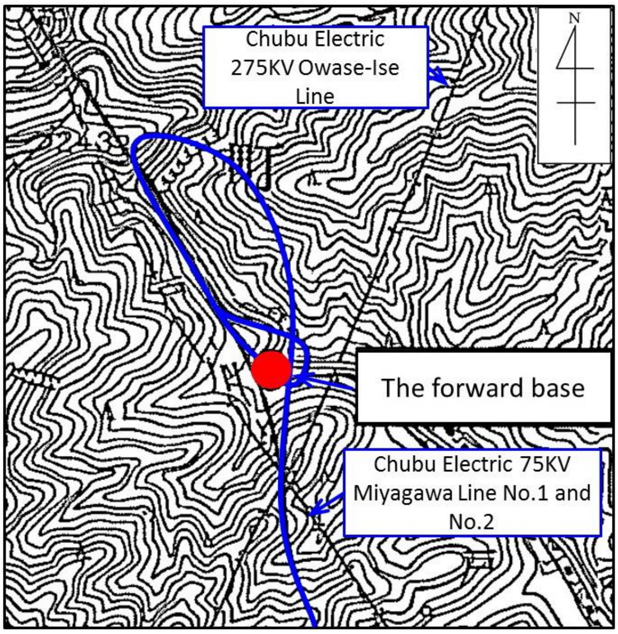
(The rest is omitted)

On the TBM-KY paper which was used before the flight of the accident, check marks were placed on all confirmation matters including the flight route and measures on obstacles or items that might be scattered, and there were a picture of trees in the front of fuselage and the description of 36 m sling length as preliminary survey flight confirmation matters in Yamato-dani. KY matters said, "Be careful for forward trees due to long sling." However, there were no description of the forward base in the preliminary survey flight conformation matters and KY matters.

2.13.2 Information on Permission and Application for Flight lower than Minimum Safety Altitude

According to "Permission application for flight at an altitude lower than a minimum safety altitude (the first application) (No. SHINKOUJOU 2116, February 16, 2015)" submitted to Osaka

Regional Civil Aviation Bureau by the Company, the Company was permitted to fly at the altitude less than the minimum safety altitude for the flight of the accident by Osaka Regional Civil Aviation Bureau. The application form described, "*Regarding the crossing (flying above) of power transmission lines, the permission is obtained from the electric company, and if the lines clearly visible, the Helicopter flies above the electric wires between pylons, otherwise it flies above the pylon after confirming the pylon number (displayed at the upper part).*" According to the figure attached in the application form, the leaving route from the forward base was a route where the Helicopter once left and turned to the northwest and then passed above the vicinity of the Pylon No.64.



(Figure 7: figure indicating Flight Route Attached in the Application Form (The part of flight route is colored, and names of power transmission lines and display of north are added.))

2.13.3 Information on Obstacle Markings and Obstacle Lights

(1) Obstacle markings

Objects which must be installed with obstacle markings are prescribed in Article 51-2, of Civil Aeronautics Act, and Article 132-2, of Ordinance for Enforcement of the Civil Aeronautics Act. Neither Pylon No.64 nor No.65 are applicable to the objects with a height of more than 60 m from the ground surface or the water surface prescribed in the above mentioned articles, therefore it is not obliged to install the obstacle markings. The power transmission lines stretched between Pylon No.64 and No.65 are not applicable to the overhead wire stipulated and notified by the Minister of Land, Infrastructure, Transport and Tourism pursuant to item (iii) of paragraph (1), Article 132-2 of the same Act, therefore it is not obliged to install the obstacle markings and they are not actually installed.

(2) Obstacle lights

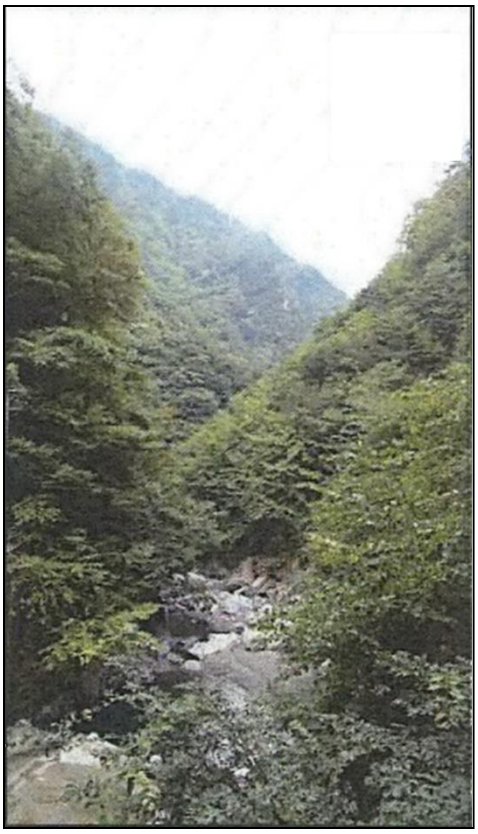
Objects which must be installed with obstacle lights are prescribed in Article 51, of Civil Aeronautics Act. Neither Pylon No.64 nor No.65 are applicable to the objects with a height of more than 60 m from the ground surface or the water surface prescribed in Civil Aeronautics Act, so it is not obliged to install the obstacle lights. The power transmission lines stretched between Pylon No.64 and No.65 are exempted from the installation of obstacle lights under the permission of Osaka Regional Civil Aviation Bureau based on the application from the provider, and they are not actually installed.

2.13.4 Performance of the Helicopter

According to the flight manual for the Helicopter, the Helicopter could make out of ground effect (OGE) hovering (condition which gave the heaviest load on the engine in the specification table) even with single engine under the weight and meteorological conditions in the accident. This shows that when both engines of the Helicopter were in operation, there was extremely large excessive horse power.

2.13.5 Information from Colleague Pilot

According to the statement of a colleague pilot, the similar tasks were performed with other type of helicopter (Bell 412) at the accident site about 1 month ago. On the day before the accident occurred, the captain returned to Nagoya base of the Company afternoon but was tied up, therefore the colleague pilot could not report the tasks to be in the accident site until the evening. That time, he did not have the impression that the captain was quite familiar with the situation near the forward base, and explained the situation of power transmission lines around the forward base. Regarding the length of slings, the Helicopter was larger than a fuselage with which the colleague pilot performed tasks, therefore he said, "It will need 44 m", but the nearby on-board mechanic said, "40 m will be enough." The Yamato-dani is a gorge between almost vertical cliffs, where pilots must carefully watch trees so as not to contact them. The shorter sling is better due to less swing, and the length of the long sling of 40 m in Yamato-dani is very rare.



(Photo 9: Yamato-dani (Provided by the Company))

The on-board mechanic has long experiences and guides the captain well to dedicate himself to the control without any concerns.

Although the Company does not blame captains for having made an additional round flight, it actually affects the time when ground workers get down mountains. Pilots are released from stress when unloading the loads. Before fuel supply, pilots often consider the next fuel plan, thinking: "If fuel was increased a little, one more round flight could be made."

Regarding the leaving direction from the forward base to the Helipad, if the Helicopter is light-weight without much fuel and loads, it can vertically climb, so that it crosses the pylon if possible though this action also depends on the wind. After the loads is unloaded, in order to obtain altitude and speed as soon as possible, the Helicopter climbs at a stroke with as high power as possible, turns the nose to the traveling direction, accelerates, and shifts to the climbing attitude. But, when it is difficult to cross the power transmission lines with the Helicopter performance, it once flies in the opposite direction to obtain altitude. As the pilot's common sense, the distance to the power transmission lines which are linear shaped obstacles can not be judged in crossing the lines, therefore they always pass over the pylon instead of crossing the lines with visual contact.

There is no determined callout procedures*4 in loads transportation tasks.

Although pilots suffer various stresses in their first site, if they understand the situation of the site to some extent and its meteorological condition is good, about one-hour flight does not tire them out.

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*4 "Callout procedures" mean predetermined voice procedures to communicate between persons on board.

3. ANALYSIS

3.1 Qualification of Personnel

The Captain held a valid airman competence certificate and a valid aviation medical certificate.

3.2 Aircraft Airworthiness Certificate

The Helicopter had a valid airworthiness certificate and had been maintained as prescribed.

3.3 Relation to Meteorological Conditions

As described in 2.7, it is highly probable that the weather near the forward base at the time of the accident did not affect the Helicopter's flight.

3.4 Sequence of the Helicopter's Flight

As described in 2.1, 2.9.2, and 2.9.3, the Helicopter took off from the Helipad, traveled twice between the forward base and Yamato-dani, and left from hovering in order to go to the Helipad from the forward base for fuel supply, without keeping sufficient distance to the power transmission lines above the ground; therefore, it is highly probable that it collided with the power transmission lines located about 185 m from Pylon No. 64 in the direction towards Pylon No. 65, and crashed.

3.5 Situation when the Helicopter Collided with Lines and Crashed

Based on the damages of the power transmission lines and the Helicopter's body described in 2.9.2 and 2.9.3(2), it is somewhat likely that the nose was put between 1L middle external line and middle internal line in the attitude where the Helicopter was nosed up higher than the ordinary climbing attitude with little tilting to the right or left. That time, the Helicopter had sufficient speed for moving forward and climbing; therefore, it is highly probable that it flew to 2L upper internal lines with inertia while canopy, equipment parts of the nose, the cowling in the upper part of the fuselage and so on fell off, during which the whole of the Helicopter collided with the power transmission lines.

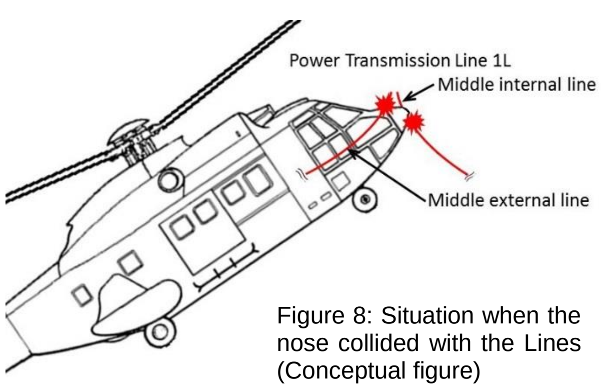


Figure 8: Situation when the nose collided with the Lines (Conceptual figure)

Based on the wreckage scattering of the Helicopter, the damages of the power transmission line, and the damages and discoloration part of MRB described in 2.9.1, 2.9.2, 2.9.3(1), and 2.12.3, it is highly probable that each MRB of the Helicopter mainly hit the power transmission lines several times to cut or damage them, while each MRB itself was ruptured and scattered from the basis. Based on the description of 2.9.3(3), it is highly probable that the strength limit of TB was exceeded by the collision between MRBs and the power transmission lines, causing the rupture in the connection part with the body. At that time, it is highly probable that the rotating TRBs of the Helicopter shaved off the skin in the right lower part of the vertical fin, while TRBs themselves were also ruptured. It is highly probable that the Helicopter whose MRBs and TB were ruptured in the air crashed into the mountainside almost directly below the power transmission lines.

3.6 Situation of Engines in Accident

Based on the internal damages of both engines described in 2.12.1, it is highly probable that the compressor had been rotating when the Helicopter crashed and external forces were exerted on the engines. Besides, the indication of the pitch indicator described in 2.12.2 corresponds to the value of collective pitch for the climbing Helicopter.

As the view of design and manufacturer described in 2.12.2, the following contents are estimated by taking the result of detailed wreckage investigation and the indication of indicators into the comprehensive consideration.

It is also probable that the abnormal value in a part of indications of 2.12.2 might be affected by the impact, and it is highly probable that both engines worked and supplied output when the Helicopter collided with the power transmission lines. It is somewhat likely that the captain kept the collective pitch lever in the climb position and did not move it until the accident.

3.7 Selection of Leaving Route

As described in 2.13.2, the leaving route from the forward base in the application form approved by Osaka Regional Civil Aviation Bureau was a route in which the Helicopter once flew to the northwest and passed above the vicinity of Pylon No.64; however, as described in 2.13.4, it is highly probable that the Helicopter had extremely large excessive horse power at the accident, and it is somewhat likely that the captain selected the route over the pylon or the power transmission lines in order to directly go to the Helipad. As described in 2.13.5, it is somewhat likely that the captain tried to pass over Pylon No.64 which is closest to the forward base instead of crossing the power transmission lines which are linear shaped obstacles with visual contact, as dictated by pilot's common sense. As described in Figure 3 and 2.12.4, however, there was the sun in the direction towards the Pylon No.64, which was too dazzling for the pilot to directly look ahead; therefore, it is somewhat likely that he turned about 40° to the left and went in the direction of the power transmission lines with which the Helicopter collided.

It is highly probable that if the Helicopter had flown along the route in the application form, the collision with the power transmission lines would have been avoided. In addition, even in the case of leaving from the forward base surrounded by obstacles towards the direction for crossing the power transmission lines, it is highly probable that if sufficient attentions had been paid to the lines to which the distance was hard to perceive, and the Helicopter had shifted to the forward flight for the pylon after carefully making a vertical climb while keeping the attitude constant until the pylon was seen below, the collision with the power transmission lines could have been avoided.

3.8 Flight Control in the Accident

As described in 2.13.5, if the Helicopter increased the output at the time unloading loads, climbed at a stroke, directed the nose to the traveling direction, and accelerated to shift to the climbing attitude, it is somewhat likely that the attitude of the Helicopter had largely changed, and that it was difficult to accurately grasp the relationship of positions between the Helicopter and the power transmission lines to which the distance was hard to perceive.

The Helicopter was nosed up higher than the ordinary climbing attitude as described in 3.5, and the collective pitch lever was not moved as described in 3.6; therefore, it is somewhat likely that the captain tried to avoid the power transmission lines by pulling the cyclic stick towards himself just before the Helicopter collided with the lines, but he could not afford to avoid the lines by turning or suddenly stopping the Helicopter (lowering the collective pitch lever). It is somewhat likely that this is because the captain did not visually confirm the power transmission lines just until the collision, or because he could not judge the distance to the lines which are linear shaped obstacles and got closer to the lines than expected.

Although it is somewhat likely that the following factors had influences on these, it could not be identified because the captain was dead.

① The sunlight dazzled him from the right side when he saw the sky in the flying direction.

② It was hard to control the Helicopter while seeing the power transmission lines due to the steep angle of the lines.

③ The Helicopter climbed at a shallower angle than the captain expected.

④ The captain did not look at the outside because he was absorbed in indicators and so on in the Helicopter.

3.9 Factors of Preventing the Captain from Paying Sufficient Attention to Lines

As described in 2.13.3, the obstacle markings and the obstacle lights were not installed in the power transmission lines with which the Helicopter collided; however, it is highly probable that the captain had confirmed and grasped this in the preliminary survey flight; therefore, it is probable that if the captain had paid sufficient attentions to the power transmission lines, the collision with the lines could have been avoided even when they were not installed.

Although it is somewhat likely that the following factors had influences on the fact that the captain could not pay sufficient attentions to the power transmission lines, it could not be identified because the captain was dead.

① He could not afford to take it into consideration because he considered the quantity of fuel supply, and so on.

② His concentration was deteriorate after he completed difficult loads transportation.

As described in 2.1, a similar loads transportation task was scheduled also on the day after the accident, and if the captain was aware of rain forecast before dawn on the day after the accident as described in 2.7.3, it is somewhat likely that the captain felt time pressure that the scheduled task might not be finished if the task on the day of the accident was behind schedule. It is somewhat likely that this affected the selection of routes or the flight control in leaving.

As described in 2.13.5, though there is no callout rules of leaving procedures in leaving the loading site, and so on in the loads transportation task of the Company, if the captain calls out the leaving procedures, it is probable that the advice is expected from the on-board mechanic and it can be expected that the captain himself reconfirms the attention to obstacles for controling the Helicopter carefully.

3.10 Preparation before Flight

It is highly probable that the preliminary survey flight confirmation matters and KY matters described in 2.13.1 were notes for long-sling tasks in Yamato-dani. There was no description about the forward base in these matters; therefore, it is somewhat likely that the captain did not pay particular attention to approaching and leaving the forward base.

Based on the description of 2.5(2), it is highly probable that there was no specific problem in the skills and experiences of the captain.

3.11 Fire, Firefighting and Rescue Activities

As described in 2.11, it is highly probable that the activities on fire, firefighting and rescue related to the accident were appropriate in mountain regions.

4. PROBABLE CAUSES

In this accident, it is highly probable that the Helicopter did not fly with sufficient distance to the power transmission lines stretched in the air when it left and climbed from hovering at the loading site of the forward base, causing the collision with the power transmission lines, which damaged the fuselage and made it crash.

Regarding the fact that the Helicopter did not fly with sufficient distance to the power transmission lines, it is somewhat likely that the captain did not visually confirm the lines soon until the collision, or he could not distinguish the distance to the lines and got closer to the lines than expected.

5. SAFETY ACTIONS

Safety actions taken by the Company after the accident

1 The operation standards were revised as follows:

(1) Callout procedures were introduced for the captain and the on-board personnel to confirm approach/leaving routes and obstacles near the route before the start of approach or leaving.

(2) Skill management for on-board mechanics was introduced because on-board mechanics are involved in the callout.

(3) The captain and the helicopter dispatcher directly communicate by phone or other measures about the results of preliminary survey flight, flight environments, and task contents after the preliminary survey flight in the day of the task and before the start of flight for loads transportation.

(4) Regarding the flight route around the loading site, the scheduled approach/leaving routes including the turning direction, pylon number of power transmission lines above the ground, and obstacles near the route are confirmed in TBM-KY, and the information shall be shared among relevant workers.

(5) Information contents are clearly written concerning the matters to be passed on to next duty captain.

(6) In order to warn the dangerous direction in climbing from the loading site, markings were introduced on the ground.

2 The summary of loads transportation site and contact network attached in an operational request form were revised as follows:

(1) The approach/leaving direction for the loading site and pylon number to be crossed when the helicopter crosses over the power transmission lines were decided and clearly written in the information document of the loads transportation flight task provided for the captain. If there are power transmission lines near the loading site, the approach/leaving route map with an enlarged view of the vicinity of the loading site is attached. In addition, if the approach/leaving routes pass through the vicinity of obstacles, such as photos concerning the obstacles are attached for the reference.

(2) Whenever task environments are changed in the information document of the loads transportation flight task provided for the captain, the document is updated to reflect the latest information.

3 Training and skill review

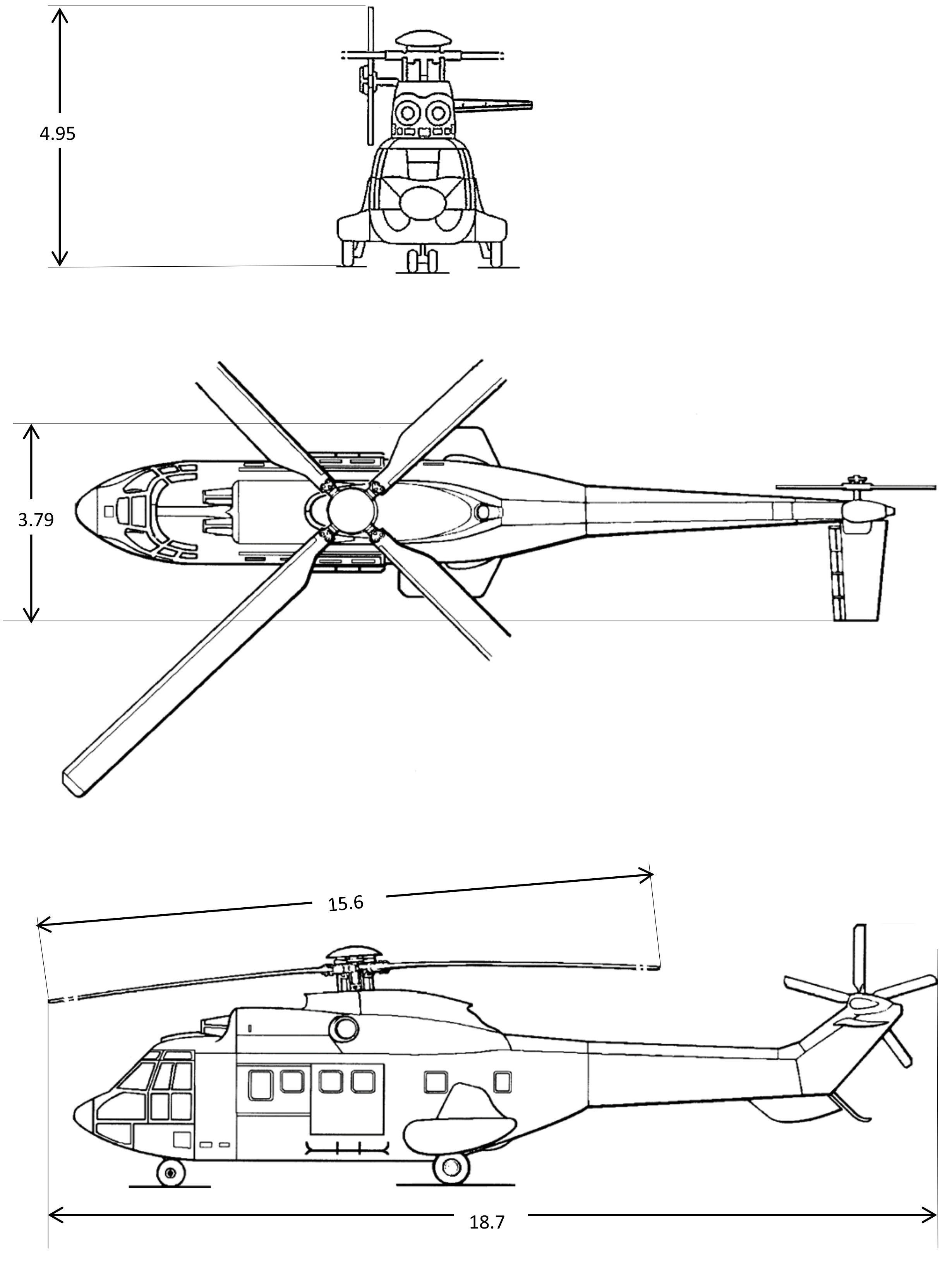
(1) Special training about the items introduced as safety actions was conducted for captains and on-board mechanics engaged in loads transportation flight tasks, and mechanics and sales staffs engaged in ground work. In addition, special review was conducted for the training items

of captains and on-board mechanics.

(2) Lectures by guest instructors are planned about human factor, CRM, and other items related to flight operation, and the training is planned each fiscal year. In addition, an item of checking the implementation status of the planned safety education is added to the checklist of internal safety audit.

Appendix 1: Three Angle View of Aerospatiale AS332L1

Unit: m

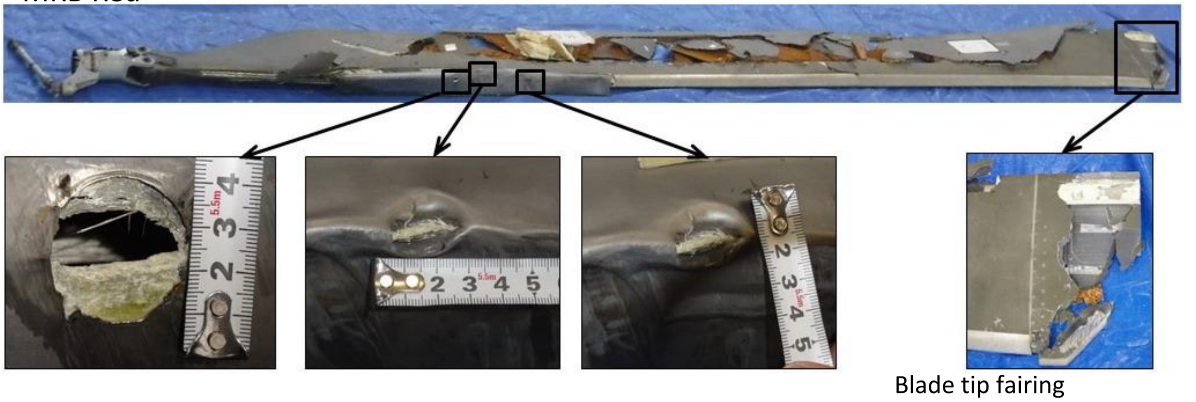


Appendix 2: Damage Situation of MRBs

MRB Yellow

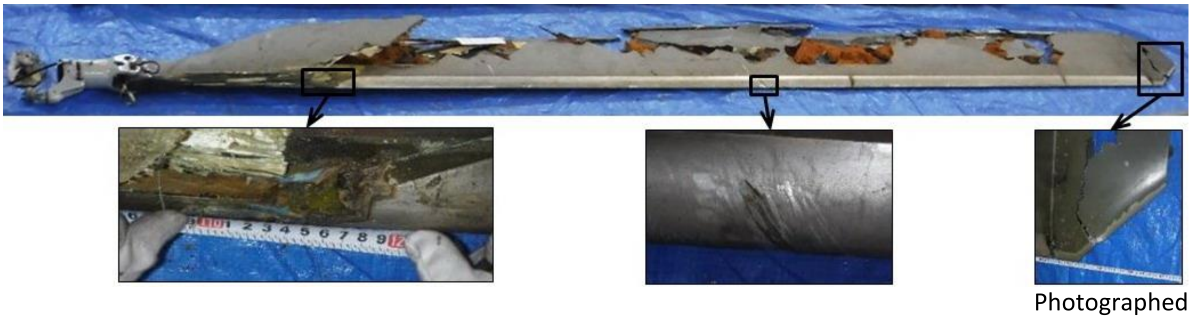
Leading-edge strip

MRB Red



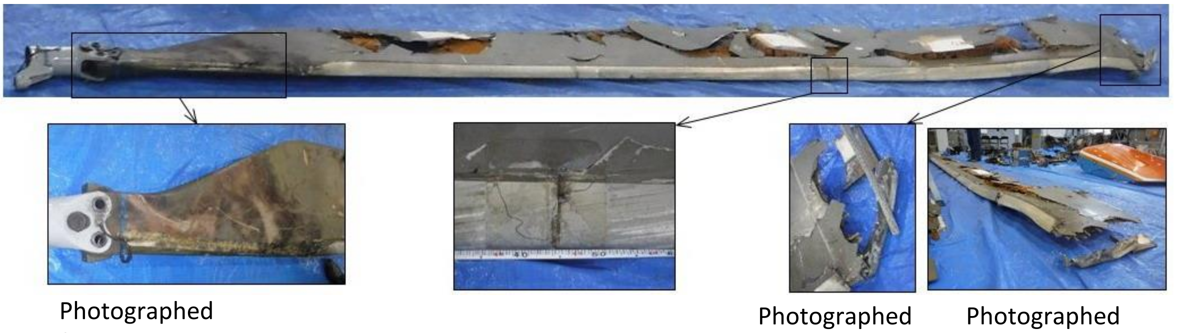
Blade tip fairing photographed from above

MRB Black



Photographed from above

MRB Blue



Photographed from above

Photographed from above

Photographed from wing end